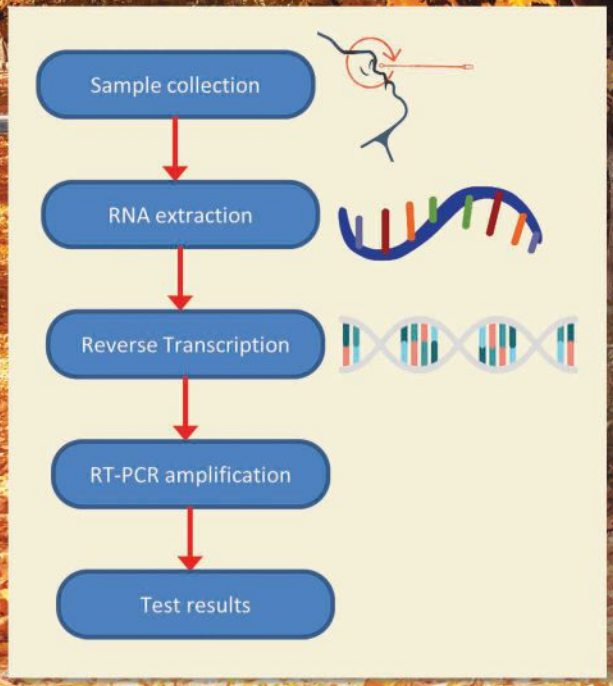
IEEE Canadian Review

La revue canadienne de l'IEEE

Fall/Automne 2021 — No. 88

Aiming for the New Normal





Fight Against COVID-19

Northern Microgrids

Celebrating IEEE Canada Awards

IEEE Canada
The Institute of Electrical and Electronic Engineers Inc.

IEEE Foundation

IEEE

We have 30 million reasons to be proud.

Thanks to our donors, supporters and volunteers who answered the call of the ***Realize the Full Potential of IEEE*** **Campaign**, helping impact lives around the world through the power of technology and education.



Illuminate



Educate



Engage



Energize

Realize Your Impact

Learn how: ieeefoundation.org/campaign



Jason Gu
Ph.D., P.Eng., FEIC, FCAE

2020–2021 IEEE Canada President and Region 7 Director
Président de l'IEEE Canada et directeur de la région 7, 2020–2021

Dear friends and IEEE Canada members,

Warm greetings to all our IEEE Canada members and volunteers. In this issue, as the outgoing IEEE Canada president/Region 7 director, I recap some of the events that have happened so far this year as well as the challenges and achievements of the past two years.

CCECE'2021

I am happy to report that the 2021 IEEE Canada Conference on Electrical and Computer Engineering (CCECE'2021) was successfully held from 12 to 17 September. Due to the spread of COVID-19, this IEEE Canada 34th flagship conference was completely virtual. To hold the conferences online, the CCECE'2021 organization committee faced many challenges and put in a tremendous amount of work. IEEE Canada Past-President Maike Luiken also hosted a forum at the conference and chaired the panel of IEEE Canada President-Elect candidates.

(Continued on p. 2)

Chers amis et membres de l'IEEE Canada,

Salutations à tous nos membres et bénévoles de l'IEEE Canada. Dans ce numéro, en tant que président sortant de l'IEEE Canada/directeur de la région 7, je récapitule certains des événements qui se sont produits jusqu'à présent cette année ainsi que les défis et les réalisations des deux dernières années.

CCECE 2021

Je suis heureux d'annoncer que la Conférence 2021 de l'IEEE Canada sur le génie électrique et informatique (CCECE 2021) s'est déroulée avec succès du 12 au 17 septembre. En raison de la propagation du COVID-19, cette 34e conférence phare de l'IEEE Canada était entièrement virtuelle. Pour tenir les conférences en ligne, le comité d'organisation CCECE 2021 a fait face à de nombreux défis et a fourni un travail colossal. La présidente sortante de l'IEEE Canada, Maike Luiken, a également organisé un forum lors de la conférence et présidé

(Suite p. 2)

Contents / matières

News / Nouvelles

President's Message 1
A Few Words From the Editor-in-Chief 6
EE Humor 30
IEEE Canadian Foundation 31
How and Why I Support the IEEE Canadian Foundation 33
IEEE Canada Awards 2021 34

Features

Electrical and Computer Engineering at the Heart of the Fight Against the COVID-19 Pandemic 8
Lessons Learned in a Northern Microgrid Implementation 20

Engineering Management / Gestion du génie

Biz Tech Report 45



(President's Message cont'd from p. 1)

As a part of CCECE'2021, the IEEE Canada Awards Gala was hosted online and chaired by Celia Desmond. We also invited this year's A.G.L. McNaughton Award winner, Prof. Rajni Patel, to give an online speech in recognition of the honour he received. Let us congratulate all the winners of these prestigious awards. IEEE Canada is extremely grateful to all those who submitted and endorsed this year's nominees and encourages all of its members to nominate again in the coming year.

ANTEM 2021

This year saw the International Symposium on Antenna Technology and Applied Electromagnetics take place virtually for the first time since it became an IEEE Canada conference. The event was hosted online from 8 to 11 August from Winnipeg, Canada due to the COVID-19 pandemic. The theme of this year's conference was "Making Space" and attracted many researchers, students, and engineers from the areas of antennas and applied electromagnetics. This conference allowed many people from all around the world to meet online and disseminate their research advancements and discoveries. It welcomed more than 130 attendees from 22 countries, who participated in 18 main sessions.

IEEE EPEC is IEEE Canada's premier power and energy conference, focusing on innovations in the electric power sector.

IEEE Day 2021

This year's IEEE (Canada) Day was on 5 October and featured the theme "Leveraging Technology for a Better Tomorrow." IEEE President-Elect Ray Liu presented a video speech for the event and was on hand to interact with IEEE Canada volunteers and members. We also had presentations from the regional leaders of this region: Member Services Group Chair and IEEE Women in Engineering Committee Chair Winnie Ye, Educational Service Group Chair Murray MacDonald, incoming 2022 IEEE Canada Student Activities Committee Chair Saida Maaroufi, and External Relations Group Chair Kexing Liu, all of whom showcased IEEE Canada/Region 7 activities and benefits to IEEE Members.

EPEC 2021

The 2021 IEEE Canada Electric Power and Energy Conference (EPEC 2021) was moved to a virtual platform and was held 22–24 and 30–31 October 2021. IEEE EPEC is IEEE Canada's premier power and energy conference, focusing on innovations in the electric power sector. The conference featured paper presentations, special sessions, panels, tutorials, and exhibitors. Please visit the conference website at https://epec2021.ieee.ca/.

2021 Board Meetings

We have had three IEEE Canada Board meetings in 2021: one each in March, April, and May. Valuable experience was gained

(Continued on p. 3)

(Message du Président suite de p. 1)

les discussions des candidats à la présidence désignée de l'IEEE Canada.

Dans le cadre de CCECE 2021, le gala des prix IEEE Canada a été organisé en ligne et présidé par Celia Desmond. Nous avons également invité l'A.G.L. Le lauréat du prix McNaughton, le professeur Rajni Patel, prononcera un discours en ligne en reconnaissance de l'honneur qu'il a reçu. Félicitons tous les lauréats de ces prix prestigieux. L'IEEE Canada est extrêmement reconnaissant à tous ceux qui ont soumis et approuvé les candidatures de cette année et encourage tous ses membres à proposer à nouveau une candidature au cours de l'année à venir.

ANTEM 2021

Cette année, le Symposium international sur la technologie des antennes et l'électromagnétisme appliqué a également eu lieu virtuellement pour la première fois depuis qu'il est devenu une conférence de l'IEEE Canada. L'événement a été organisé en ligne du 8 au 11 août à partir de Winnipeg, au Canada, en raison de la pandémie de COVID-19. Le thème de la conférence de cette année était «Making Space» et a attiré de nombreux chercheurs, étudiants et ingénieurs des domaines des antennes et de l'électromagnétisme appliqué. Cette conférence a permis à de nombreuses personnes du monde entier de se rencontrer en ligne et de diffuser leurs avancées et découvertes en matière de recherche. Il a accueilli plus de 130 participants de 22 pays, qui ont participé à 18 sessions principales.

Journée IEEE 2021

Cette année, la Journée IEEE (Canada) a eu lieu le 5 octobre et avait pour thème «Optimiser la technologie pour un avenir meilleur». Le président élu de l'IEEE, Ray Liu, a présenté le discours vidéo de l'événement et était sur place pour interagir avec les bénévoles et les membres de l'IEEE Canada. Nous avons également eu des présentations des dirigeants régionaux de cette région : Winnie Ye, présidente du groupe des services aux membres et présidente du comité des femmes en génie de l'IEEE, Murray MacDonald, président du groupe des services éducatifs, Saida Maaroufi, présidente du comité des activités étudiantes de l'IEEE Canada 2022, et Kexing Liu, présidente du groupe des relations extérieures, qui ont tous présenté les activités et les avantages de l'IEEE Canada/Région 7 aux membres de l'IEEE.

EPEC 2021

La conférence 2021 de l'IEEE Canada sur l'énergie et l'électricité (EPEC 2021) a été déplacée vers une plate-forme virtuelle et se tiendra du 22 au 24 et du 30 au 31 octobre 2021. IEEE EPEC est la principale conférence de l'IEEE Canada sur l'électricité et l'énergie, axée sur les innovations dans le secteur de l'énergie électrique. Nous aurons des présentations papier, des sessions spéciales, des panels, des tutoriels et des exposants. Pour les dernières mises à jour, veuillez visiter le site Web de la conférence à https://epec2021.ieee.ca/

Réunions du conseil d'administration 2021

Nous avons eu deux réunions du conseil d'administration de l'IEEE Canada jusqu'à présent en 2021 : une en mars et une en mai. Une expérience précieuse a été acquise en organisant les réunions en ligne grâce aux bénévoles dévoués Cinnati Loi, Jeffrey Arcand, Scott Melvin et bien d'autres.

(Suite p. 3)

(President's Message cont'd from p. 2)

while hosting the meetings online thanks to dedicated volunteers Cinnati Loi, Jeffrey Arcand, Scott Melvin, and many others.

IEEE Canada Volunteers' Activities

Despite the COVID-19 pandemic, IEEE Canada volunteers have worked diligently to organize hundreds of educational, technical, professional, and humanitarian events. We have received a great amount of positive feedback on these events. The IEEE Canada Steering Committee (SteerCom) has approved a special fund this year to organize a technical writing workshop, together with the 2021 EPEC conference and activities, to support IEEE student branch activities. This fund has to be spent by the end of this year. I encourage all student branches to take this opportunity to plan events that attract new members and benefit current members.

IEEE Canadian Journal of Electrical and Computer Engineering

The *Canadian Journal of Electrical and Computer Engineering* (*CJECE*) has been renamed *IEEE Canadian Journal of Electrical and Computer Engineering* (*IEEE CJECE*) and increased its reputation. Thanks to Editor-in-Chief (EIC) Mohamed Shehata, Yang Shi, and the editorial team, *IEEE CJECE* has increased its number of publications by 31% in 2021 while maintaining its low acceptance rate. *IEEE CJECE* has also met its goal of rapid review and access to *IEEE Xplore* for publication. *IEEE Canadian Review* (*ICR*) is back to normal, with three issues published annually thanks to EIC Jahangir Khan, and *ICR* aims for peer-reviewed articles in the future.

Since I took over the position of Region 7 director/IEEE Canada president, the whole world has been hit by the COVID-19 pandemic. This greatly impacted our daily lives and led to major fluctuations in academics, industries, and professional societies.

(Continued on p. 4)

(Message du Président suite de p. 2)

Activités des bénévoles de l'IEEE Canada

Malgré la pandémie de COVID-19, les bénévoles de l'IEEE Canada ont travaillé avec diligence pour organiser des centaines d'événements éducatifs, techniques, professionnels et humanitaires. Nous avons reçu de nombreux retours positifs sur ces événements. Le comité directeur de l'IEEE Canada (SteerCom) a approuvé un fonds spécial cette année pour organiser l'atelier de rédaction technique, ainsi que la conférence EPEC 2021, afin de soutenir les activités de la branche étudiante de l'IEEE. Ce fonds doit être dépensé d'ici la fin de cette année. J'encourage toutes les branches étudiantes à saisir cette occasion pour planifier des événements qui attirent de nouveaux membres et profitent aux membres actuels.

La revue Canadienne de Génie Électrique et Informatique de l'IEEE

Le Journal Canadien du Génie Électrique et Informatique de l'IEEE (CJECE) a été renommé *le Journal Canadien du Génie Électrique et Informatique (IEEE CJECE)* et a accru sa réputation. Grâce au rédacteur en chef (EIC) Mohamed Shehata, Yang Shi et à l'équipe éditoriale, *IEEE CJECE* a augmenté son nombre de publications de 31 % en 2021 tout en maintenant son faible taux d'acceptation. *IEEE CJECE* a également atteint son objectif de révision rapide et d'accès à *IEEE Xplore* pour publication. *La Revue Canadienne de L'IEEE (RCI)* est également de retour à la normale, avec trois numéros publiés chaque année grâce à EIC Jahangir Khan, et la *RCI* vise à l'avenir des publications évaluées par des pairs.

Depuis que j'ai pris le poste de directeur de la région 7/président de l'IEEE Canada, le monde entier a été touché par la pandémie de COVID-19. Cela a eu un impact considérable sur notre vie quotidienne et a entraîné des fluctuations importantes dans les universités, les industries et les sociétés professionnelles. Pour relever ce défi, la région 7 a déplacé toutes ses activités en ligne et a fourni un soutien

(Suite p. 4)

IMPORTANT UPDATES

IEEE Canadian Review (*ICR*) is now a "default-digital" publication.

What does this mean?

- All IEEE Canada members will receive *ICR* in digital formats, either through the website or through the IEEE app.
- Members who have explicitly requested not to receive electronic communication will not receive the digital copies. Default mail delivery of print copies will be discontinued to those members in the future. Members are encouraged to opt in for print copies or modify their electronic communication preferences to receive digital copies.
- A print copy will be delivered only to those full-grade members who request it. This will be provided free of additional costs (included in the annual membership fee). Members can opt in for print or digital copies through IEEE membership renewal web page.

(President's Message cont'd from p. 3)

To face that challenge, Region 7 moved all its activities online and provided online support for region-, section-, chapter-level, and affinity group meetings, as well as for IEEE Canadian conferences, technical seminars, workshops, symposiums, and forums. With many technologists, scientists, and engineers practicing social distancing and isolation, we want to emphasize our continued support for the professional community during the pandemic as IEEE Canada is fully operational despite the current challenges.

Committee Restructuring

At the 5 June 2018 SteerCom meeting, the decision was made to set up an ad hoc "restructuring committee" to review IEEE Region 7's committee structure and suggest improvements. The committee worked hard to replace the original three-group structure with a five-group one, comprising external relations, member services, publications and communications, educational services, and operational support groups. This newly established group structure started in January of 2021, and with it, alignment and operational efficiency has improved.

Website Development

We have received many complaints about the IEEE Canada website, and actions have been taken. IEEE Canada President-Elect Robert Anderson and Secretary Michael Lamoureux, together with the Executive Committee (ExCom) members, and committee, group, and area chairs, will improve the content of the website with a follow up to a new design and development. Stay tuned for a brand-new look of the IEEE Canada website.

This newly established group structure started in January of 2021, and with it, alignment and operational efficiency has improved.

Working together with our dedicated volunteers, we have fostered relationships with industry, government, and other professional societies, such as Engineering Institute of Canada (EIC), Canadian Academy of Engineering (CAE), Partnership Group for Science and Engineering (PAGSE), Canadian Heads of Electrical and Computer Engineering (CHECE), and Destination Canada. We have also improved the transparency in nominations, elections, finances, and awards and recognitions.

Thanks to All Our Volunteers

By the end of 2021, Dr. Luiken will complete her term as IEEE Canada past-president/Region 7 past-director 2020–2021. During 2021, Dr. Luiken has also been the IEEE Member and Geographic Activities vice-president, which has added extensive responsibilities and duties to her position as the past-president. She has been enthusiastic and put in endless effort to contribute to the IEEE Canada ExCom and we are grateful for all her hard work.

(Continued on p. 5)

(Message du Président suite de p. 3)

en ligne pour les réunions de groupes régionaux, de section, de branche et d'affinité, ainsi que pour les conférences, séminaires techniques, ateliers, symposiums et forums de l'IEEE au Canada. Avec de nombreux chercheurs et ingénieurs pratiquant la distanciation sociale et l'isolement, nous voulons souligner notre soutien continu à la communauté professionnelle pendant la pandémie alors que l'IEEE Canada est pleinement opérationnel malgré les défis actuels.

La Restructuration des Comités

Lors de la réunion du SteerCom du 5 juin 2018, la décision a été prise de mettre en place un «comité de restructuration» ad hoc pour examiner la structure du comité de la région 7 de l'IEEE et proposer des améliorations. Le comité a travaillé dur pour remplacer la structure originale à trois groupes par une structure à cinq groupes, comprenant les relations extérieures, les services aux membres, les publications et les communications, les services éducatifs et les groupes de soutien opérationnel. Cette nouvelle structure de groupe a démarré au printemps 2021, et avec elle, l'alignement et l'efficacité opérationnelle se sont améliorés.

Cette nouvelle structure de groupe a démarré au printemps 2021, et avec elle, l'alignement et l'efficacité opérationnelle se sont améliorés.

Développement de sites Web

Nous avons reçu de nombreuses plaintes concernant le site Web de l'IEEE Canada et des mesures ont été prises. Le président élu de l'IEEE Canada, Robert Anderson et le secrétaire Michael Lamoureux, ainsi que tous les membres du comité exécutif (ExCom) et les présidents de comité, de groupe et de zone, amélioreront le contenu du site Web avec un suivi de la conception et du développement du nouveau cadre. Restez à l'écoute pour un tout nouveau look du site Web de l'IEEE Canada.

En collaboration avec nos bénévoles dévoués, nous avons noué des relations avec l'industrie, le gouvernement et d'autres sociétés professionnelles, telles que l'Institut canadien des ingénieurs (ICI), l'Académie canadienne du génie (ACG), le Groupe de partenariat pour la science et l'ingénierie (PAGSE), Chefs du génie électrique et informatique (CHECE) et Destination Canada. Nous avons également amélioré la transparence des nominations, des élections, des finances, des récompenses et des reconnaissances.

Merci à tous nos bénévoles

D'ici la fin de l'année 2021, Maike Luiken terminera son mandat en tant que présidente sortante de l'IEEE Canada/directrice sortante de la région 7 2020-2021. En 2021, Maike Luiken a également été membre de l'IEEE et vice-présidente des activités géographiques, ce qui a ajouté de nombreuses responsabilités et fonctions à son poste de présidente sortante. Elle a été enthousiaste et a déployé des efforts sans fin pour contribuer à l'ExCom de l'IEEE Canada et nous sommes reconnaissants pour tout son travail acharné.

(Suite p. 5)

(President's Message cont'd from p. 4)

Welcome to the President and President-Elect

In 2022, we will welcome Robert Anderson from the Southern Alberta Section as IEEE Canada president/Region 7 director for 2022–2023. Our IEEE Canada president-elect/Region 7 director-elect 2022–2023 will be Thamir "Tom" F. Murad from the Toronto Section. This is also an opportunity for me to welcome all the new and reappointed volunteers to the 2022 IEEE Canada/Region 7 Board of Directors and its committees. Thanks to all the volunteers for your willingness to put in ideas, enthusiasm, effort, and energy to serve our professional community. Thank you to all the volunteers and members of IEEE Canada for the last two unforgettable years. ■

Jason Gu, Ph.D., P.Eng., FEIC, FCAE
2020–2021 IEEE Canada President
2020–2021 IEEE Region 7 Director

(Message du Président suite de p. 4)

Bienvenue au président et au président élu

En 2022, nous accueillerons Robert Anderson de la section sud de l'Alberta en tant que président de l'IEEE Canada/directeur de la région 7 pour 2022-2023. Notre président élu de l'IEEE Canada/directeur élu de la région 7 2022-2023 sera Thamir «Tom» F. Murad de la section de Toronto. C'est également l'occasion pour moi d'accueillir tous les nouveaux bénévoles et les reconduits au sein du conseil d'administration 2022 de l'IEEE Canada/Région 7 et de ses comités. Merci à tous les bénévoles pour votre volonté de mettre des idées, de l'enthousiasme, des efforts et de l'énergie au service de notre communauté professionnelle. Merci à tous les bénévoles et membres de l'IEEE Canada pour ces deux dernières années inoubliables. ■

Jason Gu, Ph.D., P.Eng., FEIC, FACG
Président de l'IEEE Canada 2020–2021
Directeur de la région 7 de l'IEEE 2020–2021

IEEE Canadian Review

La revue canadienne de l'IEEE

IEEE Canadian Review is published three times per year: Spring, Summer, and Fall.

Its **principal objectives** are:
To inform Canadian members of IEEE on issues related to the impacts of technology and its role in supporting economic development and societal benefits within Canada. To foster growth in the size and quality of Canada's pool of technology professionals to serve our increasingly knowledge-based economy.

IEEE Canadian Review - La Revue canadienne de l'IEEE **is published by The Institute of Electrical and Electronics Engineers, Inc.'s Canadian unit.** | **All rights reserved. © 2021 by The Institute of Electrical and Electronics Engineers, Inc., 3 Park Avenue, New York, NY 10016-5997, U.S.A.** | **The editorial content of this magazine does not represent official positions of the IEEE or its organizational units.** | **Return Canadian undeliverables to: IEEE Canada, 1431 Christina St. N, Sarnia, Ontario, N7V 3E2**

The National Library of Canada
ISSN 1481-2002
La Bibliothèque nationale du Canada

Advertising Policy

Organizations are invited to place corporate advertising in *IEEE Canadian Review*. For information regarding rates and copy requirements, please contact the advertising manager.

Circulation

The circulation of *IEEE Canadian Review* is the entire membership of IEEE Canada, plus external subscribers.

Information for Authors

Authors are invited to contribute submissions in electronic form to *IEEE Canadian Review*. Please contact one of the editors. Responsibility for the content rests upon the authors and not the IEEE, nor its members, nor the editors of the publication.

Annual Subscription Price

Free of charge to all IEEE members in Canada.

For IEEE members outside Canada: $20.00/year. Nonmembers: $35.00/year. Corporations and libraries: $37.50/year. Additional copies may be ordered at a cost of $7.50 each from the administrator.

Reprint Permission

Abstracting is permitted with credit to the source. Libraries are permitted to photocopy for private use of patrons. Instructors are permitted to photocopy isolated articles for noncommercial classroom use without fee. For other copying, reprint or republication questions, please write to the editor-in-chief. *IEEE Canadian Review* is printed in Canada, postage paid at Toronto, Ontario.

Change of address

- **Do-it-yourself** with MyIEEE: http://www.ieee.org/myieee
- **Email** address.change@ieee.org
- **Tel** 1 (800) 678-4333
- **Mail** IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08855-1331, USA

Member of / membre constituant de
Engineering Institute of Canada
l'Institut canadien des ingénieurs



Jahangir Khan, Ph.D., P.Eng., SMIEEE
mjakhan@ieee.org

Dear readers,

I hope you have had a great summer and are now cozying up for a splendid autumn, maybe even Christmas or the new year. During the past few months, we have seen a gradual re-entry into a post-COVID-19 world, with more in-person meetings, social events, and travels. We sincerely hope that this trend will continue and the horrors of the last few years will be behind us.

(Continued on p. 7)

Chers lecteurs,

J'espère que vous avez passé un bel été et que vous vous préparez maintenant pour un automne splendide, peut-être même Noël ou le nouvel an. Au cours des derniers mois, nous avons assisté à une rentrée progressive dans un monde post-COVID-19, avec davantage de réunions en personne, d'événements sociaux et de voyages. Nous espérons sincèrement que cette tendance se poursuivra et que les horreurs de ces dernières années seront derrière nous.

(Suite p. 7)

IEEE Canada www.ieee.ca
Visit IEEE Canada website for latest information

2021 Officers
President
Jason Gu

President Elect
Robert Anderson

Past President
Maike Luiken

Secretary
Michael Lamoureux

Treasurer
Dan Coode

Director Emeritus
Ray Findlay

Parliamentarian
Celia Desmond

Chair IEEE Canadian Foundation
David Whyte

Groups & Committees

MEMBER SERVICES
Member Services Group (MSG)
Winnie Ye

Life Members Committee (LMC)
John Harris

Membership Development Committee (MDC)
Samantha Sriyananda

Regional Student Representative (RSR)
Melissa Vosough Tehrani

Student Activities Committee (SAC)
Jamiul Alam

Women in Engineering (WIE) Committee
Winnie Ye

Young Professionals (YP) Committee
Zied Bouida

EXTERNAL RELATIONS
External Relations Group (ERG)
Kexing Liu

Humanitarian Initiatives Committee (HIC)
Anis Ben Arfi

IEEE Standards Association Liaison
Glenn Parsons

Industry Relations Committee (IRC)
Nehad El-Sherif

Outreach and Partnership Committee (OPC)
Dale Tardiff

PAGSE Committee (PCR) Liaison
Kexing Liu

PUBLICATIONS & COMMUNICATIONS
Publications and Communications Group (PCG)
Ekram Hossain

Advertising (AC) Coordinator
Sana Abou-Shaaban

IEEE Canada Electronic Newsletter (IECN)
Yasaman Amannejad

ICJECE Co-Editors in Chief
Mohamed Shehata/
Yang Shi

IEEE Canadian Review
Jahangir Khan

Translation Committee (TC)
Clement Ahoua

EDUCATIONAL ACTIVITIES
Educational Services Group (ESG)
Murray Macdonald

Educational Activities Committee (EAC)
Deyasini Majumdar

STEM Outreach Committee (SOC)
Murray Macdonald

Training Coordinator
Rossitza Marinova

OPERATIONAL SUPPORT
Operational Support Group (OSG)
David Michelson

Chapter & Student Branch Chapter (CSCC)
Scott Melvin

History Committee (HC)
David Michelson

Meeting Coordinator
Jeffrey Arcand

Region Vitality Coordinator
Xavier Fernando

Volunteer Tools Committee
Kung Chi
Cinnati Loi

Web Committee/ Website
Dennis Michaelson

AWARDS & RECOGNITION
Celia Desmond

CONFERENCE ADVISORY
Alexandre Nassif

AUDIT COMMITTEE
Luc Matteau

NOMINATIONS AND APPOINTMENTS COMMITTEE
Maike Luiken

Area Chairs
Area East
Gerard Dunphy

Area Central
Ahmed Hussein

Area West
Balbir Gill

Section Chairs
Canadian Atlantic
Joshua Fritz

Montreal
Hamidreza Sadreazami

New Brunswick
Gerhard Dueck

Newfoundland-Labrador
Weimin Huang

Ottawa
Ajit Pardasani

Quebec City
Xavier Maldague

Saint Maurice
Dominic Rivard

Hamilton
Waldemar Smoluch

Kingston
Suzan Eren

Kitchener Waterloo
Nitin Padmanabhan

London
Xianbin Wang

Peterborough
Helder Pinheiro

Toronto
Ali Nabavi-Niaki

Windsor
Mojtaba Kordestani

North Saskatchewan
Jeremy Gates

Northern Canada
Iyub Adam

South Saskatchewan
Irfan Al-Anbagi

Southern Alberta
Rod Mcneil

Vancouver
Steven McClain

Victoria
Xiaodai Dong

Winnipeg
Phil Ferguson

Administrator
Carol De Campos

(A Few Words From the Editor-in-Chief cont'd from p. 6)

Throughout the pandemic, *IEEE Canadian Review* (*ICR*) has published timely columns on how Canada has been adapting to these new realities. As a professional organization, IEEE has contributed significantly to the pandemic knowledge base. This edition of *ICR* presents another thorough and in-depth feature column written by Sarra Guefrachi and Habib Hamam, this one focusing on the role of electrical and electronic engineers fighting the COVID-19 pandemic. Published both in English and French, I believe our readers will find it informative and exciting.

The summer 2020 edition of *ICR* published an article on the issues of powering northern and remote communities. This edition continues the discussion through Alex Nassif's article on a real-world deployment example. I expect the colorful charts, plots, and analyses presented in this article to invoke much discussion.

For the first time in Canadian history, we recently observed the National Day for Truth and Reconciliation.

Like in previous years, this edition of *ICR* congratulates the winners of IEEE Canada Awards. In addition, we applaud the achievements of our volunteers, members, and sections, which have received accolades through various recognitions. The IEEE Canadian Foundation has been playing a tremendous role in collecting and distributing benevolent funds for our members. The contributions made by the funders are acknowledged in the edition through an Honor Roll. Thank you very much for your generosity and support.

For the first time in Canadian history, we recently observed the National Day for Truth and Reconciliation. At our schools and workplaces, we wore orange shirts and learned about the grievances and trauma endured by indigenous people. As a part of IEEE Canada, the editorial team of *ICR* stands in solidarity with the affected people and look forward to a journey of healing and prosperity. Enjoy this edition of *ICR*. Please share your thoughts and suggestions as you read. ■

(Quelques mots du rédacteur en chef suite de p. 6)

Tout au long de la pandémie, La Revue Canadienne de l'IEEE (RCI) a publié des chroniques opportunes sur la façon dont le Canada s'est adapté à ces nouvelles réalités. En tant qu'organisation professionnelle, l'IEEE a contribué de manière significative à la base de connaissances sur la pandémie. Cette édition de la RCI présente une autre chronique complète et approfondie écrite par Sarra Guefrachi et Habib Hamam, celle-ci se concentre sur le rôle des ingénieurs électriciens et électroniciens dans la lutte contre la pandémie de COVID-19. Publié à la fois en anglais et en français, je pense que nos lecteurs le trouveront informatif et passionnant.

L'édition d'été 2020 de a publié un article sur les enjeux de l'alimentation des collectivités nordiques et éloignées. Cette édition poursuit la discussion à travers l'article d'Alex Nassif sur un exemple de déploiement dans le monde réel. Je m'attends à ce que les graphiques, les intrigues et les analyses colorées présentés dans cet article suscitent beaucoup de discussions.

Comme les années précédentes, cette édition de la RCI félicite les gagnants des IEEE Canada Awards. De plus, nous applaudissons les réalisations de nos bénévoles, membres et sections, qui ont reçu des éloges à travers diverses reconnaissances. La Fondation canadienne de l'IEEE a joué un rôle énorme dans la collecte et la distribution de fonds de bienfaisance pour nos membres. Les contributions apportées par les bailleurs de fonds sont reconnues dans l'édition par le biais d'un tableau d'honneur. Merci beaucoup pour votre générosité et votre soutien.

Pour la première fois dans l'histoire du Canada, nous avons récemment célébré la Journée nationale pour la vérité et la réconciliation. Dans nos écoles et sur nos lieux de travail, nous avons porté des chemises orange et avons appris les griefs et les traumatismes endurés par les peuples autochtones. En tant que membre de l'IEEE Canada, l'équipe éditoriale de l'ICR est solidaire des personnes touchées et attend avec impatience un voyage de guérison et de prospérité. Profitez de cette édition de la RCI. S'il vous plaît partagez vos pensées et suggestions pendant que vous lisez. ■

EDITOR-IN-CHIEF / RÉDACTEUR EN CHEF
Jahangir Khan
BC Hydro
6911 Southpoint Drive
Burnaby, BC V3N 4X8
Tel: (604) 528-2910
Email: mjakhan@ieee.org

VICE EDITOR-IN-CHIEF / VICE-RÉDACTEUR EN CHEF
Jonathan Palmer
CIMA+
j.y.palmer@ieee.org

Adam Detillieux
Omron Automation
a.r.detillieux@ieee.org

SPECIAL FOCUS EDITOR / DIRECTRICE DE LA RÉDACTION THÉMATIQUE
Maike Luiken
maike.luiken@ieee.org

CONTRIBUTING EDITORS / RÉDACTEURS COLLABORATEURS
Alexandre Abecassis
Fasken Martineau DuMoulin
aabecassis@fasken.com

Terrance J. Malkinson
SAIT Polytechnic
malkinst@telus.net

Dave Michelson
University of British Columbia
dmichelson@ieee.org

Jon Rokne
University of Calgary
rokne@ucalgary.ca

Dario Schor
Magellan Aerospace
schor@ieee.org

ASSOCIATE EDITORS / ADJOINTS À LA RÉDACTION
Habib Hamam
Université de Moncton
habib.hamam@ieee.org

Khelifa Hettak
Communications Research Centre
khelifa.hettak@crc.gc.ca

Dave Kemp
Past-President, IEEE Canada
d.kemp@ieee.org

Camille-Alain Rabbath
Defence Research & Development Canada
rabbath@ieee.org

Vijay Sood
University of Ont. Institute of Technology
vijay.sood@uoit.ca

Haibin Zhu
Nipissing University
haibinz@nipissingu.ca

Ahmed Farouk
Wilfrid Laurier University
afarouk@wlu.ca

Gautam Srivastava
Brandon University
srivastavag@brandonu.ca

Nezih Mrad
Department of National Defence
Nezih.Mrad@forces.gc.ca

IEEE PERIODICALS MAGAZINES DEPARTMENT
445 Hoes Lane,
Piscataway, NJ 08854 USA

Katie Sullivan
Manager, Journals Production

Christine Torrento
Journals Production Manager

Janet Dudar
Senior Art Director

Gail A. Schnitzer
Associate Art Director

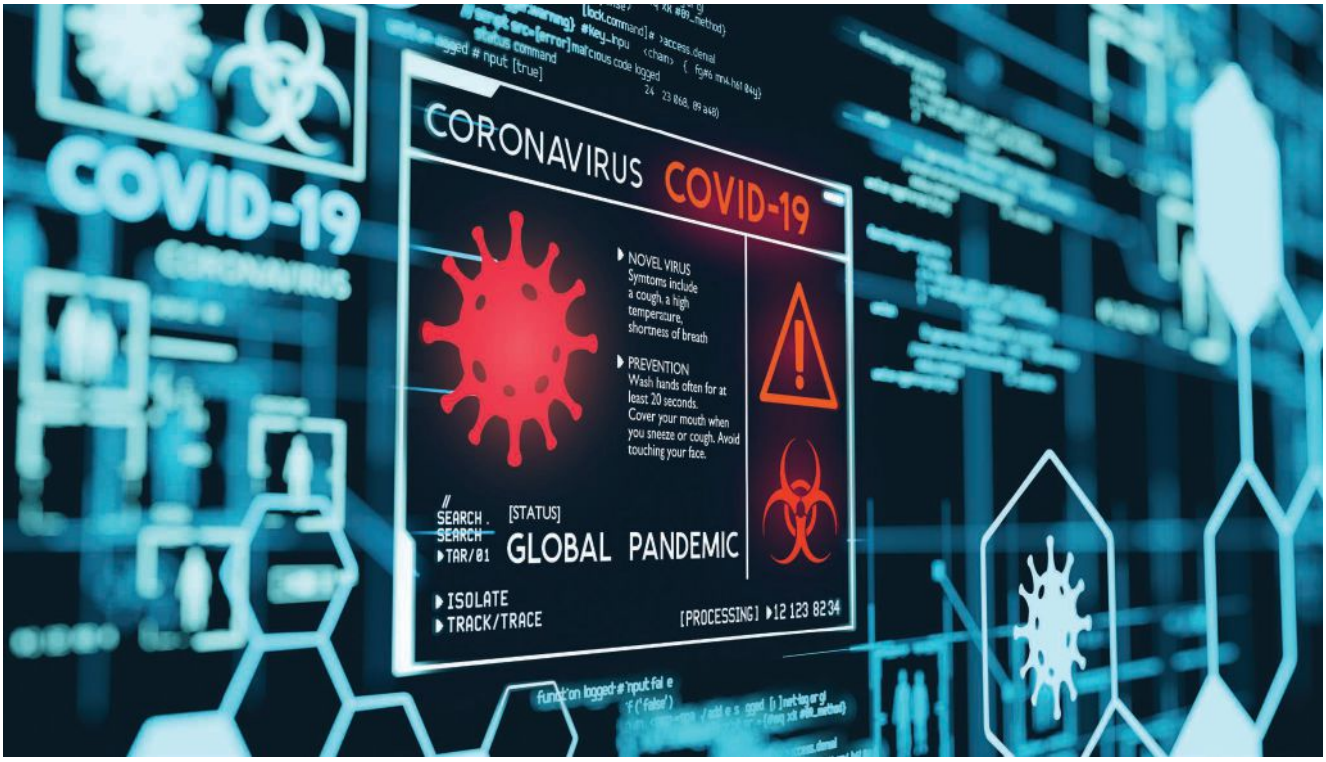
Theresa L. Smith
Production Coordinator

Felicia Spagnoli
Advertising Production Manager

Peter M. Tuohy
Production Director

Kevin Lisankie
Editorial Services Director

Dawn M. Melley
Senior Director, Publishing Operations



©SHUTTERSTOCK.COM/SOLARSEVEN

Electrical and Computer Engineering at the Heart of the Fight Against the COVID-19 Pandemic

Le génie électrique et informatique au cœur de la lutte contre la pandémie COVID-19

by Sarra Guefrachi and Habib Hamam
Université de Moncton, New Brunswick, Canada

Abstract

The COVID-19 pandemic has surprised the world, turned the lives of the inhabitants of the planet upside down, and threatened their existence. The whole of society engaged to the fight against this threat, in particular the professionals and researchers. While doctors and medical personnel have been the army chiefs in this war, engineers have chosen to be in the forefront in supporting them. Information engineering was one of their tools. In this article, we outline the contribution of engineering to this struggle. Special interest will be given to the four main sectors of information engineering related to the COVID-19 pandemic, namely, information management, virus detection, prediction of the pandemic waves, and intelligent search of relevant data related to the pandemic.

Introduction

In 2019, a new virus, severe acute respiratory syndrome coronavirus (SARS-CoV-2), emerged in Wuhan, China, which caused an infectious disease. The World Health Organization called it the *2019 coronavirus* (*COVID-19*) on 11 February 2020. The disease spread rapidly around the world, with a surge in new cases around

Résumé

La pandémie de COVID-19 a surpris le monde, a bouleversé la vie des habitants de la terre et a menacé leur existence. Toute la société s'est engagée dans la lutte contre cette menace, les professionnels et les chercheurs en particulier. Alors que les médecins et le personnel de la santé se trouvaient les chefs de l'armée dans cette guerre, les ingénieurs se sont vus dans les premiers rang pour les soutenir, par entre autres l'ingénierie de l'information. Dans cet article nous exposons la contribution de l'ingénierie dans cette lutte. Un intérêt spécial sera porté aux quatre secteurs principaux de l'ingénierie de l'information en lien avec la pandémie COVID-19, à savoir la gestion de l'information, le diagnostic du virus, la prédiction des vagues de la pandémie récupération automatique des données pertinentes en lien avec la pandémie.

Introduction

in 2019, un nouveau virus, le coronavirus du syndrome respiratoire aigu sévère (SRAS-CoV-2), est apparu à Wuhan, en Chine, provoquant une maladie infectieuse qui a été plus tard appelée maladie à coronavirus 2019 (COVID-19) par l'Organisation mondiale de la santé le 11 février 2020. Cette maladie s'est

the world from early February 2020 to early March 2020. On 12 March 2020, the spread of COVID-19 was announced by the World health Organization as a global pandemic. As of February 2021, a total of 113 million cases of COVID-19 were recorded from all over the world in two successive waves of spread, with 2.5 million confirmed deaths. The COVID-19 pandemic presented a huge global disruption, with drastic economic, environmental, and social impacts across the globe.

Health-care professionals are still on the frontlines in the fight against COVID-19 by treating patients and working on vaccine development. This situation has left other professionals wondering what they can do. How can they help society end this pandemic?

Of course, engineering has a key role to play in the short and long term. The IEEE organization in the world, in general, and in Canada in particular, played an important role in this struggle. To give just one example, the IEEE Hamilton Section recently organized a conference in October 2020 about protection against COVID-19 by using the energy produced by germicidal ultraviolet (UV) irradiation [1].

Engineers and researchers in Canada have discussed, among other things, a straightforward approach to damper airborne transmission of the virus. It consists of inactivating viruses within a short period of time after their production. Germicidal UV light, generally operating at a wavelength of 253.7 nm, is effective in this context. However, a dose of radiation high enough to inactivate the virus can be harmful to the skin and eyes. However, far-UVC light (207–222 nm) effectively destroys pathogens [2] without harming exposed human tissue [3]–[8]. Far-222-nm UVC light has already been shown to effectively destroy the airborne influenza virus [9]. Most recently, this research has been extended to explore the effects of extreme UV on airborne coronaviruses, αHCoV-229E and βHCoV-OC43 [9]. Low doses of 1.7 and 1.2 mJ/cm2 inactivated 99.9% of the nebulized coronavirus 229E and OC43, respectively.

Because all human coronaviruses have similar genome sizes, it is likely that far-UV light will show inactivation effects similar to other coronaviruses (including SARS-CoV-2). According to the results of βHCoV-OC43, within the current regulatory exposure limit (~3mJ/cm^2/h), a continuous exposure to extreme UV light in an occupied public place will cause roughly 90% of the virus' inactivation in approximately 8 min, 95% in roughly 11 min, 99% in approximately 16 min, and 99.9% inactivation in 25 min. Therefore, while staying within the current regulatory dose limits, long-distance UVC exposure at low dose rates can safely and immensely reduce the environmental level of airborne coronaviruses in inhabited public places. Intensive work is currently exploring this avenue.

As the spectrum of the engineer's contribution to the fight against the COVID-19 pandemic is very wide, we will be satisfied with information engineering and the role it has played or can play to deal with the COVID-19 pandemic. We have identified four main areas of information engineering related to the COVID-19 pandemic:

- information management
- virus detection
- predicting the waves of the pandemic
- an intelligent search of relevant data related to the pandemic.

Information Management

Initiatives to Manage the Large Flow of Data

The data related to COVID-19 must be collected, saved, indexed, shared, with the authorized concerned persons and managed

rapidement propagée à travers le monde, avec une augmentation très rapide des nouveaux cas constatés dans le monde entier entre début février et début mars 2020. Le 12 mars 2020, l'Organisation mondiale de la santé a déclaré que la propagation du COVID-19 est une pandémie mondiale. En Février 2021, un total de 113 millions de cas de COVID-19 étaient enregistrés dans le monde sur deux vagues de propagation successives, avec 2.5 millions de décès confirmés. La pandémie COVID-19 a été une énorme perturbation mondiale avec d'immenses impacts économiques, environnementaux et sociaux à travers le monde.

On trouve toujours les professionnels de la santé en première ligne dans la lutte contre le COVID-19 en soignant les patients et travaillant sur le développement d'un vaccin. Cette situation a laissé d'autres professionnels se demander ce qu'ils peuvent faire? Comment peuvent-ils contribuer à aider la société à mettre fin à cette pandémie?

Certes, l'ingénierie a un rôle primordial à jouer à court et à long terme. L'organisme IEEE dans le monde en général et au Canada en particulier a joué un rôle important dans cette lutte. Pour ne donner qu'un exemple, IEEE Hamilton a organisé récemment au mois d'octobre 2020 une conférence sur la protection contre le COVID-19 en utilisant l'énergie produite de l'irradiation germicide ultraviolette [1].

Des ingénieurs et chercheurs au Canada ont discuté entre autres une approche directe pour limiter les transmissions virales aéroportées. Elle consiste à inactiver les virus dans un court laps de temps après leur production. La lumière ultraviolette germicide, opérant généralement à une longueur d'onde de 253.7nm, est efficace dans ce contexte. Cependant, une dose de radiation, assez élevée pour inactiver le virus, peut présenter un danger pour la santé de la peau et des yeux. En revanche, la lumière UVC lointaine (207–222nm) détruit efficacement les agents pathogènes [2] sans nuire aux tissus humains exposés [3]–[8]. Il a été déjà démontré que la lumière UVC lointaine de 222nm détruit efficacement le virus de la grippe aéroporté [9]. Dernièrement cette étude a été étendue pour explorer l'efficacité des UVC lointains contre les coronavirus aéroportés, alpha HCoV-229E et bêta HCoV-OC43 [9]. De faibles doses de 1.7 et 1.2 mJ/cm2 ont inactivé 99.9% des coronavirus 229E et OC43 en aérosol, respectivement. Comme tous les coronavirus humains ont des tailles génomiques similaires, la lumière UVC lointaine est de nature à démontrer une efficacité d'inactivation similaire contre d'autres coronavirus, y compris le SRAS-CoV-2. Sur la base des résultats du bêta-HCoV-OC43, une exposition continue aux UVC lointains dans les lieux publics occupés, respectant la limite d'exposition réglementaire actuelle (~3mJ/cm2/heure), entraînerait une inactivation virale d'environ 90% en ~8 minutes, 95% en ~11 minutes, 99% en ~16 minutes et 99,9% d'inactivation en ~25 minutes. Ainsi, tout en restant dans les limites de dose réglementaires actuelles, une exposition aux UV-C lointains à faible débit de dose peut potentiellement fournir en toute sécurité une réduction majeure du niveau ambiant de coronavirus en suspension dans l'air dans les lieux publics occupés. Des travaux intensifs explorent actuellement cette avenue.

Vu que le spectre de la contribution de l'ingénierie à la lutte contre la pandémie COVID-19 est très large, nous allons nous contenter de l'ingénierie de l'information et du rôle qu'elle a joué ou qu'elle peut jouer pour faire face à la pandémie COVID-19. Nous avons identifié quatre secteurs principaux de l'ingénierie de l'information en lien avec la pandémie COVID-19, à savoir:

- Gestion de l'information
- Diagnostic du virus
- Prédiction des vagues de la pandémie
- Récupération automatique des données pertinentes

efficiently; this is the role of information management engineers in the fight against the pandemic. These engineers have played an important role and been praised for developing digital platforms that collect accurate and up-to-date data, which are made publicly available in a timely manner. In [11], Hamam discusses the risks and opportunities presented by the deployment of technology during the COVID-19 pandemic and beyond. He lays out the pros and cons of using information technology during the coronavirus pandemic.

In this context, a new research initiative funded by the European Union's (EU's) EU-RESPONSE [12], where a clinical research network was established to fight COVID-19 and many other emerging infectious diseases. The EU-RESPONSE alliance, led by the National Institutes of Health and Medical Research, has brought together 21 partners with world-class research capabilities from 13 EU countries such as Norway, Switzerland, and Turkey to build an adaptive platform to use the COVID-19 fight against other infectious diseases. These platforms have innovative, random, and controlled test designs that can simultaneously study various therapies for diseases. First, EU-RESPONSE is focusing on evaluating drugs that can be used to treat COVID-19 in multicenter clinical trials across Europe. The genius of managing this large data flow is at the center of this initiative, which offers a high level of coordination among the concerned parties and which provides a comprehensive development strategy for COVID-19 platforms in Europe. This initiative provides easy access to new therapies to be tested as well as support for setting up trials of these platforms.

This highlights the need for strong engineering capabilities so that relevant researchers and frontline responders against the pandemic can effectively identify the consequences of the pandemic. Thus, they can, among others, provide governments and health organizations with reliable advice for the public and make relevant decisions in the control and management of this virus. Therefore, there is a real need for the availability of relevant information to support policy decisions and monitor results. In this context, the Health Data Research Network Canada (HDRNC) [13] provides data on the health of Canadians and helps accelerate and improve analytical work, predictive modeling, and research related to COVID-19. This network is also responsible for ensuring that all of the data are recorded, stored, and disseminated in a timely manner and with integrity. It sets up and manages a data infrastructure on the health of the population.

In addition, the HDRNC is also able to bring together collaborators from all over Canada around various analysis, predictive modeling, and research activities. In fact, the long-term impact of COVID-19 is not yet understood. The COVID-19 pandemic is already having a greater impact on society, national economies, and global relations, and these effects will continue for several years. Accordingly, researchers have taken the initiative to design a platform that addresses and analyzes this problem under the name of *The World Pandemic Research Network* (*WPRN*) [14], which represents a list of research projects and resources that targets the social and human impacts of the COVID-19 pandemic. The WPRN is interdisciplinary, but it mainly involves the humanities and social sciences, which are at the forefront of helping our society deal with the socioeconomic impact of this crisis. Regular updates and follow-ups of these data are essential to offer information on the number of cases, deaths, and recoveries around the world and to give some perspectives on current events. Thus, if HDRNC members could relate the results of

Gestion de l'information

Des initiatives pour gérer le grand flux de données

Les données en lien avec COVID-19 doivent être collectées, sauvegardées, répertoriées, partagées avec les personnes autorisées concernées et d'une gérées efficacement, d'où le rôle des ingénieurs gestionnaires de l'information.

Ces ingénieurs ont joué un rôle important et louable en développant des plateformes numériques pour collecter des données précises et à jour qui sont rendues disponibles publiquement et en temps opportun. Dans [11], H. Hamam discute les risques et les opportunités présentés par la diffusion de la technologie pendant la pandémie COVID-19 et au-delà. Il a exposé le pour et le contre de l'utilisation des technologies de l'information pendant la pandémie de Covid-19.

Dans ce cadre une nouvelle initiative d'une recherche, financée par l'union européenne (UE), EU-RESPONSE [12], a eu lieu afin d'établir un réseau de recherche clinique pour traiter le COVID-19 et d'autres maladies infectieuses émergente. Le consortium EU-RESPONSE, dirigé par l'Institut national de la santé et de la recherche médicale (INSERM), rassemble 21 partenaires dotés de capacités de recherche de classe mondiale provenant de 13 pays de l'UE, de Norvège, de Suisse et de Turquie, afin de construire des plateformes adaptatives pour lutter contre le COVID-19 et les autres maladies infectieuses. Ces plateformes présentent une conception d'essai contrôlée, randomisée et innovante, qui permet d'étudier simultanément diverses thérapies pour une maladie. L'EU-RESPONSE se concentre dans un premier temps sur l'évaluation des médicaments réutilisés pour traiter le COVID-19 dans le cadre d'essais cliniques multicentriques à travers l'Europe. Le génie de la gestion de ce grand flux de données est au centre de cette initiative qui offre un haut niveau de coordination entre les concernés, et qui fournit une stratégie de développement complète pour les plateformes COVID-19 en Europe. Cette initiative offre un accès aisé aux nouvelles thérapies à tester ainsi qu'un soutien pour la mise en place d'essais de ces plateformes. Elle éclairera par la suite les stratégies possibles pour mettre en œuvre les tests cliniques des vaccins candidats.

Cela a mis en relief le besoin de fortes capacités d'ingénierie pour que les chercheurs concernés et les intervenants sur la ligne de front contre la pandémie puissent identifier efficacement les conséquences de celle-ci. Ainsi, ils peuvent entre autres fournir aux gouvernements et aux organismes de la santé de donner des conseils fiables au public et de prendre des décisions pertinentes en matière de contrôle et de gestion de ce virus. De ce fait, Il existe un réel besoin de disponibilité des informations pertinentes pour soutenir les décisions politiques et contrôler les résultats. Dans ce contexte, le réseau de recherche sur les données de santé du Canada (RRDS Canada) [13] offre des données sur la santé des Canadiens et contribuent à accélérer et à améliorer les travaux d'analyse, de modélisation prédictive et de recherche relatifs à la COVID-19. Ce réseau est également responsable de s'assurer que les tous les données sont enregistrées, stockées et diffusées dans le temps et avec intégrité. Il met en place et gère une infrastructure de données sur la santé de la population. Par ailleurs, le RRDS Canada est également en mesure de rassembler des collaborateurs des quatre coins du Canada autour de diverses activités d'analyse, de modélisation prédictive et de recherche. En réalité, l'impact à long terme du COVID-19 n'est pas encore compris. La pandémie de COVID-19 a déjà des conséquences plus importantes pour les sociétés, les économies nationales et les relations mondiales, et celles-ci se poursuivront pendant des

COVID-19 tests to existing data, it would be possible to deepen our interpretation of these data. For example, in addition to counting and forecasting the number of COVID-19 cases, we could produce an analysis of decades of accumulated knowledge about diseases, demographics, and the use of the healthcare system to improve our understanding of the situation and provide answers to the following questions: What influences the numbers? Have we reached the top? When will this pandemic be over?

Challenges for Managing Data About COVID-19

With the increase in the number of reported cases, the research management of COVID-19 quickly became complicated. The data system must be relational in nature, able to link many people to many others in the system. Assigning a unique ID to each person in the system will help support this.

Ideally, the data system should help to map the many-to-many relationship between confirmed cases and contacts to support data analysis and mapping of COVID-19 transmission sources. The data system must be user friendly, flexible, and accessible to different terminals (computer, laptop, smart phone, and so on). A cloud-based system is likely to offer more flexibility and ensure routine protection, updating, and storage of data. However, unique laws and jurisdictional regulations could require local data storage.

In addition, the system must be capable to be operated by IT personnel in the fields of public health, data management, and epidemiology without the support of vendors or designers. In this way, modules can be quickly updated when new data collection needs are determined. It also helps to generate predefined and ad hoc reports to manage requests. In addition, it improves the ability to seamlessly integrate with other modules to achieve quality assurance and perform more epidemiological analyses. The data system must also be interoperable with existing monitoring systems.

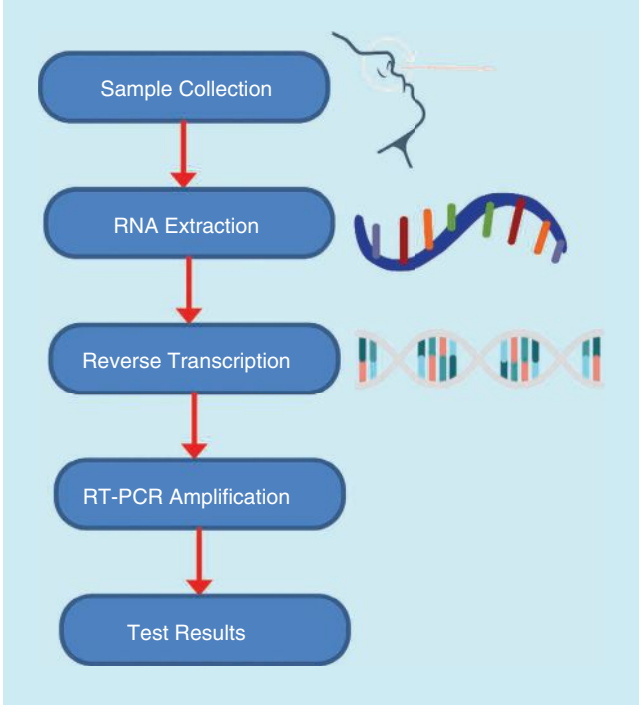


Figure 1: A traditional nucleic acid test based on a reverse transcription polymerase chain reaction (RT-PCR).

années. Dans ce cadre, des experts et des chercheurs ont pris l'initiative pour concevoir une plateforme pour traiter et analyser ce problème sous le nom "The World Pandemic Research Network", (WPRN) [14] qui représente une répertorie des projets de recherche et des ressources traitant l'impact social et humain de la pandémie COVID-19. Le WPRN est transdisciplinaire mais il s'adresse principalement aux sciences humaines et sociales, qui sont en première ligne pour aider nos sociétés à faire face à l'impact socio-économique de cette crise

Des mises à jour régulières et des suivis de ces données sont nécessaires pour offrir des informations sur le nombre de cas, de décès et de guérisons à travers le monde et donner une certaine perspective sur les événements actuels. Donc, si les membres du RRDS Canada pouvaient relier les résultats des tests de dépistage de la COVID-19 aux données existantes, il serait possible d'approfondir notre interprétation de l'information. Par exemple, en plus de compter et de prévoir le nombre de cas de COVID-19, nous pourrions produire des analyses à partir des décennies de connaissances accumulées sur les maladies, les facteurs démographiques et l'utilisation du système de santé pour améliorer notre compréhension de la situation et donner des éléments de réponses à: Qu'est-ce qui influence les chiffres? Avons-nous atteint le sommet? Quand cette pandémie va être finie?

Défis pour la gestion des données au sujet de COVID-19

La gestion des recherches sur le COVID-19 deviendra rapidement compliquée à mesure que le nombre de rapports de cas augmente. Le système de données doit être de nature relationnelle et doit être capable de relier plusieurs individus à de nombreux autres individus dans le système. Attribuer à chaque personne du système un identifiant unique aidera à soutenir cela.

Idéalement, le système de données devrait faciliter la cartographie des relations plusieurs-à-plusieurs entre les cas identifiés et les contacts afin de prendre en charge l'analyse des données et la cartographie de la propagation de la source de la transmission de COVID-19. Le système de données doit être convivial, flexible et accessible par différents terminaux (ordinateur, laptop, téléphone intelligent, …). Un système basé sur les nuages informatiques (cloud) est de nature à offrir plus de flexibilité et d'assurer la protection, la mise à jour ainsi que le stockage routinier des données. Toutefois des lois et réglementations juridictionnelles uniques peuvent exiger un stockage de données sur site (on-premises data storage).

De plus, le système doit pouvoir être manipulé par le personnel informatique de santé publique, de gestion des données et d'épidémiologie, sans avoir besoin du soutien du fournisseur ou du concepteur. Ceci permettra des mises à jour rapides des modules au fur et à mesure que de nouveaux besoins de collecte de données sont identifiés. Il facilitera également la production des rapports prédéfinis et ad hoc pour la gestion des requêtes. De plus, ceci augmentera la capacité d'intégration de manière transparente avec d'autres modules pour réaliser l'assurance qualité et effectuer plus d'analyses épidémiologiques. Le système de données doit également être interopérable avec les systèmes de surveillance existants.

Diagnostic du virus

Dans l'attente d'un vaccin ou un traitement le moyen le plus efficace pour lutter contre la propagation une maladie à transmission rapide est la détection précoce du virus afin d'isoler les sujets infectés [15]. Actuellement, il existe trois méthodes dans la pratique clinique pour diagnostiquer le COVID-19, qui sont résumées comme suit:

Detection of the Virus

While waiting for a vaccine or treatment, the most effective way to control the spread of a rapidly transmitted disease is the early detection of the virus to isolate infected individuals [15]. Currently, there are three clinical methods for diagnosing COVID-19, which are recapitulated as follows.

Nucleic Acid-Based Test

Intensive research has been done to adapt the structure of COVID-19. This is necessary for the development of vaccines and diagnostic measures to further limit the spread of the virus. Currently, the COVID-19 virus is diagnosed by using nucleic acid-based testing approaches. Figure 1 shows the principle of traditional nucleic acid testing based on reverse transcription polymerase chain reaction (RT-PCR). The SARS-CoV-2 genome was rapidly sequenced [16]. A unique sequence for the diagnosis of COVID-19 has been determined. An RT-PCR is a nucleic acid amplification test that has long been used to detect RNA viruses in clinical settings [17].

In RT-PCR, reverse transcriptase is first used to convert RNA into its complementary DNA (cDNA), which is amplified by a PCR. To establish the reaction, the reverse transcription of viral SARS-CoV-2 viral RNA was first performed. As a result, RNA is converted into cDNA strands, and then specific regions of cDNA are amplified.

During public health emergencies, very sensitive methods are desirable. Although studies have shown that RT-PCR may not be as sensitive as chest scans in certain stages of COVID-19 infection, its specificity makes it much better than other methods of detecting SARS-CoV-2. Therefore, it is important to rationally pick specific diagnostic methods to fight the virus epidemic. Any negligence or compromise in the diagnosis can have disastrous consequences. Wang et al. proposed combining RT-PCR with other methods and the patient's epidemiological history to more reliably diagnose SARS-CoV-2 infection [18]. In fact, Chinese authorities have used RT-PCR in combination with a chest scanner to diagnose COVID-19 in Wuhan.

The role of the engineer here is restricted to the mechanical and electronic design of the diagnostic instrument as well as the scanner. On top of that comes the engineering of data management.

Chest X-Ray

Currently, RT-PCR-based COVID-19 testing takes 4–6 h to generate results. In addition, the availability of test kits presents another serious problem in terms of effective disease detection. To deal with these problems, approaches based on radiological imaging [(CT) and X-ray chest images] have been proposed in several recent works by applying artificial intelligence and deep learning [20]–[23]. In fact, due to advancements in the fields of artificial intelligence and deep learning, the domain of medical imaging has recently undergone revolutionary changes for many diseases, like cancer, pneumonia, ARDS, MERS, SARS, and so on. During the current COVID-19 pandemic, it has become even more urgent for deep learning-based approaches to be used in real time. The successful application of deep learning-based approaches is essential to potentially offer enormous utility, especially with regard to rapid disease testing and detection.

Echtioui et al. [24], develop a neural network-based model, which consists of 10 convolutional layers; this allows for the detection of patients affected by COVID-19 with an accuracy of 91.34%. In recent research works [25], three deep learning

Test basé sur l'acide nucléique

Des recherches intensives ont été menées en vue de connaitre la structure du virus. Ceci est nécessaire au développement à la fois du vaccin et des mesures de diagnostic pour limiter davantage la propagation du virus. Actuellement, le diagnostic de COVID-19 est effectué à l'aide d'une méthode de test basée sur l'acide nucléique. La figure 1 montre le principe du test d'acide nucléique traditionnel basé sur la RT-PCR.

Le génome du SRAS-CoV-2 a été rapidement séquencé [16]. Des séquences uniques ont été identifiées pour le diagnostic du COVID-19. La réaction de transcription inverse-polymérase en chaîne (RT-PCR) est un test d'amplification d'acide nucléique qui a été longtemps utilisé pour la détection des virus à ARN dans des contextes cliniques [17].

Dans la RT-PCR, la transcriptase inverse est d'abord utilisée pour convertir l'ARN en son ADN complémentaire, amplifié par PCR (réaction en chaîne par polymérase). Pour la mise en place de la réaction, on procède initialement à une transcription inverse de l'ARN du virus SARS-CoV-2 qui convertit l'ARN en brin d'ADN complémentaire (ADNc) qui est ensuite suivie par l'amplification de régions spécifiques de l'ADNc.

Dans une urgence de santé publique, des méthodes très sensibles sont souhaitables. Bien que des études aient montré que la RT-PCR peut être moins sensible qu'un scanner thoracique à certains stades du COVID-19, sa spécificité la rend supérieure aux autres méthodes de détection du SRAS-CoV-2. Il est important alors de choisir rationnellement des méthodes de diagnostic spécifiques pour combattre les épidémies virales. Toute négligence ou compromis dans le diagnostic peut avoir des conséquences dévastatrices. Wang et co-auteurs ont suggéré de combiner la RT-PCR avec d'autres méthodes ainsi que les antécédents épidémiologiques des patients pour diagnostiquer l'infection par le SRAS-CoV-2 de manière plus crédible [18]. En effet, les autorités chinoises ont adopté cette approche pour diagnostiquer le COVID-19 à Wuhan en combinant la RT-PCR avec un scanner thoracique.

Le rôle de l'ingénieur ici se restreint à la conception mécanique et électronique de l'instrument du diagnostic ainsi que du scanner. À ceci s'ajoute le génie de la gestion des données.

Radiographie pulmonaire

À l'heure actuelle, les tests de détection de COVID-19 sont effectués sur la base d'une réaction de transcription inverse-polymérase en chaîne (RT-PCR), qui prend généralement 4 à 6 heures pour générer des résultats. En plus, la disponibilité des kits de test pose un autre problème sérieux en termes de détection efficace de la maladie. Pour faire face à ces problèmes, des approches basées sur l'imagerie radiologique (images thoracique CT et X-ray) ont été proposées par plusieurs récents travaux en appliquant des approches basées sur l'intelligence artificielle et l'apprentissage en profondeur (Deep Learning) [20]–[23]. En fait, le domaine de l'imagerie médicale a connu des changements révolutionnaires dans un passé récent, en raison des progrès dans le domaine de l'intelligence artificiel et de l'apprentissage profond, pour de nombreuses maladies, comme le cancer, la pneumonie, le SDRA, le MERS, le SRAS, etc.

Au cours de la pandémie actuelle de COVID-19, il est devenu encore plus urgent que de telles approches basées sur l'apprentissage profond soient utilisées en temps réel. Une application réussie de telles approches basées sur l'apprentissage profond peut potentiellement avoir une très grande utilité, en particulier en ce qui concerne les tests et la détection rapides de la maladie. A. Echtioui et ses collègues [24], développent un modèle basé sur un réseau de neurones composé de 10 couches

networks, namely, ResNet50, InceptionV3, and Vision Geometry Group 16 (VGG16), were trained and tested on an augmented database, which contains chest X-ray images (both COVID-19 and normal). The experimental results show that our proposed models achieve an accuracy of 97.2, 98.1, and 98.3% for Resnet50, InceptionV3, and for VGG16, respectively. Figure 2 provides an overview of the methodology used for this study and describes the proposed method of deep learning based on majority voting [h26].

Tao Ai et al. at Huazhong University of Science and Technology in Wuhan, China, examined the diagnostic value and consistency of chest-computed tomography compared to RT-PCR testing of nasopharyngeal swab samples in 1,014 COVID-19 patients who received both chest testing and RT-PCR. The researchers found that 59 and 88% of the patients, respectively, had positive results according to RT-PCR and chest CT. Based on the positive results of RT-PCR, the sensitivity of the chest scanner indicating the presence of the COVID-19 virus is 97%. Seventy-five percent of patients with negative RT-PCR results had positive chest CT results. Forty-eight percent of them were considered highly probable cases and 33% of them were classified as probable cases [27].

According to these studies, at certain stages of COVID-19 infection, RT-PCR tests are not as sensitive and reliable as chest images. False-negative cases of RT-PCR tests can be detrimental to the control of COVID-19, especially early in the epidemic. The caveat for chest x-ray testing is that at an early stage of infection the patient's lungs may not develop the damaging features that could be detected by CT scans, which increases the rate of false negatives. In addition, the characteristics of a chest test for COVID-19 show similarities to other viral pneumonias, resulting in false-positive detections. The research activities in this area are intensive and generally carried out by information engineering research centers and laboratories.

convolutives. Ceci permet la détection des patients atteints de COVID-19 avec une précision de 91.34%. Dans le cadre d'une recherche qu'on a fait récemment, S. Guefrechi et ses collègues [25] implémentent trois réseaux d'apprentissage en profondeur, à savoir ResNet50, InceptionV3 et VGG16, qui ont été entrainés et testés sur une base de données augmentée, qui contient des images radiographiques pulmonaire (COVID-19 et normale). Les résultats expérimentaux montrent que nos modèles proposés atteignent une précision de 97.20% pour Resnet50, 98.10% pour InceptionV3 et 98.30% pour VGG16.

La Figure 2 donne un aperçu de la méthodologie de cette étude qui décrit la méthode proposée d'apprentissage profond basée sur par le vote majoritaire [26].

Tao Ai, et ses collègues de l'Université des sciences et technologies de Huazhong à Wuhan, en Chine, ont examiné la valeur diagnostique et la cohérence de la tomodensitométrie thoracique par rapport à un test RT-PCR d'échantillons de prélèvement nasopharyngé chez 1014 patients atteints de COVID-19 qui ont subi à la fois des tests thoraciques et RT-PCR. Les chercheurs ont constaté que 59% et 88% des patients avaient des résultats positifs selon le RT-PCR et le scanner thoracique, respectivement. Sur la base des résultats positifs de la RT-PCR, la sensibilité du scanner thoracique indiquant la présence du virus de COVID-19 est de 97%. 75% des patients avec des résultats de RT-PCR négatifs avaient des résultats positifs au scanner thoracique, parmi eux, 48% étaient considérés comme des cas hautement probables et 33% étaient considérés comme des cas probables [27].

Selon ces études diagnostiques, les tests RT-PCR n'étaient pas aussi sensibles et fiables que les images thoraciques à certains stades du COVID-19. Les cas faux négatifs des tests RT-PCR peuvent être préjudiciables au contrôle du COVID-19, en particulier au début de l'épidémie. La mise en garde pour les tests par radiographie pulmonaire, est que, à un stade précoce de

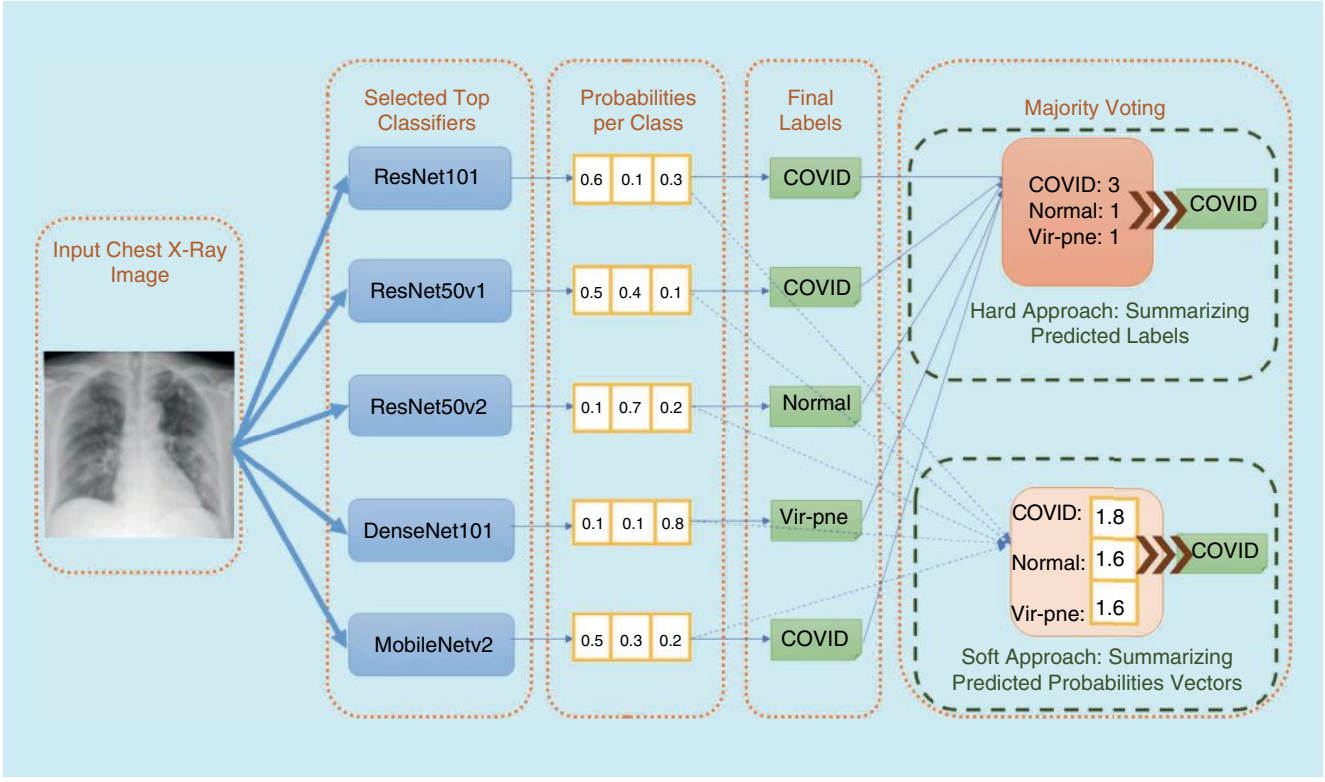


Figure 2: A classification model using majority voting [26]. ResNet: residual neural network.

Immunofluorescence Tests

Another established diagnostic method is the immunoassay. This method can detect the viral protein antigens or serum antibodies of patients who have been exposed to SARS-CoV-2. These antibody tests are important for detecting previous infections. The detection of SARS-CoV-2 antibodies provides doctors with important clinical information; it can be used as an additional effective indicator for suspected cases with negative viral nucleic acid detection or combined with nucleic acid detection for the diagnosis of suspected cases. Figure 3 explains the concept of detecting COVID-19 using an immunofluorescence test [28].

In reality, the main classes of immunoglobulins include IgG, IgM, IgA, IgE, and IgD, which help detect diseases. When infected with pathogens, IgG is the first line of defense initiated as a part of the immune response. They create an immunological memory to further fight COVID-19 infection. This first line is mainly targeted in the detection of the COVID-19 virus. It is worth noting that IgM shows in the subject's blood when infected by SARS after one week, and IgG can be detected eight days after infection [29], [30]. In a study of postsymptomatic patients, Amanat et al. detected high immune responses in IgA and IgM [31]. By using recombinant viral proteins, this immunoassay succeeds in detecting antibodies within three days of the development of the first symptoms.

However, the main issue with this method is that it is only suitable for symptomatic subjects who must have an immune response to SARS-CoV-2. At this point, some patients may already be seriously ill. Nevertheless, immunoassays are faster and cheaper than RT-PCR methods [32]. This method also has the unique advantage of identifying individuals with strong immune responses to the virus. Therefore, these people can serve as potential donors for treatment and research purposes.

Predicting the Waves of the Pandemic

Many preventive measures have been taken, such as hand disinfection, social distancing, and isolation, to reduce the spread of COVID-19 [33], [34]. Throughout the pandemic, wearing masks

l'infection, les poumons d'un patient peuvent ne pas développer des caractéristiques dommageables qui peuvent être détectées par les tomodensitométries, ce qui augmente le taux de faux négatifs. De plus, les caractéristiques d'un test thoracique de COVID-19 présentent des similitudes avec d'autres pneumonies virales, ce qui entraîne des détections faussement positives.

Les activités de recherche dans ce domaine sont intensives et généralement menées par des centres et laboratoires de recherche en ingénierie de l'information.

Tests d'immunofluorescence

L'immuno-essai est une autre méthode de diagnostic établie. Cette méthode détecte les antigènes de protéines virales ou les anticorps sériques chez les patients qui ont été exposés au SARS-CoV-2. Ces tests d'anticorps sont importants pour détecter les infections antérieures.

La détection des anticorps contre le SRAS-CoV-2 offre des informations cliniques vitales pour les médecins. Elle peut être utilisée comme un indicateur supplémentaire efficace pour les cas suspects de détection d'acide nucléique viral négatif ou en conjonction avec la détection d'acide nucléique dans le diagnostic des cas suspects. La Figure 3 explique le principe de la détection de COVID-19 à travers les tests d'immunofluorescence [28].

En fait, la principale classe d'immunoglobines comprend les IgG, IgM, IgA, IgE et IgD qui peuvent contribuer à la détection des maladies. Les IgG sont la première ligne de défense initiée dans le cadre de la réponse immunitaire lorsqu'elles sont infectées par un agent pathogène. Elles créent une mémoire immunologique pour lutter davantage contre l'infection. Cette première ligne est principalement ciblée dans la détection du virus du COVID-19. Il convient de noter que des IgM apparaissent dans le sang du sujet lorsqu'il est infecté par le SARS après une semaine et que des IgG peuvent être détectées 8 jours après l'infection [29], [30]. Dans une étude sur des patients postsymptomatiques, Amanat et co-auteurs ont détecté des réponses immunitaires élevées en IgA et IgM [31]. En utilisant des protéines virales recombinantes, ce dosage immunologique réussit à

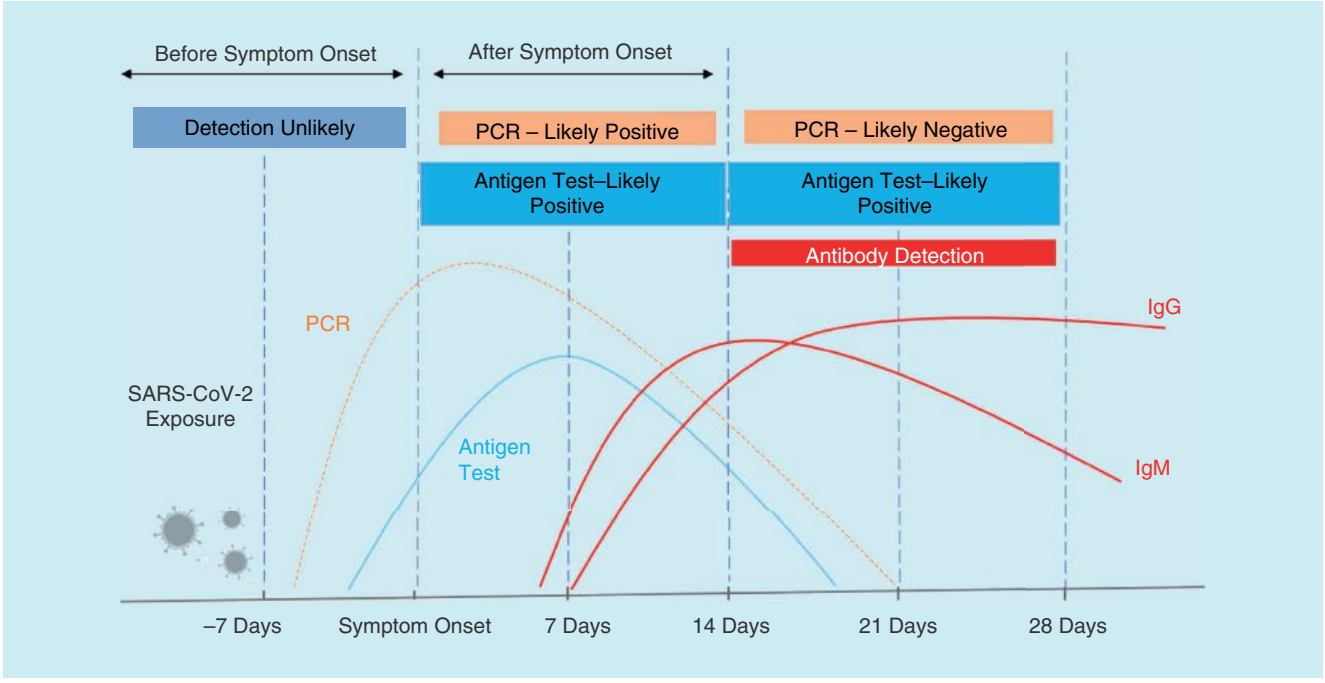


Figure 3: The concept of the rapid tests used for SARS-CoV-2.

and other personal protective equipment has been a controversial issue worldwide. However, the data show that they slow the propagation speed and reduce the transmission rate [35]. It is not yet known how effective these preventive measures will be in keeping the incidences of cases low after the end of the confinement and whether these measures can stop the second wave. In this context, engineers and experts suggest advancing models to estimate the consequences of easing restrictions, increasingly focusing on measures to prevent a second, or even third, wave of the coronavirus.

One of the most common misconceptions about the COVID-19 pandemic is to assume that we will not face a recurrence after the first wave of the disease subsides. This completely wrong understanding leads people to ignore necessary health habits and engage in certain inappropriate behaviors, such as parties or vacations. These conditions will cause double pressure on medical staff and endanger the lives of many people around the world.

Ghanbari et al. recommend an analysis of existing data to predict the number of people infected in the second wave of COVID-19 in Iran [36], which has been severely affected by the pandemic from the beginning. In fact, they proposed a mathematical model based on numerical simulation. Many scenarios regarding the progress of the second wave of COVID-19 in the next few months were discussed. They predict that the second wave of COVID-19 will be more severe than the first one [36].

During the past few months, intensive information engineering research has been carried out to study various aspects of this virus. Fanelli and Piazza analyzed and predicted the manner of the spread of COVID-19 in China, Italy, and France [37]. They claim that the infection must be reduced significantly and rapidly for the peak of the epidemic (or pandemic) and the death rate to drop sharply. Torrealba-Rodriguez et al. [38] used a mathematical model to predict COVID-19 cases in Mexico.

In [39], the pandemic peaks in South Africa, Turkey, and Brazil were predicted and analyzed. The effectiveness of social distancing measures on the spread of COVID-19 has been studied in the top-10 countries affected by COVID-19 [40]. Ahmadi et al. [41] studied some climatic parameters useful for the COVID-19 epidemic in Iran. The majority of these models have been developed by engineers to trace the spread of this virus. Various modeling methods were also used to advance second-wave predictions. The efforts of mathematical and computer modeling engineers here have a huge impact on public health policy for the prevention and control of COVID-19.

In this spirit, another study showed that the highest mortality rate of the Spanish pandemic influenza in 1918 was also related to the second wave of the disease. The second wave of pandemic activity peaked at the end of October, but the subsequent second wave broke out in the midwinter of the following year [42]. Taking COVID-19 as an example, studying the disease's behavior and prevalence of the second and even last wave seems to be an important aspect. This concern is the main motivation of information engineers.

The concerns about the second wave of COVID-19 have intensified as many countries have moved toward ending their confinements and lifting movement restrictions and quarantine. In nearly all of these countries, mathematical and computer modeling engineers have warned that more contact between them may lead to an increase in the number of patients and a higher prevalence of diseases. In this context, the engineering community offers results and estimates that can be used in future decision making to control the disease and prevent further damage.

détecter des anticorps au bout de 3 jours après le développement du premier symptôme.

Cependant, le problème majeur de cette méthode est qu'elle ne fonctionne que pour les sujets post-symptomatiques qui doivent avoir une réponse immunitaire au SRAS-CoV-2. À ce stade, certains patients peuvent être déjà gravement malades. Néanmoins, les dosages immunologiques sont plus rapides [32] et moins chers que les méthodes RT-PCR. Le procédé présente également un avantage unique d'identification des individus qui ont de fortes réponses immunitaires contre le virus et, par conséquent, peuvent servir de donneurs potentiels à des fins thérapeutiques et de recherche.

Prédiction des vagues de la pandémie

De nombreuses mesures de prévention, telles que la désinfection des mains, la distanciation sociale et la quarantaine ont été mises entreprises afin de réduire la propagation du COVID-19 [33], [34]. Le port de masques et d'autres équipements de protection individuelle était une question controversée dans le monde entier tout au long de cette pandémie, mais les données montrent qu'il peut ralentir la propagation et réduire les taux de transmission [35]. On ne sait pas dans quelle mesure ces précautions seront efficaces pour continuer à maintenir les taux de cas bas lors de la réouverture, et si ces mesures peuvent empêcher une deuxième vague. Dans ce contexte, des ingénieurs et des experts suggèrent des études de modélisation pour estimer les conséquences de l'assouplissement des restrictions, en se concentrant de plus en plus sur les mesures visant à prévenir une deuxième, voire troisième, vague du coronavirus.

L'une des idées fausses courantes sur la maladie COVID-19 est de supposer que nous ne verrons pas de récidive après la disparition de la première vague de la maladie. Cette perception complètement fausse pousse les gens à ne pas respecter les protocoles sanitaires nécessaires et à se livrer à certains comportements inappropriés, tels que des rencontres ou des voyages de vacances. Ces conditions exerceront une double pression sur le personnel médical et mettront en danger la vie de nombreuses personnes dans le monde.

Ghanbari et co-auteurs proposent une étude pour analyser les données existantes afin de prédire le nombre de personnes infectées dans la deuxième vague de COVID-19 en Iran [36], un pays fortement atteint par la pandémie dès son début. En effet, ils proposent un modèle mathématique en se basant sur des simulations numériques. Plusieurs scénarios de progression de la deuxième vague de COVID-19 dans les prochains mois, ont été discutés. Ils prévoient que la deuxième vague de COVID-19 sera plus sévère que la première [36].

Pendent les derniers mois, des travaux de recherche intensifs en ingénierie de l'information ont été menés sur l'étude de divers aspects de ce virus. Atangana et co-auteurs ont analysé et prédit la manière de la propagation du COVID-19 en Chine, en Italie et en France [37]. Ils affirment que le taux d'infection devait être réduit de manière significative et rapide pour observer une diminution considérable du pic épidémique (ou plutôt pandémique) et du taux de mortalité. Un modèle mathématique a été utilisé dans [38] pour prédire les cas de COVID-19 au Mexique.

Une analyse prédictive du pic pandémique en Afrique du Sud, en Turquie et au Brésil a été présentée dans [39]. L'efficacité des mesures de distanciation sociale sur la propagation du COVID-19 a été étudiée dans les dix principaux pays touchés par le COVID-19 [40]. Les auteurs de [41] ont étudié certains paramètres climatologiques utiles sur l'épidémie de COVID-19 en Iran. La majorité de ces modèles sont développés par des ingénieurs pour tracer la propagation de ce virus. Diverses

Automatic Retrieval of Relevant Data

The COVID-19 pandemic imposed a global priority for R&D on emerging diseases. Researchers in a wide variety of fields, from clinicians to epidemiologists, require effective access to the most recent publications in their areas of interest. An intelligent, automatic search of relevant data plays a vital role in classifying the flow of articles by subject area and topic to facilitate the development process and accelerate research efforts.

By causing a global emergency, the COVID-19 pandemic was viewed as the "black swan," and it is compared to the economic scene of World War II [43]. In this context, a set of data sets was designed to monitor the progression of COVID-19 in real time and enable epidemiological forecasting [44], [45]. It has become easier to collect scientific articles on COVID-19 for findings based on the literature (for example, CORD-197), to follow the dissemination of information about COVID-19 in social networks [46].

In particular, researchers at Johns Hopkins University have recently developed a dashboard to control and see reported cases of COVID-19 in real time by displaying the number and location of confirmed COVID-19 cases, deaths, and recovery in all of the affected countries [43].

Another data set was shared with the public on 24 March 2020 to facilitate analysis and monitoring of the COVID-19 pandemic. This data set provides real-time personal data: symptoms, start date, travel confirmation, and travel history [44].

The Allen Institute for Artificial Intelligence has developed a free dynamic database containing 128,000 articles about COVID-19, called *CORD-19*. The goal is to allow researchers to use the latest advances in natural language processing (NLP) to generate new knowledge to deal with COVID-19.

An intelligent, automatic search of relevant data plays a vital role in classifying the flow of articles by subject area and topic to facilitate the development process and accelerate research efforts.

Moreover, Chen et al. [46] have offered a database, updated regularly, that collects COVID-19 tweets published since 21 January 2020 and in different languages around the world. Khadhraoui et al. [47] tried to automate the search of related works by adopting supervised machine learning classification models. They created a new public SPD/ED data set in the field of biomedicine based on the title, abstract, keyword, and complete scientific papers. This data set is a collection of four different categories of scientific articles classified according to the classification of epidemiological research (analysis, descriptive, meta-analysis, and so on). Although these data sets have been extensively studied and have contributed to the study of the coronavirus pandemic, they are unlikely to inform the credibility of the coronavirus information to help fight the virus.

The coronavirus pandemic is causing a lot of false and misleading information on social networks and search engines. Hundreds of news websites have contributed to the publication of false information about the coronavirus. People who believe in counterfeit goods (such as consuming chlorine dioxide or industrial bleach, which can cure or prevent coronavirus), may take ineffective or extremely dangerous measures to protect themselves from the virus [48]. In this context, engineers and researchers are motivated to fight against this "infodemic" by classifying and

Récupération automatique des données pertinentes

La pandémie de COVID-19 a imposé une priorité mondiale pour la recherche et le développement sur les maladies émergentes. Les chercheurs dans une grande variété de domaines, des cliniciens aux épidémiologistes, doivent tous avoir un accès effectif aux publications les plus récentes dans leurs domaines d'intérêt. La récupération automatique des données pertinentes peut jouer un rôle essentiel dans l'organisation du flux des articles par domaine et thème pour faciliter le processus de développement et accélérer les efforts de recherche.

En causant une urgence mondiale, la pandémie de COVID-19 été considérée comme un la puissance de l'imprévisible, le cygne noir, et assimilé à la scène économique de la Seconde Guerre mondiale [43]. Dans ce contexte, un ensemble de jeux de données est devenu disponible, pour suivre en temps réel la progression du COVID-19 et pour aider à la prévision épidémiologique [44], [45]. Il est devenu plus aisé de collecter les articles scientifiques sur COVID-19 pour des découvertes fondées sur la littérature (par exemple, CORD-197), pour suivre la diffusion d'informations sur le COVID-19 dans les réseaux sociaux [46].

Plus précisément, des chercheurs de l'Université Johns Hopkins ont développé récemment un tableau de bord pour visualiser et suivre les cas signalés de COVID-19 en temps réel en présentant la localisation et le nombre de cas confirmés de COVID-19, décès et rétablissements pour tous les pays touchés [43].

Un autre jeu de données partagé au public le 24 mars 2020 a été conçu pour faciliter l'analyse et le suivi de la pandémie de COVID-19, qui fournit en temps réel des données individuelles: symptômes, date de début, confirmation et historique de voyage [44]. L'institut d'Allen pour l'intelligence artificielle a développé une base de données gratuite et dynamique composée de plus de 128000 d'articles sur le COVID-19, nommée CORD-19. L'intention est de mobiliser les chercheurs pour profiter des progrès récents du traitement du langage naturel

méthodes de modélisation ont été utilisées aussi afin de faire des prédictions de la deuxième vague. Les efforts des ingénieurs de modélisation mathématique et informatique ici peuvent avoir un impact énorme sur la politique de santé publique pour la prévention et le contrôle du COVID-19.

Dans ce contexte, une autre étude historique suggère que le taux de mortalité le plus élevé dans la grippe pandémique espagnole en 1918 était également lié à la deuxième vague de la maladie. Cette deuxième vague d'activité pandémique a culminé à la fin d'octobre, mais a été suivie par une autre vague de maladies au milieu de l'hiver de l'année qui suit [42]. Dans le cas du COVID-19, l'étude du comportement et de la prévalence de la maladie dans la deuxième et même les dernières vagues semble être un point significatif. Cette préoccupation a été la principale motivation pour les ingénieurs de l'information.

Ces préoccupations concernant la deuxième vague de COVID-19 se sont intensifiées alors que de nombreux pays du monde entier s'orientent vers la réouverture et la levée des restrictions de circulation et de la quarantaine. Dans presque tous ces pays, les ingénieurs de modélisation mathématique et informatique préviennent qu'un plus grand nombre de contacts entre eux peut entraîner une augmentation du nombre de patients et une prévalence plus élevée de la maladie.

La communauté des ingénieurs offre ici des résultats et des estimations qui peuvent être utilisés dans la prise de décision future pour contrôler la maladie et prévenir d'autres dommages.

retrieving multimodal repositories, to facilitate the assessment of news reliability on COVID-19.

The databases created to collect fake news and rumors are usually designed for different purposes. They may contain only news content that may be full articles or short queries, contain only media information, or even both content and social media information.

In particular, NELA-GT-2018 [49] provides a large-scale database that contains approximately 713,000 news reports from February to November 2018 before the COVID-19 era. The articles were gathered from 194 news media with multiple tags, which were obtained directly from sources known for their high credibility, transparency, and authenticity. These data sets contain only textual information useful for research, while information on the way fake news and rumors are spread on social media is very limited. This motivated the engineering community to create data sets such as FakeNewsNet and FakeHealth [50], [51].

FakeNewsNet is a data set that collects verified complete news articles (true or false) by covering news broadcasts on Twitter. The FakeHealth data set collects verified reviews (true or false) of https://www.healthnewsreview.org and provides detailed explanations and social comments about news posted on Twitter [51]. It is worth noting that FakeHealth focuses on health data, and CoAID is also a recently released data set of false information about COVID-19 research [52].

Scientific evidence must be readily available, especially during a pandemic. Here the engineer can contribute to improve access to the relevant data related to COVID-19.

Conclusions

The COVID-19 pandemic caused a global health crisis that profoundly affected the way we view our world and daily life. The medical community has completely reoriented its focus and efforts on tackling this global pandemic. Engineering has been seen as an essential element in this struggle. Many efforts and initiatives were deployed in this fight.

Several research activities confirm that engineering professors and their students have quickly adapted their research to develop specific COVID diagnostic, treatment, and monitoring solutions. Moreover, electrical and computer engineers have been applying models and computational methods to understand how this infectious disease spreads, optimized the curve, and learned from data to make predictions about the state of the pandemic.

In addition to electrical and computer engineering, we must recognize the contribution of other engineering disciplines in the fight against the pandemic. In particular, mechanical and mechatronic engineers have been examining not only the development of antiviral surface coatings but also the use of 3D printers to cover the growing need for personal protective equipment and other instruments, such as N95 masks, face shields, and ventilator components.

Do not forget the chemical engineers who create self-cleaning surfaces from advanced polymer coatings and composites. They have been exploring nanotechnology to design and implement antimicrobial coatings that can kill/disactivate bacteria, fungi, and viruses, and superhydrophobic self-cleaning surfaces that can repel liquid droplets—even the annoying ones that become airborne when someone sneezes.

Furthermore, biomedical engineers have accelerated and scaled up vaccine production and the method of its delivery. They also participated in the formulation of a better understanding of the interactions between our bodies and the molecular entities that exert the therapeutic effects of drugs.

(NLP) pour générer de nouvelles connaissances en vue de lutter contre le COVID-19.

De plus, Chen et ses collègues [46] ont offert une base de données, mis à jour régulièrement, et qui recueille des tweets COVID-19 publié depuis le 21 janvier 2020 et dans des différentes langues du monde entier. Dans une autre recherche, M. Khadhraoui et ses collègues [47] ont essayé d'automatiser la recherche bibliographique en adoptant des modèles de classification de l'apprentissage automatique supervisé. Ils ont créé un nouveau jeu de données publique SPD/ED dans le domaine biomédical basée sur le titre, le résumé, les mots-clés et les articles scientifiques complets. Ce jeu de données est une collection de plusieurs articles scientifiques classés en quatre catégories différentes selon la taxonomie des études épidémiologiques (analytique, descriptive, méta-analyse et autres).

Bien que ces jeux de données étaient largement étudiés et ont contribué à la recherche sur la pandémie de coronavirus, ils ne sont pas de nature à notifier la crédibilité des informations sur le coronavirus pour aider à lutter contre ce virus.

La pandémie de coronavirus entraîne une vague d'informations fausses et trompeuses sur les réseaux sociaux et les moteurs de recherche. Des centaines de sites Web d'actualités ont contribué à la publication de fausses informations sur les coronavirus. Les personnes qui croient à de faux articles (par exemple la consommation de dioxyde de chlore, un agent de blanchiment industriel, peut guérir ou prévenir le coronavirus), pourrait prendre des mesures inefficaces ou extrêmement dangereuses pour se protéger du virus [48]. Dans ce contexte, les ingénieurs et les chercheurs sont motivés pour lutter contre cette «infodémie», en faisant la classification et la récupération des référentiels multimodaux, pour faciliter l'évaluation de la fiabilité des actualités sur COVID-19.

Les bases de données créées pour collecter les fausses nouvelles et les rumeurs sont généralement conçues avec différents objectifs. Elles peuvent ne contiennent que du contenu d'actualités pouvant être des articles complets ou de courtes requêtes, ne contiennent que des informations sur les médias, ou contiennent à la fois du contenu et des informations sur les réseaux sociaux.

Plus précisément, NELA-GT-2018 [49] est une base de données à grande échelle d'environ 713 000 articles de presse de février à novembre 2018, avant l'aire de COVID-19. Les articles sont collectés à partir de 194 médias d'information avec plusieurs étiquettes directement obtenues à partir des sources réputées par leur bonne crédibilité, transparence, et authenticité. Ces jeux de données ne contiennent que des informations textuelles utiles pour la recherche avec des informations limitées sur la façon dont les fausses nouvelles et les rumeurs se propagent sur les réseaux sociaux. Ceci motive la communauté des ingénieurs à construire des jeux de données, tels que «FakeNewsNet» et «FakeHealth» [50], [51].

Le «FakeNewsNet» est un jeu de données qui recueille des articles d'actualité complets vérifiés (réels ou faux) en couvrant les actualités diffusées sur Twitter. Le jeu de données «FakeHealth» recueille des revues vérifiées (réelles ou fausses) de HealthNewsReview.org avec des explications détaillées et des engagements [51] sociaux concernant l'actualité diffusée sur Twitter. Il convient de noter que «FakeHealth» se concentre sur les données de santé, tout comme «CoAID», un jeu de données récemment publié sur la désinformation de la recherche sur COVID-19 [52].

Les preuves scientifiques doivent être facilement accessibles, en particulier pendant une pandémie. Ici l'ingénieur peut contribuer pour améliorer l'accès aux données pertinentes liés au COVID-19.

References

[1] N. Mahyar, "COVID-19 protection with the power of ultraviolet germicidal irradiation," IEEE vTools. [Online]. Available: https://events.vtools.ieee.org/m/239118

[2] K. Narita et al., "222-nm UVC inactivates a wide spectrum of microbial pathogens," *J. Hosp. Infect*., 2020.

[3] M. Buonanno et al., "207-nm UV light – A promising tool for safe low-cost reduction of surgical site infections. I: In vitro studies," *Plos One*, vol. 8, no. 10, p. e76968, 2013. doi: 10.1371/journal.pone.0076968.

[4] M. Buonanno et al., "Germicidal efficacy and mammalian skin safety of 222-nm UV light," *Radiat. Res*., vol. 187, no. 4, pp. 483–491, 2017.

[5] B. Ponnaiya, M. Buonanno, D. Welch, I. Shuryak, G. Randers-Pehrson, and D. J. Brenner, "Far-UVC light prevents MRSA infection of superficial wounds in vivo," *PLos One,* vol. 13, no. 2, p. e0192053, 2018. doi: 10.1371/journal.pone.0192053.

[6] K. Narita et al., "Disinfection and healing effects of 222-nm UVC light on methicillin-resistant *Staphylococcus aureus* infection in mouse wounds," *J. Photochem. Photobiol. B*, vol. 178, no. Supplement C, pp. 10–18, 2018. doi: 10.1016/j.jphotobiol.2017.10.030.

[7] K. Narita et al., "Chronic irradiation with 222-nm UVC light induces neither DNA damage nor epidermal lesions in mouse skin, even at high doses," *PLoS One*, vol. 13, no. 7, p. e0201259, 2018. doi: 10.1371/journal.pone.0201259.

[8] N. Yamano et al., "Long-term effects of 222 nm ultraviolet radiation C sterilizing lamps on mice susceptible to ultraviolet radiation," *Photochem. Photobiol*., 2020. doi: 10.1111/php.13269.

[9] D. Welch et al., "Far-UVC light: A new tool to control the spread of airborne-mediated microbial diseases," *Sci. Rep*., vol. 8, no. 1, p. 2752, 2018.

[10] M. Buonanno, D. Welch, I. Shuryak, and D. J. Brenner, "Far-UVC light (222 nm) efficiently and safely inactivates airborne human coronaviruses," *Sci. Rep*., vol. 10, p. 10285, 2020. doi: 10.1038/s41598-020-67211-2.

[11] H. Hamam, "COVID-19 surprised us and empowered technology to be its own master, Tapuya Science," *Technol. Soc. (USA)*, vol. 3, no. 1, pp. 272–281. doi: 10.1080/25729861.2020.1822072.

[12] "Commission supports international clinical research network to treat COVID-19." https://ec.europa.eu/info/news/commission-supports-international-clinical-research-network-treat-covid-19-2020-sep-18_fr

[13] "COVID-19." https://www.hdrn.ca/fr/covid

[14] "Addressing the societal and human impact of the COVID-19 pandemic," The World Pandemic Research Network. https://council.science/current/blog/addressing-the-societal-and-human-impact-of-the-covid-19-pandemic/

[15] "Managing epidemics: Key facts about major deadly diseases," WHO, 2018. https://www.who.int/publications/i/item/managing-epidemics-key-facts-about-major-deadly-diseases

[16] D. L. Heymann and N. Shindo, "COVID-19: What is next for public health?" *Lancet*, vol. 395, pp. 542–545, 2020. doi: 10.1016/S0140-6736(20)30374-3.

[17] S. A. Bustin and R. Mueller, "Real-time reverse transcription PCR (qRT-PCR) and its potential use in clinical diagnosis," *Clin. Sci*., vol. 109, pp. 365–379, 2005. doi: 10.1042/CS20050086.

[18] C. Wang, P. W. Horby, F. G. Hayden, and G. F. Gao, "A novel coronavirus outbreak of global health concern," *Lancet*, vol. 395, pp. 470–473, 2020. doi: 10.1016/S0140-6736(20)30185-9.

[19] N. Verma, D. Patel, and A. Pandya, "Emerging diagnostic tools for detection of COVID-19 and perspective," *Biomed Microdevices*, vol. 22, p. 83, 2020. doi: 10.1007/s10544-020-00534-z.

[20] I. D. Apostolopoulos and T. A. Mpesiana, "COVID-19: Automatic detection from x-ray images utilizing transfer learning with convolutional neural networks," *Phys. Eng. Sci. Med*., vol. 43, pp. 635–640, Apr. 2020. doi: 10.1007/s13246-020-00865-4.

[21] A. Narin, C. Kaya, and Z. Pamuk, "Automatic detection of coronavirus disease (COVID-19) using X-ray images and deep convolutional neural networks," 2020, arXiv:2003.10849.

[22] T. Ozturk, M. Talo, E. A. Yildirim, U. B. Baloglu, O. Yildirim, and U. Rajendra Acharya, "Automated detection of COVID-19 cases using deep neural networks with X-ray images," *Comput. Biol. Med*., p. 103,792, 2020. doi: 10.1016/j.compbiomed.2020.103792.

Conclusion

La pandémie de COVID-19 a créé une crise sanitaire mondiale qui a eu un impact profond sur la façon dont nous percevons notre monde et notre vie quotidienne. La communauté médicale a complètement réorienté son attention et ses efforts sur la lutte contre cette pandémie mondiale. L'ingénierie s'est vue un élément essentiel dans cette lutte. De nombreux efforts et initiatives ont été déployé cette lutte.

Plusieurs recherches confirment que des professeurs d'ingénierie et leurs étudiants ont rapidement adapté leurs recherches pour développer des solutions de diagnostic, de traitement et de suivi spécifiques au COVID.

De plus, les ingénieurs électriciens et informaticiens appliquent des modèles et des méthodes de calcul pour comprendre comment cette maladie infectieuse se propage, optimisent la courbe et apprennent des données pour faire des prédictions sur l'état de la pandémie.

En plus du génie électrique et informatique il faut reconnaitre la contribution des autres génies dans lutte contre la pandémie. En particulier, les ingénieurs en mécanique et mécatronique examinent le développement de revêtements de surface antiviraux mais aussi l'utilisation des imprimantes 3D pour couvrir le besoin croissant d'équipement de protection individuelle et d'autres équipements, tels que des masques N95, des écrans faciaux, et les composants du ventilateur.

Il ne faut pas oublier les ingénieurs chimistes qui créent des surfaces autonettoyantes à partir de revêtements polymères avancés et de composites. Ils explorent la nanotechnologie pour fabriquer des revêtements antimicrobiens qui peuvent tuer/désactiver les bactéries, les champignons et les virus, et les surfaces autonettoyantes superhydrophobes qui peuvent repousser les gouttelettes de liquide - même celles gênantes qui deviennent aéroportées lorsque quelqu'un éternue.

De plus, les ingénieurs biomédicaux accélèrent et intensifient la production de vaccins et la manière dont ils sont livrés. Ils participent également à la formulation d'une meilleure compréhension des interactions entre nos corps et les entités moléculaires qui exercent les effets thérapeutiques des médicaments. ■

[23] P. K. Sethy and K. B. Santi, "Detection of coronavirus disease (COVID-19) based on deep features," 2020.

[24] A. Echtioui, W. Zouch, M. Ghorbel, C. Mhiri, and H. Hamam, "Detection methods of coronavirus disease (COVID-19)," *SLAS Technol*., vol. 25, no. 6, 2020. doi: 10.1177/2472630320962002.

[25] S. Guefrechi, M. B. Jabra, A. Ammar, A. Koubaa, and H. Hamam, "Deep learning based detection of COVID-19 from chest X-ray images," *Multimed Tools Appl*., pp. 1–18, 2021. doi: 10.1007/s11042-021-11192-5.

[26] M. Ben Jabra, A. Koubaa, B. Benjdira, A. Ammar, and H. Hamam, "COVID-19 diagnosis in chest X-rays using deep learning and majority voting," *Appl. Sci. (Switzerland)*, vol. 11, p. 2884, 2021. doi: 10.3390/app11062884.

[27] A. Tao et al., "Correlation of chest CT and RT-PCR testing for coronavirus disease 2019 (COVID-19) in China: A report of 1014 cases," *Radiology*, vol. 296, no. 2, pp. E32-E40, 2020. doi: 10.1148/radiol.2020200642.

[28] "SARS-CoV-2 (COVID-19): Test Rapide IgG/IgM pour le diagnostic," Clini Sciences. https://www.clinisciences.com/lire/newsletter-26/sars-cov-2-covid-19-test-rapide-2264.html

[29] R. Racine and G. M. Winslow, "IgM in microbial infections: Taken for granted?" *Immunol. Lett*., vol. 125, pp. 79–85, 2009. doi: 10.1016/j.imlet.2009.06.003.

[30] Z. Wan, X. Zhang, and X. Yan, "IFA in testing specific antibody of SARS coronavirus," *South China J. Prev. Med*., vol. 29, pp. 36–37, 2003.

[31] F. Amanat et al., "A serological assay to detect SARS-CoV-2 seroconversion in humans," *Nat. Med*., vol. 26, p. 1033, 2020. doi: 10.1038/s41591-020-0913-5.

[32] C. Sheridan, "Fast, portable tests come online to curb coronavirus pandemic," *Nat. Biotechnol*., vol. 38, p. 515, 2020. doi: 10.1038/d41587-020-00010-2.
[33] C. J. Courtemanche, J. Garuccio, A. Le, J. C. Pinkston, and A. Yelowitz, "Did social-distancing measures in Kentucky help to flatten the COVID-19 curve?" Inst. for the Study of Free Enterprise Working Papers.
[34] M. Saez, A. Tobias, D. Varga, and M. A. Barceló, "Effectiveness of the measures to flatten the epidemic curve of COVID-19. The case of Spain, "*Sci. Total Environ*., vol. 727, p. 138,761, 2020. doi: 10.1016/j.scitotenv.2020.138761.
[35] J. Howard et al., "Face masks against COVID-19: An evidence review," Preprints. doi: 10.20944/preprints202004.0203.v1
[36] G. Behzad, "On forecasting the spread of the COVID-19 in Iran: The second wave," *Chaos Solitons Fractals*, vol. 140, p. 110,176, Nov. 2020. doi: 10.1016/j.chaos.2020.110176.
[37] D. Fanelli and F. Piazza, "Analysis and forecast of COVID-19 spreading in China, Italy and France," *Chaos Solitons Fractals*, vol. 134, p. 109,761, May 2020. doi: 10.1016/j.chaos.2020.109761.
[38] O. Torrealba-Rodriguez, R. A. Conde-Gutiérrez, and A. L. Hernández-Javier, "Modeling and prediction of COVID-19 in Mexico applying mathematical and computational models." *Chaos Solitons Fractals*. vol. 138, p. 109946, 2020. doi: 10.1016/j.chaos.2020.109946.
[39] S. Djilali and B. Ghanbari, "Coronavirus pandemic: A predictive analysis of the peak outbreak epidemic in South Africa, Turkey, and Brazil," *Chaos Solitons Fractals*. vol. 138, p. 109971, 2020. doi: 10.1016/j.chaos.2020.109971.
[40] T. P. B. Thu, P. N. H. Ngoc, N. M. Hai, and L. A. Tuan, "Effect of the social distancing measures on the spread of COVID-19 in 10 highly infected countries," *Sci. Total Environ*., p. 140430, 2020. doi: 10.1016/j.scitotenv.2020.140430.
[41] M. Ahmadi, A. Sharifi, S. Dorosti, S. J. Ghoushchi, and N. Ghanbari, "Investigation of effective climatology parameters on COVID-19 outbreak in Iran," *Sci. Total Environ*., vol. 72910, p. 138705, 2020. doi: 10.1016/j.scitotenv.2020.138705.
[42] N. J. Cox and K. Subbarao, "Global epidemiology of influenza: past and present. *Annu Rev Med*. vol. 51, pp. 407–421, 2000. doi: 10.1146/annurev.med.51.1.407.
[43] N. Maria et al., "The socio-economic implications of the coronavirus and COVID-19 pandemic: A review," *Int. J. Surg*., pp. 185–193, 2020.
[44] D. Ensheng, D. Hongru, and G. Lauren, "An interactive web-based dashboard to track COVID-19 in real time," *Lancet*, vol. 20, no. 5, pp. 533–534, 2020.
[45] B. Xu et al., "Epidemiological data from the COVID-19 outbreak, real-time case information," *Sci. Data*, vol. 7, no. 1, pp. 1–6, 2020. doi: 10.1038/s41597-020-0448-0.
[46] E. Chen, K. Lerman, and E. Ferrara, "Tracking social media discourse about the COVID-19 pandemic: Development of a public coronavirus Twitter data set," *JMIR Public Health Surveill*., vol. 6, no. 2, p. e19273, 2020. doi: 10.2196/19273.
[47] M. Khadhraoui, H. Bellaaj, M. Ben Ammar, H. Hamam, and M. Jmaiel, *Machine Learning Classification Models with SPD/ED Dataset: Comparative Study of Abstract Versus Full Article Approach*. Berlin: Springer-Verlag, 2020, pp. 348–356.
[48] S. H. Spencer. "Fake coronavirus cures, part 1: MMS is industrial bleach," FactCheck, Feb. 2020. https://www.factcheck.org/2020/02/fake-coronavirus-cures-part-1-mms-is-industrial-bleach/
[49] N. Jeppe, D. H. Benjamin, and A. Sibel, "NELA-GT-2018: A large multi-labelled news dataset for the study of misinformation in news articles," in *Proc. Int. AAAI Conf. Web Social Media*, vol. 13, pp. 630–638, 2019.
[50] K. Shu, D. Mahudeswaran, S. Wang, D. Lee, and H. Liu, "FakeNewsNet: A data repository with news content, social context and dynamic information for studying fake news on social media," 2018, arXiv:1809.01286.
[51] D. Enyan, S. Yiwei, and S. Wang, "Ginger cannot cure cancer: Battling fake health news with a comprehensive data repository," in *Proc. Int. AAAI Conf. Web Social Media*, vol. 14, pp. 853–862, 2020.
[52] C. Limeng and L. Dongwon, "CoAID: COVID-19 healthcare misinformation dataset," 2020, arXiv:2006.00885.

About the Authors



Sarra Guefrachi was born on 5 November 1996 in Gabes, Tunisia. She received her baccalaureate in science degree in 2015 and chose to pursue an engineering career, continuing her studies at the Preparatory Institute of Tunis El Manar. After succeeding with the national engineering exam, she enrolled at the National Engineering School of Sfax, Tunisia, to pursue electrical engineering. During her third year, she focused on embedded systems. At the end of 2020, she graduated from the National Engineering School of Sfax, with excellence, for her final-year project. Her project was about the classification of radiographic images using deep learning and prediction of the second wave of COVID-19. Sarra is involved in community life as an active Member of IEEE, and she was elected president of the IEEE Power & Energy Society Student Chapter at the National School of Engineers in Sfax. Currently, she is pursuing her master's degree in applied science with Prof. Habib Hamam at Université de Moncton, New Brunswick, Canada.



Habib Hamam obtained his B.Eng. and M.Sc. degrees in information processing from the Technical University of Munich, Germany, in 1988 and 1992, respectively, and his Ph.D. degree in physics and applications in telecommunications from Université de Rennes I conjointly with France Telecom Graduate School in 1995. He also obtained the postdoctoral diploma "Accreditation to Supervise Research in Signal Processing and Telecommunications" from Université de Rennes I in 2004. From 2006 to 2016, he was a Canada Research Chair in Optics in Information and Communication Technologies. He is currently a full professor in the Department of Electrical Engineering at the Université de Moncton, New Brunswick, Canada. He is an OSA Senior Member, IEEE Senior Member, and a registered professional engineer in New Brunswick. He is the editor-in-chief of *CIT Review* and an associate editor of *IEEE Canadian Review*. His research interests include optical telecommunications, wireless communications, diffraction, fiber components, radio-frequency ID, information processing, data protection, information processing for COVID-19, deep learning, and data mining with applications on health. He is also interested in strategic studies on North Africa and the Middle East and participated in development projects in this region.

Lessons Learned in a Northern Microgrid Implementation

by Alexandre Nassif

The planning, design, and operation of microgrids introduce technical challenges to transmission and distribution system owners and operators. In addition to ensuring the adequacy of energy balance under all operational scenarios, the system operator is accountable for defining the hosting capacity of renewable energy sources; the associated management; and maintaining protection, security, and dependability while designing an effectively grounded system.

The Current Landscape of Microgrids

The existing classification of microgrids generally categorizes them in five main groups: campus, community, remote off grid, military base, and commercial and industrial (C&I) microgrids. An argument can be made to group them in more general terms, encompassing those connected to the bulk electric system (BES), which comprises campus, community, and C&I microgrids, or those separated from the BES, such as off-grid or remote communities and military bases. The second group typically represents mission-critical applications and has grown in number, as they have stronger drivers. Regardless of how the industry realizes this categorization, it is a foundational requirement that, during its islanded state, a microgrid performs in a safe, reliable, and economical manner. Its operation must meet certain standards of energy management, stability, power quality, protection, and grounding. These factors have a direct correlation with a microgrid's design and overall penetration level in the context of distributed energy resources (DERs).

Remote Microgrids

The cost of transmission infrastructure often discourages the interconnection of remote communities into the BES. Currently, there are about 300 diesel-reliant communities in Canada, as depicted in Figure 1. Of these, about 170 sites are identified as Aboriginal [1]. The Canadian federal government is providing incentives in the form of a limited number of grants to reduce diesel dependency and associated greenhouse gas (GHG) emissions (from the perspective of both electricity production and diesel transportation) and improve supply reliability [2]. These initiatives are conducive to fostering the application of renewable or alternative sources of generation, such as photovoltaics (PVs) and/or battery energy storage systems (BESSs).

The Fort Chipewyan Project and Its Challenges

There have been strong drivers toward lessening diesel dependency in remote communities. Government, residents,

©SHUTTERSTOCK.COM/KEWIKO



and utilities strive to improve the environmental outlook in these areas. Being remote, off-grid communities have limited accessibility, often facing difficulties related to diesel supply. Additionally, fuel management and high operational and maintenance costs are stimulating the adoption of alternative sources of energy and energy storage.

This community has close to 850 inhabitants and is a European settlement, but it is also home to three First Nations. It is located on the western tip of Lake Athabasca and adjacent to Wood Buffalo National Park. It is not connected to the Alberta BES and has no natural gas pipelines either, being a community for which energy is entirely supplied by diesel generators, which are owned by ATCO Electric, an electric utility that supplies most of the geographical area of Alberta and some of the Canadian territories. One of the most northernmost settlements in Alberta, it has no permanent, all-season road access, and the winter ice road is the only practical means of delivering large volumes of diesel. Historically, the ice road has only been able support heavy tankers during a narrow window each year, as illustrated in Figure 2. This figure illustrates the duration of operation of the ice road based on an 11-year record, which averages to only 43 days per year. During these windows, heavy tankers continually transport diesel to ensure all of the storage tanks are topped up when the ice road closes, typically mid-March.

The diesel plant in the community contains 12 tanks—each with a capacity of 325,000 L. To allow for temperature-caused expansions, each tank is filled up to a maximum of 90% capacity, and the bottom 15,000 L cannot be normally reached. This amounts to a total useable capacity of about 3,330,000 L. To handle seasonal uncertainties, a margin equivalent to one month of supply is required. In 2018, 3,294,000 L of diesel were consumed, clearly not meeting the required reserve. A view of the diesel tanks is shown in Figure 3.

Due to various municipal infrastructure upgrades, such as upgrading three sewage lift stations, a new wastewater treatment pumping system, and building and operating a new recreational facility, electricity consumption is steadily increasing. A load growth study completed in 2018 revealed that the forecasted load shows an increasing trend, as indicated in Figure 4.

The forecasts suggest that the plant would likely run out of fuel if no action was taken. This would require diesel delivery by aircrafts—a major logistical challenge at extremely high cost to rate payers. This would also put the community at risk, as this shortage would happen during the coldest winter months (prior to



Figure 1: Remote communities in Canada. (Source: https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/reducing-diesel-energy-rural-and-remote-communities/20542.)

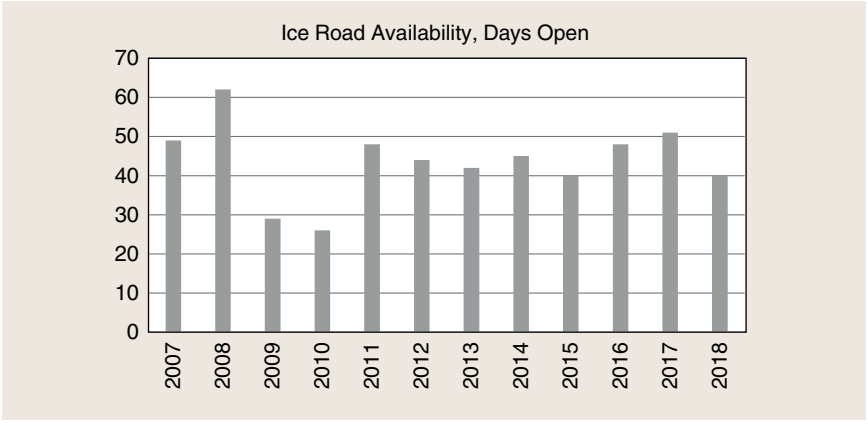


Figure 2: Ice road availability (days open) from 2007 to 2018. (Source: [9].)



Figure 3: The north view of the diesel tanks.

the ice road reopening, which is typically at the end of January).

What Options Were Available

The traditional utility operation methods would involve expanding the fuel storage to reduce the risk of fuel shortage. However, the utility saw this as an opportunity to innovate and simultaneously reduce GHG emissions by incorporating renewable energy sources as part of the community portfolio. A wide range of feasibility studies were conducted with a focus on solar and wind energy. The community, being in North Alberta, has good solar potential. However, the wind resources are not adequate at practical hub heights, as shown in Figure 5. A comprehensive economic analysis was conducted to compare the option of a hybrid microgrid with the addition of more diesel tanks. The results favored the microgrid, in part due to the high costs of diesel tanks. The operational and maintenance costs of the diesel generators (which can be reduced due to the offset energy production provided by renewable energy sources) was also an important factor. In addition, the opportunity for partnership and government grants (as explained in the next section) also supported the microgrid concept.

Project Economics, Community Engagement, and Environmental Benefits

The three local Indigenous communities have long had a vision of transitioning to cleaner electricity as well as energy independence. This vision aligned with the utility's own goals of moving to a lower-emitting future. The project was designed with careful consideration to not only provide a sustainable energy solution but to also provide meaningful economic benefits for the residents.

The economics of the project were compared under three scenarios:

- expanding fuel storage capability by adding three diesel tanks, a solution forecasted to mitigate the fuel shortage for five years
- a utility-owned, 2.6-MW PV plus a 1.6-MW/MWh BESS operated with a microgrid controller
- a community-owned 2.2-MW PV, a utility-owned 600-kW PV, plus a 1.6-MW/MWh BESS operated with a microgrid controller.

The results of this analysis are shown in Figure 6. This shows that a partnership with the three First Nations is the most economic option. The economic analysis was performed for the entire duration of the project (25 years), assuming a replacement of the PV and BESS inverters as per the manufacturers' recommendations and as per their estimated useful life. The economic analysis considered the ongoing reduction of diesel consumption and the generators' operational and maintenance expenses as well as any incremental expenses to maintain the newly introduced technology.

The system optimization analysis resulted in a two-phased staging and is presented in the next section. The first project phase was the construction of the 600-kW solar farm to mitigate the imminent risk of diesel shortage and was constructed in 2019. The second phase included the BESS, microgrid controller, and community-owned 2,200 kW solar farm, which was successfully energized in November 2020, in time and under budget. In total, the solar array consists of 7,664 solar panels; the BESS is made up of 5,808 cells packed in 264 battery modules.

With this project, the utility and three First Nations achieved the most important project objectives, ones that prioritize environmental and socioeconomic outcomes to deliver an enhanced quality of life for the community:

- offsetting significant diesel consumption using renewable technology to deliver cleaner energy to the community and, in so doing, reducing GHG emissions, air pollutants, smog, and odour
- allowing the Indigenous partners direct ownership and participation in Alberta's energy sector
- creating jobs and opportunities for skills training, retraining, and mentorship as

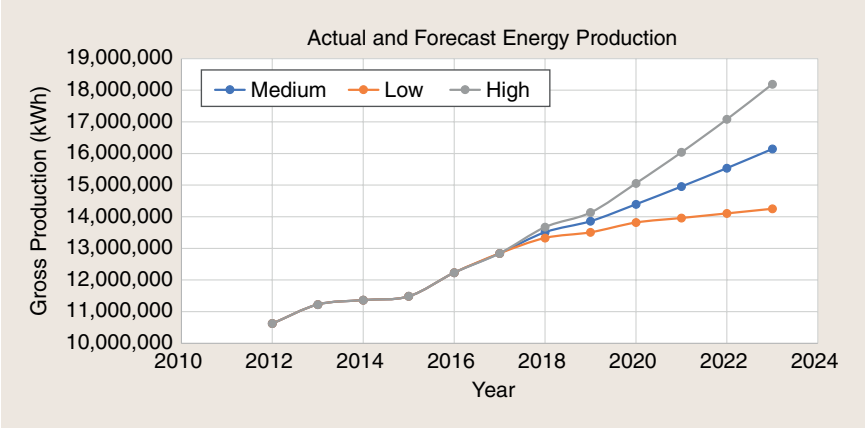


Figure 4: The system load forecast as established in 2018.

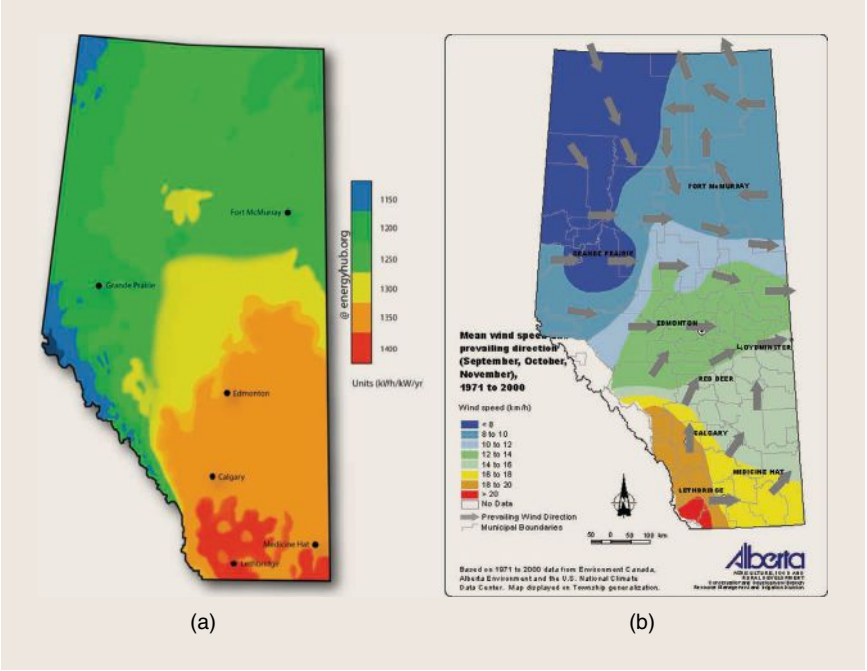


Figure 5: The (a) solar and (b) wind potentials in Alberta. (Source: https://www.energyhub.org/.)

well as stimulating local economic development
- improving the reliability, use, and efficiency of existing diesel generators while increasing the flexibility and resiliency of the local power system.

The overall environmental benefits include the following:

- reducing diesel use by 800,000 L annually and eliminating the need to add new diesel storage tanks
- reducing CO_2 emissions by 2,145 tonnes each year, improving air quality in the immediate vicinity
- providing 25% of the community's electricity through renewable sources
- reducing the number of diesel trucks on the winter ice road by 25 annually
- reducing the safety and environmental risks associated with diesel transportation (improved air quality, reduced noise, decreased risk of spills/accidents, and so on).

In addition to the technical and environmental benefits, there were additional community benefits. The utility played a pivotal role throughout in the community engagement. The project enabled community ownership and self-sustaining economic development through job creation, investment in infrastructure, and revenue from the sale of clean energy. Electricity produced at the facility will be purchased by the utility under a long-term power purchase agreement and will be distributed throughout the community via the local electricity distribution system—all without increasing community electricity rates.

The project's development also provided opportunities, such as jobs, skills training, and capacity building. In addition to utility personnel and contractors, local community residents were also employed throughout the project, providing construction/logistical support and even installing solar panels. The utility adjusted its training programs and supervised the installation to build skills and competencies with the technology. Community members will continue to monitor the system for an additional three years, supported by remote guidance from the utility.

System Optimization

Much research has reported advances in optimizing energy sources in remote communities, and they provide a valuable foundation and rationale for microgrid planning and design. In this project, the utility applied the learnings from a wide range of previous researchers and adopted algorithms from those investigations. The lessons learned during the conception, planning, design, and commissioning of this project can answer many questions that have not been addressed previously in research papers. The results quantify the project capital and operational cost dependency on the PV and BESS sizes. The sizing exercise was performed in HOMER Pro software with dispatch strategy routines modified in MATLAB. Additionally, a siting strategy for the BESS was required and had to be proposed based on practical constraints. This section provides a high-level summary of these studies. For more information on the algorithms, techniques, and procedures, the reader can refer to [3] and [4].

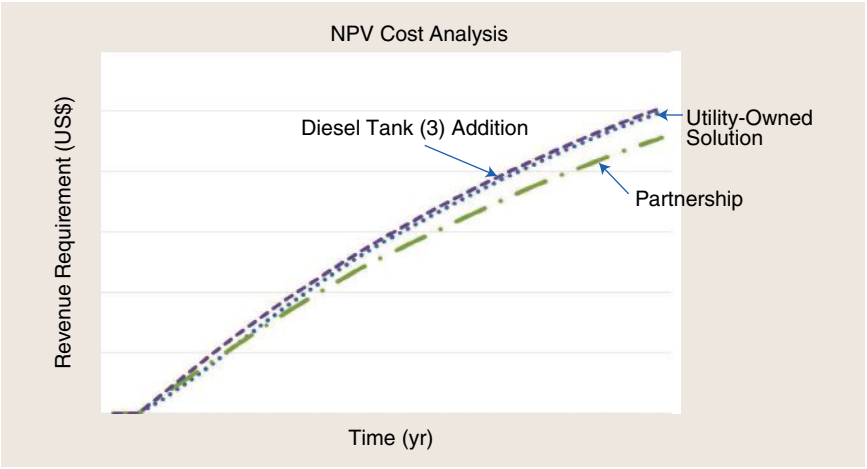


Figure 6: The results of the economic analysis.



Figure 7: A conceptual representation of the system.

The isolated system includes four 4.16-kV diesel generators and a 25-kV distribution system. Most of the town is about 8 km south of the diesel plant. A conceptual representation of the ultimate configuration is shown in Figure 7. The loads are lumped together and represented as a single load. The two solar farms are depicted in Figure 7. Figures 8–10 show the 600-kW PV farm, part of the rows built for the 2.2-MW PV farm, and one of the three trailers containing the PV inverters, respectively.


Figure 8: An aerial view of the 600-kW (phase 1) PV farm.



Figure 9: A portion of the 2.2-MW (phase 2) PV farm during construction.

The 1.6-MW/1.6-MWh BESS was also a result of the optimization algorithm. As with any BESS for similar applications, it relies on a battery management system (BMS) to control the battery pack state of charge (SoC). By controlling the SoC, the BMS can extend the longevity of a battery pack and avoid damage when operating under certain conditions. The available energy at any given time is a direct relationship of the available capacity, the self-discharge rate, the BESS output power, and the time step. The lithium battery packs had their SoCs constrained between 20% and 80%. Figure 11 shows a view of the battery cells inside the battery building.



Figure 10: An interior view of one of the three inverter buildings housing the PV inverters.



Figure 11: An interior view of the battery room showing the battery cells.

The diesel generators are optimized not to operate below 30% of their rating to avoid operating under inefficient conditions (Figure 12). They have three ratings: a nominal (1.15 MW), prime (1.285 MW), and overload rating (1.413 MW).

The microgrid controller includes functions that ensure autonomous (diesel-off) or grid-connected (diesel-on) operation, manage disconnection and reconnection (transition), and control power exchange with the diesel generators.

The microgrid controller is set to perform the following tasks:

- coordinate the dispatch of local generation sources and loads
- set the active and reactive power exchanges
- manage the disconnection and reconnection of the diesel generators
- enable frequency and voltage control
- manage black starts (system energization in response to an outage) as required.



Figure 12: One of the diesel generators in the diesel plant.

Sizing of the PV and BESS Systems

The functions and constraints contained in this section are an integral part of the HOMER software. Both platforms were used. The objective function minimizes the annual system cost to best benchmark the cost analysis. This cost is a summation of the annual capital, operation maintenance, replacement, fuel, and emission costs.

BESS Allocation Analysis

The PV system was located based on where land could be secured for such a large project. As a result, only the BESS allocation was studied. Two objectives were included in the optimization problem: 1) the total electric loss of the system and 2) the voltage profile. For this analysis, the system was modeled in CYME/CYMDIST and its time series long-term dynamic module. In this simulation, system loading hourly data were inputted into the simulation tool as well as the local global horizontal irradiance levels, as obtained from Environment Canada. The utility identified six potential locations to house the BESS, based on the available building leases. For each of these six locations, the long-term dynamic simulation was run for a full year. The output active and reactive powers of the diesel generators, PV system, and BESS as well as the voltage profiles of all nodes were monitored.

The simulation results presented in [3] determined that the best place to install the BESS is at the diesel plant, as this configuration yields the smallest system loss over a one-year period. Accordingly, voltage profiles along the entire system were monitored. The lowest undervoltages and highest overvoltages for an entire year were analyzed.

Microgrid Controller Dispatch Strategy

The dispatch strategy is needed to ensure load and generation are continuously matched, and it has a large impact on the system performance, as expected. In this project, the maximum PV output exceeds the minimum load. Extensive simulations have suggested the need for an efficient and economic strategy to not only maximize renewable energy production but also reduce engine runtime. This strategy is presented in [3]. The algorithm was developed in HOMER Pro with customization in MATLAB. Figure 13 illustrates the energy production breakdown at three different stages of the project.

Further to the optimization exercise conducted to optimize these systems, sensitivity studies based on exhaustive searches were carried out to visualize the impact of changing these recommendations. The objective was to determine at which point further PV addition "saturates" the system in the form of excess energy. Figure 14 shows combinations of PV and BESS that would result in savings equivalent to the addition of more diesel tanks. These results already included the 600-kW PV farm in its baseline. The results were very useful in quantifying the incremental impacts of alternative sizes and were useful for making a final decision on the community-owned PV farm. It also suggests a BESS larger than what was procured would not result in much more savings as compared to the need to arrive at alternatives to installing more diesel tanks.

The First Technical Challenge: Renewable Resource Hosting Capacity

When the project was first conceived and staged into two phases, the natural question one would ask is the following: how big can the phase 1 PV farm be? To address this question, the author proposed a method based on the frequency recovery of diesel generator(s) to rapid reduction in renewable generation production. This is founded on the principle that, in an isolated grid, the dynamic behavior of the synchronous generators is a major limiting factor. Figure 15 shows the system configuration for the phase 1 PV. This system is studied by varying an abrupt reduction in PV output and analyzing the diesel generators' response by using electromagnetic transient (EMT) simulations. Several hundred simulations were conducted to capture various system events. A high-level summary is presented in this section. The reader is encouraged to refer to [5] for more details.

The abrupt reduction in PV output (at 5 s) for various installed ratings (represented in the percentage of the smallest synchronous generator) is shown in Figure 16, which illustrates expected frequency excursions. The figure suggests that penetration levels as low as 28% can result in a frequency drop nearing 57 Hz. For a penetration level of 83%, the frequency drops near 51 Hz. Clearly, some of these penetration levels would cause the diesel generator frequency relay pick-up and trip initiation, blacking out the entire community.

Rather than ascertain whether a frequency relay would pick up or not, this work proposed determining the amount of time the frequency would deviate below a certain threshold. Figure 17 illustrates the time at which the frequency dips below different thresholds (57, 58, and 59 Hz) as the PV penetration level increases.

This figure was derived specifically for the microgrid under development. To become more adoptable, sensitivity studies presented in [5] consider typical system parameters and allow drawing the following general conclusions:

- The lower the inertia constant, the faster the diesel generator will respond to a disturbance, recovering from the frequency dip more rapidly. Larger values of the inertia constant result in a slower response.

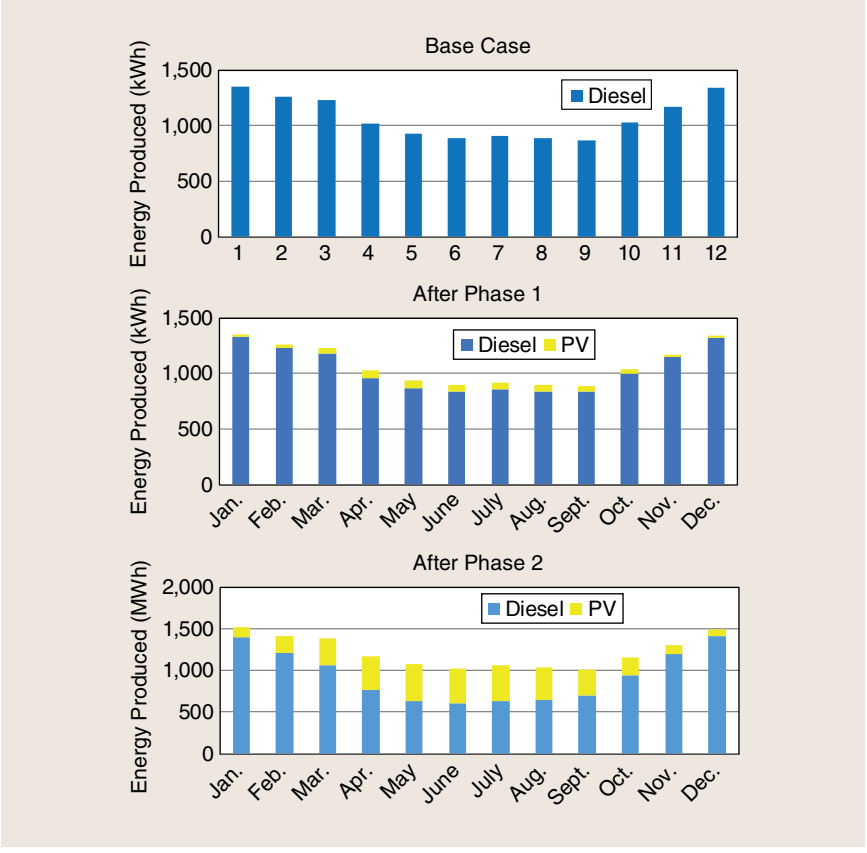


Figure 13: The projected and realized diesel and PV production with the microgrid solution implemented.

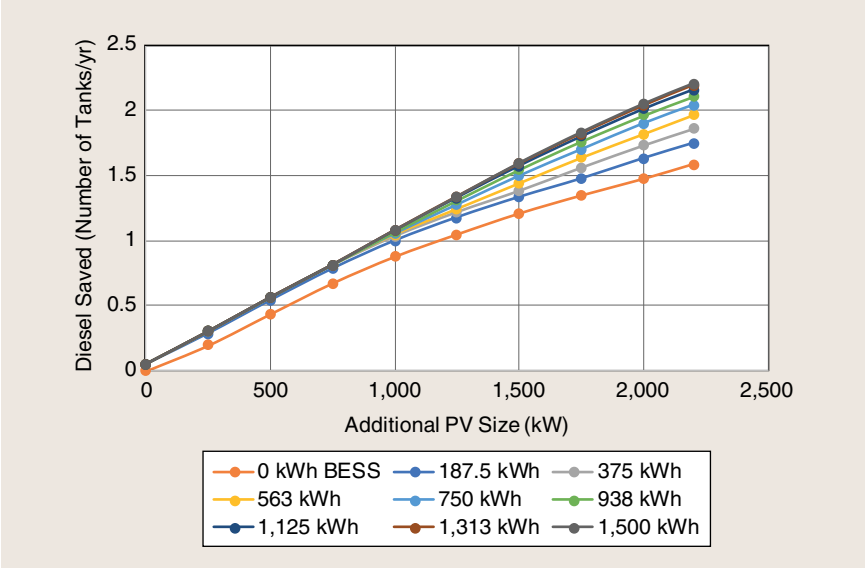


Figure 14: The diesel savings sensitivity analysis for the different BESS and PV sizes.

- The more loaded the generator, the less capable it will be to recover from a disturbance.
- The lower the power factor (lagging) of a load, the higher will be the reactive power demand from the generator, resulting in overexcitation. This overexcitation strengthens the field excitation voltage, increasing stability and causing the generator to respond to disturbances more rapidly.

These findings suggested a hosting capacity of about 40% of the full rating of a single generator, or approximately 450 kW (ac) for the aggregate PV plant. Conventional PV design practices also suggested a dc rating of about 600 kW.

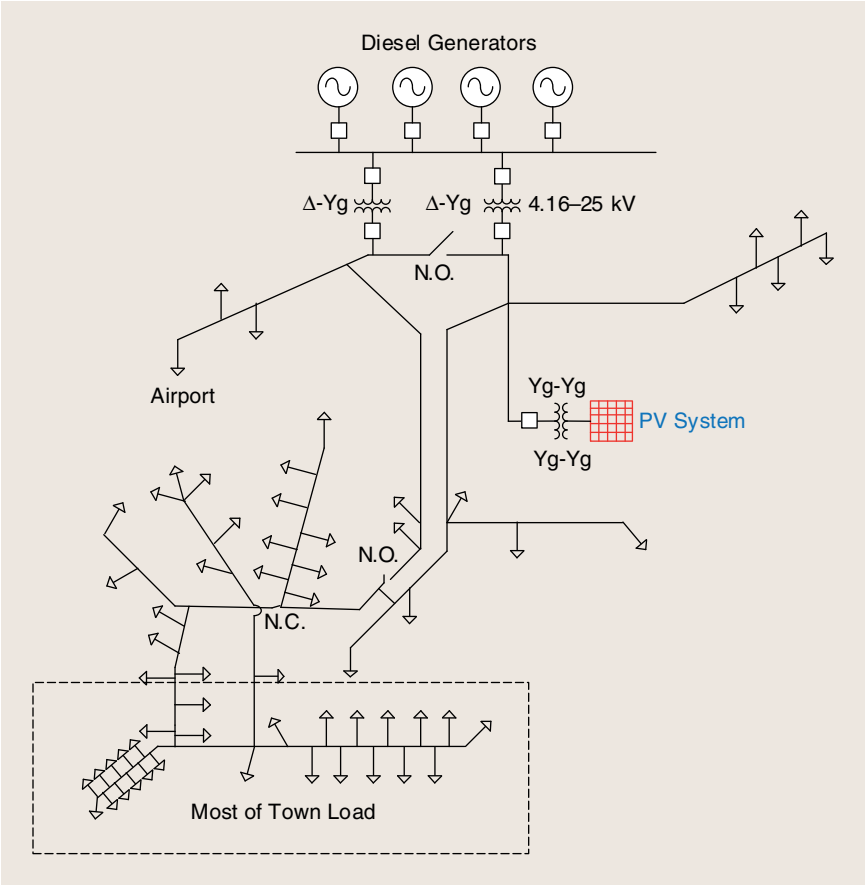


Figure 15: The isolated microgrid used for the hosting capacity study.

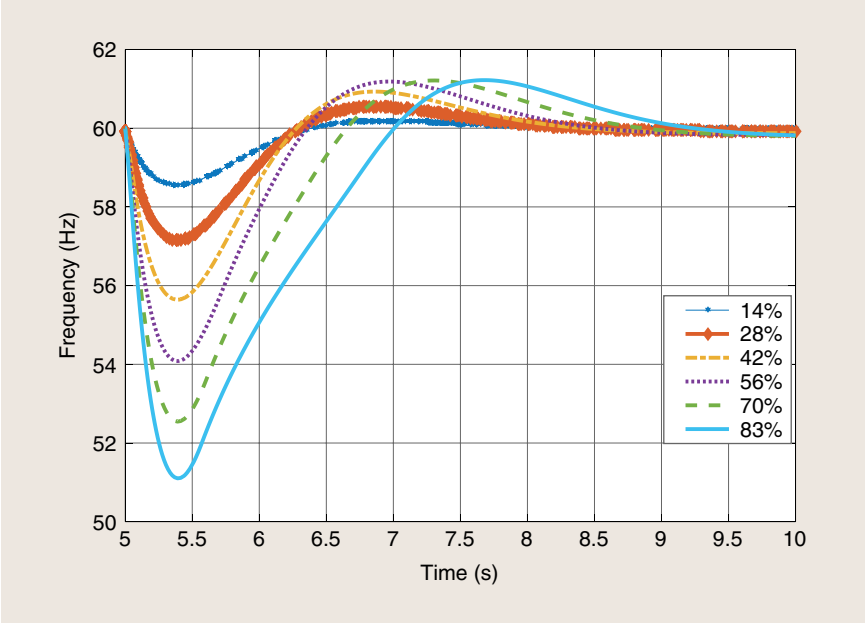


Figure 16: The frequency response for the total loss of the PV farm.

Protection and Grounding in Microgrids

Reliable protection and grounding schemes have been well established for power systems connected to the BES. With the advent and proliferation of microgrids, however, these subjects need to be revisited, as traditional philosophies are no longer sufficient to cope with reduced short circuit levels of DERs. A DER-dominated microgrid will experience a limitation in the functionality of traditional overcurrent elements. This can degrade protection coordination and selectivity and requires a philosophy that is nonstandard in distribution systems. Furthermore, with most DERs operating as positive-sequence current sources and not naturally supplying ground current, performance grounding becomes a fundamental concern. Additional ground sources are required and must be appropriately sized for the needs of the microgrid. This section presents a high-level summary of the protection and grounding schemes used in this microgrid. For more details, the reader can refer to [6].

Protection Philosophies

Protection and grounding are interrelated subjects. Traditional distribution system protection is predominantly employed as nondirectional definite-time and timed overcurrent protection. These elements can reliably protect systems containing only one source (i.e., a substation or a generation plant). In multisourced systems, where the protection sensing element can experience reverse current in both steady-state and short circuit conditions, it becomes necessary to employ overcurrent protection with torque control. This adaptation worked well when emerging DERs were predominantly rotating synchronous machines, which supply considerable amounts of short circuit current.

The proliferation of inverter-based generation has introduced a scenario where DERs supply smaller amounts of short circuit current, which tend to render static overcurrent protection ineffective. Adaptive protection schemes were proposed by many researchers to address this shortcoming, but they also have limitations, especially for ground faults, since most inverters supply a constant current balanced supply. While grid-forming BESS inverters are typically capable of supplying imbalanced currents, their fault currents

are normally comparable in magnitude to their nameplate steady-state current. To fully realize the protection of an inverter-dominated microgrid, it is imperative to consider protection philosophies that do not rely on current sensing. While researchers have made great strides in advancing adaptive protection schemes, these rely on complex algorithms, require the topology of the distribution infrastructure to be modified, or have not achieved a high degree of commercial maturity for mission-critical applications.

Among mature relaying elements, undervoltage is commonly present in the protection suite of generators and is used to protect the generator rather than the system. Relying on this element represents a paradigm shift because of the following:

- This is an element not typically used to protect distribution systems. As such, adequate settings are not as established.
- It is difficult to ensure required trip times are achieved, as the voltage behavior is not as predictable as current. EMT simulations are required, and the results highly depend on modeling assumptions.
- Protection coordination between undervoltage and overcurrent schemes is not straightforward.

Having said this, the trends established by standards, such as IEEE Standard 1547, have dictated the capabilities of inverter-based DERs, which are normally more resilient to abnormal voltage and frequency conditions and allow flexible voltage pickup settings. To increase dependability, underfrequency elements can also be used. Both the voltage and frequency behaviors of the BESS cannot be characterized easily by using generic models. While a vendor-provided model can help characterize the voltage envelope by conducting short circuit studies, the frequency behavior requires EMT simulations and very accurate modeling.

Effective Grounding

Effective grounding is a condition required for the safe and reliable operation of power systems by multiple standards. The following excerpt from IEEE Standard C62.92.1 highlights the importance of grounding and serves as a preamble to its application. "There is no simple answer to the application of grounding. Each of a number of possible solutions to a grounding problem has at least one feature that is outstanding, but which is obtained at some sacrifice of other features that may be equally worthy."

Protection and grounding have conflicting requirements. Temporary overvoltages (TOVs) usually result from insufficient ground currents during a ground fault. The classical and extreme example is a three-wire ungrounded system, where a ground fault results in the healthy phases rising to line-to-line values, while the faulted phase does not supply any fault current to the ground. Conversely, a fully grounded system will not experience any voltage rise in the healthy phases but will have large fault current to the ground. Hence, having adequate ground sources ensures the TOV is mitigated to an acceptable level.

Effective Grounding and Degree of Grounding

IEEE Standard 142 prescribes the requirements for a system to be considered effectively grounded. Accordingly, a location is called *effectively grounded* if it is grounded through a sufficiently low impedance such that, for all system conditions, the ratio X_0/X_1 is positive and not greater than three, and the ratio R_0/X_1 is positive and not greater than one. It is also possible to express TOV as a function of the degree of grounding, which is the ratio $K = Z_0/Z_1$.

TOV

TOV is defined as the voltage ratio between the highest phase voltage of an unfaulted (healthy) phase during a ground fault and the prefault voltage (both are phase-to-ground voltages). TOV can be expressed as a function of the degree of grounding K as demonstrated in [6], mathematically describing the ungrounded, effectively grounded, and fully grounded.

Coefficient of Grounding and Effective Grounding

The coefficient of grounding (COG) is defined as the highest root mean square line-to-ground power-frequency voltage on a sound phase, at a selected location, during a line-to-ground fault affecting one or more phases, as explained in IEEE Standards 141 and 142. Its relationship with TOV and the boundary conditions for effectively grounding were defined in [6], which suggests a TOV of <138% is one of the conditions for effectively grounded for some system assumptions. Conversely, other assumptions translate the condition for effectively grounded to TOV = 125%. This has led to utilities adopting one or the other threshold to accept a system grounding characteristic, especially when interconnecting DERs.

Grounding Practices When Integrating DERs

Standards such IEEE Standard 1547-2018 address the several possible grounding conditions when interconnecting DERs. However, no standard provides a definite prescription of which transformer winding configurations are necessary for interconnection, allowing electric utility discretion on how to achieve effective grounding. As explained in [7], some utilities do not allow a DER transformer connection configured as a Δ–Yg (low-side Δ) because this transformer provides a low impedance ground path, effectively reducing the ground current flowing through upstream protective devices due to the infeed effect [8].

For the reasons discussed, distribution utilities often require DER step-up

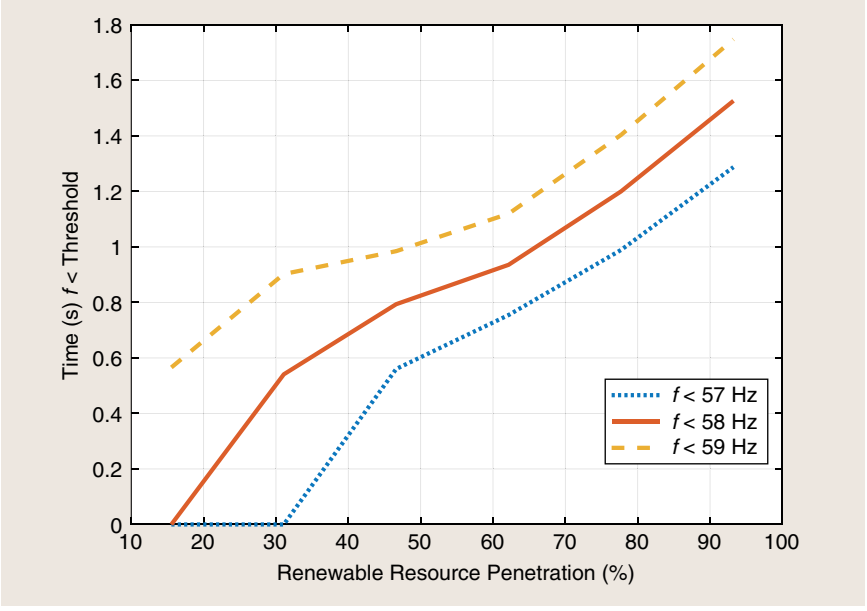


Figure 17: The timing the frequency dips below the threshold at variable penetration levels.

transformers to be configured as Yg–Δ (low-side Yg) or as Yg–Yg. The Yg–Δ configuration has the obvious effect of disallowing any ground fault current to flow into the distribution system, effectively eliminating the infeed effect and increasing COG. String inverters and central inverters used for PV generation applications are oftentimes constructed in delta or ungrounded wye and do not supply zero-sequence current, as they are strictly built as balanced current sources. As a result, unless the Δ–Yg configuration is used, PV generators will not contribute any ground current to ground faults.

When in an islanded operation, a microgrid will require a ground source to supply line-to-ground connected loads. A workable option is to incorporate this ground reference in the grid-forming asset, which can be the BESS. This can be achieved by either using a Δ–Yg step-up transformer configuration or by installing an additional grounding transformer. The first option has the advantages of reducing the COG, reducing ground fault currents in the low-voltage side of the BESS terminal, and improving the ground fault detection on the high-voltage side of the step-up transformer.

System Topology

The area has a very rocky and sandy soil, with very high soil electric resistivity. To improve the ground fault detection, both feeders have a continuous multigrounded neutral (MGN). The MGN has an expected effect of reducing the overall ground fault resistance due to the combined effect of the various installed electrodes. Due to poor soil resistivity, a grounding plate is often required, as conventional rod electrodes frequently cannot reduce equivalent resistance to a desired level. Figure 18 illustrates the system topology after project completion. Each of the four

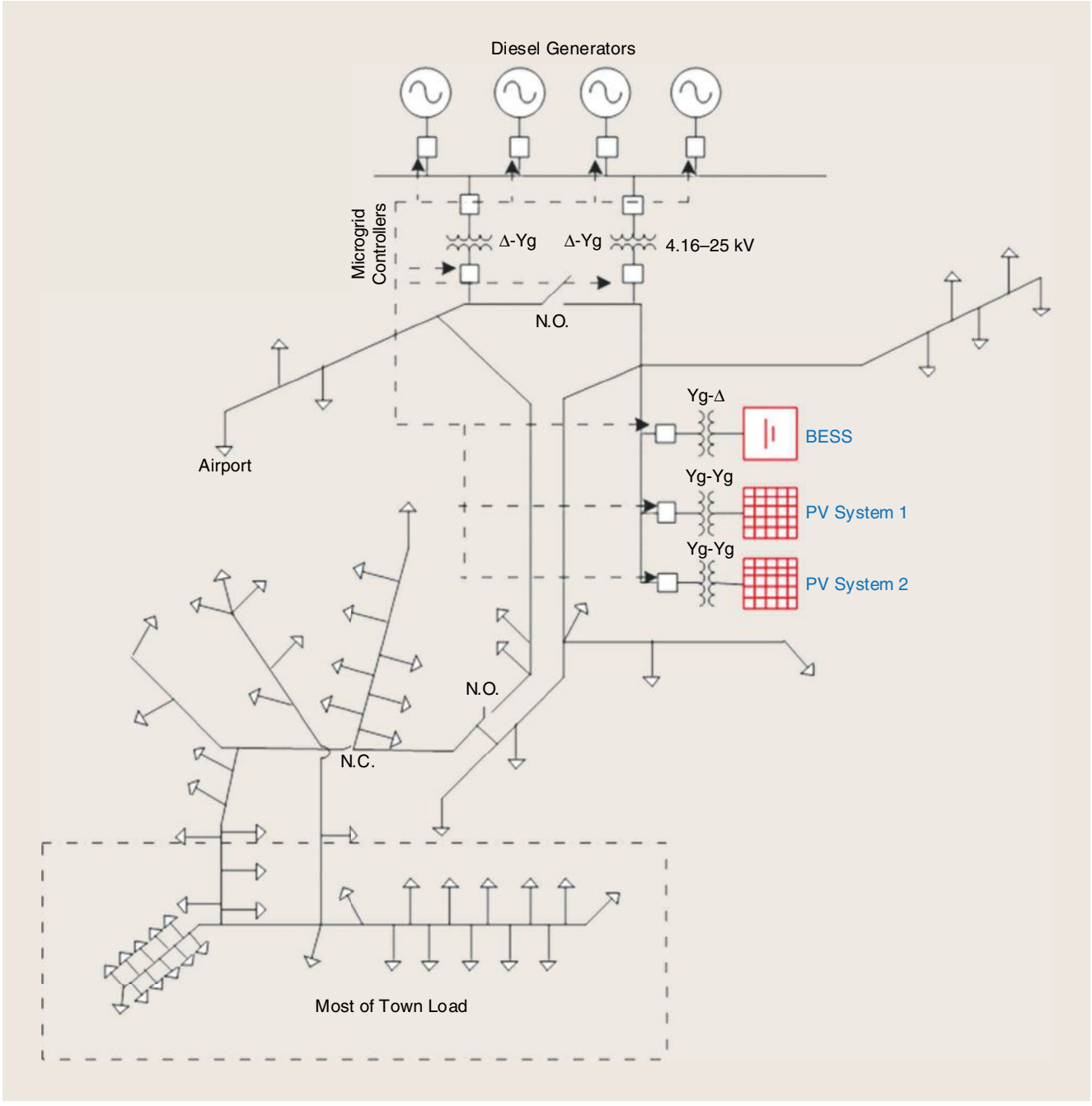


Figure 18: A remote microgrid fitted with DERs and a microgrid controller.

diesel generators, the main feeder breakers and reclosers, the PV systems, and the BESS were fitted with a decentralized microgrid controller, represented by the dot-dashed lines.

The following are notable characteristics and implemented measures:

- *Available short circuit current in islanded mode*: The BESS is coupled through a Δ–Yg (Δ low-side) transformer, resulting in substantial line–ground (LG) fault contribution (due to the BESS step-up transformer). It is not possible to use nondirectional overcurrent protective elements to adequately protect the system for LLL faults, and only for LG faults (due to the ground source provided by the BESS transformer).
- *Voltage polarization (torque control)*: While the BESS inverter contributes a short circuit current only slightly higher than the rated LLL fault current, it contributes much higher for an LG fault. The settings chosen for the BESS interrupter require voltage polarization to avoid tripping on an upstream fault on the distribution system, which is to be cleared by the main feeder fault interrupter.
- *Undervoltage protection*: Due to the reduction in fault current, undervoltage elements were adopted for both the BESS and PV. The voltage envelope obtained through short circuit studies revealed that, for distribution system faults, the experienced voltage drops at the BESS and PV plants (measured at their low-voltage bus) are on the same order of magnitude whether they are operating in grid-connected or islanded mode, allowing the use of a single settings group for each of the devices.
- *Autoreclosing philosophy*: No autoreclosing is enabled at the PV and BESS interrupters, but the microgrid controller has the capability of closing them without human intervention, as required by the operational and restoration algorithms. This was done for three reasons. First, under grid-connected mode, reclosing should not be enabled, as the interrupter only protects the BESS step-up transformer, and any fault is likely to be permanent. Second, this avoids the need for two settings groups. Third, even if reclosing was enabled under islanded mode, the BESS would be unable to ride through its trip, as the entire PV plant would trip upon experiencing an outage and would not return to service for 5 min, requiring initiation of the plant restoration procedure.
- *Performance grounding requirements*: Due to the system configuration, the diesel powerplant step-up transformers are intentionally kept maintained in the system during islanded operation to both maintain the diesel plant station service energized and to provide additional ground sources. As a result, the system has adequate COG and TOV and is effectively grounded during both operating modes. The Δ–Yg (Δ low-side) BESS step-up transformer contributes to this adequacy.

Microgrid Restoration and Black-Start Strategy

While there are established standards for the electrical interconnection and interoperability of microgrids (in the IEEE 1547 and IEEE 2030 families of standards), there is flexibility to strategize its restoration and black-start procedures. This microgrid configuration is not expected to deteriorate the system stability and reliability. It is also expected it will not require modifying the black-start procedure from what is in place prior to the microgrid implementation, and only integration efforts are required. The following steps are followed to restore the system in the case of a community-wide blackout:

1. The microgrid controller directs the BESS and PV offline.
2. Plant operators initiate a start of all available diesel generators.
3. Generator breakers are closed, energizing the plant.
4. The generator breakers are closed with a 1-min time delay in between.
5. Feeder breakers are closed. If there is a system fault, the normal fault finding, isolation, and restoration are followed by service workers. If there is no system fault, proceed to next step.
6. After a settable time delay, if the system voltage and frequency are normal, the BESS is started in grid-following mode.
7. After a settable time delay (5 min by default), if the system voltage and frequency are normal, the PV starts production in grid-following mode (this is the only mode the PV inverters can operate).

Looking up to the Future

Even though the topic of microgrids has been in vogue for more than two decades, most deployments have been either proof-of-concept or demonstration projects. Rarely can business cases be justified unless there are grants involved or an investment that can be categorized as R&D and is not lucrative. This microgrid development, however, made economic sense without grants. However, due to the tangible benefits to the local economy, the environment, and to the resident First Nations, grants were provided to the First Nations by both the provincial and federal governments, enabling their active participation in the creation and ownership of this project along with the electric utility.

This project allowed the utility to discover and overcome many practical challenges that were logistical in nature but also technical, as demonstrated by our past publications. The electric utility is taking these learning experiences to further microgrid developments in its other remote communities, and we hope to further contribute to improving the quality of life of other First Nations, to the environment, and to the scientific knowledge. ■

References

[1] J. Royer, "Status of remote/off-grid communities in Canada," Government of Canada, 2011. https://www.nrcan.gc.ca/energy/publications/sciences-technology/renewable/smart-grid/11916

[2] "Climate leadership: Report to minister," Alberta, 2015. https://open.alberta.ca/publications/climate-leadership-2015

[3] A. B. Nassif, R. Anderson, and F. Nejabatkhah, "Planning of a northern isolated microgrid," in *Proc. 2019 IEEE Electr. Power Energy Conf. (EPEC)*, pp. 1–6. doi: 10.1109/EPEC47565.2019.9074829.

[4] F. Nejabatkhah, Y. W. Li, A. B. Nassif, and T. Kang, "Optimal design and operation of a remote hybrid microgrid," *CPSS Trans. Power Electron. Appl.*, vol. 3, no. 1, pp. 3–13, Mar. 2018. doi: 10.24295/CPSSTPEA.2018.00001.

[5] A. B. Nassif, "A frequency response-based renewable resource hosting capacity method for isolated grids," in *Proc. CIGRE Canada Conf.*, Toronto, ON, 2020, pp. 1–8.

[6] A. B. Nassif, "A protection and grounding strategy for integrating inverter-based distributed energy resources in an isolated microgrid," *CPSS Trans. Power Electron. Appl.*, vol. 5, no. 3, pp. 242–250, Sept. 2020. doi: 10.24295/CPSSTPEA.2020.00021.

[7] A. Vukojevic, "Lessons learned from microgrid implementation at electric utility," in *Proc. 2018 IEEE PES Innov. Smart Grid Technol. Conf.*, Washington, D.C., pp. 1–5. doi: 10.1109/ISGT.2018.8403338.

[8] A. B. Nassif, "An analytical assessment of feeder overcurrent protection with large penetration of distributed energy resources," *IEEE Trans. Ind. Appl.*, vol. 54, no. 5, pp. 5400–5407, Sept./Oct. 2018. doi: 10.1109/TIA.2018.2810260.

[9] "Fort Chipewyan winter road updates," Regional Municipality of Wood Buffalo, Fort McMurray, AB, Mar. 19, 2021. https://www.rmwb.ca/modules/news/en/ftchipwinterroad

About the Author

Alexandre Nassif (nassif@ieee.org) is a specialist engineer at ATCO and LUMA Energy.

We Just Couldn't Resist ...

David Green
St. John's NL
davidgreen@ieee.org

Allan was a successful electrical engineer, but his real passion had been classical music. He had taken violin lessons all during grade school. He kept playing during his engineering career to keep his skills sharp, and he even took music theory courses at the local university to expand his musical knowledge.

He quit his job to pursue his passion further. He successfully auditioned for the local orchestra. After several months, he had learned the intricacies of working with this musical ensemble and was promoted to the first violin section. A few months after that, he became the leader of that section and hence became the orchestra's concertmaster. Finally, after a couple of years, the orchestra's long-standing maestro retired, and Allan took on the role himself.



©SHUTTERSTOCK.COM/MINIARIA / ©SHUTTERSTOCK.COM/MINIARIA

Allan was ambitious. He took on very challenging orchestral works and brought out the very best in the ensemble. They practiced long hours, pulled off many magnificent performances, and delighted audiences across the country. Soon they became world renowned. Under Allan's stern and steady baton, the orchestra performed these masterworks in Massey Hall in Toronto, Carnegie Hall in New York City, and Royal Albert Hall in London, all to wild acclaim.

Even though he felt like he had accomplished as much as he could, Allan wanted to pull off one final concert before finally retiring from his musical career. This one would be very special: it was to be held outdoors in Vienna, Austria. The big day came, and even though there were ominous rainclouds far to the east, they decided to proceed with the concert rather than disappoint the eager attendees.

The musicians of the orchestra made their way to the stage, followed by their fearless leader. After the ritual bows from the performers, the thunderous applause eventually subsided, and the audience became silent with anticipation. Just as Allan raised his arms to cue the first dramatic chords of the piece, a bolt of lightning struck him down! The crowd was aghast.

As emergency personnel tended to him, one music aficionado in the crowd told the person next to him: "This is indeed tragic, but nobody should be surprised. Everyone knows Al is a great conductor." ■



IEEE Canadian Foundation
La Fondation Canadienne de L'IEEE.

FROM THE PRESIDENT—The IEEE Canadian Foundation extends its sincere gratitude to these IEEE Members and friends whose outstanding generosity is elevating IEEE's presence and benefits in Canada for students and others. Here you will find Foundation donors for 2020. Also listed are donors who have made bequests in their will or made memorial or tribute contributions as well as individual donations from industry and organizations.

In 2020, donor gifts and investments provided $64,751 to help support

- three IEEE Canadian Foundation scholarships
- 11 IEEE Canadian Foundation Special Grants
- one IEEE Canada Women in Engineering Prize
- seven IEEE Canada Medals (W.S. Read Outstanding Service Award, Fessenden Award, R.H. Tanner Industry Leadership Award, J.M. Ham Outstanding Engineering Educator Award, P. Ziogas Electric Power Award, J.J. Archambault Award, and M.B. Broughton Award)
- two IEEE Canadian Foundation Québec Science Fair Prizes

In 2020, donor gifts and investments provided $64,751.

- one Findlay Scholarship
- one Gargantini–Strybosch Scholarship
- one Cercone Scholarship
- one Power Quality Scholarship
- four other endowed awards and scholarships.

Thank you so much for your support in 2020 and your continued support in 2021.



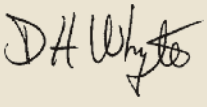
DU PRÉSIDENT—La Fondation canadienne de l'IEEE exprime sa sincère gratitude à ses membres et amis de l'IEEE dont la générosité exceptionnelle rehausse la présence et les avantages de l'IEEE au Canada pour les étudiants et autres. Vous trouverez ici les donateurs de la Fondation pour 2020. Sont également répertoriés les donateurs qui ont fait des legs testamentaires ou des contributions commémoratives ou hommages, ainsi que des dons individuels de l'industrie et des organisations.

En 2020, les dons et les investissements des donateurs ont fourni 64 751 $ pour aider à soutenir

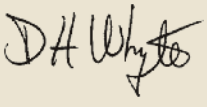
En 2020, les dons et les investissements des donateurs ont fourni 64 751 $.

- Trois bourses de la Fondation canadienne de l'IEEE
- 11 subventions spéciales de la Fondation canadienne de l'IEEE
- Un prix IEEE Canada pour les femmes en génie
- Sept médailles IEEE Canada (le Prix de service exceptionnel W.S. Read, le Prix Fessenden, le Prix du leadership de l'industrie R.H. Tanner, le Prix du meilleur enseignant en génie J.M. Ham, le Prix de l'énergie électrique P. Ziogas, le Prix J.J. Archambault et le Prix M.B. Broughton)
- Deux prix IEEE Fondation canadienne Expo-sciences Québec
- Une bourse Findlay
- Une bourse Gargantini-Strybosch
- Une bourse Cercone
- Une bourse d'études sur la qualité de l'énergie
- Quatre autres prix et bourses sont proposés.

Merci beaucoup pour votre soutien en 2020 et votre soutien continu en 2021.



David H. Whyte
President,
IEEE Canadian Foundation



David H. Whyte
Président de la Fondation
Canadienne IEEE

IEEE Canadian Foundation
Fondation Canadienne de l'IEEE

2020 Honour Roll of Donors

Tableau d'honneur des donateurs 2020

LEADERSHIP ASSOCIATION
L'ASSOCIATION LEADERSHIP

Leader/Chef ($10,000–$25,000)
IEEE Canada
(Glass Service Medal)
Winnipeg Section

Patron/Mécène ($5,000–$9,999)

Associate/L'Associate ($2,500–$4,999)

Sponsor/Parrain ($1,000–$2,499)
Dr. Keith B. Brown
CDN Online Giving (Benevity)
Ray Findlay
Jason Gu
Maike Liuken

ADVOCATES ASSOCIATION
L'ASSOCIATION DES AVOCATS

Gold Advocate/Avocat Or ($500–$999)
Eric Auzins
David Dossot
Nicholas Hall-Patch
Denard Lynch
Sydney Tang
David Whyte

Silver Advocate/Avocat Argent ($250–$499)
Jeffrey Arcand
Bateman
Casiato
Donna Findlay
Murray MacDonald
McDonald
Arun Ogale
Leonard Petrie
Hafizur Rahman

Bronze Advocate/Avocat Bronze ($100–$249)
G. Aitken
Anon
Harold Briggs
William Broughton
L. Campbell
R. Chatterjee
Ruhua Chen
Ronald Clifton
John Densley
Branislav Djokic
John D. Dorey
Louis-Gilles Durand
W. Dutfield
Jose Figueroa
Emanuel Gianni
Eric Holdrinet
Mark Huggins
Emanuel Istrate
David Kemp
Thomas Kern
Witold Kinsner
J. Lambert
Peter Leach
Warren Lefrancois
Gabriel Lengyel
Scott Lowell
Howard Malm
Luc Matteau
Cosmin Munteanu
M. Musick
Shawn Nicholl
Guy Olivier
J. Pearce
Robert Potter
David Rogers
Tarunbikash Roy
Paul Sadowski
Dario Schor
Rachad Shoucri
Tom Skinner
David Thomson
Wayne Wagner
J. Want
Howard Wintle
Paul J. Zsombor-Murray

Advocate/Avocat ($25–$99)
Dr. M. Fayek Abulela
Paul Acchione
John Ahern
Metin Akgun
A. Alcock
Donald Allan
Rob Anderson
Jason Aspin
Danut Bancea
Anader Benyamin-Seeyar
Wayne Best
Edward Bodfish
Louis Borgogelli
E. Bridges
Barry Butwell
Carmine Casella
James Cavers
Kee Chan
Anthony Cheung
William Chidlow
Carlos Christoffersen
Brent Christopherson
Doug Cline
Dan Coode
Stewart Crampton
S. Douglas Cromey
Daniel Dalle
Wladyslaw Danielak
Leanne Dawson
Jeffrey Deloughery
R. Demers
Celia Desmond
James Dietrich
John G. Driscoll
Jean-P. Dubost
Brian Eatock
Jim Ellis
Scott Fang
Richard Farquharson
Darryl Filazek
Michel Fortier
Wesley Friesen
Charles Gallant
James Gilliland
Mark Green
C. Guelke
Vishwa Gupta
Jean-Francois Hache
J. Hamilton
Richard Hampton
Robert Hanna
John Harris
J. Haslett
R Haythornthwaite
Harvey Hicks
John Hunter
Richard Johnston
Edward Jull
Graham Jullien
L. Kessler
Ismael Kourouma
Paulin Laberge
Anil Lal
A. Leite
John Lodge
David Lyons
Michael Macdonald
Donald Madill
Winston Madray
Jaidev Mahajan
Franco Mammarella
David Mann
William Marchand
James Mcconnach
Michael Mcguire
Hugh McKay
Ronald McOuat
Delfin Montuno
Tim Musclow
K. Natarajan
Frank Nelles
John Nisbet
Peter Onno
Frank Oreskovich
Brian Osborne
Juliusz Ostrowski
Joseph Pandolfo
Anton Perera
Dennis Peters
Dorina Petriu
Mark Pinkus
R. Przysiezniak
John Richardson
Donald Robinson
Donald Roy
Marin Sampaleanu
Frank Schaedlich
Roger Schinkel
Edgar Schutt
John Scott
Brian Scott
E. Shadeed
Narayan Shankar
Duncan Sharp
Pietra Shirley
Bernard Shoub
A. Stanbury
David Storrie
Jiri Svoboda
James Swetlikoe
Honorato Tapang
R. Terreault
Marc-Andre Tetrault
Michel Tetu
Giao Trinh
Malcolm Vant
John Vardalas
Ian D. Vogt
Norman VonStyp
Andrew Waggott
Robert Walker
Conal Walsh
Robert M. Watson
R. M. Watson
Arthur Webster
Dean Weiten
Paul Wiancko
B. Winter
KunMing Wong
Kenneth Wu
T. Wyatt
Kevin Yau
Alfred Yu
David Yurach
Laura Zapata-Aspiazu
Yilin Zhao

THE CANADIAN IEEE HERITAGE CIRCLE HONOURED PHILANTHROPISTS
(RECOGNIZING LONG-STANDING SUPPORTERS)

LE CERCLE D'HÉRITAGE DE L'IEEE CANADIEN PHILANTHROPE HONORÉ
(RECONNAISSANCE DE SUPPORTEURS À LONG TERME)

NIVEAU REGINALD FESSENDEN LEVEL ($5,000–$9,999)

Bob Alden Fund
Keith Brown
Ray Findlay
London Hydro
George Spark

NIVEAU ADAM BECK LEVEL ($1,000–$4,999)

Amir Aghdam
Eric Auzins
Elmer Bourque
Donald Cowan
Ian Dutton
Dave Kemp
Witold Kinsner
Scott Lowell
Maike Luiken
Denard Lynch
Howard Malm
Luc Matteau
Andrew Molozzi
John Mowbray
Lawrence Murphy
Guy Olivier
John Plant
Robert Potter
Hugh Swain
Sydney Tang
Simon Taylor
David Whyte

The honour roll formally recognizes all donors contributing $25 or more. The foundation extends our thanks also to those donors who are not listed.

La liste d'honneur reconnaît officiellement tous les donateurs qui versent 25$ ou plus. La fondation remercie également les donateurs qui ne sont pas inscrits sur la liste.

In Recognition or in Memory of/A la reconnaissance de ou a la mémoire de
Dr. Robert Alden
by Luc Matteau
Wallace S. Read
by Dave Kemp
Dr. Glenn Swift
by James Dietrich

Planned Giving/Don planifé
Fiorenza Albert-Howard
Miro Forest
David Whyte

IEEE Canadian Foundation
Fondation canadienne de l'IEEE

David H. Whyte, President / Président Ph: 416-233-7946
Luc Matteau, Treasurer / Trésorier Ph: 705-743-7712
456 Rogers Street, Peterborough, Ontario K9H 1W9

http://ieeecanadianfoundation.org
president.ieeecanadianfoundation@ieee.ca
treasurer.ieeecanadianfoundation@ieee.ca

Fiorenza Albert-Howard

Fiorenza Albert-Howard
IEEE Life Senior Member
f.alberthoward@ieee.org

Let me introduce myself: my name is Fiorenza Albert-Howard, and I joined IEEE when I moved to the United States from Italy, where I was born and received my degrees in engineering and in computer sciences. In Italy, the university is free. You need only buy books for the classes. Very often, students would purchase used books as they can be very costly. After arriving in the United States, I noticed how expensive the universities were. As a Member of IEEE, I soon realized the importance of the programs and higher-education mission served by the Institute.

During my extremely enjoyable career, I was fortunate to meet and work with some of the pioneers of the academic and professional fields with which I was involved. I appreciate how important it is to support other young individuals, women and men equally, who can benefit from and flourish with a scholarship meant to defray an expensive university tuition.

Our students are the "why" we do what we do, but you are the "how."

At my neighbourhood college, Capilano University, in British Columbia, I have set up an endowment for students in engineering and computing. As the pandemic encroached, I realized that I should also plan to leave a support base for future students, which is why I established a share of my estate for the IEEE Canadian Foundation: to contribute, in the future, to the extraordinary work done by the Foundation itself.

I am asking all of you to do the same. Our students are the "why" we do what we do, but you are the "how." You are the essential piece of the puzzle that gives our students the momentum they need to achieve their higher-education dreams. It is because of your generosity that IEEE students are able to channel their innovation, imagination and passion into pursuing meaningful careers.



The year 2020 was a difficult one for many, and it is continuing to be so. But our gift can provide hope and encouragement, enabling students to continue to pursue their dreams.

Throughout these tough times, we have witnessed kindness and compassion from many individuals and communities who have come together to support one other. This is the key to strengthening our capacity to inspire imagination among our students and provide them hope for the future.

Your generous donation, at any level, will reduce the impact of COVID-19 on a struggling student. If you've ever found yourself in need, you would certainly appreciate the helping hand of a stranger. Today is the time to be kind and caring.

Even a small donation can make a significant impact on a student. You will ensure that every student in need receives the necessary help to succeed. For many of us, these are challenging times. COVID-19 continues to impact our community, fundamentally changing how we work and learn. We want to make sure that the IEEE Canadian Foundation continues its work to support students in their journey. ■

About the Author

Fiorenza Albert-Howard has worked in computing throughout her entire professional life, managing several large projects in Europe with IBM, Olivetti, General Electric, and Honeywell. In the United States, she was with Hughes Aircraft and Southern California Edison. In Canada, she worked with BC Telephone, where she directed the design of the digital provincial network. At the University of British Columbia (UBC), she served as the director of networking and telecommunications, where she spearheaded the design and implementation of a fiber-backbone network for UBC.

She received her B.Sc. degree in civil engineering; her master of business administration degree in statistics, actuarial, and demographic sciences; and her Ph.D. degree in statistics applied to computer sciences, all from the University of Roma, Italy. She has published three books on computers and system analysis, and several articles in Italian and American magazines.

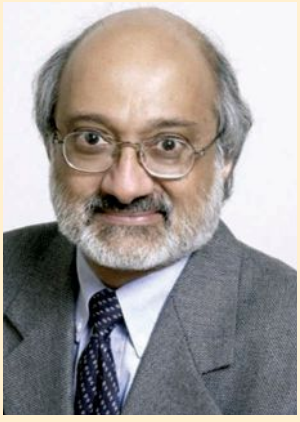
She is engaged in volunteering with several organizations, both in Canada and internationally. In particular, she is involved with IEEE, the Canadian Federation of University Women, and Capilano University Foundation. She has served as chair of the IEEE Technical Field Awards Council, and she is a member of the IEEE Life Members Committee, IEEE Foundation Grants Evaluation Committee, and IEEE Canadian Foundation.

2021 IEEE CANADA A.G.L. MCNAUGHTON GOLD MEDAL
MÉDAILLE D'OR A.G.L. MCNAUGHTON DE L'IEEE CANADA 2021

For outstanding contributions to robotics, control systems, haptics, and teleoperations and their practical applications
Pour contributions exceptionnelles à la robotique, aux systèmes de contrôle, à l'haptique et à la téléopération et à leurs applications pratiques

Rajni Patel, London, ON

Dr. Rajni Patel received the Ph.D. degree in electrical engineering from the University of Cambridge, England, in 1973 and currently holds the position of distinguished university professor and Tier 1 Canada Research Chair in the Department of Electrical and Computer Engineering with cross appointments in the Department of Surgery and the Department of Clinical Neurological Sciences at Western University. Dr. Patel is a founding member of Canadian Surgical Technologies and Advanced Robotics and serves as its director of engineering. He has over 35 years of research experience in the design, simulation, prototyping, and control of advanced robotic systems. He has also made significant contributions to the development and application of intelligent control techniques, and computational and robustness issues in control system design. From 1991 to 2000, Dr. Patel collaborated with the Canadian Space Agency (CSA) and Bombardier Inc. on three of CSA's Strategic Technologies in Automation and Robotics programs. Since 2000, Dr. Patel's research has focused on applications of robotics, teleoperation, and haptics in minimally invasive surgery and



therapy, surgical training, and skills assessment, and more recently on applications for neurological movement disorders, including those due to Parkinson's disease and stroke.

Dr. Patel is a Life Fellow of IEEE, a Fellow of the Royal Society of Canada, Canadian Academy of Engineering, and the American Society of Mechanical Engineers (ASME). He has served on the editorial boards of several journals, including *IEEE Transactions on Robotics*, *IEEE/ASME Transactions on Mechatronics*, *IEEE Transactions on Automatic Control*, *Automatica*, and *Journal of Medical Robotics Research*. Dr. Patel is the editor of *Minimally Invasive Surgical Robotics, Volume 1* (of four volumes) of *The Encyclopedia of Medical Robotics*, published in 2018. ■

Dr. Rajni Patel a obtenu le doctorat en génie électrique de l'Université de Cambridge, Angleterre, en 1973 et occupe présentement le poste de professeur émérite et titulaire d'une chaire de recherche du Canada de niveau 1 au département de génie électrique et informatique avec nominations conjointes au département de chirurgie et au département des sciences neurologiques cliniques à l'Université Western. Dr. Patel est membre fondateur de Canadian Surgical Technologies and Advanced Robotics (CSTAR) et en est le directeur de l'ingénierie. Il a plus de 35 ans d'expérience en recherche dans la conception, la simulation, le prototypage et le contrôle de systèmes robotiques avancés. Il a également apporté des contributions significatives au développement et à l'application de techniques de contrôle intelligent, ainsi qu'à des enjeux de calcul et de robustesse dans la conception de systèmes de contrôle. De 1991 à 2000 Dr. Patel a collaboré avec l'Agence spatiale canadienne (ASC) et Bombardier Inc. à trois des programmes de technologies stratégiques en automatisation et en robotique (TSAR) de l'ASC. Depuis 2000 les recherches de Dr. Patel se sont penchées sur les applications de la robotique, de la téléopération et de l'haptique dans la chirurgie et la thérapie à effraction minimale, la formation chirurgicale et l'évaluation des compétences, et plus récemment sur les applications des troubles neurologiques du mouvement y compris ceux dus à la maladie de Parkinson et aux accidents vasculaires cérébraux. Dr. Patel est Fellow à vie de l'IEEE, Fellow de la Société royale du Canada, de l'Académie canadienne du génie et de l'American Society of Mechanical Engineers (ASME). Il a siégé aux comités de rédaction de plusieurs revues notamment *IEEE Transactions on Robotics, IEEE/ASME Transactions on Mechatronics, IEEE Transactions on Automatic Control, Automatica* et le *Journal of Medical Robotics Research.* Dr. Patel est rédacteur en chef de *Minimally Invasive Surgical Robotics, volume 1* (de 4 volumes) de *l'Encyclopedia of Medical Robotics* publiée en 2018. ■

2021 IEEE CANADA R.A. FESSENDEN MEDAL
MÉDAILLE R.A. FESSENDEN DE L'IEEE CANADA 2021

For exceptional technical contributions to wireless communications and networks
Pour contributions techniques exceptionnelles aux communications et réseaux sans fil

Weihua Zhuang, Waterloo, ON

Weihua Zhuang received the Ph.D. degree in electrical engineering in 1993 from the University of New Brunswick. She has been with the Department of Electrical and Computer Engineering, University of Waterloo, since 1993, where she is a university professor and a Tier 1 Canada Research Chair in Wireless Communication Networks. Dr. Zhuang was a recipient of the 2021 R.A. Fessenden Award from IEEE Canada, 2021 Women's Distinguished Career Award from the IEEE Vehicular Technology Society, 2017 Technical Recognition Award in Ad Hoc and Sensor Networks from the IEEE Communications Society, and a corecipient of 12 Best Paper Awards from premier international conferences. She was the editor-in-chief of *IEEE Transactions on Vehicular Technology* from 2007 to 2013, technical program chair/cochair of the 2017/2016 fall IEEE Vehicular Technology Conference, and technical program symposia chair of the 2011 IEEE Global Communications Conference. She is an elected member of the Board of Governors and vice-president for publications of the IEEE Vehicular Technology Society. She was an IEEE Communications Society Distinguished Lecturer from 2008 to 2011. Dr. Zhuang is a Fellow of IEEE, the Royal Society of Canada, Canadian Academy of Engineering, and the Engineering Institute of Canada. ■



Weihua Zhuang a reçu le doctorat en génie électrique en 1993 de l'Université du Nouveau-Brunswick. Elle travaille au Département de génie électrique et informatique de l'Université de Waterloo depuis 1993, où elle est professeure et titulaire d'une chaire de recherche du Canada de niveau 1 sur les réseaux de communication sans fil. Dr. Zhuang a reçu le prix R.A. Fessenden 2021 de l'IEEE Canada, le Women's Distinguished Career Award 2021 de l'IEEE Vehicular Technology Society, le Technical Recognition Award in Ad Hoc and Sensor Networks 2017 de l'IEEE Communications Society, et a été co-récipiendaire de 12 prix du meilleur article lors de conférences internationales de premier plan. Elle a été rédactrice en chef d'IEEE Transactions on Vehicular Technology de 2007 à 2013, présidente/coprésidente du programme technique de l'IEEE VTC aux automnes 2016 et 2017, et présidente des colloques du programme technique de l'IEEE GLOBECOM 2011. Elle est membre élue du Conseil des gouverneurs et vice-présidente pour les publications de l'IEEE Vehicular Technology Society. Elle a été conférencière distinguée de l'IEEE Communications Society de 2008 à 2011. Dr. Zhuang est membre de l'IEEE, de la Société royale du Canada, de l'Académie canadienne du génie et de l'Institut canadien des ingénieurs. ■

Dr. Zhuang a reçu le prix R.A. Fessenden 2021 de l'IEEE Canada.

IEEE Awards
Prix de l'IEEE

IEEE Dennis J. Picard Medal for Radar Technologies and Applications
For contributions to the development of the theory and practice of radar, especially cognitive radar and adaptive filtering
Simon Haykin, McMaster University, ON

IEEE Award in Power Engineering
For contributions to the theory and practice of high-frequency power-conversion systems
Praveen K. Jain, Queen's University, ON

2021 IEEE CANADA P.D. ZIOGAS ELECTRIC POWER MEDAL
MÉDAILLE P.D. ZIOGAS D'ÉNERGIE ÉLECTRIQUE DE L'IEEE CANADA 2021

For contributions to the theory and practice of power system stability and operation
Pour contributions à la théorie et à la pratique de la stabilité et de l'opération des réseaux électriques

Chi Yung Chung, Saskatoon, SK

C.Y. Chung is a professor, the NSERC/SaskPower Senior Industrial Research Chair in Smart Grid Technologies, and SaskPower Chair in Power Systems Engineering in the Department of Electrical and Computer Engineering at the University of Saskatchewan, Canada. He is a prominent leader for advancing academic activities and applied research in power systems engineering development in the province of Saskatchewan. He is now leading a research team, supported by SaskPower and NSERC of Canada, to conduct cutting-edge and long-term smart grid research for SaskPower and address critical technical issues associated with smart grid technologies and their applications to real power systems.



Prof. Chung is currently a senior editor of *IEEE Transactions on Power Systems*, vice-editor-in-chief of *Journal of Modern Power Systems and Clean Energy*, and a subject editor of *IET Generation, Transmission & Distribution*. He is an IEEE PES Distinguished Lecturer and a member of the IEEE PES Fellow Evaluation Committee. He is also a Fellow of IEEE, EIC, IET, and HKIE. ■

Prof. Chi Yung Chung est professeur, titulaire de la chaire de recherche industrielle CRSNG-SaskPower en technologies des réseaux intelligents et de la chaire SaskPower en génie des systèmes électriques au département de génie électrique et informatique de l'Université de la Saskatchewan, Canada. Il est un chef de file de premier plan pour l'avancement des activités universitaires et de la recherche appliquée au développement du génie des systèmes électriques dans la province de Saskatchewan. Il dirige actuellement une équipe de recherche, appuyée par SaskPower et le CRSNG du Canada, pour mener des recherches de pointe et à long terme sur les réseaux intelligents pour SaskPower et aborder des questions techniques cruciales associées aux technologies de réseaux intelligents et à leurs applications aux systèmes électriques concrets.

Prof. Chung is présentement rédacteur senior pour *IEEE Transactions on Power Systems*, vice-rédacteur en chef du *Journal of Modern Power Systems and Clean Energy* et rédacteur thématique pour *IET Generation, Transmission & Distribution*. Il est conférencier émérite de l'IEEE PES et membre du comité d'évaluation des Fellow de l'IEEE PES. Il est également Fellow de l'IEEE, l'ICI, l'IET et HKIE. ■

IEEE Canada Exemplary Section Awards
Prix de sections exemplaires de l'IEEE Canada

"For good section leadership, management, and administration"
"Pour un bon leadership, la gestion et l'administration de la section"

Exemplary Large Section Award/Prix de grande section exemplaire
Montréal Section
(With honourable mention to the Toronto Section)

Exemplary Medium Section Award/Prix de section moyenne exemplaire
Southern Alberta Section

Exemplary Small Section Award/Prix de petite section exemplaire
London Section

2021 IEEE CANADA C.C. GOTLIEB MEDAL
MÉDAILLE C.C. GOTLIEB DE L'IEEE CANADA 2021

For foundational contributions to member-dependence predictions, power-aware coherence, and value-aware hardware acceleration for machine learning

Pour contributions fondamentales aux prédictions de dépendance des membres, à la cohérence sensible à la puissance et à l'accélération matérielle sensible à la valeur pour l'apprentissage automatique

Andreas Moshovos, Toronto, ON

Andreas Moshovos teaches how to design and optimize computing hardware at the University of Toronto, where he has the privilege of collaborating with several talented students on techniques to improve execution time, energy efficiency, and cost. He has also taught at Northwestern University, USA, the University of Athens, Greece, the Hellenic Open University, Greece, and as an invited professor at the École Polytechnique Fédérale de Lausanne, Switzerland. He studied computer science at the University of Crete, Greece; New York University, USA; and the University of Wisconsin-Madison, USA. He received the ACM SIGARCH Maurice Wilkes Award in 2010, an NSF CAREER Award in 2000, two IBM Faculty awards,



a Semiconductor Research Corporation Inventor Recognition Award, and a MICRO Hall of Fame Award. He has served as the program chair for the ACM/IEEE International Symposium on Microarchitecture and the IEEE International Symposium on the Performance Analysis of Systems and Software. He is a Fellow of ACM and IEEE. ■

Andreas Moshovos enseigne la conception et l'optimisation du matériel informatique à l'Université de Toronto où il a le privilège de collaborer avec plusieurs étudiants talentueux sur des techniques pour améliorer le temps d'exécution, l'efficacité énergétique et les coûts. Il a également enseigné à la Northwestern University aux États-Unis, à l'Université d'Athènes et l'Université ouverte de Grèce, et en tant que professeur invité à l'École Polytechnique Fédérale de Lausanne en Suisse. Il a étudié l'informatique à l'Université de Crète en Grèce, à l'Université de New York et à l'Université du Wisconsin-Madison aux États-Unis. Il a reçu le prix ACM SIGARCH Maurice Wilkes en 2010, un prix NSF CAREER en 2000, deux IBM Faculty Award, un Inventor Recognition Award de la Semiconductor Research Corporation et un

Il a reçu le prix ACM SIGARCH Maurice Wilkes en 2010.

prix MICRO Hall of Fame. Il a été président du programme de l'ACM/IEEE International Symposium on Microarchitecture et de l'IEEE International Symposium on the Performance Analysis of Systems and Software. Il est membre de l'ACM et de l'IEEE. ■

IEEE Canada Student Awards
Prix étudiants IEEE Canada

Larry K. Wilson Regional Student Volunteer Award
First place: **Annika Benson**
Second place: **Eptehal Mashnoush**
Third place: **Andrei Gavrilov**

Website Competition
First place: Ryerson University
Second place: University of Ottawa

Regional Exemplary Student Branch
First place: University of Toronto and Carleton University
Second place: Ryerson University

2021 IEEE CANADA J.M. HAM OUTSTANDING ENGINEERING EDUCATOR MEDAL
PRIX J.M. HAM D'ÉDUCATEUR EXCEPTIONNEL EN GENIE DE L'IEEE CANADA 2021

For exceptional training and education leadership in the design of silicon photonic devices and systems for applications in optical communications, biosensors, and quantum information

Pour leadership exceptionnel en matière de formation et d'éducation dans la conception de dispositifs et de systèmes photoniques au silicium pour des applications dans les communications optiques, les biocapteurs et l'information quantique

Lukas Chrostowski, Vancouver, BC

Lukas Chrostowski received his BEng in electrical engineering from McGill University in 1998, and a Ph.D. in electrical engineering and computer science from the University of California, Berkeley, in 2004. He joined the Department of Electrical and Computer Engineering, University of British Columbia, in 2005, and was promoted to full professor in 2015.

With research interests in silicon photonics, optoelectronics, high-speed laser design, fabrication, and test for applications in optical communication systems and biophotonics, he has published more than 200 journal and conference publications. He coauthored the book *Silicon Photonics Design* (Cambridge University Press, 2015). Dr. Chrostowski was the codirector of the Advanced Materials and Process Engineering Laboratory Nanofabrication Facility (2008–2016). Dr. Chrostowski is the program director of the NSERC



CREATE Silicon Electronic-Photonic Integrated Circuits training program in Canada and has been teaching numerous silicon photonics workshops and courses since 2008. Dr. Chrostowski received the Killam Teaching Prize at the University of British Columbia in 2014. He was an elected member of the IEEE Photonics Society 2014–2016 Board of Governors and serves as the Associate VP of Education. He was awarded a Natural Sciences and Engineering Research Council of Canada Discovery Accelerator Supplements Award in 2015. ■

Lukas Chrostowski a obtenu son B.Ing. en génie électrique de l'Université McGill en 1998, et un Ph.D. en génie électrique et informatique de l'Université de Californie, Berkeley, en 2004. Il s'est joint au Département de génie électrique et informatique de l'Université de la Colombie-Britannique en 2005, et a été promu professeur titulaire en 2015.

Avec des intérêts de recherche en photonique sur silicium, optoélectronique, conception, fabrication et test de lasers à grande vitesse (VCSEL), pour des applications dans les systèmes de communication optique et la biophotonique, il a publié plus de 200 articles dans des revues et conférences. Il est coauteur du livre *Silicon Photonics Design* (Cambridge University Press, 2015). Dr. Chrostowski a été codirecteur de l'installation de nanofabrication de l'Advanced Materials and Process Engineering Laboratory (AMPEL), 2008–2016. Dr. Chrostowski est directeur du programme de formation CRSNG FONCER Silicon Electronic-Photonic Integrated Circuits (Si-EPIC) au Canada et a enseigné de nombreux ateliers et cours sur la photonique au silicium depuis 2008.

Dr. Chrostowski a reçu le Prix d'enseignement Killam à l'Université de Colombie-Britannique en 2014. Il a été élu membre du conseil des gouverneurs de l'IEEE Photonics Society 2014-2016 et en est VP associé du comité d'éducation. Il a reçu une subvention du programme de Suppléments d'accélération à la découverte du Conseil de recherches en sciences naturelles et en génie du Canada en 2015. ■

Dr. Chrostowski a reçu le Prix d'enseignement Killam à l'Université de Colombie-Britannique en 2014.

IEEE Technical Field Awards
Prix de domaines techniques de l'IEEE

2021 IEEE Eric E. Sumner Award

For contributions to the theory and practice of source coding

En-Hui Yang, University of Waterloo, ON

2021 IEEE CANADA OUTSTANDING ENGINEER MEDAL
MÉDAILLE D'EXCELLENCE EN INGÉNIERIE DE L'IEEE CANADA 2021

For outstanding contributions to the theory and applications of computer control systems, networked control, remote-state estimation, and advanced alarm management and design

Pour contributions exceptionnelles à la théorie et aux applications des systèmes de contrôle informatique, u contrôle en réseau, estimation de l'état à distance, et gestion et conception avancées des alarmes

Tongwen Chen, Edmonton, AB

Tongwen Chen is presently a professor and Tier 1 Canada Research Chair in Intelligent Monitoring and Control in the Department of Electrical and Computer Engineering at the University of Alberta, Edmonton, Canada. He received the BEng degree in automation and instrumentation from Tsinghua University (Beijing) in 1984, and the MASc and Ph.D. degrees in electrical engineering from the University of Toronto in 1988 and 1991, respectively.

His research interests include computer- and network-based control systems, process safety and alarm systems, and their applications to the process and power industries. He has served as an associate editor



for several international journals, including *Automatica* and *IEEE Transactions on Automatic Control*. He is a Fellow of IEEE, IFAC, and the Canadian Academy of Engineering. ■

Tongwen Chen est actuellement professeur et titulaire d'une chaire de recherche du Canada de niveau 1 en Surveillance et contrôle intelligents au Département de génie électrique et informatique de l'Université de l'Alberta, à Edmonton, Canada. Il a obtenu le baccalauréat en administration des sciences de l'automatisation et de l'instrumentation de l'Université Tsinghua (Beijing) en 1984, et la maîtrise et le doctorat en génie électrique de l'Université de Toronto en 1988 et 1991 respectivement.

Ses intérêts de recherche comprennent les systèmes de contrôle informatisés et en réseau, les systèmes de sécurité des processus et d'alarme, et leurs applications aux industries des procédés et de l'énergie. Il a été rédacteur en chef adjoint de plusieurs revues internationales dont *Automatica* et *IEEE Transactions on Automatic Control*. Il est membre de l'IEEE, de l'IFAC et de l'Académie canadienne du génie. ■

IEEE Canada President's Makes a Difference Award 2020

For his significant contributions to IEEE Canada, IEEE activities in Ottawa, and the engineering field as a whole

Pour ses contributions importantes à l'IEEE Canada, les activités IEEE à Ottawa et le domaine de l'ingénierie dans son ensemble

Jeffrey Arcand, Ottawa, ON

IEEE Canada WIE and YP Awards
Prix IEEE Canada WIE and YP

IEEE WIE International Group of the Year Award

Large Section—Toronto Section

IEEE YP Canada Group of the Year Award

South Saskatchewan Section

2021 IEEE CANADA W.S. READ OUTSTANDING SERVICE MEDAL
MÉDAILLE D'EXCELLENCE DE SERVICE W.S. READ DE L'IEEE CANADA 2021

For outstanding service and dedication to IEEE Canada (Region 7) and its members
Pour service et dévouement exceptionnels envers l'IEEE Canada (Région 7) et ses members

Voicu Groza, Ottawa, ON

Dr. Voicu Groza is a full professor and associate director, computer engineering at the School of Electrical Engineering and Computer Science, University of Ottawa. He received the Dipl. Ing. degree in computer engineering and Dr. Ing. degree in electrical engineering from the Polytechnic Institute of Timisoara, Timisoara, Romania, in 1972 and 1985, respectively. He has published more than 400 technical papers in journals, conference proceedings, and books, and received five patents. He was a principal investigator or co-investigator in more than 50 research grants and contracts and has supervised 90 graduate students. His current research interests include biomedical instrumentation and measurements, and high-speed data-acquisition systems.

Dr. Groza has been volunteering in the frame of the IEEE Instrumentation and Measurement Society (IMS), both at the Ottawa Chapter and the worldwide society-administration level. He has held leadership roles on the organization and technical program committees of numerous international conferences, such as IEEE International Symposium on Medical



Measurement and Applications (2008–2018). Dr. Groza has been chair of the Working Group P1721 on Standard for Objective Measurement of Systemic Arterial Blood Pressure in Humans of the IEEE Standards Association, and he currently serves as chair of the Subcommittee on Blood Pressure Measurement of TC-25 Medical and Biological Measurements of the IEEE Instrumentation and Measurement Society. He served as a member of the Administrative Committee (AdCom) of the IEEE Instrumentation and Measurement Society; he is a representative of the IMS in the AdCom of the IEEE Biometrics Council. Dr. Groza is a Fellow of IEEE and the Engineering Institute of Canada. ■

Dr. Voicu GROZA est professeur titulaire et directeur associé en génie informatique à l'École de science informatique et de génie électrique de l'Université d'Ottawa. Il a reçu le diplôme d'ingénieur en génie informatique et le doctorat en génie électrique de l'Université Polytechnique de Timisoara, Roumanie en 1972 et 1985, respectivement. Il a publié plus de 400 articles techniques dans des revues, des actes de conférence et des livres, et a reçu cinq brevets. Il a été chercheur principal ou co-chercheur pour plus de 50 subventions et contrats de recherche et a supervisé 90 étudiants de cycles supérieurs. Ses intérêts de recherche actuels comprennent l'instrumentation et les mesures biomédicales et les systèmes d'acquisition de données à grande vitesse.

Dr. Groza a fait du bénévolat pour le chapitre d'Ottawa de l'IEEE Instrumentation and Measurement Society (IMS) ainsi qu'à l'administration de la société mondiale. Il a occupé des postes de direction au sein des comités d'organisation et des programmes techniques de nombreuses conférences internationales dont l'IEEE International Symposium on Medical Measurement and Applications (MeMeA 2008–2018). Dr. Groza a été président du groupe de travail P1721 de l'IEEE Standards Association sur la norme pour la mesure objective de la pression artérielle systémique chez l'humain et est actuellement président du sous-comité sur la mesure de la pression artérielle du

Il a publié plus de 400 articles techniques dans des revues, des actes de conférence et des livres.

comité technique TC-25 Medical and Biological Measurements de l'IMS. Il a été membre du comité administratif de l'IMS et est la représente au comité administratif de l'IEEE Biometrics Council.

Dr. Groza est Fellow de l'IEEE et de l'Institut canadien des ingénieurs. ■

2021 IEEE CANADA E.F. GLASS WESTERN CANADA MERIT MEDAL
MÉDAILLE D'EXCELLENCE E.F. GLASS DE L'OUEST DU CANADA DE L'IEEE CANADA 2021

For outstanding contributions to the Southern Alberta Section and Region 7 Western Area
Pour contributions exceptionnelles à la section du sud de l'Alberta et à la zone ouest de la Région 7

Lawrence Whitby, Calgary, AB

Lawrence Whitby is a Senior Member of IEEE. He has volunteered at most levels of IEEE, beginning locally in Southern Alberta as EMBS chair, vice chair, chair, and various functions at local conferences. He was the volunteer chair for the PES 2009 GM, EPEC 2014, I&CPS 2015, and I&CPS 2019. He was the technical cochair of CCECE 2010. In that conference, he made a track for EMBS (first time for CCECE), and chaired other tracks at that conference. He was Western Area chair for Region 7 for three years and membership development chair for Region 7 for three years. He was also a member of the Geographic Unit Operations Subcommittee (GUOS) for IEEE. He has been a Member of IEEE for 37 years.

Mr. Whitby has also volunteered for the Instrumentation Systems and Automation Society (ISA). He was secretary, treasurer, vice-president, and president of the ISA Calgary



Section over a span of four years. He volunteered for technical committees and chaired the SP37.16 Subcommittee on Pressure, which updated and published *A Guide for the Dynamic Calibration of Pressure Transducers*. He was also the public relations chair for Wescanex 1990. Mr. Whitby is currently employed at the Southern Alberta Institute of Technology, where he is teaching in the mechanical engineering technology program. ■

Lawrence Whitby est membre senior de l'IEEE. Il a fait du bénévolat à la plupart des niveaux de l'IEEE en commençant localement dans le sud de l'Alberta en tant que président du chapitre EMBS, vice-président et président de section, et diverses fonctions lors de conférences locales. Il a été président de l'Assemblée générale de PES 2009, EPEC 2014, I&CPS 2015 et 2019. Il a été coprésident technique de CCGEI 2010. Lors de cette conférence, il a inauguré un volet pour l'EMBS (une première pour la CCGEI), et il en a présidé d'autres volets. Pour la Région 7 il a été président de la zone ouest pendant trois ans et président du comité de développement de l'effectif aussi pendant trois ans. Il a également été membre du sous-comité des opérations des unités géographiques (GUOS) de l'IEEE. Il est membre de l'IEEE depuis 37 ans.

M. Whitby a également fait du bénévolat pour l'International Society of Automation (ISA). Il a été secrétaire, trésorier, vice-président et président de la section de Calgary de l'ISA sur une période de 4 ans. Il s'est porté volontaire pour des comités techniques et a présidé le sous-comité SP37.16 sur la pression, qui a mis à jour et publié *A Guide for the Dynamic Calibration of Pressure Transducers*. Il a également été président des relations publiques de Wescanex 1990.

M. Whitby est actuellement employé au Southern Alberta Institute of Technology où il enseigne dans le cadre du programme de technologie du génie mécanique. ■

MGA Leadership Award

(*Up to three awarded annually, receive plaque and US$500*)

To recognize those individuals who have exhibited exemplary and substantive leadership of an extraordinary nature in implementing activities that support the goals of MGA at the local, regional, national, and/or international level.

Winnie Ye (R7), Ottawa Section

- For exemplary leadership and distinguished contributions in promoting and supporting activities at local, regional, and international IEEE engineering communities.

2021 IEEE CANADA M.B. BROUGHTON CENTRAL CANADA MERIT MEDAL
MÉDAILLE D'EXCELLENCE M.B. BROUGHTON DU CENTER DU CANADA DE L'IEEE CANADA 2021

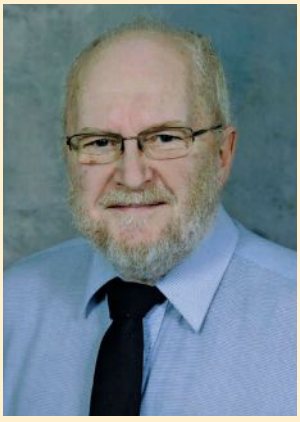
For his contributions to the IEEE Canada Sections and Conferences
Pour ses contributions aux sections et conférences de l'IEEE Canada

John Harris, Oakville, ON

John Harris (LSIEEE) is a retired design engineer. He received his B.Eng and Ph.D. from McMaster University and his M.E.Sc from the University of Western Ontario.

He spent most of his career designing landline telephone sets for Bell Northern Research/Northern Electric/Northern Telecom. He performed cost reductions on the traditional rotary dial telephone (500-set) and introduced the first electronic telephone, sneakily housed in a 500-set. Among the features included in electronic telephone sets were memory dialers, ring tones, and caller ID, called *custom local access to special services* when he introduced it.

He worked at B.E.L-Tronics, where he designed the first cordless caller-ID telephone and automotive parts. He was certified as a QS-9000 auditor. He worked at Memex/e-Manufacturing Inc., where he



designed CNC controllers for lathes and milling machines. He was certified as an AS-9000 auditor.

Dr. Harris is a registered professional engineer in the province of Ontario. He was active in the IEEE London Section in the 1970s and 1980s. He has been active in the Hamilton Section since 2000. He has been treasurer for Canadian conferences (CCECE, EPEC, and IHTC). He has been chair of the IEEE Canada Life Members Committee since 2016. ■

John Harris (LSIEEE) est un ingénieur concepteur retraité. Il a obtenu son B.Eng et son Ph.D. de l'Université McMaster et sa M.E.Sc. de l'Université Western Ontario.

Il a passé la majeure partie de sa carrière à concevoir des postes téléphoniques fixes pour Recherches Bell-Northern/Northern Electric/Northern Telecom. Il a réalisé des réductions de coûts sur le téléphone à cadran traditionnel (modèle 500) et a conçu le premier téléphone électronique, astucieusement logé dans un modèle 500. Parmi les fonctionnalités incluses dans les postes téléphoniques électroniques figuraient la composition automatique, les sonneries et l'identification de l'appelant, appelés CLASS (Custom Local Access to Special Services) lorsqu'il l'a introduit.

Il a travaillé chez B.E.L-Tronics où il a conçu le premier téléphone sans fil avec identification de l'appelant ainsi que des pièces automobiles. Il a été certifié en tant qu'auditeur QS-9000.

Il a travaillé chez Memex/e-Manufacturing Inc. où il a conçu des contrôleurs CNC pour tours et fraiseuses. Il a été certifié en tant qu'auditeur AS-9000.

Il est actif dans la section de Hamilton depuis 2000.

Dr. Harris est un ingénieur professionnel enregistré dans la province de l'Ontario. Il a été actif dans la section IEEE de London dans les années 70 et 80. Il est actif dans la section de Hamilton depuis 2000. Il a été trésorier de conférences canadiennes (CCGEI, EPEC et IHTC). Il est président du comité des membres à vie de l'IEEE Canada depuis 2016. ■

MGA Young Professionals Achievement Award

(*Up to six awarded annually, receive plaque and US$250*)

To recognize those substantive projects or achievements of a relatively short nature (one to three years), but which have left an undeniable imprint on the fabric of IEEE Young Professionals operations.

Zied Bouida (R7), Ottawa Section

- For exemplary leadership and distinguished contributions in promoting IEEE Young Professional activities in Region 7 and globally.



The IEEE Canadian Foundation, a registered charity in Canada, is the philanthropic partner of IEEE in Canada. Donations support scholarships and prizes as well as McNaughton Learning Resource Centres and grants to new and innovative initiatives. The IEEE Canadian Foundation welcomes directed gifts from individuals, associations, corporations, and foundations. These are used to endow annual awards that meet worthy but unfilled needs, and further the purpose of the donor and the IEEE Canadian Foundation www.ieeecanadianfoundation.org.

IEEE Canada Women In Engineering Prize/Prix Femmes En Génie De L'IEEE Canada
Leanne Dawson, Southern Alberta Section
IEEE Canadian Foundation Scholarships/Bourses d'études de la Fondation canadienne de l'IEEE
Robert Conrad, University of Ottawa
Alexandria Shields, University of Saskatchewan
Aashna Narang, Carleton University
Dr. Raymond D. Findlay Scholarship/Bourse d'études Dr. Raymond D. Findlay
Anikka Benson, Dalhousie University
IEEE Canada Power Quality Scholarship/Bourse en Qualité de l' Énergie de l'IEEE Canada
Maram Yousef, University of Calgary
IEEE Canadian Foundation Nick Cercone Graduate Scholarship in Computer Science/Bourse Nick Cercone de la IEEE Fondation canadienne d'études supérieures en sciences informatiques
Amna Liaqat, University of Toronto
IEEE Canadian Foundation Gargantini-Strybosch Scholarship/Bourse d'études Gargantini-Strybosch
Omer Abubaker, University of Ottawa

IEEE Canada Members elected as/Membres de l'IEEE Canada élus 2021 IEEE Fellows/Fellows de l'IEEE 2021

Dr. Alireza Bakhshai, Kingston, ON, Canada,
for contributions to the development of synchronization techniques for power electronics converter
Prof. Timothy Barfoot, Toronto, ON, Canada,
for contributions to mobile robot navigation
Prof. Gene Cheung, Toronto, ON, Canada,
for contributions to graph spectral image processing and interactive video streaming
Prof. Natalie Enright Jerger, Toronto, ON, Canada,
for contributions to networks on chip for many-core architectures
Prof. Sophie LaRochelle, Quebec, QC, Canada,
for contributions to fiber devices and data transmission technologies
Dr. Rongxing Lu, Fredericton, NB, Canada,
for contributions to security and privacy in vehicular communications
Prof. Yasser Mohamed, Edmonton, AB, Canada,
for contributions to the control and dynamic analysis of microgrids and power electronic systems
Prof. Roberto Morandotti, Montreal, QC, Canada,
for contributions to integrated nonlinear and quantum optics
Prof. Andreas Moshovos, Toronto, ON, Canada,
for contributions to out-of-order processor microarchitecture and multiprocessor memory systems
Dr. Akshay Rathore, Montreal, QC, Canada,
for contributions to the design and advancement of power electronics for drives and automotive industries
Prof. Alla Sheffer, Vancouver, BC, Canada,
for contributions to mesh parameterization and hexahedral meshing
Prof. Mohammad Uddin, Barrie, ON, Canada,
for contributions to control techniques for ac motor drives
Prof. Yingxu Wang, Calgary, AB, Canada,
for contributions to real-time autonomous systems
Dr. Hamidreza Zareipour, Calgary, AB, Canada,
for contributions to the modeling of energy storage for system operation and planning
Prof. Xiaoping Zhang, Toronto, ON, Canada,
for contributions to signal processing in finance

IEEE Collabratec™

Bright Minds. Bright Ideas.



Introducing IEEE Collabratec™

The premier networking and collaboration site for technology professionals around the world.

IEEE Collabratec is a new, integrated online community where IEEE members, researchers, authors, and technology professionals with similar fields of interest can **network** and **collaborate**, as well as **create** and manage content.

Featuring a suite of powerful online networking and collaboration tools, IEEE Collabratec allows you to connect according to geographic location, technical interests, or career pursuits.

You can also create and share a professional identity that showcases key accomplishments and participate in groups focused around mutual interests, actively learning from and contributing to knowledgeable communities. All in one place!

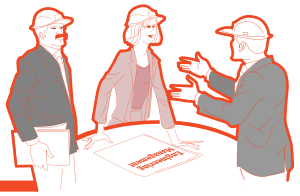
Network.
Collaborate.
Create.

Learn about IEEE Collabratec at
ieee-collabratec.ieee.org

IEEE



Biz Tech Report



by Terrance Malkinson

We live in a digital world where the Internet is improving our quality of life. Regrettably, we are all susceptible to overuse and addiction to screens. *Overcoming Internet Addiction For Dummies*, the 2021 book authored by David Greenfield, provides readers with the information and resources needed to discover how much screen time is too much, along with practical suggestions on how to reduce it. Readers learn how to recognize, manage, and treat Internet addiction and how to manage a healthy and sustainable lifestyle. The author is the founder and clinical director of the Center for Internet and Technology Addiction and is a leading authority on behavioral and process addiction, Internet and screen behavior, and the treatment of Internet and video game addiction.

A Calgary company has won international awards for a new ventilator that can support up to four patients at the same time. Convergence Medical Sciences [www.convergencemed.ca] won an international Red Dot Design Award as well as the 2021 International Design Excellence Award for creating the Valence InVent Xtend device. Invented by Dr. Steven Roy, a critical care medicine fellow at the University of Calgary, the goal was to find a solution for building ventilators at a low cost. Teaming up with University of Calgary engineer Dr. Jihyun Lee and intensive care doctor Dr. Paul McBeth, they created a way to adjust the pressure so that each patient can receive their own breath pressure and volume as well as trigger pressure alarms in the case of an emergency. Dr. Roy hopes that the device will be an accessible, low-cost solution that helps people in developing countries. It is currently pending Health Canada licensing and approval.

The June 2021 Parliamentary Report of the Standing Committee on Natural Resources strongly suggests that the federal government needs to protect Canada's critical minerals industry [www.ourcommons.ca/DocumentViewer/en/43-2/RNNR/report-6/]. Minerals including magnesium, lithium, cobalt, chromite, nickel, copper, platinum, and others are used to make electric car batteries, mobile phone components, and solar panels to name but a few. The report details how Ottawa has failed to secure Canadian supply chains for strategic minerals. This will have consequences as next-generation technologies emerge. The report found that Canada has not utilized its mineral wealth because of regulatory burdens and hesitancy among capital investors.

The United Nations Intergovernmental Panel on Climate Change issued a report warning that without a radical reduction of our greenhouse gas emissions, we are on a path for global warming that will have serious consequences [https://news.un.org/en/story/2021/08/1097362]. We are increasingly experiencing the effects of climate change across Canada, including more intense wildfires, heat waves, and drought. Our Arctic region is warming at more than twice the rate of the rest of the world. This summer, fires raged across British Columbia (B.C.), and the hottest temperature ever recorded in Canada was reached in June—49.6 °C in Lytton, B.C. In the Rockies, glaciers are melting, and many will disappear in the near future. The urban heat island effect has created temperature extremes in cities. It is important to act quickly while we still have the capability to limit global warming.

Deep Genomics [www.deepgenomics.com], led by University of Toronto biomedical engineering professor Brendan Frey, has raised US$180 million to fund its business of discovering and developing drugs using artificial intelligence (AI). Deep Genomics has 10 drugs in preclinical development, four of which are set to enter human trials by mid-2023. By then, it expects to have 30 drugs in preclinical research. The company uses AI to sift through vast amounts of data on novel compounds and genetic mutations to focus on potential drugs. It uses simulations to

About the Author



Terrance Malkinson is the author of more than 580 peer- and editorial-reviewed publications and is now retired. His diverse career path includes 26 years in medical research as a founding member of the Faculty of Medicine at the University of Calgary as well as a three-year appointment as a business manager with the General Electric Company followed by a one-year applied research appointment with SAIT Polytechnic. He is an alumni of continuing professional education programs with Outward Bound International, Banff Centre for Management, the Massachusetts Institute of Technology, and the University of Colorado.

During his long career, he has advanced both basic and applied medical, health and wellness, scientific, and engineering knowledge. He has trained and mentored undergraduate, graduate, and postdoctoral students as well as staff in the business sector and government. He is a 45-year, Life Senior Member of IEEE. He has served in many professional public and private governance, and publication roles. He is the recipient of several peer-selected earned awards including induction into the Order of the University of Calgary, IEEE achievement medals, and APEX awards for publication excellence. In retirement, he vigorously continues an extensive portfolio of basic and applied research projects. His other passions include communicating emerging technologies to the public, investigative journalism, philanthropy, and mentorship. His current research interests in emerging technologies and health and wellness extend to being an accomplished multisport triathlete, including, among other events, the completion of 11 long-distance Ironman triathlons.

make billions of predictions across the human genome. This can simplify and speed up the search for drugs. Their current focus of interest is complex diseases caused by multiple genetic mutations.

Redlen Technologies

Inc. [www.redlen.com] is a B.C. company that develops high-resolution X-ray imaging technology using cadmium zinc telluride (CZT). CZT is a chemical compound that can be employed to measure the energy of individual light particles and translate the readout into electrical signals. The process generates diagnostic results in colour that are highly accurate, produces 10-times-more information than existing computed tomography (CT) scanners, and requires 40–80% less radiation. The company is working with six of the world's top makers of CT scanners to introduce its semiconductor and sensor system into their machines. CEO Glenn Bindley expects the technology to have regulatory approval and be fully commercialized by 2025. Redlen was founded in 1999, in a garage, by former Teck Cominco metallurgists Bob Redden and Brian Lent. The company's technology was based on the CZT crystal growth work they had done for the Canadian Space Agency.

CZT is a chemical compound that can be employed to measure the energy of individual light particles and translate the readout into electrical signals.

Montreal-based Paladin

AI [www.paladin.ai] was founded with the purpose of using AI-driven analytical tools to improve and accelerate aviation training. Paladin does not manufacture flight simulators, develop courseware for pilot training, or replace flight instructors; rather, it provides analytical services, integrating its AI and machine learning into existing training tools and utilizes the computing power of the cloud. When a pilot is in a simulator, everything is captured in real time. By extracting and analyzing the information, Paladin provides insight into a pilot's level of knowledge and technical competencies and assists in generating a personalized training plan. Paladin believes the technology has applications beyond the aviation training industry. ■

Canadian Journal of Electrical and Computer Engineering–an IEEE Journal

IEEE Canadian Journal of Electrical and Computer Engineering (*CJECE*), issued quarterly, has been publishing high-quality refereed scientific papers in all areas of electrical and computer engineering since 1976.

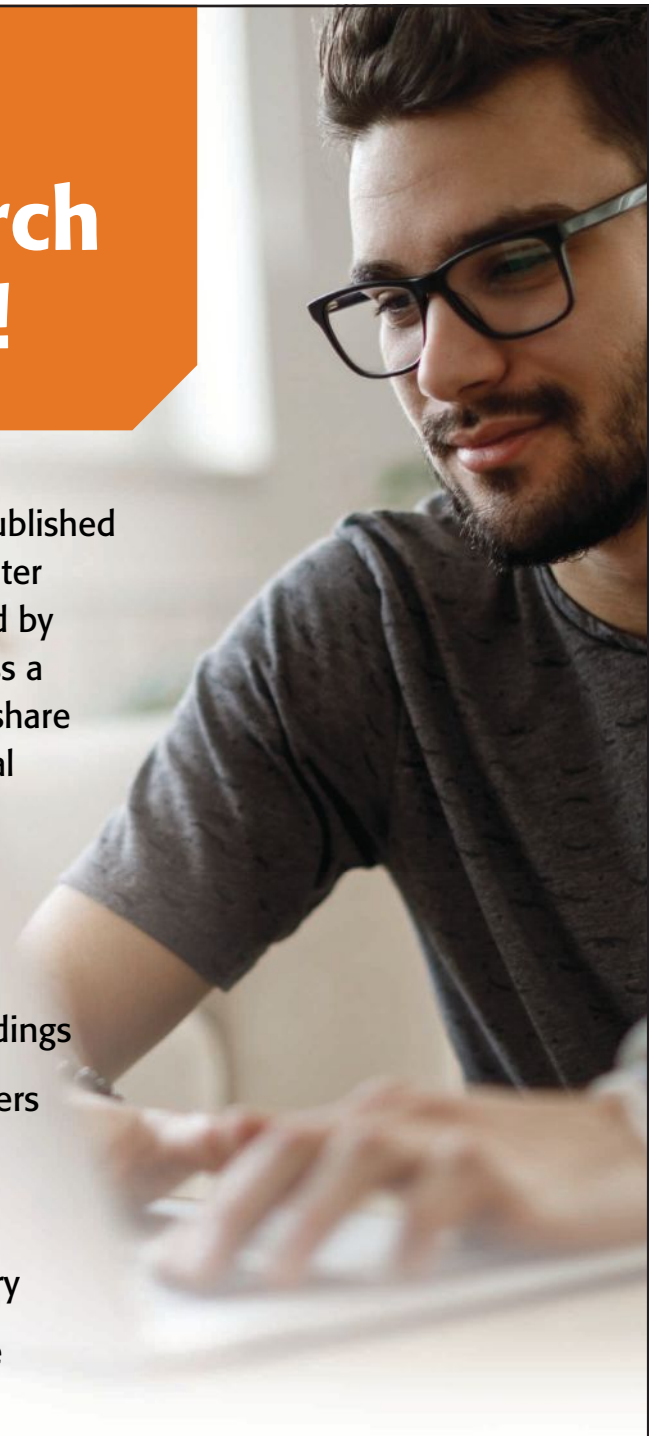
IEEE CJECE is accepting papers presenting new and original results, techniques or concepts in the following areas (inclusive, but not limited to):

- Bioengineering /biomedical engineering
- Signal processing
- Image processing
- Circuits
- Control systems
- Electromagnetics
- Energy and power systems
- Microelectronics
- Artificial intelligence
- Wireless communication
- Communication systems
- Computer networks
- Software engineering
- Cybersecurity
- Computer systems
- Robotics



For more information, please visit: http://www.journal.ieee.ca/

Share Your Preprint Research with the World!



TechRxiv is a free preprint server for unpublished research in electrical engineering, computer science, and related technology. Powered by IEEE, TechRxiv provides researchers across a broad range of fields the opportunity to share early results of their work ahead of formal peer review and publication.

BENEFITS:

- Rapidly disseminate your research findings
- Gather feedback from fellow researchers
- Find potential collaborators in the scientific community
- Establish the precedence of a discovery
- Document research results in advance of publication

Upload your unpublished research today!

Follow @TechRxiv_org

Learn more techrxiv.org

TechRxiv™

Powered by IEEE

EngineeringCareers.ca

Employers: find the perfect candidate, register at:
https://employers.engineeringcareers.ca/

Job seekers: find the best engineering job, register at:
https://www.engineeringcareers.ca/

The Engineering
Institute of Canada

TAP.
CONNECT.
NETWORK.
SHARE.



Connect to IEEE–no matter where you are–with the IEEE App.

- Stay up-to-date with the latest news
- Schedule, manage, or join meetups virtually
- Get geo and interest-based recommendations
- Read and download your IEEE magazines
- Create a personalized experience
- Locate IEEE members by location, interests, and affiliations

Download Today! Download on the App Store · GET IT ON Google Play

IEEE



420,000+ members in 160 countries.
Embrace the largest, global, technical community.

People Driving Technological Innovation.

ieee.org/membership

#IEEEmember

IEEE

KNOWLEDGE COMMUNITY PROFESSIONAL DEVELOPMENT CAREER ADVANCEMENT



You'll never let her down, no matter what.

IEEE Member Group Term Life Insurance

To learn more*, visit IEEEinsurance.com/life

*For information on coverage features, costs, eligibility, renewability, limitations and exclusions

Group Term Life Insurance is available only for residents of the U.S. (except territories), Puerto Rico and Canada (except Quebec). This is underwritten by New York Life Insurance Company, 51 Madison Ave., New York, NY 10010 on Policy Form GMR. This is administered by Mercer Health & Benefits Administration LLC. This coverage is available to residents of Canada (except Quebec). Mercer (Canada) Limited, represented by its employees Nicole Swift and Pauline Tremblay, acts as broker with respect to residents of Canada.

Program Administered by Mercer Health & Benefits Administration LLC
In CA d/b/a Mercer Health & Benefits Insurance Services LLC
AR Insurance License #100102691 | CA Insurance License #0G39709

94982 (12/21) Copyright 2021 Mercer LLC. All rights reserved.

IEEE