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IEEE Engineering in Medicine & Biology Society (EMBC)
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Mini-Symposia Title:

Computational Intelligence in Biomedical Engineering
Towards Wellness through Prediction and Prevention

Mini-Symposia Organizers' Name & Affiliation:

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Theme:

○ 10. Biomedical & Health Informatics

Mini-Symposia Synopsis— Max 2000 Characters

Computational intelligence has emerged as a key field within the domain of biomedical engineering. Especially in the case of applied areas like healthcare, food and water safety, physiology, genetic engineering etc., the aspect of computational intelligence is highly prominent. Considering its relevance in the recent times, Mini Symposium is focused to highlighting the theoretical and practical aspects of computational intelligence, further reaching to machine learning, predictive modeling etc. to different fields of biomedical engineering.

The primary goal of this Mini Symposia is to highlight the trending research in this field across the world. It would provide a global perspective of the state of the art. The secondary goal is to open a platform for discussion on the existing challenges in applying computational intelligence in biomedical engineering, which would lead to finding collaborative solutions to the existing problems in this field.

Featuring invited talks from 6 speakers (having diverse backgrounds) followed by papers specifically directed to this domain, the Mini Symposium aims at fortifying the global discussion on computation intelligence in biomedical engineering.

Speaker 1 Synopsis

Dr. Luis Kun
Fellow AIMBE, Life Fellow IEEE, Fellow IAMBE

Distinguished Professor Emeritus of National Security Affairs
William Perry -Center for Hemispheric Defense Studies-National Defense University, USA

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Lecture topic: Digital Health, disease prevention and privacy protection: An interoperable balance in the Information and de-information age

Abstract:
On Monday March 21, 1994 Vice President AL GORE gave a keynote on the creation of a Global Information Infrastructure (GII), known also as the Information Superhighways Speech at the World Telecommunication Development Conference, in Buenos Aires, Argentina. His vision included: The GII will help educate our children and allow us to exchange ideas within a community and among nations. It will be a means by which families and friends will transcend the barriers of time and distance. It will make possible a global information marketplace, where consumers can buy or sell products. I ask you, the delegates to this conference, to set an ambitious agenda that will help all governments, in their own sovereign nations and in international cooperation, to build this Global Information Infrastructure. For my country's part, I pledge our vigorous, continued participation in achieving this goal." Along the way, many challenges have accompanied its development and use. While the 21st Century was coined as the Information Era, it has also become the de-information one. As never before the interoperability of global multi-disciplines and inter-disciplines offer the opportunity to include early prediction, prevention and even cure of disease. The current COVID pandemic has provided a unique opportunity to expand this "superhighway". Yet for some the high price of access and or the protection of privacy and confidentiality of personal information have become impediments to its use. How can society balance these threats?

Bio: Dr Kun is currently a Distinguished Professor Emeritus of National Security Affairs (CHDS/NDU). He graduated from Uruguay's Merchant Marine Academy and holds a BSEE, MSEE and PhD in Biomedical Engineering from UCLA. He is a Life Fellow of the
IEEE, the American Institute for Medical and Biological Engineering, and the International Academy of Medical and Biological Engineering. As Senior IT Advisor representing the Agency for Health Care Policy and Research (AHCPR), he chaired the Privacy and Security of Information in the Vicepresident's Committee on Telehealth and was one of the 9 authors of the first Report to the US Congress on
Telemedicine. He was largely responsible for the first Telemedicine Homecare Legislation signed by President Clinton. As a Professor of Homeland Security (HLS) at the National Defense University he developed all the curricula on that track: HLS Inf. Management, HLS Tools & Techniques and Protection of Critical Infrastructures. He is currently the chairman of the Distinguished Lecturer (DL) Program for IEEE SSIT (and was a DL for both EMBS and Computers multiple times), member of the Board of Governors of SSIT and
its representative in IEEE LSTC, and a member of EMBS ADCOM. He is co-founding Editor in Chief of Springer's
Journal of Health and Technology. For the IEEE USA Medical Technology Policy Committee, he was the founding chair of the Electronic Medical Record and HPCC WG, and prior to 9/11, the Founding Chair of the Bioterrorism WG. In 2007 he became the Founding chair of IEEE-USA's Critical Infrastructure Protection
Committee.

Speaker 2 Synopsis

Dr. Isaac Chairez

Unidad Profesional Interdisciplinaria de Biotecnología-Instituto Politécnico Nacional
Instituto Tecnológico de Estudios Superiores de Monterrey, Campus Guadalajara

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Lecture topic: Event driven machine learning based control of active electromyography orthosis for assisted muscle-skeletal rehabilitation

Abstract:
This study presents the application of an event driven controller aided of an artificial intelligence algorithm to regulate the activity of active orthoses. The event driving formulation considers that triggering the orthoses actions depending on the electrical power of the electrophysiological signal. The event activity is characterized implementing a moving time window analysis of the electromyography signal which yields the definition of the needed movement for the orthosis. The selection of the movement that must be developed by the orthoses is based on a signal classifier using differential neural networks that performs a continuous electromyography classifier. The proposed classifier implements a homogeneous ensemble signal classifier based on multilayered neural network with continuous dynamics. The selection of the learning laws for the neural network classifier is defined by a formal stability analysis using the second method of Lyapunov. The proposed classifier is associated to a reference trajectory generator which are used as part of the robust controller implementation. The selected controller uses a state dependent set of gains for a class of linear and sliding mode controllers which are tested with the proposed event driven neural network classifier. The gains are estimated using a barrier function that characterizes the active regions for the orthosis's movements. The suggested artificial intelligence-based controller is tested on lower limb mobile exoskeleton device aimed to provide active movement of the orthosis in both virtual and experimental cases. The evaluated tests are successful in both cases including some evaluations with five volunteers.

Bio:
Dr Chairez received his engineering degree in 2002 form the UPIBI-IPN. The M. Sc. and the PhD Automatic Control Degrees from the Automatic Control Department in CINVESTAV-IPN in 2004 and 2007. His main contributions have considered the application of biomedical technologies, automatic control theories and artificial intelligence algorithms which have been integrated in diverse technical advances such as biped robotic devices for rehabilitation, intelligent orthosis, novel robotic implementations of intelligent automatic controllers and some others. He is now working with the Professional Interdisciplinary Unit of Biotechnology at the National Polytechnique Institute and the Instituto Tecnológico de Estudios Superiores de Monterrey campus Guadalajara. He has published about 170 scientific papers in recognized international journals, one book on application of intelligent controllers for chemical and biological processes as well as about 300 publications in international and national conferences. He has served as associate editor of three journals included in the Scopus index as well as program chair of several international and national conferences on biomedical engineering and automatic control. In particular, he served as editor in chief of the Mexican Journal of Biomedical Engineering, one of the most prestigious journals in Latin-American on this field for a period of 4 years. Dr Chairez has been teaching for 20 years in biomedical engineering and automatic control.

Speaker 3 Synopsis

Prof. Parag Chatterjee

University of the Republic, Uruguay
& National Technological University, Buenos Aires, Argentina

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Lecture topic: Artificial Intelligence Toward Predictive Risk Analysis in Cardiometabolic Diseases – A Case Study of the National Liver Transplantation Program, Uruguay

Abstract:
Cardiovascular diseases stand as the leading cause of death globally, taking almost 18 million lives per year. One of the challenges in this domain being the risk handling, modeling cardiovascular dynamics in high-risk groups is important. Some aspects of this mission include screening for subclinical atherosclerosis, development of a database to store ubiquitous information obtained non-invasively, development of bio-mathematical model integrating values for arterial structure and function into traditional cardiovascular risk assessment, generation of detailed and comprehensive report comparing patient data with reference data from the healthy population. In this direction, the Vascular Age approach counts paramount, considering its potential in multiparametric risk estimation towards personalized cardiovascular diagnosis. Artificial Intelligence has been one of the prime areas contributing to the reengineering of healthcare paradigms. The domains of IoT and Artificial Intelligence is quite transdisciplinary and lead to a fascinating array of applications towards proffering efficient healthcare services. The aspect of cardiometabolic diseases is highly impactful in the domain of liver transplantation. In this aspect, a case study will be presented based on the National Liver Transplantation Program of Uruguay, highlighting the use of Machine Learning toward predictive analytics of cardiometabolic diseases post-transplantation using health parameters. It is focused on a study performed on the transplanted patients considering their entire set of pre-transplantation parameters followed by a detailed calculation of cardiometabolic risk profile. The risk profiles facilitate the early prediction of post-transplantation risks like metabolic syndrome. This talk will shed light in these areas pertaining to cardiometabolic diseases, providing a holistic view to the trending aspects of cardiometabolic diseases, and the new paradigms of IoT and machine learning towards intelligent prediction and prevention.

Bio:
After receiving master's degree in Computer Science from University of Calcutta, India, Prof. Chatterjee currently works as an assistant professor at the Department of Biological Engineering, University of the Republic Uruguay, and as a research professor at the National Technological University, Buenos Aires, Argentina. His current research is focused to data analysis and computational intelligence in the domain of eHealth, especially in cardiometabolic diseases.
He has been a TED^{x} speaker and currently associate editor of the Internet of Things journal, Elsevier.

Speaker 4 Synopsis

Dr. Leandro J. Cymberknop
IEEE EMBS Senior Member

Research and Development Group in Bioengineering (GIBIO),
National Technological University, Buenos Aires, Argentina

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Lecture topic: Cardiovascular Engineering at GIBIO: Academic Platform for Human Resources Training in Research and Development of Preventive and Predictive Technologies

Abstract:
The Research and Development Group in Bioengineering (GIBIO) at the National Technological University of Argentina (UTN.BA) focuses its activities in the field of predictive and preventive engineering in terms of the development of cardiovascular diseases. Given that both ischemic heart disease and cerebrovascular accident are currently the two major causes of mortality worldwide, the identification at an early age of vulnerable, asymptomatic subjects with subclinical cardiovascular disease is revealed as one of the more promising, regarding the diagnosis, prognosis and treatment of said condition. As a result, the development of non-invasive technology, together with an intelligent and integrated management of information, plays a central role, which must necessarily be approached in a multidisciplinary way. In its functional structure, the GIBIO has an innovative component in its human resources training, where engineering and medicine students develop their academic skills jointly, through specific undergraduate and graduate courses. This interaction promotes an exchange of needs, opinions and concerns that is solved in a synergistic way, giving rise to creative solutions that can be implemented and evaluated in ad-hoc designed protocols. In this sense, the "Cardiovascular Assessment Program for UTN.BA Community" implemented by the GIBIO at UTN.BA in 2019, constitutes an ideal ecosystem where research and technological development are combined in a unified axis, by virtue of its standardized cardiovascular evaluation protocols. In addition to their empirical training on validated biomedical equipment (electrocardiography, echocardiography and hemodynamic monitoring, among others), students are encouraged to work on specific problems and propose innovative improvements to existing methodologies. For this they have access to a laboratory for the design and development of biomedical devices aimed at cardiovascular well-being jointly with area for signal processing, images and artificial intelligence techniques. The GIBIO proposal has generated extremely encouraging results. Although the students have differentiated basic training in medicine and engineering, their link within the multiple fields (academic courses, research activities and technological development) promotes the management of a language of common understanding, allowing ideas to be promoted and discussed with high levels of depth and motivation.

Bio:
Dr Cymberknop received his Electronics Engineering degree and PhD degree in Signal and Image processing from National Technological University, Buenos Aires (UTN.BA), Argentina. He is currently the deputy director and coordinator of the Group of Research and Development in Bioengineering (GIBIO) at the same institution, where he develops his activities as a researcher and full-time assistant professor at the Secretariat of Science, Technology and Productive Innovation and Electronics Department. He is also member of the academic committee of the university's PhD program and reviewer of the postgraduate committee. In his IEEE career, Dr Cymberknop is the former chair of IEEE EMBS Argentina chapter and currently working as the professional advisor of the IEEE EMBS student branch chapter of UTN.BA. His research projects involve an active participation of undergraduate, postgraduate and doctoral students and are mainly focused on cardiovascular modeling, bio-signal processing and portable biomedical devices development, for cardiovascular disease prevention.

Speaker 5 Synopsis

Dr. Esteban J. Pino
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Lecture topic: Unobtrusive and pervasive monitoring: challenges and opportunities

Abstract:
Sensing physiological data in non-standard settings opens new possibilities for distributed health, pervasive monitoring, and prompt screening for otherwise undetected conditions. Distributed health can also result in increased hospital capacity without building new facilities. By caring for patients in their usual environment, people are more comfortable and hospital resources are saved for critical patients.
Unobtrusive systems are a way to move health care into people's homes or work that can be acceptable for the user. This would allow discrete monitoring of persons during their daily living without interfering with their regular activities. Unobtrusive sensors can provide new and rich data to evaluate health status in otherwise unmonitored population. This pervasive monitoring for prediction and prevention opens the possibility to improve care and reach otherwise unattended population. However, this monitoring is seldom conducted under ideal conditions. People are moving, speaking, and interacting, which is completely different than when in a hospital bed or during a scheduled medical exam. This new paradigm opens two challenges: how to deal with bad quality data and how to preserve the privacy of the user. A proposal for both challenges will be presented in this talk. New methods used to detect data quality can result in improved performance even from old algorithms. Also, giving the user the choice of how much data to share may provide a good balance between privacy and data availability Insights from projects developed for sleep monitoring and ballistocardiogram (BCG) measurements will guide this discussion.

Bio: Dr. Pino (S'96, A'99, S'02, M'08, SM'14) received the Electronics Engineering degree in 1997, M.Sc. in E.E. degree in 2000 and D.Sc. in E.E. in 2009 from the Universidad of Concepción, Concepción, Chile.
From 2004 to 2006 he was a research fellow at the Brigham and Women's Hospital in Boston, MA. In 2004 he joined the Universidad de Concepción to help in the formation of an undergraduate program for Biomedical Engineering. From 2010 to 2016 he was the head of that program at Universidad de Concepcion. He is currently Associate Professor at the Electrical Engineering Department. His research interests include unobtrusive sensors for physiological monitoring and biomedical signal processing. He is the author of several book chapters and peer-reviewed articles.
Dr. Pino is chair of IEEE Chile Sur section and mentor to the IEEE EMBS Biomedical Engineering Student Club at the Universidad of Concepción. He has been an IEEE member for 25 years and a volunteer on several committees along the years.

Speaker 6 Synopsis

Dr. Ricardo L. Armentano
IEEE EMBS Senior Member
EMBS IEEE Distinguished Lecturer

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Lecture topic: Transforming Data into Future Insights to Keep Homo Elasticus in Good Health

Abstract:
After the age of 20, when the individual has completed their growth process, the elastic fibers which provide most of the elasticity to the human body (they are present throughout it) stop renewing or they do so to a limited extent. What is less known is that these fibers are vital for a variety of functions, such as breathing and nutrition. For this reason, the "elastic capital" available starts deteriorating, more or less rapidly, according to our life style. Under this premise, current worldwide research is focused on developing solutions to study, protect, stimulate or even replace elastic fibers or the viscoelastic components in the body. As a result of this, the elastic properties of tissues and organs, involved in many pathologies, are emerging as a new and promising field of research in biology and medicine. Medical prevention aims to identify apparently healthy individuals from those who develop a disease and thus initiate preventive treatment for the latter. This identification of asymptomatic patients at risk is part of a preventive medicine which, according to what is advocated, will have to take on an ever-greater relevance in the coming years. Thanks to technological advances in non-invasive exploration of human vessels, it is now possible to detect preclinical disturbances and thus select, among risk groups, people with silent alterations from those who are free from them. Our physical-mathematical models that integrate all the cardiovascular hemodynamic factors could be of considerable interest in daily clinical practice to predict the occurrence of cardiac events in greater detail than with the use of traditional risk factors. With this new approach, costs would be reduced, therapeutic management could be optimized, and results in patient follow-up and treatment could be improved. It is through work on scientific experimentation and collaboration with interdisciplinary international groups that the author discovered the immense wealth of this unconventional research. This article is intended to position itself within a broader context, more fundamental than that of immediate application, taking into account the formal nature, contributing in its own way to answering that constantly renewed question about the particularities of the mechanisms put into service by nature to man, but that man has not yet put at its service.

Bio:
Dr Armentano received his Engineering degree in 1984. He obtained his PhD in Physiological Sciences (1994) from the University of Buenos Aires and from Université de Paris VII Diderot in Biomechanics – Mechanics of Biological Systems (1999). The technological developments derived from his doctoral theses have led to renowned methods of cardiovascular diagnosis which are used in Latin American countries in vascular exploration centers, as well as in the European Hospital George Pompidou in Paris where he made his second Post Doc. Currently he is Distinguished Professor of Biomedical Engineering and Director of the Biological Engineering Department and Principal Investigator of UNPD/84/002 at Universidad de la República (Uruguay). He is also Director of the PhD program on signal processing and head of the Bioengineering R&D group (GIBIO) at Universidad Tecnológica Nacional, Buenos Aires (Argentina). He is a member of IEEE EMBS Technical Committee on Cardiopulmonary Systems and Physiology-based Engineering. In 2019, Ricardo Armentano was conferred the IEEE R9 Eminent Engineer Award and he served as EMBS IEEE Distinguished Lecturer. He has served as the AdCom 2015 EMBS IEEE Latin America Officer and was the Chairperson of the 32nd International Conference EMBS/IEEE Buenos Aires 2010. He has acquired international recognition in the field of cardiovascular hemodynamics and arterial hypertension. He has taught in the fields of cardiovascular dynamics and in the broad area of engineering in medicine and biology and has extensive experience in PhD supervision and examination. He is on the editorial board of journals of cardiovascular research and is a reviewer for 15+ international scientific journals. He has 250+ publications including a book, book chapters and peer-reviewed articles. Recently, he was also appointed Fellow of the International Academy of Medical and Biological Engineering, IAMBE.