IEEE SMC 2018

IEEE Advancing Technology for Humanity

IEEE INTERNATIONAL CONFERENCE ON SYSTEMS, MAN, AND CYBERNETICS

Miyazaki, JAPAN, Oct 7-10, 2018

Workshop on Brain-Machine Interface Systems

Global Current and Emerging Brain Initiative Meeting

Brain Hackathon

IEEE SMC Systems, Man, and Cybernetics Society

SCIENCE COUNCIL OF JAPAN 日本学術会議

BMI Workshop, Brain Hackathon, Meeting of Global Current and Emerging Brain Initiatives Program at a Glance

Time	Sunday, October 7	Monday, October 8							Tuesday, October 9	Wednesday, October 10
	Hackathon Room: 2F Fountain	**Hackathon Room: 2F Fountain**	**Room: 2F R01 Orchard North**	**Room: 2F R02 Orchard South**	**Room: 2F R03 Gibraltar**	**Room: 3F R04 Zuiyo**	**Room: 3F R05 Kaiho**	**Room: 4F R06 Crystal**	**Room: 2F Fountain**	**Room: 2F Fountain**
8:00-8:30	**Invited Talk:** An overview of BCI approaches and how to use BCI technology for communication, motor rehabilitation and cognitive assessment	Hacking								
8:30-9:00										
9:00-9:30										
9:30-10:00			**Session:** *Human-Machine Systems and Cognitive Cybernetics*	**Session:** *Novel Technical Approaches to Improving Functional Diagnosis and Prognosis*	**Session:** *Tools, Metrics, and Databases*	**Session:** *Invasive BCIs, ECoG Analysis*	**Session:** *Multimodal HMIs*		**Meeting of Global Current and Emerging Brain Initiatives** *See insert for the program	**BMI Keynote:** Brain science demonstrates consciousness as a key for future AI **(9:30-10:15)**
10:00-10:30	**Invited Talk:** Multisensory BCIs in applications for robotics, VR/AR, art, dementia monitoring	**Invited Talk:** BCIs for labeling our environment								**BMI Keynote:** BCI and recognition of human emotions using multiway component analysis **(10:15-11)**
10:30-11:00		Hacking								
11:00-11:30										**Invited Talk:** The EU human brain project: advancing knowledge in neuroscience, computing, brain-related medicine
11:30-12:00										**Panel 1:** Future research opportunities and funding in brain research and neurotechnologies
12:00-12:30	**Invited Talk:** Current and future BCI applications									
12:30-13:00										
13:00-13:30	**Invited Talk:** How to run a real-time BCI application successfully		**Session:** *Novel BCI/HCI Paradigms*	**Session:** *BCI and Robotics*	**Session:** *Passive BCIs*	**Session:** *Deciphering Natural Cortical Representations for BMIs*	**Session:** *Real World Applications (SSVEP and Spellers)*			**Panel 2:** Important topics in designing and building real world neuro-technologies: What is new?
13:30-14:00										
14:00-14:30		Hackathon Project Presentations								**Panel 3:** Merging minds and machines: Integrating AI with current brain research and future neurotechnologies
14:30-15:00										
15:00-15:30										
15:30-16:00										**BMI Workshop Closing Session, Posters, and Reception (All are welcome)**
16:00-16:30		Jury Meeting	**Session:** *Brain-Inspired Systems and Unconventional BCI Applications*	**Session:** *BCIs for Neurorehab and Body Augmentation*	**Session:** *Deep Learning for Brain-Machine Interfaces*	**Session:** *Real World Applications (Automotive and Exoskeletons)*	**Session:** *BCI Modelling, Analysis, and Performance*	**Panel:** Standards for Neuro-technologies		
16:30-17:00										
17:00-17:30	**Invited Talk:** Non-invasive and invasive BCIs for research projects and medical applications	Award Ceremony*								
17:30-18:00										
18:00-18:30		*Winning Hackathon projects to be displayed Tuesday, October 9, 18:00-19:00, 4F Foyer							**Posters**	

Welcome Message from the BMI Workshop Organizers

The 2018 IEEE International Conference on Systems, Man, and Cybernetics (SMC 2018) will be held in Miyazaki, Japan. SMC 2018 is the flagship conference of the IEEE Systems, Man, and Cybernetics Society. It provides an international forum for researchers and practitioners to report recent innovations and developments as well as exchange ideas and advances in all aspects of systems science and engineering, human machine systems, and cybernetics. Advances in systems science and engineering, human-machine systems, and cybernetics have increasing importance in the creation of intelligent environments involving technologies interacting with humans to provide an enriching experience and an improved quality of life.

The IEEE SMC 2018 8th Workshop on Brain-Machine Interface (BMI) Systems will be held on October 7–10, 2018 as part of the SMC 2018 program. The goal of the Workshop is to provide a forum to present research results and facilitate the interaction and intellectual exchange between researchers, developers, and consumers of BMI technology. Contributions report the latest advances, innovations, and applications in the field of BMI, including affective BMIs, hybrid BMIs, deep learning for BMIs, BMI-controlled robots, neurorehabilitation, and other real-world applications. These topics represent both challenges to the field and a tremendous opportunity for collaborative and multidisciplinary research, thus requiring expertise in systems engineering, human-machine systems, cybernetics, neuroscience, medicine, robotics, and other disciplines. This year's theme is ***International Brain Initiative: Bringing Together Disciplines and Countries***. We welcome all SMC 2018 delegates who are involved or interested in learning more about the state-of-the-art and future challenges in BMI-related topics including sensors, machine learning, big data, neurorehabilitation, and standards to attend this Workshop.

A meeting of Global Current and Emerging Brain Initiatives will be held October 9, 2018 as part of the BMI Workshop and SMC2018. The IEEE SMC Society and the IEEE President, James Jefferies, are proud to invite you to a special meeting of global current and emerging Brain Initiative leaders and representatives from other groups working on large-scale multi-year brain projects from Australia, Canada, China, Europe (HBP), Japan, Korea, New Zealand, Poland, Russia, and US (NSF and NIH). Also participating are representatives from the IEEE Brain Initiative, International Neuroethics Society, industry, and other stakeholders. IEEE, as a new participant, welcomes collaborative discussions with all stakeholders to better align and integrate IEEE with other existing brain efforts. IEEE is a global technical community of 420,000+ professionals across multiple technology domains, many active in global brain projects. ***Participation is free and open to all SMC 2018 delegates.***

Topics will include status of global brain projects and the International Brain Initiative; the IEEE Brain Initiative and other relevant activities; future collaborations and cooperation among Brain Initiatives, industry, and funding agencies; translational neuroscience and neural engineering, including standards development; neuroethics; sharing of brain data; open discussions, and other topics. The Workshop should attract engineers, scientists, programmers, mathematicians, quantitative analysts, and others to the multi-disciplinary field of neuroscience.

The 2018 BMI Workshop will also feature a Panel on Standards for Neurotechnologies, the BR41N.IO BCI Hackathon, a tutorial, three panels, a number of prominent invited speakers, and presentations of contributed papers. The Workshop is organized by the *IEEE SMC Technical Committee on Brain-Machine Interfaces Systems* and is technically co-sponsored by the *IEEE Brain Initiative* and *IEEE Standards*.

Papers

The goal of the Workshop is to provide a forum for researchers to present research results and facilitate the interaction and intellectual exchange between researchers, developers, and consumers of BMI and brain-research technology. This year, we have 92 papers accepted after careful peer-review by at least three experts in BMI-related fields and will be presented across **15 regular and special sessions** in: human-machine systems (HMS) and cognitive cybernetics; novel approaches to improve functional diagnosis/prognosis; tools, metrics and databases; invasive BCIs; multimodal HMS; passive/affective BMIs; BMI and robotics; deciphering cortical representations for BMIs; deep learning for BMIs; real-world applications: SSVEP and spellers; automotive and

exoskeletons; novel BMI paradigms; BMI modeling, analysis, and performance; BMIs for neurorehabilitation and body augmentation; and brain-inspired systems and unconventional BMI applications.

We are also pleased to have two outstanding BMI keynote speakers:

- Mitsuo Kawato (Director of Brain Information Communication Research Laboratory, ATR, Japan): *Brain Science Demonstrates Consciousness as a Key for Future AI*
- Andrzej Cichocki (Skolkovo Institute of Science and Technology, Russia): *Brain Computer Interface and Recognition of Human Emotions Using Multiway Component Analysis*

We also have five excellent BMI invited speakers giving seven invited talks:

- Jan Bjaalie (Leader, Neuroinformatics Platform, EU Human Brain Project): *The EU Human Brain Project: advancing knowledge in neuroscience, computing, and brain-related medicine*
- Tomasz (Tomek) M. Rutkowski (RIKEN AIP, Japan): *Multisensory BCIs in applications for robotics, VR/AR, art and dementia monitoring*
- Christoph Guger (CEO, g.tec medical engineering GmbH, Austria): (1) *An overview of BCI approaches and how to use BCI technology for communication, motor rehabilitation and cognitive assessment: demonstration;* (2) *Current and future applications of BCIs,* and (3) *How to run a real-time BCI application successfully*
- Kyousuke Kamada (Asahikawa Medical University, Japan): *Non-invasive and invasive Brain-Computer Interfaces for medical application and research projects*
- Paul Sajda (Chair, IEEE Brain Initiative): *BCIs for labeling our environment*

BR41N.IO Brain-Computer-Interface Hackathon

Hackathons are two-day brainstorming and collaborative marathons that create an environment supporting the rapid production of working prototypes. SMC 2018 attendees and non-SMC 2018 attendees interested in BCI/BMI and related technologies may participate in the **free** *Brain Computer Interface Hackathon* organized by the BMI Workshop to be held on Sunday, October 7th and Monday, October 8th, 2018. There are over $4,200 in cash and hardware prizes donated by the sponsors and organizers. Register at the 2018 IEEE SMC Brain Hackathon website or email Christoph Guger at <guger@gtec.at> if you have questions.

Standards Meeting, Tutorial, and Panels

Other highlights of the Workshop include a Panel on Standards for Neurotechnologies (October 8, 16:00 – 18:00, Crystal room) to advance and identify current needs and challenges for standardization of neurotechnologies. Representatives from industry, academia, technologists, and other stakeholders will be present, including members from the IEEE Industry Connections group on neurotechnologies, IEEE Standards Association, and the IEEE Brain Initiative. The possibility of deploying and commercializing BMI-based solutions with human users requires researchers, manufacturers, and regulatory agencies to ensure these devices comply with well-defined criteria for their safety and effectiveness. Consequently, there is an increased interest in development of appropriate standards for BMI systems and related neurotechnologies.

BMI tutorial will be held on October 7, 2018:

- How to Improve Performance in Brain-Computer/Machine Interface

The Workshop will also feature three **Panels**:

- *Future Research Opportunities and Funding in Brain Research and BMI*
- *Important Issues in Designing and Building Real World Neurotechnologies: What is New?*
- *Minds and Machines: Integrating AI with current Brain Research and Future Neurotechnologies*

We will close the Workshop with an open discussion on October 10, 2018 on "*What Have We Learned, Where Do We Go From Here?*" at 15:10 followed by a poster session and a reception at 16:00-17:00. All are welcome.

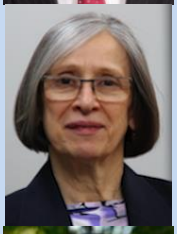
Organization Committee and Sponsors

We would like to thank the many organizations and individuals who worked hard in organizing this Workshop, including the Technical Program Chairs and Co-Chairs: *Masayuki Hirata, Jun Morimoto, Ricardo Chavarriaga, Jing Jin, Riki Matsumoto, and Yingxu Wang*; Special Session Chair and Co-Chairs: *Kyousuke. Kamada, Keiichi Kitajo, Yaoping Hu, Tim Mullen, Shinji Nishimoto, Vino. Prasad, Ivan Volosyak, Fei-Yue Wang, and Dongrui Wu*; Publicity and Sponsorship Chairs: *Yu-Fei Huang and Margaret Thompson*; Media Relations Chair: *Sara Breinbauer, Technical Editor, Start Mason Dambort* as well as the Brain Hackathon organizers: *Christoph Guger, Tiago H. Falk, Kyousuke Kamada,* and *Tim Mullen* and the Hackathon student competition Chairs: *Kojiro Matsushita* and *Takeshi Ogawa*.

A special thank you also to all those who helped make the Brain Initiatives Meeting a reality, including the IEEE President and CEO *James A. Jefferies* for hosting the meeting, and the leaders of Global Current and Emerging Brain Initiatives, as well as allied organizations, including: *Nick B. Langhals*, National Institute of Neurological Disorders and Stroke (NIH/NINDS, USA);); *Uri Hasson*, National Science Foundation, USA; *Mitsuo Kawato*, ATR, Japan; *Jan Bjaalie*, EU Human Brain Project; *Bo Xu*, China Brain Project, Chinese Academy of Sciences; *Jeong-woo Sohn*, Korea Brain Initiative; *Sharath Sriram*, Australian Brain Alliance; *Yingxu Wang*, Hotchkiss Brain Institute, Canada; *Cliff Abraham* and *Peter Thorn*, Brain Research New Zealand; *Andrzej Cichocki*, SKOLTECH, Russia; *Wlodzislaw Duch*, Polish Brain Initiative, *Henry T. (Hank) Greely*, International Neuroethics Society; *Randy Schekman*, Aligning Science Across Parkinson's Initiative; *Dimitar Filev*, Ford Motor Company; *Paul Sajda*, IEEE Brain Initiative; *Edward Tunstel*, IEEE SMC Society; *Konstantinos Karachalios*, IEEE Standards Association; and *Ricardo Chavarriaga*, IEEE. We also thank the BMI Workshop and Brain Hackathon sponsors and supporters for their generous funding and support.

We look forward to meeting you in Miyazaki!
Michael H. Smith, Ljiljana Trajkovic, Tiago H. Falk, and Christoph Guger, Workshop Chair and Co-Chairs

Michael H. Smith
General Chair
m.h.smith@ieee.org
University of California, Berkeley, USA

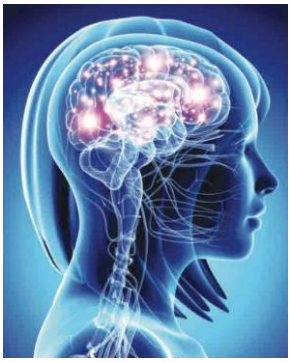


Ljiljana Trajkovic
Co-Chair
ljilja@cs.sfu.ca
Simon Fraser University, Canada

Tiago H. Falk
Co-Chair
falk@emt.inrs.ca
INRS-EMT, University of Quebec, Canada

Christoph Guger
Co-Chair
guger@gtec.at
g.tec medical engineering GmbH, Austria

Meeting of Global Current and Emerging Brain Initiatives
Tuesday, October 9, 9:30-18:30, Room: 2F Fountain



The IEEE Systems, Man, and Cybernetics Society and the IEEE President, James Jefferies, will host a special meeting of global Brain Initiative leaders and representatives from other groups working on large-scale multi-year brain projects from Australia, Canada, China, Europe (HBP), Japan, Korea, New Zealand, Poland, Russia, and US (NSF and NIH). Also participating are the IEEE Brain Initiative, the International Neuroethics Society, representatives from Industry, and other interested stakeholders. IEEE, as a new participant, welcomes collaborative discussions with all stakeholders to better align and integrate IEEE with other existing brain efforts. IEEE is a global technical community of 420,000+ professionals across multiple technology domains, many active in global brain projects.

The topics discussed at this meeting are driven by input from the global Brain Initiatives representatives and other stakeholders. We hope these discussions will support the efforts of the Kavli Foundation and others to establish an International Brain Initiative. This will be IEEE's first collaborative meeting with global Brain Initiative leaders.

This meeting, hosted by IEEE, is open to all. The preliminary agenda and topics to be discussed as suggested by the global Brain Initiatives representatives and others includes:

1) Status of Global Brain Projects and the International Brain Initiative;
2) IEEE Brain Initiative and activities;
3) Attracting engineers, scientists, programmers, mathematicians, quantitative analysts, and others to the multi-disciplinary field of neuroscience;
4) Future collaborations and cooperation:
    a. Among Brain Initiatives, industry, and other stakeholders (e.g., joint proposals);
    b. Among funding agencies (e.g., open process for joint partnerships between funding agencies with other countries);
    c. Ability of performers/researchers to support multiple global initiatives.
5) Topics brain researchers should undertake, translational neuroscience and neural engineering;
6) Neuroethics; Standards development;
7) Sharing of brain data;
8) Open discussion and other topics.

This is an open meeting with limited seating. Free to all SMC2018 attendees. Non-SMC2018 attendees can attend this meeting at a special registration rate. Interested parties from academic, funding agencies (both public and private), industry, and others are invited to attend this meeting.

For more information, registration, or questions, please visit:
https://go.epfl.ch/smc2018_GlobalBrainInitiatives
or contact Dr. Michael H. Smith <m.h.smith@ieee.org>, Chair.

IEEE
Advancing Technology for Humanity

Meeting of Global Current and Emerging Brain Initiatives
List of Invited Participants

Michael Smith, (Chair) 2018 IEEE SMC Meeting of Global Current and Emerging Brain Initiatives

Jim Jefferies, IEEE President and CEO

Nick B. Langhals, Program Director, Nat. Inst Neurological Disorders and Stroke (NIH/NINDS), USA

Uri Hasson, Program Director, Cognitive Neuroscience, NSF, USA

Mitsuo Kawato, ATR, Brain Information Communication Research Group, Kyoto, Japan

Andrzej Cichocki, Laboratory Head and Professor, SKOLTECH, Russia

Bo Xu, Member, Working Group, China Brain Project, Chinese Academy of Sciences

Jan Bjaalie, Leader, Neuroinformatics Platform, EU Human Brain Project

Wlodzislaw Duch, Director, Neurocognitive Laboratory, Poland

Jeong-woo Sohn, Member, Working Group, Korea Brain Initiative

Sharath Sriram, Member, Executive Committee, Australian Brain Alliance

Ricardo Chavarriaga, Chair, IEEE Group on Standards for Neurotechnology

Tiago H. Falk, INRS-EMT, University of Quebec, Canada

Yingxu Wang, Hotchkiss Brain Institute, University of Calgary, Canada

Cliff Abraham, Co-Director, Brain Research New Zealand

Peter Thorn, Co-Director, Brain Research New Zealand

Henry T. (Hank) Greely, President, International Neuroethics Society

Randy Schekman, Advisory Council Chair, Aligning Science Across Parkinson's Initiative *

Dimitar Filev, Ford Research and Innovation Center, Ford Motor Company

Ljiljana Trajkovic, Director-Elect, IEEE

Edward Tunstel, President, IEEE Systems, Man, and Cybernetics Society

Paul Sajda, (Moderator), Chair, IEEE Brain Initiative

Konstantinos Karachalios, Managing Director, IEEE Standards Association

* Taped presentation, remote presence

Meeting of Global Current and Emerging Brain Initiatives
Agenda

Tuesday, October 9, 9:30-18:30, Room: 2F Fountain

9:30-10:00 Opening Ceremony, Introductions, IEEE President

10:00-12:30 Status of Global Brain Projects, International Brain Initiative, IEEE Brain Initiative, current research and future applications to benefit humanity.

12:30-13:30 Working Lunch:
Future Research and funding opportunities among brain initiatives and funding agencies.
Future Collaborations and Cooperation:

a. Brain Initiatives, industry, and other stakeholders (joint proposals);
b. Funding agencies (open process for joint partnerships between funding agencies with other countries);
c. Ability of performers/researchers to support multiple global initiatives.

13:30-14:30 Neuroethics, sharing brain data, open data repositories, attracting engineers, scientists, programmers, mathematicians, quantitative analysts, and others to the multi-disciplinary field of neuroscience.

14:30-15:30 Topics that brain researchers should undertake, translational neuroscience, neural engineering, encouraging future development of neurotechnologies to benefit those in need.

15:30-16:00 Coffee Break and Posters

16:00-17:00 Role of IEEE in brain community, development of standards, formation of International Brain Initiative, other important issues.

17:00-18:00 Open discussion, future plans, establishment of working groups to address issues discussed at this meeting and making future recommendations.

18:00-18:30 Networking, posters

19:00 Banquet

Meeting of Global Current and Emerging Brain Initiatives
Bios of Invited Participants

Michael Smith, Ph.D., is the **Chair of the 2018 IEEE SMC Meeting of Global Current and Emerging Brain Initiatives**.
He has also served as the Chair or Co-Chair of eight IEEE SMC BMI Workshops, including this year's workshop. He currently is the Chairman of the Board of Furaxa, Inc, a biotech company, and a Visiting Scholar at the University of California, Berkeley. He also serves on the Advisory Board of UC Berkeley's Center for Neural Engineering & Prostheses, is a Senior Advisor of the IEEE Brain Initiative, and is also the Chair of IEEE SMC's Technical Committee on Brain-Machine Interface Systems. He previously served as President of the Intelligent Robotics Corporation, President of the IEEE Systems, Man, and Cybernetics (SMC) Society, and President of the North American Fuzzy Information Processing Society. He is also the recipient of the IEEE SMC Joseph G. Wohl Outstanding Career Award. His research interests include the development of low-cost, real-world Brain-Computer Interface Systems, AI, and robotics. Dr. Smith received four degrees from UC Berkeley, including a M.S., MBA, and Ph.D.

James, A. Jefferies, IEEE President & CEO. Jim Jefferies retired from AT&T and Lucent Technologies following 33 years in engineering and executive positions including fiber optic cable development and manufacturing, quality assurance, and supply chain management. He managed the engineering teams that delivered the first commercial fiber optic cables for AT&T. He served as logistics vice president, responsible for worldwide supply chain and export planning. He has led teams in major technology transfers, transitions of information technology, and organizational change. He has also worked in the entrepreneurial sector as Chief Operating Officer for USBuild.com in San Francisco, CA, USA.

Jim served two separate terms on the IEEE Board of Directors, as well as the 2015 IEEE-USA President. As President of IEEE-USA, Jim supported the expanded focus on public visibility, young professionals, and humanitarian outreach. He received his BS in Electrical Engineering from the University of Nebraska and an MS in Engineering Science from Clarkson University. He attended the Stanford University Graduate School of Business as a Sloan Fellow and earned an MS in Management. Jim is a member of the IEEE Eta Kappa Nu honorary society and a licensed professional engineer (Emeritus).

Nick B. Langhals, Ph.D. serves as Program Director for Neural Engineering within the Repair and Plasticity Cluster at the **National Institute of Neurological Disorders and Stroke (NIH/NINDS)**. Nick Langhals is a team lead in both the **Brain Research through Advancing Innovative Neurotechnologies® (BRAIN) Initiative** as well as the Stimulating Peripheral Activity to Relieve Conditions (SPARC) program. He currently manages a grant portfolio in the areas of neurotechnology development, validation, and translation for applications in neuroscience, neurophysiology, neuromodulation, and other interfaces with the nervous system. Prior to arriving at the NIH in 2015, Dr. Langhals served as a Research Assistant Professor in Plastic Surgery and Biomedical Engineering at the University of Michigan. Dr. Langhals served as Co-Director of the Neuromuscular Laboratory, which has developed a regenerative peripheral nerve interface (RPNI) to extract prosthetic control signals and restore lost sensation to amputees for the control of replacement upper and lower extremity prostheses.

Uri Hasson serves as Program Director for the Cognitive Neuroscience program at the US **National Science Foundation**. He is a member of NSF's "**Understanding the Brain**" coordinating group and is involved in NSF's **Integrative Strategies for Understanding Neural and Cognitive Systems (NCS) program**. Dr. Hasson obtained his Ph.D. in Cognitive Psychology from Princeton University (2004), and then completed post-doctoral training at the University of Chicago where, as part of his work, he developed methods for utilizing grid-computing resources for analysis of neuroimaging data. He holds joint appointments at the University of Trento (Italy) and the University of Chicago (USA) and his scientific work addresses the computations that support language comprehension and the coding of uncertainty.

Mitsuo Kawato received a B.S. degree in physics from Tokyo University in 1976 and M.E. and Ph.D. degrees in biophysical engineering from Osaka University in 1981. From 1981 to 1988, he was a faculty member and lecturer at Osaka University. From 1988, he was a senior researcher and then a supervisor in ATR. Since 2003, he has been Director of ATR Computational Neuroscience Laboratories. Since 2004, he has been an ATR Fellow. In 2010, he became **Director of ATR Brain Information Communication Research Laboratories**. In 2018, he was jointly appointed as a Special Advisor, RIKEN Center for Advanced Intelligence Project (AIP). For the last fifteen years he has been working in computational neuroscience and neural network modeling. He published about 250 papers, reviews and books. Research topics include decoded neurofeedback as an experimental tool to manipulate spatiotemporal brain activity patterns, rs-fcMRI based biomarkers of mental disorder, advanced fMRI neurofeedback therapy, simulation study of dendritic spines, feedback-error-learning model and its applications to industrial robot manipulators, movement trajectory formation, bi-directional theory for interactions between cortical areas, cerebellar internal models, and teaching by demonstration for robots.

Andrzej Cichocki received the M.Sc. (with honors), Ph.D. and Dr.Sc. (Habilitation) degrees, all in electrical engineering from Warsaw University of Technology (Poland). He spent several years at University Erlangen (Germany) as an Alexander-von-Humboldt Research Fellow and Guest Professor. In 1995-2018, he was a Senior Team Leader and Head of the laboratory for Advanced Brain Signal Processing, at RIKEN Brain Science Institute (Japan) and now he is a Professor in the **Skolkovo Institute of Science and Technology - SKOLTECH (Russia)** and adjunct/visiting professor in Tokyo University of Agriculture and Technology (TUAT) in Japan, Hangzhou Dianzi University (HDU) in China, Nicolaus Copernicus University, in Poland, and Institute of Systems Research Institute of Polish Academy of Science. He is author of more than 500 peer-review papers and 5 monographs in English (two of them translated to Chinese). He serves or served as Associated Editor of, IEEE Trans. on Signals Processing, IEEE Trans. on Neural Networks and Learning Systems, IEEE Trans. on Cybernetics, Journal of Neuroscience Methods and he was as founding Editor in Chief for Journal Computational Intelligence and Neuroscience. Currently, his research focus on deep learning, tensor decompositions, tensor networks for big data analytics, multiway blind source separation, and Brain Computer Interface. His publications currently report over 36,000 citations according to Google Scholar, with an h-index of 82. Dr Cichocki is currently among 3 the most cited Polish computer scientists and he is Fellow of the IEEE since 2013.

Bo Xu has been working on speech and language research for more than 20 years. Now he is the President of the Institute of Automation, Chinese Academy of Sciences (CAS) and Associate Director, **Center for Excellence in Brain Science and Intelligence Technology, CAS**. His currently interests include auditory modeling, spoken dialogue understanding and translation based on brain-inspired cognition model.

Jan Bjaalie, M.D., Ph.D. is professor at the **Institute of Basic Medical Sciences, University of Oslo**, and leader of the Neuroinformatics Platform of the **EU Human Brain Project**. He was founding Executive Director of the **International Neuroinformatics Coordinating Facility (INCF)** and is currently head of the INCF Norwegian Node and member of the INCF Council for Training, Science, and Infrastructure. His research group has studied wiring patterns in the brain and developed data systems for organizing and managing heterogeneous neuroscience research data by use of a new generation of digital brain atlases. The group develops software and workflows for analysis of data integrated in the atlases ("Google maps of the brain"). Jan Bjaalie is Chief Editor of Frontiers in Neuroinformatics and Section editor of Brain Structure and Function.

Wlodzislaw Duch heads the Neurocognitive Laboratory in the Center of Modern Interdisciplinary Technologies at Nicolaus Copernicus University (NCU), Torun, Poland. His Lab is using neuroimaging techniques, behavioral experiments and computational modelling working with infants, children and adults, and is currently hosting Polish node of the International Neuroinformatics Coordination Facility (INCF), working on integration of various activities in the country to form **Polish Brain Initiative**. His MSc (1977) was in theoretical physics, Ph.D. in quantum chemistry (1980), postdoc at the USC, Los Angeles (1980-82), D.Sc. in applied math (1987). He has worked as the Nanyang Visiting Professor (2010-12) and Visiting Professor (2003-07) in the School of Computer Engineering, Nanyang Technological University, Singapore; University of Florida; Max-Planck-Institute, Munich, Germany, Kyushu Institute of Technology, Meiji and Rikkyo University in Japan, and several other institutions. He is/was on the editorial board of IEEE TNN, CPC, NIP-LR, Journal of Mind and Behavior, and 14 other journals; was co-founder & scientific editor of the "Polish Cognitive Science" society and journal; served two terms as the President of the European Neural Networks Society executive committee (2006-2008-2011), a member of IEEE CIS Technical committee; Fellow of the International Neural Network Society. Expert of the EU science programs, member of the high-level expert group of European Institute of Innovation & Technology Health (EIT) program. He has served as the **deputy minister for science and higher education in Poland** (2014-15), as the Vice-President for Research and ICT Infrastructure at NCU University (2012-14).

Jeong-woo Sohn is a member of the Working Group, **Korea Brain Initiative**. He is a professor at the department of medical science at the University of Catholic Kwandong University in the Republic of Korea. He also serves as a vice president of the National Association of Cognitive Science Industry in Korea. He obtained his bachelor's degree in nuclear engineering, and a master's degree in cognitive science from the Seoul Nation University in Korea. He also received a Ph.D. degree in Brain and Cognitive Sciences from the University of Rochester, USA. After this, he was a post-doctoral researcher at the University of Pittsburgh, USA. He then returned to Korea and became a principal researcher at the Medical Device Development Center of the Daegu-Gyeonbuk Medical Innovation Foundation. He led a research group who did medical imaging investigations during this time. As a recognition of his contributions to the medical device industry, he was awarded the Medical Device Achievement Award by the Ministry of Food and Drug Safety of Korea. His research interests are brain and machine interface, motor learning, and statistical analysis on neural data.

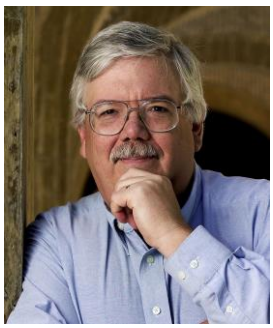
Sharath Sriram is engaged extensively in science policy and advocacy, with current roles on the Executive of the **Australian Brain Alliance** and the Policy Committee of peak body Science and Technology Australia. He jointly leads the Functional Materials and Microsystems Research Group at RMIT University. He is also the Founding Deputy Director and Scientific Coordinator of RMIT University's $30 million Micro Nano Research Facility. He specializes in the use of oxide thin films and nanofabrication for nanoelectronics and electromagnetic devices. He was a recipient of an ARC Post-Doctoral Fellowship (2011-2014) and examples of his recognition includes the 2012 NMI Prize for Measurement Excellence from the National Measurement Institute, Australia; a 2012 Victoria Fellowship; the 2016 Australian Museum 3M Eureka Prize for Emerging Leader in Science; and being named among Australia's Most Innovative Engineers 2016 by Engineers Australia.

Tiago H. Falk is an Associate Professor at the Institut national de la recherche scientifique **(INRS, University of Quebec**) in Montreal, **Canada** where he directs the Multimodal Signal Analysis and Enhancement (MuSAE) Laboratory. His research interests lie at the crossroads of telecommunications and biomedical engineering with particular focus on the development of affective brain/body-machine interfaces and anthropomorphic, human-inspired multimedia technologies, as well as on new signal processing and machine learning paradigms for improved brain health diagnostics. He is Editor of the recently-released book Signal Processing and Machine Learning for Biomedical Big Data, published by CRC Press in July 2018. Prof. Falk is a Senior Member of the IEEE, a member of the Sigma Xi Research Society, and an elected member of the Global Young Academy (GYA), the IEEE SPS Audio Processing Technical Committee (2017-2020), Academic Chair of the Canadian Biomedical and Biological Engineering Society and Co-Chair of the IEEE SMC BMI Technical Committee. He is also Area Editor for the IEEE Signal Processing Magazine, an Associate Editor for the International Journal of Healthcare Engineering, and a Guest Editor for Frontiers in Neurology on the Research Topic Neurotrauma: from emergency room to back to day-to-day life. He is **co-chair of the 2018 IEEE SMC Brain-Machine Interface Systems Workshop**, as well as the 2017 and 2018 IEEE SMC BMI Hackathon.

Yingxu Wang, Hotchkiss Brain Institute, University of Calgary, **Canada**, is professor of cognitive systems, brain science, software science, and denotational mathematics. He is the Founding President of International Institute of Cognitive Informatics and Cognitive Computing (ICIC, http://www.ucalgary.ca/icic/). He is Fellows of BCS, ICIC and WIF, P.Eng of Canada, and Senior Members of IEEE and ACM. He has held visiting professor positions at Oxford University (1995), Stanford University (2008 | 2016), UC Berkeley (2008), and MIT (2012), respectively. He received a PhD in Computer Science from the Nottingham Trent University, UK, in 1998 and has been a full professor since 1994. He is the founder and steering committee chair of the annual IEEE International Conference on Cognitive Informatics and Cognitive Computing (ICCI*CC) since 2002. He is founding Editor-in-Chiefs of Int'l Journal of Cognitive Informatics & Natural Intelligence, Int'l Journal of Software Science & Computational Intelligence, and Journal of Mathematical & Computational Methods. He is Associate Editor of IEEE Trans. on Cognitive and Development Systems (TCDS) and the Computer Society Representative to the steering committee of TCDS. Dr. Wang is the initiator of a few cutting-edge research fields such as cognitive informatics, denotational mathematics, abstract intelligence (aI), mathematical models of the brain, the spike frequency modulation (SFM) theory, cognitive computing systems, cognitive learning engines, and the cognitive knowledge base theory. He has published 490+ peer reviewed papers and 36 books in aforementioned transdisciplinary fields. He has presented 42 invited keynote speeches in international conferences. He has served as general chairs or program chairs for more than 26 international conferences. He has led 10+ international, European, and Canadian research projects as PI by intensive collaborations with renowned peers and leading industrial partners. He is the recipient of dozens international awards in the past three decades.

Cliff Abraham is Professor of Psychology and co-Director of a national research centre on the aging brain, **Brain Research New Zealand**. He received a PhD in Neuroscience from the University of Florida and spent 5 years of postdoctoral research at the University of Otago and the University of Gothenburg, Sweden. He returned to Psychology at Otago to take up a Lectureship at Otago, where he has remained since. He is a Fellow of the Royal Society of New Zealand, and in 2009 was awarded the University of Otago's Distinguished Research Medal. Professor Abraham's research is focused on the neural mechanisms of learning and memory, particularly with respect to the mechanisms of synaptic plasticity and metaplasticity, as well as the mechanisms and therapeutic potential of secreted amyloid precursor protein.

Peter Thorn is Co-Director of Brain Research New Zealand–Rangahau Roro Aotearoa, and has a joint professorial appointment in the Section of Audiology and Department of Physiology at the University of Auckland. He is Director of the Eisdell Moore Centre, a centre for research in hearing and balance disorders. He is on the Directorate of **Brain Research New Zealand**, a national Centre of Research Excellence. He completed his PhD at the University of Auckland and post-doctoral studies at the University of Auckland and at the Kresge Hearing Research Institute, University of Michigan. His research is in the area of sensory neurobiology particularly inner ear homeostasis and the influence of noise exposure and aging on hearing. He is the Chairman of the National Foundation for the Deaf and is on the Board of the Deafness Research Foundation. In 2009, he was made a Companion of the New Zealand Order of Merit (CNZM) for services to audiology and auditory neuroscience.



Henry T. (Hank) Greely is the Deane F. and Kate Edelman Johnson Professor of Law and Professor, by courtesy, of Genetics at Stanford University. He specializes in ethical, legal, and social issues arising from advances in the biosciences, particularly from genetics, neuroscience, and human stem cell research. He is President of the **International Neuroethics Society**; directs the Stanford Center for Law and the Biosciences and the Stanford Program on Neuroscience in Society; chairs the California Advisory Committee on Human Stem Cell Research; and serves on the Neuroscience Forum of the National Academy of Medicine; the Committee on Science, Technology, and Law of the National Academy of Sciences; and the NIH BRAIN Initiative's Multi-Council Working Group, whose Neuroethics Division he co-chairs. He was elected a fellow of the American Association for the Advancement of Science in 2007.

Randy Schekman is the Advisory Council Chair of the **Aligning Science Across Parkinson's Initiative**. He is also a Professor in the Department of Molecular and Cell Biology, University of California, Berkeley, and an Investigator of the Howard Hughes Medical Institute. He studied the enzymology of DNA replication as a graduate student with Arthur Kornberg at Stanford University. His current interest in cellular membranes developed during a postdoctoral period with S. J. Singer at the University of California, San Diego. At Berkeley, he developed a genetic and biochemical approach to the study of eukaryotic membrane traffic. Among his awards are the Gairdner International Award, the Albert Lasker Award in Basic Medical Research and the **Nobel Prize in Physiology or Medicine**, which he shared with James Rothman and Thomas Südhof. He is a member of the National Academy of Sciences, the Institute of Medicine, the American Academy of Arts and Sciences, the American Philosophical Society, a Foreign Associate of the Accademia Nazionale dei Lincei and a Foreign Associate of the Royal Society of London. In 1999, he was elected President of the American Society for Cell Biology. In 2002 he was appointed Editor-in-Chief of the Annual Reviews of Cell and Developmental Biology. From 2006 - 2011 he served as Editor-in-Chief of the Proceedings of the NAS. In 2011, he was appointed Editor-in-Chief of an Open Access journal, eLife, sponsored by the HHMI, Wellcome Trust and the Max Planck Society.

Dimitar Filev is a **Henry Ford Technical Fellow** at the Ford Research & Innovation Center, Dearborn, Michigan. He is conducting research in computational intelligence, AI and intelligent control, and their applications to autonomous driving, vehicle systems, and automotive engineering. Dr. Filev has published 4 books, over 250 journal articles and conference papers, and holds 104 US patents and numerous foreign patents. He was awarded six times with the highest Ford Motor Company Award – the Henry Ford Technology Award. He is the recipient of the 2008 Norbert Wiener Award of the IEEE SMC Society and the 2015 Pioneer's Award of the IEEE CIS Society. He received his PhD. degree in Electrical Engineering from the Czech Technical University in Prague in 1979. Dr. Filev is a Fellow of the IEEE and a member of the NAE. He was president of the IEEE Systems, Man, and Cybernetics Society (2016-2017).

Ljiljana Trajkovic serves as **IEEE Division X Delegate-Elect/Director-Elect (2018)** and **IEEE Division X Delegate/Director (2019–2020).** She also serves as Senior Past President (2018–2019) of the IEEE Systems, Man, and Cybernetics Society and previously served as its President (2014–2015). Dr. Trajkovic also served as the 2007 President of the IEEE Circuits and Systems Society.

She is **General Co-Chair of the IEEE SMC 2018 Workshop on BMI Systems** and was Technical Program Chair of the IEEE SMC 2017 and 2016 Workshops on BMI Systems. She served as an Associate Editor of the IEEE Transactions on Circuits and Systems and the IEEE Circuits and Systems Magazine. Dr. Trajkovic was a Distinguished Lecturer of the IEEE Circuits and Systems Society. She is a Professional Member of IEEE-HKN and a Fellow of the IEEE.

Dr. Trajkovic is currently a Professor in the School of Engineering Science at Simon Fraser University, Burnaby, British Columbia, Canada. From 1995 to 1997, she was a National Science Foundation (NSF) Visiting Professor in the Electrical Engineering and Computer Sciences Department, University of California, Berkeley. She was a Research Scientist at Bell Communications Research, Morristown, NJ, from 1990 to 1997, and a Member of the Technical Staff at AT&T Bell Laboratories, Murray Hill, NJ, from 1988 to 1990. Her research interests include high-performance communication networks, control of communication systems, computer-aided circuit analysis and design, and theory of nonlinear circuits and dynamical systems.

Edward Tunstel serves as 2018-2019 President of the **IEEE Systems, Man, and Cybernetics Society**. He is an Associate Director of Robotics in the Systems Department of UTRC. He joined UTRC in 2017 after 10 years at Johns Hopkins Applied Physics Laboratory where he served as a senior roboticist in its research department and Intelligent Systems Center, and as space robotics & autonomous control lead in its space department. Prior to APL he was with NASA JPL for 18 years, where he was a senior robotics engineer and group leader of its Advanced Robotic Controls Group.

Dr. Tunstel maintains expertise in robotics and intelligent systems with current research interests in mobile robot navigation, autonomous control, cooperative robotics, robotic systems engineering and soft computing applications to autonomous systems. He has authored over 150 technical publications and co-edited four books in these areas. He worked on the NASA Mars Exploration Rovers mission as both a flight systems engineer responsible for autonomous rover navigation and associated V&V, and as rover engineering team lead for the mobility and robotic arm subsystems. He was involved in the daily performance assessment, planning, and operations of the Spirit and Opportunity rovers during their first four years on Mars. At APL he was recently engaged in modular open systems development efforts supporting the advanced EOD robotic systems programs, as well as robotics and autonomy research for future national security and space applications. He is now additionally engaged in human-collaborative robotics enabling operations within businesses spanning the aerospace and building industries, including manufacturing.

Paul Sajda is a Professor of Biomedical Engineering, Electrical Engineering and Radiology (Physics) at Columbia University. He is also a Member of Columbia's Data Science Institute. He received a BS in electrical engineering from MIT in 1989 and an MSE and PhD in bioengineering from the University of Pennsylvania, in 1992 and 1994, respectively. Professor Sajda is interested in what happens in our brains when we make a rapid decision and, conversely, what processes and representations in our brains drive our underlying preferences and choices, particularly when we are under time pressure. His work in understanding the basic principles of rapid decision-making in the human brain relies on measuring human subject behavior simultaneously with cognitive and physiological state. Important in his approach is his use of machine learning and data analytics to fuse these measurements for predicting behavior and infer brain responses to stimuli. Professor Sajda applies the basic principles he uncovers to construct real-time brain-computer interfaces that are aimed at improving interactions between humans and machines. He is also applying his methodology to understand how deficits in rapid decision-making may underlie and be diagnostic of many types of psychiatric diseases and mental illnesses. Professor Sajda is a co-founder of several neurotechnology companies and works closely with a range of scientists and engineers, including neuroscientists, psychologists, computer scientists, and clinicians. He is a fellow of the IEEE, AMBIE and AAAS and Chair of the IEEE Brain Initiative.

Konstantinos Karachalios is managing director of the **IEEE Standards Association** and a member of the IEEE Management Council. As managing director, he has been enhancing IEEE efforts in global standards development in strategic emerging technology fields, through technical excellence of staff, expansion of global presence and activities and emphasis on inclusiveness and good governance, including reform of the IEEE standards-related patent policy.
As member of the IEEE Management Council, he championed expansion of IEEE influence in key techno-political areas, including consideration of social and ethical implications of technology, according to the IEEE mission to advance technology for humanity. Results have been rapid in coming and profound; IEEE is becoming the place to go for debating and building consensus on issues such as a trustworthy and inclusive Internet and ethics in design of autonomous systems.

Before IEEE, Konstantinos played a crucial role in successful French-German cooperation in coordinated research and scenario simulation for large-scale nuclear reactor accidents. And with the European Patent Office, his experience included establishing EPO's patent academy, the department for delivering technical assistance for developing countries and the public policy department, serving as an envoy to multiple U.N. organizations. Konstantinos earned a Ph.D. in energy engineering (nuclear reactor safety) and masters in mechanical engineering from the University of Stuttgart.

Ricardo Chavarriaga is the coordinator of the IEEE industry activities group on Neurotechnologies. He is a senior researcher at the Center for Neuroprosthetics of the École Polytechnique Fédérale de Lausanne (EPFL), Switzerland. He holds a B.Sc. degree in Electronics Engineering from the Pontificia Universidad Javeriana in Cali, Colombia and a PhD in computational neuroscience from EPFL. He co-chairs the **IEEE SMC Technical Committee on BMI Systems**, and is part of the steering committee of the **IEEE Brain Initiative**.

His research focuses on robust brain-machine interfaces and multimodal human-machine interaction. Specifically, the decoding of cortical potentials that convey information about the user's cognitive processes. Furthermore, He investigates on how the exploitation of such processes can be integrated with shared control principles and hybrid approaches for BMI control of complex devices.

Panel: Standards for Neurotechnologies
Monday, October 8, 16:00-18:00, Room: 4F Crystal

The Industry Connections group on neurotechnologies, supported by IEEE Standards Association and the IEEE Brain Initiative, is working to identify current needs and challenges for standardization of neurotechnologies. This panel will advance discussions on this topic among representatives from industry, academia, technologists and other stakeholders.

The field of Brain-Machine Interfacing (BMI) is going through a very exciting period where numerous emergent neurotechnologies are exploiting neural signals for a range of practical applications, both clinical and non-clinical. As research with these state-of-the-art technologies continues to improve our understanding of the mammalian nervous system, such systems are currently being tested with their intended end-users in clinical and real-world environments. This translation from research prototypes to viable clinical or consumer products entails multiple challenges – both technical and commercial.

Broadly speaking, the proliferation of biosensing modalities, end effectors, applications, and prospective user populations has created the need for a more interoperable ecosystem of neurotechnologies, including traditional and novel BMIs. Furthermore, the possibility of deploying and commercializing BMI-based solutions with human users requires researchers, manufacturers, and regulatory agencies to ensure these devices comply with well-defined criteria for their safety and effectiveness. Consequently, there is an increased interest in development of appropriate standards for BMI systems and related neurotechnologies.

PANELISTS

Ricardo Chavarriaga (Chair) is the coordinator of the IEEE industry activities group on Neurotechnologies. He is a senior researcher at the Center for Neuroprosthetics of the École Polytechnique Fédérale de Lausanne (EPFL), Switzerland. He holds a B.Sc. degree in Electronics Engineering from the Pontificia Universidad Javeriana in Cali, Colombia and a PhD in computational neuroscience from EPFL. He co-chairs the **IEEE SMC Technical Committee in BMI Systems**, and is part of the steering committee of the **IEEE Brain Initiative**.

His research focuses on robust brain-machine interfaces and multimodal human-machine interaction. Specifically, the decoding of cortical potentials that convey information about the user's cognitive processes. Furthermore, He investigates on how the exploitation of such processes can be integrated with shared control principles and hybrid approaches for BMI control of complex devices.

Nick B. Langhals, Ph.D. serves as Program Director for Neural Engineering within the Repair and Plasticity Cluster at the **National Institute of Neurological Disorders and Stroke (NIH/NINDS)**. Nick Langhals is a team lead in both the **Brain Research through Advancing Innovative Neurotechnologies® (BRAIN) Initiative** as well as the Stimulating Peripheral Activity to Relieve Conditions (SPARC) program. He currently manages a grant portfolio in the areas of neurotechnology development, validation, and translation for applications in neuroscience, neurophysiology, neuromodulation, and other interfaces with the nervous system. Prior to arriving at the NIH in 2015, Dr. Langhals served as a Research Assistant Professor in Plastic Surgery and Biomedical Engineering at the University of Michigan. Dr. Langhals served as Co-Director of the Neuromuscular Laboratory, which has developed a regenerative peripheral nerve interface (RPNI) to extract prosthetic control signals and restore lost sensation to amputees for the control of replacement upper and lower extremity prostheses.

José Luis Pons is a Research Professor at the CSIC, initially at the Automation and Robotics Center and since July 2014 at the Cajal Institute. He currently directs the Neuro-Rehabilitation Group at the center, where research is carried out in the field of technology at the service of physical rehabilitation and the functional assessment of neurological disorders. His scientific interests cover areas such as Rehabilitation Robotics, neuroprosthetics, neurosciences and motor control. Industrial Engineer from the University of Navarra (1992), he obtained a PhD in Physical Sciences from the Universidad Complutense de Madrid in 1997. In 1999 he obtained the position of Senior Scientist of the Higher Council of Scientific Research at the Institute of Industrial Automation. After briefly occupying in 2007 the position of Scientific Researcher in the same center. Coordinator of more than a dozen projects from the Fifth Framework Program, expert evaluator of European projects and collaborator of the Division of Coordination, evaluation and scientific and technical monitoring of the State Agency for Research.

Konstantinos Karachalios is managing director of the **IEEE Standards Association** and a member of the IEEE Management Council. As managing director, he has been enhancing IEEE efforts in global standards development in strategic emerging technology fields, through technical excellence of staff, expansion of global presence and activities and emphasis on inclusiveness and good governance, including reform of the IEEE standards-related patent policy. As member of the IEEE Management Council, he championed expansion of IEEE influence in key techno-political areas, including consideration of social and ethical implications of technology, according to the IEEE mission to advance technology for humanity. Results have been rapid in coming and profound; IEEE is becoming the place to go for debating and building consensus on issues such as a trustworthy and inclusive Internet and ethics in design of autonomous systems.

Before IEEE, Konstantinos played a crucial role in successful French-German cooperation in coordinated research and scenario simulation for large-scale nuclear reactor accidents. And with the European Patent Office, his experience included establishing EPO's patent academy, the department for delivering technical assistance for developing countries and the public policy department, serving as an envoy to multiple U.N. organizations. Konstantinos earned a Ph.D. in energy engineering (nuclear reactor safety) and masters in mechanical engineering from the University of Stuttgart.

Joel Libove is president of **Furaxa**, and Chairman of Ultraview Corp. Specializing in analog/microwave circuit design, he has 15 patents, and received two industry awards for developing the first real-time computer bus protocol violation recognition/triggering system. He has designed over 200 products, including disk controllers, VME and PCI bus analyzers, and DC-4GSPS A/D boards. Joel also designed 36 high dynamic range variable-width DC-150 GHz pulse generation and sampling ICs in GaN, InP, SiGe and CMOS/SOI, with which he successfully demonstrated vascular and functional brain imager prototypes. He received a BSEE from Cornell, and MS and Ph.D. in EECS from UC Berkeley in 1978 and 1981. He is currently the chair of the **IEEE project P2725.1 - Standard for Microwave Structural, Vascular or Functional Medical Imaging Device Safety**.

Emil Hewage is Co-Founder & Chief Executive Officer of **Cambridge Bio-Augmentation Systems**, a leading neural engineering startup, creating the open standard hardware and software interface between the human nervous system and machines. Our team uses applied materials, machine learning, neuroscience, and the experience of our clinicians and surgeons to solve the complex problems of successfully integrating bionics into the human body. Emil undertook PhD research in computational neuroscience and machine learning at the University of Cambridge and has used this knowledge to pioneer the use of artificial intelligence for interpreting neural data. He began working with startups at age 17 and has experience in a range of industries from clean energy to medical innovations.

Carole Carey is Chair of the **IEEE EMB Standards Committee**, Liaison to IEEE-SA, and a 2016 IEEE-SA Standards Medallion Award recipient. She is a former U.S. FDA official in CDRH with over 23 years of regulatory science experience on medical devices. As a Mansfield Fellow, she trained in Japan at MHLW (Ministry of Health, Labour and Welfare) and PMDA (Pharmaceutical and Medical Devices Agency). Carole is a graduate of JHU (BSEE) and Loyola U (MEng). She founded C3-Carey Consultants, LLC.

IEEE P2725.1™ Standards Working Group
Monday, October 8, 11:50 - 13:20, Room: 4F Crystal

Joe Libove (Chair), Furaxa, Inc.

Low energy microwaves are a promising emerging modality for structural, vascular and functional brain imaging and BMI, and have the potential to be safer, and far smaller and less expensive than fMRI, and to image functional and vascular activity deeper in the brain than is possible with fNIR. This standard specifies the areas of intended usage, electromagnetic, electrical and mechanical safety and electromagnetic compatibility (EMC) requirements for both clinical medical imaging and fully-wearable consumer BMI devices. WG members, and prospective WG members are all welcome at this meeting.

Tutorial
Sunday, October 7, 15:20-17:20, Room: 2F Gibraltar

SuEV-R03-T06: Tutorial 6: How to Improve Performance in Brain-Computer/Machine Interface

Session Chair: Sung Chan Jun, Minkyu Ahn

A brain–computer/machine interface (BCI/BMI) is an emerging direct communication pathway between a brain and external devices. Over the past several decades, BCI/BMI technology has improved greatly in speed and accuracy, and its control paradigms have diversified. Considering the number of publications on BCI/BMI, interest in BCI/BMI research has increased dramatically and has led to the improvement of BCI/BMI systems. In this tutorial, BCI/BMI techniques are introduced; basic components of BCI/BMI, popular control paradigms and underlying methodological approaches are reviewed in a brief manner. Then the following current hot issues in BCI/BMI are mainly discussed in a detailed manner:

1) Performance variation and illiteracy of BCI/BMI, 2) Correlates of performance and prescreening approaches, 3) Zero-training approaches, 4) Achieving the reliable BCI system.

Lastly, future outlook as well as R&D trends of BCI/BMI are discussed.

BMI WORKSHOP KEYNOTE SPEAKERS

Brain science demonstrates consciousness as a key for future AI
Wednesday, October 10, 9:30-10:15, Room: 2F Fountain

The current boom of AI is mainly due to the deep neural networks, which lack generalization capability and requires hundreds of millions of training samples. Human brains, in contrast, exhibits great generalization across different domains, and can learn from a small sample. We hypothesize that consciousness is a key function for this capability. Utilizing a sophisticated brain decoding and real-time fMRI neurofeedback, we provide experimental supports to this hypothesis.

Mitsuo Kawato received a B.S. degree in physics from Tokyo University in 1976 and M.E. and Ph.D. degrees in biophysical engineering from Osaka University in 1981. From 1981 to 1988, he was a faculty member and lecturer at Osaka University. From 1988, he was a senior researcher and then a supervisor in ATR. Since 2003, he has been Director of ATR Computational Neuroscience Laboratories. Since 2004, he has been an ATR Fellow. In 2010, he became **Director of ATR Brain Information Communication Research Laboratories**. In 2018, he was jointly appointed as a Special Advisor, RIKEN Center for Advanced Intelligence Project (AIP). For the last fifteen years he has been working in computational neuroscience and neural network modeling. He published about 250 papers, reviews and books. Research topics include decoded neurofeedback as an experimental tool to manipulate spatiotemporal brain activity patterns, rs-fcMRI based biomarkers of mental disorder, advanced fMRI neurofeedback therapy, simulation study of dendritic spines, feedback-error-learning model and its applications to industrial robot manipulators, movement trajectory formation, bi-directional theory for interactions between cortical areas, cerebellar internal models, and teaching by demonstration for robots.

Brain Computer Interface and Recognition of Human Emotions Using Multiway Component Analysis
Wednesday October 10, 10:15-11:00, Room: Fountain 2F

Recently numerous feature extraction and classification methods have been developed for EEG analysis in various BCI applications and human emotion recognition. However, very few of them studied on exploiting the inter subject information for EEG classification. In this talk we overview tensor decompositions, deep learning and multi-way component analysis approaches and some promising and sophisticated algorithms which can improve BCI performance, especially for relatively small sample size. The main advantages of the proposed algorithms will be also briefly presented and some open challenging problems will be addressed. Some promising and emerging applications of BCI in rehabilitation and prediction of consciousness recovery in patients with disorder of consciousness will be also discussed.

Andrzej Cichocki received the M.Sc. (with honors), Ph.D. and Dr.Sc. (Habilitation) degrees, all in electrical engineering from Warsaw University of Technology (Poland). He spent several years at University Erlangen (Germany) as an Alexander-von-Humboldt Research Fellow and Guest Professor. He was a Senior Team Leader and Head of the laboratory for Advanced Brain Signal Processing, at RIKEN Brain Science Institute (Japan) and now he is a Professor in the **Skolkovo Institute of Science and Technology - SKOLTECH (Russia)**. He is author of more than 500 technical journal papers and 5 monographs in English (two of them translated to Chinese). He served as Associated Editor of, IEEE Trans. on Signals Processing, IEEE Trans. on Neural Networks and Learning Systems, IEEE Trans on Cybernetics, Journal of Neuroscience Methods and he was as founding Editor in Chief for Journal Computational Intelligence and Neuroscience. Currently, his research focus on multiway blind source separation, tensor decompositions, tensor networks for big data analytics, and Brain Computer Interface. His publications currently report over 36,000 citations according to Google Scholar, with an h-index of 82. He is Fellow of the IEEE since 2013.

BMI WORKSHOP INVITED SPEAKERS

The EU Human Brain Project: advancing knowledge in neuroscience, computing, and brain-related medicine
Wednesday, October 10, 11:00-11:30, Room: 2F Fountain

The Human Brain Project (HBP) is a major European scientific research initiative to improve our understanding of the brain and the role it plays in making us human, and to exploit the opportunities offered by the resulting knowledge. The project comprises basic and clinical neuroscience, large scale multilevel data integration, high performance computational modeling and simulation, and developments in neuromorphic computing and robotics. The HBP is building a novel infrastructure for a 21st century science of the brain, with six ICT research Platforms: Neuroinformatics (access to shared brain data), Brain Simulation (replication of brain architecture and activity on computers), High Performance Analytics and Computing (providing the required computing and analytics capabilities), Medical Informatics (access to patient data, identification of disease signatures), Neuromorphic Computing (development of brain-inspired computing) and Neurorobotics (use of robots to test brain simulations). Strong driving forces are opportunities for innovations, in AI and other domains, and relevance for health, in particular related to the immense societal burden of brain diseases of the world's ageing population. In the present phase of the project, the six platforms will be united in a Joint Platform, backed by a High-Level Support Team for users. With this, the project will gradually focus more on providing tools and services for the wider communities outside of HBP in the interest of global research collaborations and more rapid advancements towards understanding the brain.

Jan Bjaalie, M.D., Ph.D. is professor at the **Institute of Basic Medical Sciences, University of Oslo**, and leader of the Neuroinformatics Platform of the **EU Human Brain Project**. He was founding Executive Director of the **International Neuroinformatics Coordinating Facility (INCF)** and is currently head of the INCF Norwegian Node and member of the INCF Council for Training, Science, and Infrastructure. His research group has studied wiring patterns in the brain and developed data systems for organizing and managing heterogeneous neuroscience research data by use of a new generation of digital brain atlases. The group develops software and workflows for analysis of data integrated in the atlases ("Google maps of the brain"). Jan Bjaalie is Chief editor of Frontiers in Neuroinformatics and Section editor of Brain Structure and Function.

Multisensory BCIs in applications for robotics, VR/AR, art and dementia monitoring
Sunday, October 7, 10:00-11:00, Room: Fountain 2F

The talk will overview successful applications of robotic and VR/AR reactive BCIs developed by the author, in collaboration with his graduate students in Japan. The discussed applications of direct brain-robot and brain-VR/AR-agent control interfaces has been developed using visual, auditory and tactile human sensory modalities. In a reactive BCI the user intentions are decoded from the brainwaves in real-time using a non-invasive electroencephalography (EEG) and they are translated to a symbiotic robot or VR/AR agent thought-based only control. A communication protocol between the BCI output and the robot or VR/AR environment has been implemented in a symbiotic communication scenarios using an user datagram protocol (UDP) allowing for direct brain-internet-of-things (brain-IoT) control applications. Results obtained from healthy users reproducing simple brain-robot and brain-virtual-agent control tasks in online experiments support the research goal of a possibility to interact with robotic devices and virtual reality agents using symbiotic thought-based BCI technologies. The talk will also present a musical active BCI paradigm and a recent AI approach to passive BCI, which analyzes an arbitrary brain activity and allows for biomarkers monitoring of elderly users for potential dementia progress elucidation. Dementia and elderly support with AI are very hot topics of interest in aging societies. Discussion of future research directions will summarize the talk.

Tomasz (Tomek) M Rutkowski is a researcher and educator born in Poland. He lives in Japan since 1998 and focuses his professional activity on computational neuroscience (neurotechnology), multi-sensory (multimedia) applications, artificial intelligence and intelligence augmentation. He developed an award winning tactile (haptic) brain-computer interface and he is also active in multi-sensory (auditory, visual, tactile, etc.) media design. Tomek contributed also to a design of a direct brain-music interface with Prof. Furukawa's team (Tokyo National University of Fine Arts and Music) and he has been involved in a research on brain correlates of creativity together with Prof. Okada (The University of Tokyo). Currently he is an AI research scientist at RIKEN AIP in Tokyo where his research has been focused on human intelligence augmentation (IA) for dementia prevention and a passive BCI development with support of deep learning techniques. For a full publication list please check http://tomek.bci-lab.info/publications/.

An overview of BCI approaches and how to use BCI technology for communication, motor rehabilitation and cognitive assessment: demonstration
Sunday, October 7, 8:00-10:00, Room: 2F Fountain

BCI can be realized with non-invasive and invasive technologies like EEG, ECoG or fNIRS. The talk will describe how these technologies are successfully used with motor imagery, evoked potentials and steady-state responses. Important applications are communication for locked-in patients or patients with disorders of consciousness or stroke rehabilitation. During the session real BCI sessions will be performed with participants to show all necessary steps to run successfully these applications.

Current and future applications of BCIs
Sunday, October 7, 12:15-13:00, Room: 2F Fountain

Brain-computer interfaces are used for many different applications that range from spelling, cursor control to assessment of brain functions in patients with disorders of consciousness to motor rehabilitation in stroke patients. BCIs use either invasive or non-invasive brain signals and are controlled e.g. with motor imagery, evoked potentials or steady-state evoked potentials. The talk will highlight current and future applications and will explain what can be achieved. A real-time EEG based brain-computer interface will be demonstrated to make sure attendees know how to assemble EEG electrodes, inspect the data quality, perform real-time EEG analysis and to calibrate a BCI system. This is the basic requirement for running BCI experiments successfully in the BCI Hackathon.

How to run a real-time BCI application successfully
Sunday, October 7, 13:00-14:00, Room: 2F Fountain

The talk will show Hackathon participants in details how to use the Unicorn brain interface for the projects. EEG electrode assembling and data quality check, BCI system calibration and configuration and different applications are demonstrated. Furthermore, the speller, the Simulink/MATLAB interface, the painting application, Sphero control will be shown. Examples for the C# API, .NET API and Python interface will be explained.

Christoph Guger is the founder and CEO of **g.tec medical engineering GmbH**. He studied Biomedical Engineering at the Technical University of Graz, Austria and at the John Hopkins University in Baltimore, USA. During his studies, he concentrated on BCI systems and developed many of the early foundations for bio-signal acquisition and processing in real-time. g.tec produces and develops BCIs that help disabled people communicate or control their environments by their thoughts, regain motor functions after a stroke, and achieve other goals. The products and research activities have been widely presented in peer-reviewed research publications, demonstrating the high quality of g.tec's tools and methods. He is running several international BCI research projects.

Non-invasive and invasive Brain-Computer Interfaces for medical application and research projects
Sunday, October 7, 17:00-17:30, Room: 2F Fountain

Dr. Kamada will explain the usage of invasive and non-invasive BCI technology for neurosurgical applications in epilepsy and tumor patients. This includes high-gamma mapping technologies to identify the eloquent cortex of these patients in the intensive care unit and in the operating room. Furthermore, cortico cortical evoked potentials will be explained. This technique allows to rapidly map a whole cortical network by just stimulating a single cortical region. Dr. Kamada will also show how BCI technology with the ECoG can be used for BMI control.

Dr. Kamada is a neurosurgeon at the Asahikawa Medical University in Japan. He is leading a team of medical and scientific members and performs studies with the EEG, fMRI and ECoG in epilepsy, tumor and stroke patients. He developed techniques like high-gamma mapping to identify the eloquent cortex or mapping whole cortical networks. He has international collaborations in the USA and Europe in the BMI field and performs many real-time experiments in this domain. Contact him at kamady@asahikawa-med.ac.jp.

BCIs for labeling our environment
Monday, October 8, 10:00-10:30, Room: 2F Fountain

As we move through an environment, we are constantly making assessments, judgments, and decisions about the things we encounter. Some are acted upon immediately, but many more become mental notes or fleeting impressions — our implicit "labeling" of the world. In this talk I will describe our work using physiological correlates of this labeling to construct a hybrid brain-computer interface (hBCI) system or augmented navigation in a simulated 3-D environment. Specifically, we record electroencephalographic (EEG), saccadic, and pupillary data from subjects as they move through a small part of a 3-D virtual city under free-viewing conditions. Using machine learning, we integrate the neural and ocular signals evoked by the objects they encounter to infer which ones are of subjective interest. These inferred labels are propagated through a large computer vision graph of objects in the city, using semi-supervised learning to identify other, unseen objects that are visually similar to those that are labelled. Finally, the system plots an efficient route so that subjects visit similar objects of interest. We show that by exploiting the subjects' implicit labeling, the median search precision is increased from 25% to 97%, and the median subject need only travel 40% of the distance to see 84% of the objects of interest. We also find that the neural and ocular signals contribute in a complementary fashion to the classifiers' inference of subjects 'implicit labeling. In summary, we show that neural and ocular signals reflecting subjective assessment of objects in a 3-D environment can be adaptively integrated with models of that environment, resulting in an hBCI system that improves navigation and information delivery specific to the user's interests.

Paul Sajda is a Professor of Biomedical Engineering, Electrical Engineering and Radiology (Physics) at Columbia University. He is also a Member of Columbia's Data Science Institute. He received a BS in electrical engineering from MIT in 1989 and an MSE and PhD in bioengineering from the University of Pennsylvania, in 1992 and 1994, respectively. Professor Sajda is interested in what happens in our brains when we make a rapid decision and, conversely, what processes and representations in our brains drive our underlying preferences and choices, particularly when we are under time pressure. His work in understanding the basic principles of rapid decision-making in the human brain relies on measuring human subject behavior simultaneously with cognitive and physiological state. Important in his approach is his use of machine learning and data analytics to fuse these measurements for predicting behavior and infer brain responses to stimuli. Professor Sajda applies the basic principles he uncovers to construct real-time brain-computer interfaces that are aimed at improving interactions between humans and machines. He is also applying his methodology to understand how deficits in rapid decision-making may underlie and be diagnostic of many types of psychiatric diseases and mental illnesses. Professor Sajda is a co-founder of several neurotechnology companies and works closely with a range of scientists and engineers, including neuroscientists, psychologists, computer scientists, and clinicians. He is a fellow of the IEEE, AMBIE and AAAS and Chair of the IEEE Brain Initiative.

Panels

BMI Panel I
Future Research Opportunities and Funding in Brain Research and Neurotechnologies
Wednesday, October 10, 11:30-13:00, Room: 2F Fountain

Abstract

The goal of this panel of funding agencies and leaders in brain research is to address future research opportunities and funding opportunities in brain research and in the development of neurotechnologies. By identifying such opportunities, researchers will be better able to focus on successful clinical translation and commercial application of neurotechnologies in real-world situations. Questions and interactions between the panelists and the audience is highly encouraged.

Session Chair

Michael H. Smith, University of California, Berkeley

Moderator

Nick Langhals, Nat. Inst Neurological Disorders and Stroke (NIH/NINDS), USA

Panelists

Mitsuo Kawato, ATR, Brain Information Communication Research Group, Kyoto, Japan; Jan Bjaalie, Neuroinformatics Platform, EU Human Brain Project, Uri Hasson, Cognitive Neuroscience, NSF

BMI Panel II
Important Topics in Designing and Building Real World Neurotechnologies: What is New?
Wednesday, October 10, 13:00-14:00, Room: 2F Fountain

Abstract

The goal of this panel of experts on the design and development of new neurotechnologies is to address current challenges and hot topics in brain research. By identifying the challenges confronting the successful clinical translation and commercial application of neurotechnologies (including BMI/BCI systems) in real-world situations, this panel will identify opportunities for SMC and other efforts to dramatically improve the performance and benefits of such systems for the patients and users.

Session Chair

Michael H. Smith, University of California, Berkeley

Moderator

Tiago Falk, INRS-EMT, University of Quebec, Canada

Panelists

Hank Greely, International Neuroethics Society; Tim Mullen, Intheon; Riki Matsumoto, Kyoto University Graduate School of Medicine, Japan; Christoph Guger, g.tec medical engineering GmbH

Panels

BMI Panel III
Merging Minds and Machines: Integrating AI with Current Brain Research and Future Neurotechnologies
Wednesday, October 10, 14:00-15:00, Room: 2F Fountain

Abstract

Recently, there has been a great deal of discussion and research on integrating AI with current brain research and in the development of new neurotechnologies. This can be seen by recent developments in deep learning and machine intelligence. Issues such as the following will be discussed:
"Can neurotechnologies be used to integrate human intelligence and AI?"
"Can AI be used to improve/speed development of neurotechnolgy/BMI devices?
"Can AI help improve the performance of neurotechnologies/BMIs and vice versa?"
“How can we improve the interpretability of AI to improve our understanding of the brain?"
"How much enhancement of intelligence can be achieved, if any?"
"Potential risks and benefits of integrating the brain with AI"

Session Chair

Michael H. Smith, University of California, Berkeley

Moderator

Tim Mullen, Intheon

Panelists

Ljiljana Trajkovic, Director-Elect, IEEE; Ricardo Chavarriaga, IEEE Group on Standards for Neurotechnology; Wlodzislaw Duch, Neurocognitive Laboratory, Poland; Andrzej Cichocki, SKOLTECH, Russia; Yingxu Wang, University of Calgary, Canada; Jeong-woo Sohn; Korea Brain Initiative

Brain Hackathon
Sunday, October 7, 8:00 – Monday, October 8, 17:30
Room: 2F Fountain

Chair: Christoph Guger, PhD, g.tec medical engineering GmbH, Austria
Co-Chairs: Tiago H. Falk, PhD, INRS-EMT, Canada
Michael Smith, IEEE SMC BMI Workshop chair, IEEE Brain Initiative USA

Media: Sarah Breinbauer, MS, g.tec medical engineering GmbH, Austria

A gathering such as IEEE SMC 2018 brings together great minds. We invite you to be a part of the free IEEE SMC2018 Brain Hackathon, where participants are engaged in a brainstorming and collaborative round-the-clock marathon, designed to rapidly produce working prototypes. The event is organized by the BR41N.IO BCI Designer Hackathon series and IEEE SMC. The goal of this particular Brain Hackathon is to stretch the boundaries of Brain Computer Interface (BCI) technology, to put creative minds from many disciplines together, and to provide an environment for innovation, entrepreneurship, and creation of applications/products that have great potential for commercialization. Participants will have the opportunity to participate in a number of challenges. Cost to participate is FREE.

Over $4,200 in cash and hardware prizes, including at least a $1,000 BR41N.IO BCI Designer Hackathon Prize, a $1,200 IEEE Brain Initiative Brain Hackathon Prize, a $1,000 IEEE SMC Brain Hackathon Prize, and two $500 neumo Prizes will be awarded. Individual or team participants (each up to 5 persons) are welcome, with a limitation of 130 individuals/26 teams. IEEE members will be given priority. Coffee, food and more is provided.

What's a Hackathon? IEEE SMC BMI Hackathons are free-to-attend brainstorming and collaborative marathons designed to rapidly produce working prototypes. Conventional hackathons typically bring developers and technologists together over 24 hours to cram and build solutions that they can present.

Why do a Brain Hackathon? By putting creative minds from multiple disciplines together for a short period of time, we have the opportunity to discover and uncover possibilities for using BCI-related hardware and software not readily thought of. Hacks and innovation developed from hackathons have great potential for commercialization and are great events for networking.

Who Can Participate? Anyone! Both SMC 2018 attendees and non-SMC 2018 attendees—including university students and professors—with interests in BCI/BMI, cloud technologies, IoT, robotics, AR, VR, machine learning, sensors, 3D printing and design, fashion design, human-machine interface systems, control, signal processing, big data, haptics, rehabilitation, and similar areas. You do not have to be a BCI expert to participate on a team! Interdisciplinary teams with a combination of BCI and non-BCI skills are often successful in building solutions and producing working prototypes.

How do I Participate? You can register at www.br41n.io. Register as soon as possible to select your favorite project and to find other team members.

Can I submit a different project? Professional teams can also participate to develop applications during the Hackathon to demonstrate full potential of some of the sponsored hardware/software. If you are looking for team members, your project will be included in the table plan below where people can apply for it. Submit your project to www.br41n.io.

Partnerships: Participants can select from a range of pre-defined Hackathon projects arranged by the BR41N.IO Brain-Computer Interface designer Hackathon series. Designers will be able to 3D-print their own headsets and design BCI systems, and—together with programmers—create new BCI systems.

More details: www.br41n.io

Hackathon Program
Sunday, October 7, 2018, Location: 2F Fountain, Session Chair: Christoph Guger

7:30-8:00 Coffee, Breakfast
8:00-10:00 Talk: An overview of BCI approaches and how to use BCI technology for communication, motor rehabilitation and cognitive assessment: demonstration
Invited Speaker: *Christoph Guger*, PhD, g.tec medical engineering GmbH, Austria
10:00-11:00 Talk: Multisensory BCIs in applications for robotics, VR/AR, art and dementia monitoring
Invited Speaker: *Tomek Rutkowski*, PhD, Riken AIP, University of Tokyo, BCI-lab, Tokyo, Japan
11:00-12:00 Press conference with trial opportunity
Sarah Breinbauer, MS, br41n.io organizer
Invited guests:
Michael Smith, PhD, IEEE SMC BMI Workshop chair, IEEE Brain Initiative USA
Kyousuke Kamada, MD, PhD, Asahikawa Medical University, Neurosurgeon, Japan
Tadahiko Murata, PhD, Kansai University, IEEE SMC 2018 Program Chair, Japan
Christoph Guger, PhD, br41n.io organizer, Austria
Tiago H. Falk, PhD, INRS-EMT, Canada
11:30-12:00 Coffee, Food
12:00-12:15 Opening and welcome
Michael Smith, PhD and Christoph Guger, PhD
12:15-13:00 Talk: Current and future applications of BCIs
Invited Speaker: *Christoph Guger*, PhD, g.tec
13:00-14:00 Talk: How to run a real-time BCI application successfully
Invited Speaker: *Christoph Guger*, PhD, BR41N.IO mentor
14:00-14:30 Group formation
14:00-17:00 Start Hacking
17:00-17:30 Talk: Non-invasive and invasive Brain-Computer Interfaces for medical applications and research projects
Invited Speaker: *Kyousuke Kamada*, MD, PhD, Asahikawa Medical University, Asahikawa, Japan
17:30-24:00 Hacking
18:00-19:00 Coffee, Food
19:00-24:00 Hacking

Monday, October 8, 2018, Location: 2F Fountain, Session Chair: Christoph Guger
0:00-10:00 Hacking
10:00-10:30 Talk: BCIs for labeling our environment
Invited Speaker: *Paul Sajda*, PhD, Columbia University, USA
10:30-14:00 Hacking
12:00-13:00 Hacking, Coffee, Food
14:00 End Hacking
14:00-16:00 Project presentations
16:30-17:00 Jury meeting
17:00-17:30 Award ceremony

Tuesday, October 9, 18:00-19:00, Location: Foyer, Session Chairs: Christoph Guger, Michael Smith. Winning projects are displayed in the banquet room to the general IEEE SMC audience.

Sponsors and Co-Organizers

	IEEE SMC Society www.ieeesmc.org
	BR41N.IO BCI Designer Hackathon series www.br41n.io
	g.tec medical engineering GmbH www.gtec.at
	IEEE Brain Initiative https://brain.ieee.org/
	Miyuki Giken http://www.miyuki-net.co.jp/
	Neumo http://www.neumo.jp/jp/
	Intheon https://intheon.io/
	Hurobint http://www.koj-m.sakura.ne.jp/hurobint/
	Nippon Venture Capital Co., Ltd. https://www.nvcc.co.jp/en/

IEEE SMC Society BMI Technical Committee

You are welcome to join SMCS Technical Committee on Brain-Machine Interface Systems. You do not have to be a SMC Society member to join our TC, although we do encourage you to become one in order to benefit from a wide range of professional activities and privileges.

To join SMC's BMI TC, contact via e-mail a BMI TC Co-Chair and provide your name, title, position, affiliation, and a self-introduction.

We hope you will enhance your professional skills and potential through your activities in our Technical Committee.

Our Goal

Brain-Machine Interfaces (BMI) are about transforming thought into action, or, conversely, sensation into perception. One example of this paradigm contends that a user can perceive sensory information and enact voluntary motor actions through a direct interface between the brain and a prosthetic device in virtually the same way that we see, hear, walk, or grab an object with our own natural limbs.

The primary objective of the BMI Systems Technical Committee is to bring together specialists from the different areas that will be required as part of any real-world BMI system: systems neuroscience, system integration, sensors, integrated circuits, machine learning, control, robotics, biology, clinical studies, neurologists, system engineers, cybernetic experts, human-machine professionals, and other computer scientists and engineers working in this interdisciplinary environment. The goal of the TC is to provide a basis for the exchange of information and resources among these diverse communities, to enable interactions between groups from these fields and to bring a systems perspective to the field of BMI.

Join Us

- Interact with experts in Brain Machine Interface Systems, which is a relatively new and rapidly growing research field. Both invasive and non-invasive techniques (BCI) for interfacing the brain are included.
- Participate in interesting conferences and workshops.
- Make friends from different regions of the world.
- Exchange research ideas and possibly share research resources.

Additional Information:

http://www.ieeesmc.org/technical-activities/human-machine-systems/brain-machine-interface-systems

BMI Workshop Closing Session, Posters, and Reception
Wednesday, October 10, 15:10 – 17:00, Room: 2F Fountain

15:10-16:00 Open discussion with the audience and invited guests on:

"What Have We Learned, Where Do We Go From Here?"

This is the final session of the workshop, in which invited guests and audience members share insights gained regarding the as-presented state-of-the-art brain research and neurotechnologies in this Workshop and Global Brain initiative meeting. Discussions will include projections as to future advances in this field.

16:00-17:00 Poster session and networking combined with a reception. All are welcome.

Posters

Select posters will be displayed in the BMI Workshop Room on Monday, Tuesday, and Wednesday. Interested Workshop participants are invited to more in-depth discussions and interactions with paper authors during the coffee and lunch breaks, after the Brain Initiative meeting on Tuesday, and at the closing session and reception on Wednesday.

Papers
Monday, October 8

Monday, October 8, 9:30 - 11:30

2F R01	MoAM-R01	BMI H12+H30: Human-Machine Systems and Cognitive Cybernetics
2F R02	MoAM-R02	BMI H23: Novel Technical Approaches to Improving Functional Diagnosis and Prognosis
2F R03	MoAM-R03	BMI: Tools, Metrics, and Databases
3F R04	MoAM-R04	BMI: Invasive BCIs, ECoG analysis
3F R05	MoAM-R05	BMI: Multimodal HMIs

Monday, October 8, 13:30 - 15:30

2F R01	MoPM-R01	BMI: Novel BCI/HCI Paradigms
2F R02	MoPM-R02	BMI H29: BCI and Robotics
2F R03	MoPM-R03	BMI H25: Passive BCIs
3F R04	MoPM-R04	BMI H26: Deciphering Natural Cortical Representations for BMIs
3F R05	MoPM-R05	BMI H28: Real World Applications (SSVEP and Spellers)

Monday, October 8, 16:00 - 18:00

2F R01	MoEV-R01	BMI H28+H30: Brain-Inspired Systems and Unconventional BCI Applications
2F R02	MoEV-R02	BMI: BCIs for Neurorehab and Body Augmentation
2F R03	MoEV-R03	BMI H27: Deep Learning for Brain-Machine Interface
3F R04	MoEV-R04	BMI: Real World Applications (Automotive and Exoskeletons)
3F R05	MoEV-R05	BMI: BCI Modelling, Analysis, and Performance

BMI Workshop, Brain Hackathon, Meeting of Global Current and Emerging Brain Initiatives
Program at a Glance

Time	Sunday, October 7	Monday, October 8						Tuesday, October 9	Wednesday, October 10
	Hackathon Room: 2F Fountain	**Hackathon Room: 2F Fountain**	**Room: 2F R01 Orchard North**	**Room: 2F R02 Orchard South**	**Room: 2F R03 Gibraltar**	**Room: 3F R04 Zuiyo**	**Room: 3F R05 Kaiho**	**Room: 4F R06 Crystal**	**Room: 2F Fountain**	**Room: 2F Fountain**
8:00-8:30	**Invited Talk:** An overview of BCI approaches and how to use BCI technology for communication, motor rehabilitation and cognitive assessment	Hacking								
8:30-9:00										
9:00-9:30										
9:30-10:00			**Session:** *Human-Machine Systems and Cognitive Cybernetics*	**Session:** *Novel Technical Approaches to Improving Functional Diagnosis and Prognosis*	**Session:** *Tools, Metrics, and Databases*	**Session:** *Invasive BCIs, ECoG Analysis*	**Session:** *Multimodal HMIs*		**Meeting of Global Current and Emerging Brain Initiatives** *See insert for the program	**BMI Keynote:** Brain science demonstrates consciousness as a key for future AI **(9:30-10:15)**
10:00-10:30	**Invited Talk:** Multisensory BCIs in applications for robotics, VR/AR, art, dementia monitoring	**Invited Talk:** BCIs for labeling our environment								**BMI Keynote:** BCI and recognition of human emotions using multiway component analysis **(10:15-11)**
10:30-11:00		Hacking								
11:00-11:30										**Invited Talk:** The EU human brain project: advancing knowledge in neuroscience, computing, brain-related medicine
11:30-12:00										**Panel 1:** Future research opportunities and funding in brain research and neurotechnologies
12:00-12:30	**Invited Talk:** Current and future BCI applications									
12:30-13:00										
13:00-13:30	**Invited Talk:** How to run a real-time BCI application successfully									**Panel 2:** Important topics in designing and building real world neuro-technologies: What is new?
13:30-14:00			**Session:** *Novel BCI/HCI Paradigms*	**Session:** *BCI and Robotics*	**Session:** *Passive BCIs*	**Session:** *Deciphering Natural Cortical Representations for BMIs*	**Session:** *Real World Applications (SSVEP and Spellers)*			
14:00-14:30		Hackathon Project Presentations								**Panel 3:** Merging minds and machines: Integrating AI with current brain research and future neurotechnologies
14:30-15:00										
15:00-15:30										
15:30-16:00										**BMI Workshop Closing Session, Posters, and Reception (All are welcome)**
16:00-16:30		Jury Meeting								
16:30-17:00			**Session:** *Brain-Inspired Systems and Unconventional BCI Applications*	**Session:** *BCIs for Neurorehab and Body Augmentation*	**Session:** *Deep Learning for Brain-Machine Interfaces*	**Session:** *Real World Applications (Automotive and Exoskeletons)*	**Session:** *BCI Modelling, Analysis, and Performance*	**Panel:** Standards for Neuro-technologies		
17:00-17:30	**Invited Talk:** Non-invasive and invasive BCIs for research projects and medical applications	Award Ceremony*								
17:30-18:00										
18:00-18:30		*Winning Hackathon projects to be displayed Tuesday, October 9, 18:00-19:00, 4F Foyer							**Posters**	