IEEE SMC 2021

2021 International Conference on Systems, Man, and Cybernetics

Workshop on Brain-Machine Interface Systems

October 17 - 20, 2021
Melbourne, Australia (virtual)

Sponsored by

IEEE SMC Systems, Man, and Cybernetics

Welcome Message from the BMI Workshop Organizers

The 2021 IEEE International Conference on Systems, Man, and Cybernetics (SMC 2021) is the flagship conference of the IEEE SMC Society. Due to the COVID-19 pandemic, it will be held virtually from Melbourne, Australia. The conference provides an international forum for researchers to report recent innovations and developments, and to exchange ideas and advances in all aspects of systems science and engineering, human-machine systems, and cybernetics. These are areas of increasing importance to the creation of intelligent environments involving technologies interacting with humans to provide an enriching experience and an improved quality of life.

As part of SMC 2021, the **IEEE SMC 2021 11th Workshop on Brain-Machine Interface (BMI) Systems** will be held virtually from October 17–20, 2021. 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 BMIs. 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 ***Current Innovations in Neurotechnology, Human-Machine Systems, and the "Internet of Minds"***.

The 2021 BMI Workshop will feature a virtual BR41N.IO BCI Hackathon, ten invited talks, one expert panel, four contributed paper sessions, and the 2021 International BCI Award. 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*. This year, we have 19 papers accepted after careful peer-review by experts in BMI-related fields and will be presented across 4 oral sessions covering topics related to (1) Passive BMIs, (2) Improving BMI accuracy and experience, (3) Motor imagery BMIs, and (4) New trends in BMIs.

We are also pleased to have ten outstanding invited talks:

Sunday, October 17, 2021 (all times are CEST; use hackathon Zoom link below)

- **Christoph Guger** (g.tec, Austria): *Current and future BCI applications* (10:30-11:00)
- **Leo Schreiner** (g.tec, Austria): *(1) How to run a real-time BCI application* and *(2) Unicorn BCI demonstration* (11:00-12:00)
- **Tim Mullen** (Intheon, USA): *LSL and NeuroPype tools and BCI applications* (12:00-12:20)
- **Natalie Mrachacz-Kersting** (Univ. Applied Sciences and Arts, Dortmund): *BCIs for Replacement and Restoration of Lost Motor Function in Patient Populations* (15:00-15:30)
- **Eli Kinney-Lang** (University of Calgary, Canada): *More than play: Challenges and benefits driving BCI for kids* (18:00-18:30)
- **Charles Roy, Antoine Pépin, Yann Harei, Felipe Almeida** (LMDP Co., Canada): *VFC Project: An Adaptive BCI Cinema Experience* (18:30-19:00)

Monday, October 18, 2021 (all times are CEST; use hackathon Zoom link below)

- **Maryam Alimardani** (Tilburg University, Netherlands): *Passive BCIs for Enhancement and Learning with Technology* (10:00-10:30)
- **Yannick Roy** (NeuroTechX, Canada): *NeuroTechX: The International Neurotech Community* (13:00-13:30)

Tuesday, October 19, 2021 (CEST; use BCI Award Zoom link below)

- **Douglas Weber** (CMU, USA): *Injectable and Wearable Neural Interfaces* (13:00-13:45)

Virtual 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. Registered SMC 2021 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 17 and Monday, October 18, 2021. There are $3,000 in cash prizes to be won. To participate in the Hackathon, please register at https://www.br41n.io/IEEE-SMC-2021. To attend the invited talks and watch the participants showcase their innovations, please register here to obtain the link to the virtual event: https://us02web.zoom.us/webinar/register/WN_nPbs0gyrRBOaYMfW1j3UKw. Any questions about the Hackathon should be directed to guger@gtec.at.

Expert Panel
The virtual expert panel will focus on ***Developing neurotechnologies amidst a pandemic*** (Sunday, October 17, 16:00-17:00 CEST). Panelists will include *Javier Minguez* (Bitbrain, Spain), *Alex Castillo* (Neurosity, USA), *Mavi Ruiz-Blondet* (Neurable, USA), and *Graeme Moffat* (System2 Neurotech, Canada). Dr. Tiago H. Falk (INRS-EMT, Canada) will moderate the discussion. They will share their experiences in building new devices amidst a pandemic and provide hands-on insights. Participation will be via the hackathon zoom link above.

International BCI Award
The International BCI Award, endowed with US$6,000 prize, is one of the top accolades in BCI research. The BCI Award was created to recognize outstanding and innovative research in the field of Brain-Computer Interfaces. Twelve projects are nominated, and the winner will be announced at the BCI Award Ceremony on Tuesday, October 19 from 14:00-17:00 CEST by the BCI Award Chair Dr. Tomasz M. Rutkowski. To watch the invited talks and the project presentations, please register to obtain the link to the virtual event: https://us02web.zoom.us/webinar/register/WN_THZmmBtRRoiMk-NjtFoYxg

IEEE Brain Technical Community Best Paper Awards
Based on rigorous peer reviews, a jury will select up to two best papers from the IEEE SMC 2021 and the 2021 IEEE SMC BMI Workshop. The monetary award ($1,000) is supported by the IEEE Brain Technical Community.

Contributed Paper Sessions
As with all other SMC 2021 papers, Workshop paper presentations will be in the form of pre-recorded videos followed by a 5-minute live Q&A session per paper. The Q&A sessions will take place Wednesday, October 20, 2021 from 18:30-20:15 AEDT **(**Please note the different time zone from the remainder of the program**)**. Registered Workshop attendees will receive details on how to access the virtual conference platform separately.

Paper session 1 (Chair: Lisa-Marie Vortmann): Passive BMIs (18:30-18:55 AEDT)
1. *Performance of 1D-CNNs for EEG-Based Mental State Classification: Effects of Domain, Window Size, and Electrode Montage*
2. *SSVEP-Aided Recognition of Internally and Externally Directed Attention from Brain Activity*
3. *Stress Assessment and Mitigation Using fNIRS and Binaural Beat Stimulation*
4. *Cross-Intensity-Based Spatial-Temporal Clustering of Spike Trains for Brain State Estimation*
5. *Characterization of Affective States in Virtual Reality Environments Using EEG*

Paper session 2 (Chair: Lisa-Marie Vortmann): Improving BMI accuracy and experience (18:55-19:20 AEDT)
1. *Improving user experience of SSVEP-BCI through reduction of stimuli amplitude depth*
2. *Mutual Information-Based Time Window Adaptation for Improving Motor Imagery-Based BCI*
3. *Brain Computer Interface treatment for gait rehabilitation of stroke patients: Preliminary results*
4. *Classifying EEG Motor Imagery Signals Using Supervised Projection Pursuit for Artefact Removal*

19:20-19:25 AEDT - BREAK

Paper session 3 (Chair: Vinod A. Prasad): Motor Imagery BMIs (19:25-19:50 AEDT)
1. *Frequency Band Selection for a Lower-Limb MI BCI to Control a Treadmill*
2. *Inter-Subject Transfer Learning Using Euclidean Alignment and Transfer Component Analysis for Motor Imagery-Based BCI*
3. *Online Hand Motor Imagery Direction Decoding Using Brain-Computer Interface*
4. *VMD-WSST: A Combined BCI Algorithm to Predict Self-paced Gait Intention*

Paper session 4 (Chair: Vinod A. Prasad): New Trends in BMIs (19:50-20:15 AEDT)
1. *AI Can Fool Us Humans, but Not at the Psycho-Physiological Level: A Hyperscanning and Physiological Synchrony Study*
2. *Noncontact Brain□computer Interface Based on Steady-State Pupil Light Reflex Using Independent Bilateral Eyes Stimulation*
3. *Cooperative and Competitive-related Inter-Brain Synchrony during Gaming*
4. *Subject-Independent Brain-Computer Interface for Decoding High-Level Visual Imagery Tasks*
5. *Speech Activity Detection from Stereotactic EEG*

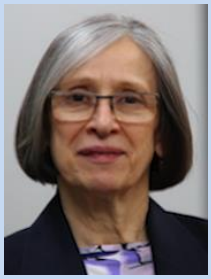
Organization Committee and Supporters

We would like to thank the many individuals who worked hard in organizing the Workshop, including the Technical Program Co-Chairs: *Abdelkader Belkacem, Sarah Power* and *Ivan Volosyak*; Special Session Co-Chairs: *Dean Krusienski* and *Yingxu Wang*; Industry Co-Chairs: *Ferdinand Ephrem* and *Javier Minguez*; Publicity Chair: *Sarah Breinbauer*, and Webmaster: *Liviu Ivanescu*, as well as Brain Hackathon Chair and Co-Chairs: *Christoph Guger*, *Tiago H. Falk*, *and Andi Partovi*.

We also thank the BMI Workshop supporters for their generous funding: IEEE Brain, g.tec, SMC, and Intheon.

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

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



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

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

Virtual BR41N.IO Brain Hackathon
Sunday October 17, 10:00 – Monday October 18, 18:00 CEST

What is it?
BR41N.IO Brain Hackathon is a brainstorming and collaborative marathon designed to be a learning experience for developers, technologists, engineers, students, artists, and scientists who cram and build brain-computer interface (BCI) applications together in teams.

Who can participate?
Anyone can participate who has interests in BMI, BCI, robotics, AR, VR, machine learning, computing, sensors, human-machine interface systems, control, signal processing, big data, haptics, rehabilitation, and similar areas. Participants do not have to be a BMI expert to participate on a team!

What's in there for me?
Be creative, think outside the box. The best BR41N.IO projects will be awarded with cash prizes:

- BR41N.IO Intheon Prize: $ 1,000
- BR41N.IO IEEE SMC Prize: $ 1,000
- BR41N.IO IEEE Brain Prize: $ 1.000

Schedule
See schedule summary on the next page

HOW TO PARTICIPATE

Step 1: Sign up for a project
There are several predefined projects which you can choose to work on. The projects are described in detail at https://www.br41n.io/IEEE-SMC-2021. Participants can use their own hardware and software, if available. There are also data analysis projects that do not require access to hardware. This year we have several hosting institutions which will provide hackathon participants with **on-site** access to BCI and neurotechnology hardware and software. **Please check with each individual hosting institution on their latest guidance concerning COVID-19.** We have hosting institutions around the world, including: Tilburg University (Netherlands), Aalborg University (Denmark), g.tec (Austria), UAU University (United Arab Emirates), MLJC (Italy), Digitale Manufaktur (Germany), and Simon Fraser University (Canada).

Step 2: Meet your team virtually
Organizers will connect you with the team members of your project. Create your own virtual meeting space using Skype, Google Hangouts, Zoom, etc. to start working on your ideas.

Step 3: Stay connected via Slack
While you work on your groundbreaking new BCI applications, organizers will be available on slack to answer all the questions that might come up and support you wherever they can via the BR41N.IO Slack channel.

Step 4: Present your projects virtually and win
You will be invited to present your results virtually via Zoom (see link in previous pages). Be ready to explain what you did, your results, and to show a demonstration (live or with a video) to the international audience.

Sponsors

IEEE brain | IEEE SMC Systems, Man, and Cybernetics Society | intheon | g.tec GUGER TECHNOLOGIES

IEEE SMC 2021 Workshop on Brain-Machine Interface Systems - Program Summary				
CEST time zone (unless stated otherwise)	**Sunday, October 17**	**Monday, October 18**	**Tuesday, October 19**	**Wednesday, October 20**
	Hackathon https://us02web.zoom.us/webinar/register/WN_nPbs0gyrRBOaYMfW1j3UKw	**Hackathon** https://us02web.zoom.us/webinar/register/WN_nPbs0gyrRBOaYMfW1j3UKw	**Workshop Special Events** https://us02web.zoom.us/webinar/register/WN_THZmmBtRRoiMk-NjtFoYxg	**Workshop Paper Q&A live sessions (AEDT Time zone)** link will be made available to registered paticipants
6:00		Start BR41N.IO Hackathon (Christoph Guger)		
10:00-10:30	Welcome	Passive BCIs for Enhancement and Learning with Technology (Maryam Alimardani)		
10:30-11:00	Current and future applications of brain-computer interfaces (Christoph Guger)	Hacking		
11:00-11:30	How to run a real-time BCI application (Leo Schreiner)			
11:30-12:00	Unicorn Brain Interface Demonstration (Leo Schreiner)			
12:00-12:30	LSL and NeuroPype tools and BCI applications (Tim Mullen)			
12:30-13:00				
13:00-13:30	Group formation and Start BR41N.IO Hackathon (virtual and hosting institutions)	NeuroTechX - The International Neurotech Community (Yannick Roy)	Injectable and Wearable Neural Interfaces (Douglas Weber)	
13:30-14:00		End BR41N.IO Hackathon		
14:00-14:30		BREAK	BCI Award and Interviews (Tomasz Rutkowski)	
14:30-15:00				
15:00-15:30	BCIs for Replacement and Restoration of Lost Motor Function in Patient Populations (Natalie Mrachacz-Kersting)	Project Presentations (Christoph Guger)		
15:30-16:00	Hacking			
16:00-16:30	Panel : Neurotechnology innvations amidst a pandemic			
16:30-17:00				
17:00-17:30	Hacking	Meeting of Hackathon Jury		
17:30-18:00		BR41N.IO BCI Hackathon Awards Ceremony (Christoph Guger, Ljiljana Trajkovic, Michael Smith)		
18:00-18:30	More than play: Challenges and benefits driving BCI for kids (Eli Kinney-Lang)			
18:30-19:00	VFC Project: An Adaptive BCI Cinema Experience (Charles Roy, Antoine Pépin, Yann Harel, Felipe Almeida)			BMI 2021 live Q&A sessions **** (AEDT time zone) ****
19:00-20:30				
24:00	BCI Hackathon Night Break			