IEEE SMC 13th Workshop on Brain-Machine Interface Systems

2023 IEEE International Conference on Systems, Man, and Cybernetics

October 1–4, 2023
Oahu, Hawaii, USA

Sponsored by

The 2023 IEEE International Conference on Systems, Man, and Cybernetics (SMC 2023) is the flagship conference of the IEEE SMC Society to be held in Oahu, Hawaii, USA. 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 2023, the **IEEE SMC 2023 13th Workshop on Brain-Machine Interface (BMI) Systems** will be held from October 1–4, 2023. This workshop is free to all SMC 2023 attendees. 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, and robotics.

The 2023 BMI Workshop will feature a BR41N.IO Brain-Computer Interface (BCI) Hackathon, several invited talks, six paper sessions, one poster session, and one virtual track session. It will also host the 2023 International BCI Award Ceremony. The Workshop is organized by the *IEEE SMC Technical Committee on Brain-Machine Interfaces Systems* and is technically co-sponsored by the *IEEE Brain Technical Community*. Thirty-four papers have been accepted after careful peer-review by experts in BMI-related fields and will be presented in sessions covering topics on active BMIs, passive BMIs, machine learning for BMIs, emerging applications of BMIs, multimodal/ multisensory BMIs, and representations of neural data for BMIs.

We are also pleased to have several outstanding invited talks:

- **Ming Hou** (DRDC, Canada): *Frontiers of Brain-Inspired Autonomous Systems*
- **Xiang Zhang** (UNC Charlotte, USA): *Self-Supervised Contrastive Learning For EEG-Based Neurological Disorder Detection*
- **Chris Ullrich (Cognixion, USA):** *Overview of Clinical BCIs – Use Cases, Challenges, and Opportunities* (remote)
- **Christoph Guger** (g.tec, Austria): *Current and future BCI applications*
- **Leo Schreiner and Martin Walchshofer** (g.tec, Austria): *(1) How to run a real-time BCI application* and *(2) Unicorn BCI demonstration*
- **Johannes Grünwald** (g.tec, Austria): *Data Analysis Projects*

Hybrid BR41N.IO Brain-Computer-Interface Hackathon
Hackathons are 24-48 hours brainstorming and collaborative marathons that create an environment supporting the rapid production of working prototypes. Registered SMC 2023 attendees interested in BCI/BMI and related technologies may participate in the *Brain Computer Interface Hackathon* organized by the BMI Workshop to be held on Sunday, October 1 and Monday, October 2, 2022. **There are $6,000 in cash prizes to be won**. To participate in the Hackathon, please register at https://www.br41n.io/IEEE-SMC-2023. Registration is free. Questions about the Hackathon should be directed to guger@gtec.at.

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 have been nominated and the winner will be announced at the BCI Award Ceremony on Tuesday, October 3 by the BCI Award Board.

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 2023 and the 2023 IEEE SMC BMI Workshop. The monetary award is supported by the IEEE Brain Technical Community. Award candidates will be presenting their works on Monday, October 2nd in Room Puna from 17:00-18:45. The session is open to all registered SMC 2023 and BMI 2023 attendees.

IEEE Brain Technical Community Networking Reception
The SMC 2023 Organizers and the IEEE Brain Technical Community will co-host a networking reception on Sunday evening (17:30–19:30, Room: Lanai). Reception is open to all registered SMC 2023 attendees.

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 Sessions Chair: *Yaoping Hu*, Webmaster: *Liviu lvanescu*, and BCI Hackathon Co-Chairs: *Christoph Guger*, *Tiago H. Falk*, *Jonas Vibell, and Francisco Fernandes*. We also thank the BMI Workshop supporters for their generous funding: IEEE Brain Technical Community, g.tec, and IEEE SMC Society.

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

GAMING PROJECTS:
- 1st BR41N.IO Prize: $ 1,000
- 2nd BR41N.IO Prize: $ 600
- 3rd BR41N.IO Prize: $ 400

DATA ANALYSIS PROJECTS:
- 1st BR41N.IO Prize: $ 1,000
- 2nd BR41N.IO Prize: $ 600
- 3rd BR41N.IO Prize: $ 400

PROGRAMMING & ARTS PROJECTS:
- 1st BR41N.IO Prize: $ 1,000
- 2nd BR41N.IO Prize: $ 600
- 3rd BR41N.IO Prize: $ 400

Schedule
The schedule summary is available on the last page of this booklet.

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-2023**. 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 worldwide, including Tilburg University (Netherlands), Aalborg University (Denmark), g.tec (Austria), UAE University (United Arab Emirates), MLJC (Italy), Simon Fraser University (Canada), West University (Romania), Tec de Monterrey (Mexico), Rochester Institute of Technology (USA), Union College (USA). At the conference teams will meet in the Hackathon room (Luna) to work together.

Step 2: Meet your team (either in person or virtually)
Teams may be "hybrid". Organizers will connect you with the remote members of your team. Create your own meeting space using Skype, Google Hangouts, or Zoom to start working on your ideas.

Step 3: Stay connected via the BR41N.IO Slack channel
While you work on your ground-breaking new BCI applications, organizers will be available in person and on slack to answer questions and support you.

Step 4: Present your projects and win
You will be invited to present your results. Be ready to explain what you did, your results, and to show a demonstration (live or using a video recording) to the international audience.

Sponsors

IEEE SMC 2023 Workshop on Brain-Machine Interface Systems - Program Summary

Hawaii time zone	Sunday, October 1 — Hackathon (Room: Puna)	Monday, October 2 — Hackathon and Technical Papers (Room: Puna)	Tuesday, October 3 — BCI Award and Technical Papers (Room: Puna)	Wednesday, October 4 — Technical Papers (Room: Puna)
8:00-9:00	SMC 2023 registration	SMC 2023 Opening Session (8:30-9:00)	BCI Award Ceremony (video)	Session: Multimodal and Multisensory Information in BMIs. Chairs: Laurent Bougrain and Gabriela Herrera
9:00-10:00	Welcome and Keynote: Frontiers of Brain-Inspired Autonomous Systems (Speaker: Ming Hou, DRDC Canada)	Hackathon Project Presentations (8:00-11:00)		
10:00-11:00	Keynote: Self-Supervised Contrastive Learning For EEG-Based Neurological Disorder Detection (Speaker: Xiang Zhang, UNCC)			
		Coffee break (10:30-10:45)	Coffee break (10:30-10:45)	Coffee break (10:30-10:45)
11:00-11:30	Current and future applications of brain-computer interfaces (Christoph Guger, video)	BR41N.IO BCI Hackathon Awards Ceremony / Session: BMI Workshop Abstracts (Poster Session, Room: Lanai)		Session: Machine learning for EEG-based Brain-Computer Interfaces. Chairs: Ivan Volosyak and Tiago Falk (10:45-12:00)
11:30-12:00	How to run a real-time BCI application (Leo Schreiner, video)			
12:00-12:30	Unicorn Brain Interface Demonstration (Leo Schreiner, video)	Lunch break	Lunch break	Lunch break
12:30-13:00	Data Analysis Projects (Johannes Gründwald, video)			
13:00-13:30		Session: Active BCIs and Applications. Chairs: Eli Kinney-Lang and Erica Floreani (13:00-14:45)	Session: Emerging Topics and Applications of BMIs. Chairs: Tiago Falk and Sarah Power	Session: Representations of Neural Data in Brain-Machine Interfaces. Chairs: Felix Putze and Dean Krusienski (13:00-14:45)
13:30-14:00				
14:00-14:30				
14:30-15:00		Coffee break (14:45-15:00)	Coffee break (14:45-15:00)	Coffee break (14:45-15:00)
15:00-15:30	Group formation and start of the BR41N.IO Hackathon			
15:30-16:00				
16:00-16:30			* Session: Passive BMIs and Applications. Chairs: Yaoping Hu and Tiago Falk (Room: Puna, 16:00-17:45)	SMC 2023 Closing Session
16:30-17:00		Industry (Remote) Keynote: Overview of Clinical BCIs – Use Cases, Challenges, and Opportunities (Speaker: Chris Ullrich, Cognixion)	* BMI Workshop Virtual Track (Room T4, 16:00-17:00)	
17:00-17:30		IEEE Brain Best Paper Award Candidate Presentations (17:00-18:45)		
17:30-18:00				
18:00-18:30	SMC 2023 Welcome Reception and IEEE Brain Networking Reception (Room: Lanai)		SMC 2023 Conference Banquet	
18:30-19:00				
19:00-19:30				
19:00-21:00	BR41N.IO Hackathon			
24:00				

Legend:
- BMI Workshop keynote/invited speakers
- BR41N.IO Designer's Hackathon
- Technical paper/poster sessions
- SMC 2023 event