Workshop

Advanced Human-Machine Interaction for Improving Quality of Life and Health

November 21 (full-day), 2018

Workshop guide

Workshop

Advanced Human-Machine Interaction for Improving Quality of Life and Health

November 21 (full-day), 2018

Sponsored by

Overview:

Human-Machine Interaction (HMI) is one of highly active research areas. It concerns a study of interactions between humans and machines/robots. The HMI technology can be applied to medical applications to improve our quality of life and health. Traditional HMI techniques often generate slow, clumsy, and non-smooth machine/robot responses and interactions. Typically, multimodal information fusion and interaction as well as feedback from clinical experts have not been fully realized. To address all these issues and fulfill clinical needs towards real medical applications, we need to integrate interdisciplinary knowledge across different fields (including, robotics, brain-computer interfaces, natural language processing & speech synthesis, haptic interfaces, artificial intelligence & machine learning, and clinical & behavioral sciences). According to this, our workshop at ICSEC2018 (https://www.icsec2018.org/) will bring together experts, working among these fields to present their recent achievements towards "Advanced Human-Machine interaction for Improving Quality of Life and Health". We will also discuss the challenges and future research directions in this area.

The full-day workshop is composed of the following parts:

- Invited talks by experts from brain-computer interfaces, natural language processing & speech synthesis, haptic interfaces & rehabilitation robotics, and clinical science (orthopedics, spine surgery and spinal cord injury),
- Spotlight poster presentations,
- Discussion and future steps

We are also pleased to invite contributions in the form of 1 page conf. style abstract on (but are not limited to) the following topics. The selected contributions will be presented as 3-mins talks at the workshop and poster presentations during the conference. All abstracts will be included in the ICSEC2018 conference proceedings. In addition, the selected abstracts will be invited to extend for the submission to our opportunity publications as listed below:

Journal of Internet Technology (SCOPUS, ISI (Q2), EI)

Journal of Computers (SCOPUS, EI)
Chiang Mai University Journal of Natural Sciences (SCOPUS, TCI)
Suranaree Journal of Science and Technology (SCOPUS, TCI)
Thai Journal of Mathematics (SCOPUS, TCI)
ECTI Transactions on Computer and Information Technology (ASEAN CITATION INDEX, TCI)

We particularly encourage young scientists to contribute and attend, even presenting their research at an early stage an engage in discussions. Submissions have to be sent to poramate.m@vistec.ac.th in PDF format. One author per accepted workshop contribution (poster) is required to register for the conference to present the accepted submission.

The workshop organizers:

- Poramate Manoonpong, Vidyasirimedhi Institute of Science and Technology, Rayong, Thailand & Nanjing University of Aeronautics and Astronautics, Nanjing, China
- Theerawit Wilaiprasitporn, Vidyasirimedhi Institute of Science and Technology, Rayong, Thailand

The workshop topics include (but are not limited to) the following:

Human-robot interaction,
Human-computer interaction,
Brain-computer interfaces,
Haptic interfaces,
Artificial intelligence and machine learning for human-machine interaction,
Natural language processing & speech synthesis for human-machine communication,
Social and behavioral sciences for human-machine interaction,
Rehabilitation robotics,
Assistive robotics,
Biomedical signal processing and control

List of speakers:

Thanate Angsuwatanakul (Biomedical engineering, Rangsit University)

Theerawit Wilaiprasitporn (School of Information Science and Technology, Vidyasirimedhi Institute of Science and Technology)

Proadpran Punyabukkana (Computer Engineering, Chulalongkorn University)

Chowarit Mitsantisuk (Electrical Engineering, Kasetsart University)

Winai Chonnaparamutt (National Electronics and Computer Technology Center, The National Science and Technology Development Agency)

Chaicharn Akkawutvanich (School of Information Science and Technology, Vidyasirimedhi Institute of Science and Technology

Suthipas Pongmanee,MD. (Spinal unit, Orthopedics department, Faculty of Medicine, Chiangmai University)

Sintip Pattanakuhar, MD. (Department of Rehabilitation, Faculty of Medicine, Chiangmai University)

Pruittikorn Smithmaitrie (Prince of Songkla University)

Final Program:

9:00 Workshop start

9:00–9:15 Brief Introduction, announcements

Poramate Manoonpong

Brain-computer interfaces for human-machine systems

9:15–9:45 *BCI-Based Human Machine Interaction: Learning and Inspiration*

Thanate Angsuwatanakul (Biomedical engineering, Rangsit University)

9:45–10:15 *Opening the Gate to Continuous SSVEP-Based Brain-Computer Interfaces*

Theerawit Wilaiprasitporn (School of Information Science and Technology, Vidyasirimedhi Institute of Science and Technology)

Spotlight 3-mins talks

10:15–10:45

Self-Regulation Training Game based on Brain Computer Interface (BCI), Thanate Angsuwatanakul et al., College of Biomedical Engineering, Rangsit University

Analysis of Binaural Beats Song based on Instrumental Piano Music: A case-study, Siriyaporn Thanawut et al., College of Biomedical Engineering, Rangsit University

An Investigation of Brain Activity Analysis for Preference Tasks using EEG – fNIRS, Nuntachai Thongpance et al., College of Biomedical Engineering, Rangsit University

Portable EEG Power Meter for Educational Application, Chalermkiat Chunhajiruttikarl et al., College of Biomedical Engineering, Rangsit University

An Efficient Development of the Shoulder Continuous Passive Motion Device, Yutthana Pititeeraphab et al., College of Biomedical Engineering, Rangsit University

Classification of Eye Movement based on Electrooculography using LED testing sphere, Tasawan Puttasakul et al., College of Biomedical Engineering, Rangsit University

Controlling Prosthesis Hand Based on EMG Signal using Myo Armband, Puwadon Phetnom et al., College of Biomedical Engineering, Rangsit University

Joint Data Training for Motor Imagery-EEG Classification, Rattanaphon Chaisaen et al., School of Information Science and Technology, Vidyasirimedhi Institute of Science and Technology

Intelligent service robot for effective human – machine interaction, Puchong Soisudarat et al., School of Information Science and Technology, Vidyasirimedhi Institute of Science and Technology

Spatio-Temporal EEG Motor Imaginary Visualization with GRAD-CAM, Tanut Choksatchawathi et al., School of Information Science and Technology, Vidyasirimedhi Institute of Science and Technology

Break

Rehabilitation & assistive robotics and haptic interfaces for physical human-machine interaction

11:15–11:45 *RHA Rehabilitation Robotics: Urban and Rural Servicing Robots*

Winai Chonnaparamutt (National Electronics and Computer Technology Center, The National Science and Technology Development Agency)

11:45–12:15 *Haptic Human-Robot Collaboration System*

Chowarit Mitsantisuk (Electrical Engineering, Kasetsart University)

Lunch

13:30–14:00 *Neuroprosthetics in Individual with Spinal Cord Injury: Clinical Efficacy and Feasibility in Real-Life*

Sintip Pattanakuhar, MD. (Department of Rehabilitation, Faculty of Medicine, Chiangmai University)

14:00–14:30 *Role of Robotic Technology in Orthopedics and Spinal Disorder*

Suthipas Pongmanee, MD. (Spinal unit, Orthopedics department, Faculty of Medicine, Chiangmai University)

15:00–15:30 *Assistive Robotics*

Chaicharn Akkawutvanich (School of Information Science and Technology, Vidyasirimedhi Institute of Science and Technology)

Break

16:00–16:30 Robot Human Interaction for Robot@Home

Pruittikorn Smithmaitrie (Prince of Songkla University)

Natural language processing & speech synthesis for human-machine communication

16:30–17:00 *Accessible Computer Engineering for Human-Machine Communication*

Proadpran Punyabukkana (Computer Engineering, Chulalongkorn University)

Special Talk, Discussion & Closing

17:00–17:30

Workshop Location

Kantary Hills Hotel

44, 44/1-4 Nimmanhaemin Road, Muang,
Chiang Mai 50200

Abstracts

Self-Regulation Training Game based on Brain Computer Interface (BCI)

Thanate Angsuwatanakul
Jamie Alexander O'Reilly
Nutthawee Tuvanonvorakul
Manus Sangworasil
Chonnipa Chan-im
Takenobu Matsuura

College of Biomedical Engineering, Rangsit University, Thailand

Keywords:

brain computer interface (BCI), self-regulation, attention level, meditation level, electroencephalography (EEG)

Abstract:

The promising technology, called Brain Computer Interface (BCI), provides a new output pathway for brain signals to share an interface and control external devices. BCI does not require any physical activity or muscle intervention to issue commands. As a potential tool for symptom alleviation, healthy users can also improve their self-regulation ability through the involvement of BCI. The aim of this study was to design and develop Brain Computer Interface game for self-regulation training. To control his brain features toward the desired stage, the user has to move a game character into 2 directions by using differential brain function. Attention is used to control "Left direction" whereas relaxation or meditation is used to control "Right direction". The user will eventually get points and pass to the next level immediately after moving the game character to the desired stage. In this study, Neuro-Sky Mindwave Mobile was used to measure EEG signal from Fpz position and to convert the signal to Attention level and Meditation level data. Arduino UNO, known as a microcontroller board, was used for data input. With Visual Studio software, the data was directly sent to a computer for processing with the intention of BCI game control. In particular, we expect the exploitation of our BCI game in the real sector and specifically for people with disabilities.

Analysis of Binaural Beats Song based on Instrumental Piano Music: A case-study

Siriyaporn Thanawut
Thanate Angsuwatanakul
Nontharat Wattanagool
Jamie Alexander O'Reilly
Saranchana Chairoek
Manus Sangworasil

College of Biomedical Engineering, Rangsit University, Thailand

Keywords:

binaural beats, brainwave, music therapy, electroencephalography (EEG)

Abstract:

Music, a beautiful technique that arouses our emotion and feelings, can modulate activity in brain structures known as music-evoked emotion. Binaural beats are subjective hearing sensations, which occur when one of tone signals is applied to one ear while the second one, with a slightly different frequency is applied to the other ear. A listener then receives two slightly different sounds. The aim of this research was to create binaural beats songs based on instrumental piano music and to determine the effectiveness of binaural beats songs by analyzing the power spectrum density of EEG signal. We created binaural beats with a frequency of 10 Hz to activate Alpha wave and 18 Hz for Beta wave. The research was conducted on a sample group of 15 healthy subjects. The results revealed that there were significant differences ($p < 0.05$) before and after the exposition of binaural beats. In addition, when increasing power spectrum density, there were statistically significant differences between the resting condition and the exposition of binaural beats observed at Fp2, T7 and T8 position for Alpha wave and only T7 position for Beta wave, ($p < 0.05$). The results, therefore, indicated that the binaural beats songs were effective to frontal and temporal lobes that are related to memory and auditory functions. An increase in Alpha wave yielded relaxation of the brain while concentration was presented by Beta wave.

An Investigation of Brain Activity Analysis for Preference Tasks using EEG – fNIRS

Nuntachai Thongpance
Thanate Angsuwatanakul
Wipawee Jung-in
Jamie Alexander O'Reilly
Kittiya A-lad
Manus Sangworasil

College of Biomedical Engineering, Rangsit University, Thailand

Keywords:

electroencephalography (EEG), event-related spectral perturbation (ERSP), time – frequency analysis, functional nearinfrared spectroscopy (fNIRS), blood oxygen-level dependent (BOLD), wavelet transform

Abstract:

Electroencephalography (EEG) and functional Near-Infrared Spectroscopy (fNIRS) are non – invasive techniques used for brain function analysis. As a useful neuroimaging technique, this study aims to highlight the application of EEG and fNIRS to examine cognitive development as well as to investigate possibilities of using EEG and fNIRS for brain function analysis with two different types of preference tasks. In this study, 30 healthy subjects were divided into 2 groups, i.e. the first group using EEG while the second one using fNIRS in experiments, and treated separately. All subjects performed on the same tasks, with the preference in arousing scents and colors. For raw data analysis, the EEG data was analyzed by the event-related spectral perturbation (ERSP). With EEG Time-Frequency Analysis, the dynamic of EEG power of each frequency was measured in the time domain before and after neuronal events. According to NIRS raw data, it was analyzed by the blood oxygen-level dependent (BOLD) signal and Wavelet Transform. In light of these results, EEG and fNIRS will indicate and characterize individual preference and brain activity.

Portable EEG Power Meter for Educational Application

Chalermkiat Chunhajiruttikarl
Jamie Alexander O'Reilly
Pramuk Kanyangern
Manus Sangworasil
Thanate Angsuwatanakul
Takenobu Matsuura

College of Biomedical Engineering, Rangsit University, Thailand

Keywords:

brain computer interface (BCI), portable eeg, neurofeedback, beta wave, alpha wave, theta wave

Abstract:

Electroencephalography (EEG) is a monitoring method to observe and record the electrical activity of nervous system generated by the brain. The oscillation of EEG signal refers to changes in brain activity. Regarding portable EEG, even though there are some commercial products available, the cost is still so expensive. To effectively measure brain activity with EEG, the EEG system is required to install at hospital setting or research laboratory. This study investigated the potential of using portable EEG to monitor brain activity of students in a classroom setting. We designed and developed portable EEG with ThinkGear AM Brainwave sensor and microcontroller. With LED light bar, our device can display the power of three brainwaves: Beta wave, Alpha wave and Theta wave effectively. One channel EEG data, Fpz, was sent to the computer via Bluetooth module and recorded with MATLAB software. The principal advantage of this device is learning activities can be adjusted according to inclass activities and the students involved.

An Efficient Development of the Shoulder Continuous Passive Motion Device

Yutthana Pititeeraphab
Kritsanapant Yamkate
Chotirat Chanchaio
Manus Sangworasil

College of Biomedical Engineering, Rangsit University, Thailand

Keywords:

shoulder continuous passive motion device, rotary encoder, rehabilitation

Abstract:

The objective of this project were to study on the An Efficient Development of The Shoulder Continuous Passive Motion Device to used treatment for postoperative shoulder pain and improves range of motion was limited shoulder motion. An Efficient Development of this project was composed of 3 main parts: 1) the input part is comprised of rotary encoder and button switch to determine the motor position, configure angle, speed and time, 2) the signal processing part by using Microcontroller with C programming language, 3) the display part is composed of liquid crystal for motor setting display. Now, the project consists of operating mode continuous passive motion, but we will use active mode in the future to storage of treatment data and support the physiotherapists with intelligent devices that using a human machine interface to control a rehabilitation for Shoulder.

Classification of Eye Movement based on Electrooculography using LED testing sphere

Tasawan Puttasakul
Jiranun Auttakunchai
Thanyaporn Charoenyingsataporn
Phichet Kawilo
Manas Sangworasil
Takenobu Matsuura

College of Biomedical Engineering, Rangsit University, Thailand

Keywords:

electrooculography (EOG), discrete cosine transform (DCT)

Abstract:

The Electrooculography (EOG) is the electronic signal from the eye's muscles. The EOG has been used for eye's controlling by the blink detection, analyzing the eye movement pattern and eye writing recognition. There are many eye's signal processing research papers and have been used with different methods, algorithms and features. We used electrooculography apply with the visual keyboard by collecting the database and control the visual keyboard through computer's monitor. This paper presents eye's movements classification based on Electrooculography (EOG) by K-mean clustering. As the features, Discrete Cosine Transform (DCT). EOG signals for 4 directions (vertical: up, down, horizontal: left, right) and each movement have angle of movement including 5 degrees (5, 10, 15, 20 and 25 degrees) were collected using LED testing sphere. From collecting these data will be use to apply with the visual keyboard to improve the accuracy.

Controlling Prosthesis Hand Based on EMG Signal using Myo Armband

Puwadon Phetnom
Napat Chantarasiri
Rattanapol Chatphutorn
Tasawan Puttasakul
Pipach Changpradit
Yutthana Pititeeraphab

College of Biomedical Engineering, Rangsit University, Thailand

Keywords:

electomyogrphy (EMG), prosthesis hand, myo armband

Abstract:

Regarding the vast variety of electromyography (EMG) applications such as rehabilitation of people suffering from some movement limitations, a lot of research has been deployed EMG signals as a diagnostic tool. In other words, this tool is used as a controlling bionic hand, which helps the amputees to regain or improve their mobility as well as to use this assistive equipment to perform the same tasks as they could pre-surgery. In this study, many efforts were put into the improvement of bionic hand devices controlled by EMG signals using Myo Armband. As for Myo Armband, there are 8 channels of dry electrodes used for measuring EMG signals from forearm muscle and input data to the microcontroller using Bluetooth. This research focuses on the movement control of a prosthesis hand based on the simple myoelectric patterns. Using EMG signals from Myo Armband, we tried to control six-pattern movements of prosthesis hand including: key grip rotate left, key grip rotate right, power grip, power grip rotate left and power grip rotate right. With the multiple input concept, the amputees will be able to

do more than one thing at a time and, therefore, have smoother and simultaneous movements.

Joint Data Training for Motor Imagery-EEG Classification

Rattanaphon Chaisaen
Theerawit Wilaiprasitporn
Thayakorn Wisutthisen
Theerasarn Pianpanit
Phattarapong Sawangjai

Bio-inspired Robotics and Neural Engineering Lab,
School of Information Science and Technology,
Vidyasirimedhi Institute of Science and Technology, Rayong, Thailand

Keywords:

Brain-Computer Interface (BCI), Electroencephalography (EEG), Motor Imagery (MI), Common Spatial Pattern (CSP), Support Vector Machine (SVM)

Abstract:

Brain-Computer Interface (BCI) is translating brain signals into computer instructions. On the other hand, it could be an interface for disabled people to control machines but the Electroencephalography (EEG) signals are difficult to record culminate in limiting the amount of training data available for classification tasks. In this work, we propose the joint data training for classification of BCI based on Motor Imagery (MI) to handle various datasets across difference recording setups. This work allows to use the state-of-the-art model, Common Spatial Pattern (CSP) that extracts spatial information and the classification algorithm that we used is the Support Vector Machine (SVM). We experimented on four different MI-EEG datasets which trained by three different datasets and tested by one unseen dataset for imagining of left and right hands movement. We expect the result of this work could be satisfied accuracy.

Intelligent service robot for effective human – machine interaction

Puchong Soisudarat
Poramate Manoonpong

Bio-inspired Robotics and Neural Engineering Lab,
School of Information Science and Technology,
Vidyasirimedhi Institute of Science and Technology, Rayong, Thailand

Keywords:

Human-machine interaction, Adaptive Control, Input Correlation Based Learning (ICO)

Abstract:

There are many challenges in the robotic field trying to include a service robot to be a part of person's daily life. Despite the service robot becomes more sophisticated, many tasks are still referred as a reactive task where the human still has to operate the robot to perform on each task and to achieve the goal. Typically, a traditional method, that supports the human task as a one-way communication from the user to the robot, is employed. From this point of view, it means that there is an interesting point to develop two-way communication between the human and the service robot which can be referred as "human-machine interaction". In order to achieve this, "adaptive control" is a major role to make the robot to be "self-adaptive". Additionally, the robot can "sense" a state of the human, and automatically perform a certain task without receiving any order from

the human. In this study, we employ input correlation based learning (ICO) for our service robot. ICO learning is a mechanism that allows the robot to learn by the correlation of the two signals called a reflex signal (referred as an unwanted signal), and a predictive signal (referred as a prior signal). The main goal is to get rid of the reflex signal or the signal that is activated when there is a failure in learning such as the robot reacts too slow for the certain task. The advantage of this ICO learning is fast, and the result of the learning is already optimized. Using this learning approach the robot will predict the human state based on the environment and information around it to be able to perform a proper action. For instance, when the temperature of the room is increasing, the rot will predict and automatically perform the action to reduce the room temperature by turning on an air conditioner.

Spatio-Temporal EEG Motor Imaginary Visualization with GRAD-CAM

Tanut Choksatchawathi
Phuridet Cherachapridi
Theerasarn Pianpanit
Phattarapong Sawangjai
Rattanaphon Chaisaen
Thayakorn Wisuttisen
Theerawit Wilaiprasitporn

Bio-inspired Robotics and Neural Engineering Lab,
School of Information Science and Technology,
Vidyasirimedhi Institute of Science and Technology, Rayong, Thailand

Keywords:

Motor Imaginary (MI), 3D Convolutional Neural Network (3D-CNN), Gradient-weighted Class Activation Mapping (GRAD-CAM), Electroencephalography (EEG)

Abstract:

The spatio-temporals patterns of motor imaginary from widely used electroencephalograms (EEG) Physionet open database. The recognition system of spatio-temporal patterns with 3-dimensions convolutional neural network (3d-CNN) is difficult to understanding cause of multi-dimensional data in EEG. This paper, we use Physionet data for model (training by 6300 data and validation by 1440 data) and show 3d-CNN method could be used with 88.4028% accuracy for prediction resting and imaginary stage. Moreover, this model integrates with Gradient-weighted Class Activation Mapping (GRAD-CAM) visualization technique in final convolutional layer to show area of model prediction.
