**MTEch KE5105**

**Knowledge engineering project**

# Understanding of EEG Signal (Motor Imagery) variation over days for general classification purpose

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# 1.0 Problem description and overview

Motor impairment is a prevalent problem that can arise from diseases such as spinal cord injury, cerebral palsy and amyotrophic lateral sclerosis (ALS) disease. The reasons for such impairment include the central nervous system being unable to transmit signals to the muscles and muscle degeneration. The understanding of nervous or brain signals can help scientists and clinicians to develop a brain computer interface (BCI) system to aid patient’s mobility (i.e. a mind-controlled wheelchair). The key to understanding these brain signals, electroencephalogram (EEG) signals, are often found in motor imagery data obtained from healthy and motor impaired patients.

Clinicians often use the electroencephalogram (EEG) as a tool for neuroimaging and the features extracted from such imagery are unique to the individual and can vary across time. The ability to classify motor signals based on motor imagery can greatly push the development of brain computer interface devices that recognise motor signals and further aid patient movement. Many methods have been proposed for classification of motor imagery. For example, Filter Bank Common Spatial Pattern (FBCSP) has been the gold standard for motor imagery classification (Krishna et al., 2016). Aside from FBCSP, deep learning techniques have been rarely used in motor imagery classification (Kumar et al., 2016). In this project, we will employ deep Convolutional Neural Nets and Generative Adversarial Networks to classify EEG signals across patients and days.

Developing an EEG classification system for Agency for Science, Technology and research (A\*STAR), the organisation can use our system to develop a decoder for brain signals that will aid in developing BCI devices for patients with ALS or heavy motor impairment.

# 2.0 Scope

The deep learning algorithm that we plan to develop to classify motor imagery should be close to or even surpass the classification performance of FBCSP. The classification problem that this project aims to solve is to classify movement motor imagery (i.e. subject moves hand or thinks of moving a hand) from idle motor imagery (i.e. subject does not move or think of moving a hand). Current FBSC Algorithm has a classification accuracy of approximately 82% to 83% (T. Yang *et al*., 2016) and this project aims to match or surpass this classification accuracy. There will be no user interface or support modules. Trained Neural Net model will be validated based on Test data to cross check whether desired results are achieved. The same will be documented based on standard practices.

# 3.0 Sources

Initial meetings have been conducted with Dr Yang Tao and Initial requirements have been gathered already. Based on Literature study, Full-fledged low-level requirements will be defined. We will be meeting Project Supervisors or Dr.Yang Tao to report progress or Clarify / Seek guidance fortnightly.

The model will be developed based on the open source dataset and pre-trained model can be used to re-train in A-star premises based on the available data with the organisation using transfer learning techniques.

**Domain Expert / Reference / Guidance:**

Dr.Yang Tao, A-Star Research Lab - I2R, Singapore

**Project Supervisors:**

Dr.Matthew , ISS - NUS

Dr.Tian-Jing, ISS - NUS

**Data Source:**

Open Source Datasets, as quoted below

<https://www.kaggle.com/c/grasp-and-lift-eeg-detection#evaluation>

<http://www.bbci.de/competition/iv/>

<https://github.com/meagmohit/EEG-Datasets>

# 4.0 Project plan

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| Date | Activity | Deliverable |
| March | Literature Review  Familiarisation with dataset | Literature review |
| April | Complete domain familiarisation  Conduct knowledge/Data acquisition  Initial System Design  Project Planning  First Presentation | Submit Report 1 to Advisor on 2/4/2019  Team Presentation on 8/4/2019 |
| May | Data Engineering  Data Cleaning  Feature Extraction from Open Source Data |  |
| June | Develop first model to test on Open Source Dataset (Signal Processing) |  |
| July | Validate & Refine first model to test on Open Source Dataset (Signal Processing) | Report on first model’s performance |
| August | Develop second(improved) model to test on Open Source Dataset | Submit Report 2 to Advisor  On 20/8/2019  Team Presentation on 26/8/2019 or 27/8/2019 |
| September | Refine second model (Generative Adversarial Networks) to test on Open Source Dataset | Report on second model’s performance |
| October | Compare Model classification performance. Test model on ALS patient Dataset |  |
| November | Report Results from ALS patient dataset |  |
| December | Prepare Final report, technical paper and System for ISS to judge | Submit to Advisors:  -Final Project Report  -Technical Paper  -IS System (Softcopy)  -Softcopies of all the above on a CD |
| January | Give a presentation and live system demo | Give Final Presentation to ISS  Conduct a live system demo |

# 5.0 Final Comments

Based on our literature review and findings, we might revise our approach and the solution. If the method is successful, BCI can be further extended to a variety of similar patients affected by seizures and epilepsy.

# 6.0 References

1. T. Yang *et al*., "EEG Channel Selection Based on Correlation Coefficient for Motor Imagery Classification: A Study on Healthy Subjects and ALS Patient," *2018 40th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, Honolulu, HI, 2018, pp. 1996-1999.

doi: 10.1109/EMBC.2018.8512701

2. S. Kumar, A. Sharma, K. Mamun and T. Tsunoda, "A Deep Learning Approach for Motor Imagery EEG Signal Classification," *2016 3rd Asia-Pacific World Congress on Computer Science and Engineering (APWC on CSE)*, Nadi, 2016, pp. 34-39.

doi: 10.1109/APWC-on-CSE.2016.017

3. Kay Gregor *Hartmann, Robin Tibor Schirrmeister and Tonio Ball, “EEG-GAN: Generative adversarial networks for electroencephalograhic (EEG) brain signals”, 5 Jun 2018*