# **Title:** Expanded Work on Development of EEG-Based BCI Application Using Machine Learning to Classify Motor Movement and Imagery

**Level:** Bachelor/Master

**Supervisor:** Yar Muhammad (Yar.Muhammad@ut.ee), **Co-supervisor:** Naveed Muhammad

A brain-computer interface (BCI) is a system that implements human-computer communication by interpreting brain signals. The signals can be recorded through different neuroimaging techniques that can read brain activity, such as electroencephalography (EEG).

The goal of BCI technology is to enable the user to communicate with or control an external device using their mind. BCIs are widely used in medicine to help patients with limited motor abilities to communicate with their environment. However, there are many challenges faced when building a BCI capable of classifying the subject's intention, such as the highly individualized nature of brain waves, which makes the development of a universal classifier difficult.

This work is aimed to develop a better electroencephalography (EEG) based machine learning classifier model capable of cross-subject motor movement and imagery classification and to build a BCI system to validate the performance of the developed classifier. The classifier was based on convolutional neural networks (CNN) with a multi-branch feature fusion approach. The classifier was developed using Tensorflow machine learning framework, the BCI system was developed in the Python programming language using the PyQT framework, and the Emotiv EPOC EEG device was used for signal collection.

The resulting classifier was tested on a publicly available dataset of 103 subjects. The classifier achieved an accuracy of 84.1% when predicting executed left- or right-hand movement and an accuracy of 83.8% when predicting imagined left- or right-hand movement.

The aim of the thesis is to extend the work in order to improve the accuracy of existing algorithm by using different approaches and techniques such as (but not limited to):

- Explore alternative models for the task at hand. More thorough comparison with state of the art.
- Test and evaluate n-fold validation
- Thorough investigation on transfer learning
- Use more intuitive/visual ways to generate results.
- Investigate the usage of a better signal acquisition device
- Real-time performance of an example task using the developed system

For a more detailed discussion on the above aspects, please refer to [1].

**Some relevant literature:**

[1] Karel, Roots, Yar Muhammad, Muhammad Naveed, "Development of EEG-Based BCI Application Using Machine Learning to Classify Motor Movement and Imagery", Bachelor Thesis, 2020, University of Tartu (https://comserv.cs.ut.ee/ati_thesis/datasheet.php?id=69742&year=2020)

[2] Karel, Roots, Yar Muhammad, Muhammad Naveed, "Fusion Convolutional Neural Network for Cross-Subject EEG Motor Imagery Classification", In Journal of Computers 2020, 9 (3), 72; Machine Learning for EEG Signal Processing, September 5, 2020 (https://doi.org/10.3390/computers9030072).

[3] Software Download and Installation Instructions Link:
https://github.com/rootskar/MotorImageryBCI