Undergraduate Thesis Projects

Required Background and Skills

The proposed topics are intended for students interested in programming, signal processing, machine learning, and the development of interactive applications. Basic programming knowledge (MATLAB or Python) is desirable, while the required background may vary depending on the topic.

Through these projects, students will have the opportunity to become familiar with brain–computer interfaces (BCIs), the recording and analysis of brain signals (EEG), digital signal processing and, depending on the topic, techniques in machine learning, software development, virtual reality (VR), and human–computer interaction (HCI).

No prior experience with EEG or BCI is required. The topics can be adapted to students' backgrounds and interests.

Contact

For more information, you can contact us through our website or directly by email at Assistant Professor Kyriaki Kostoglou (kkostoglou@upatras.gr).

If you have your own ideas or would like to adapt one of the proposed topics to your interests and preferences, please do not hesitate to contact us to discuss the possibilities.

TOPIC 01 · BCI PARADIGMS

Neuroengineering & Brain Computer Interfaces Research Infrastructure

https://bci.upatras.gr/

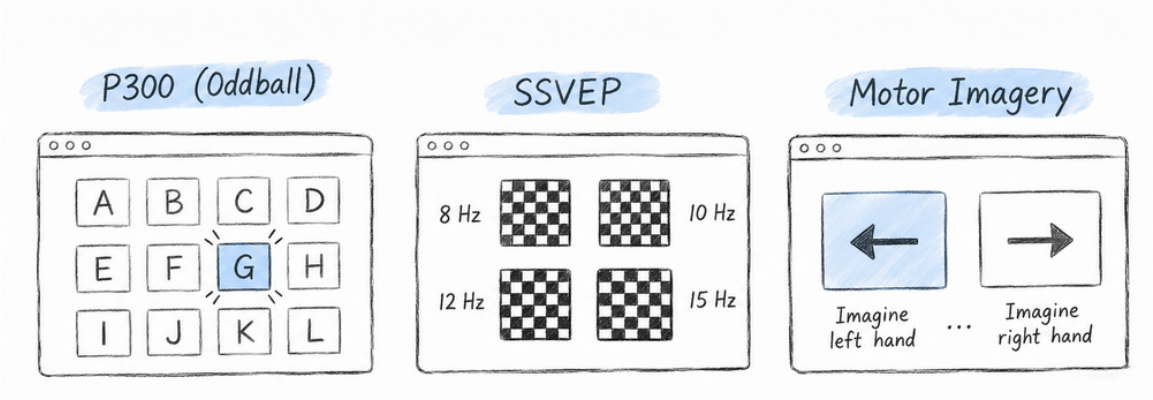
Design and Development of Experimental Paradigms for Brain–Computer Interfaces

MATLAB / Python · P300 · SSVEP · Motor Imagery

The aim of this undergraduate thesis is to design and implement experimental paradigms for brain–computer interfaces (BCIs), using MATLAB or Python. The project will focus on developing applications based on established BCI paradigms, such as P300, SSVEP, and Motor Imagery.

The applications will include the presentation of appropriate stimuli, the configuration of experimental procedures, and the capability for synchronized recording of brain activity using electroencephalography (EEG).

The developed paradigms can be used for educational demonstrations, laboratory experiments, and future research activities in the field of BCIs.



TOPIC 02 · REAL-TIME EEG

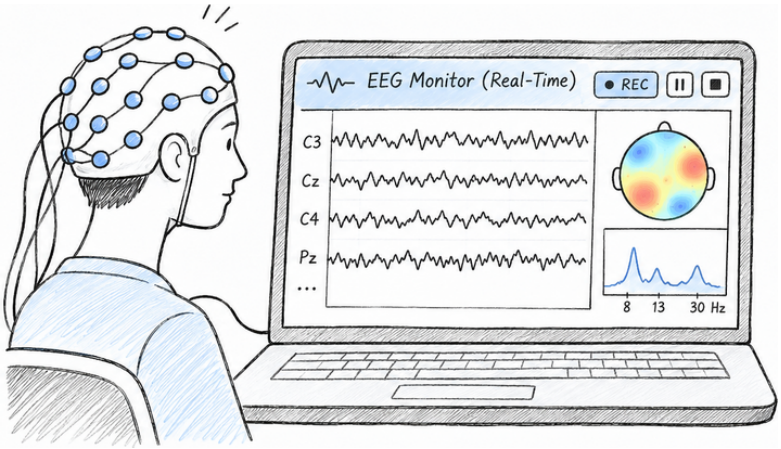
The Brain in Real Time: Development of an EEG Recording and Visualization Application

MATLAB / Python · Signal Processing · Visualization

The aim of this undergraduate thesis is to design and develop an application for recording, processing, and visualizing electroencephalographic (EEG) signals in real time, using MATLAB or Python.

The application will allow simultaneous display of multiple EEG channels, the application of basic signal processing techniques, such as digital filtering, and monitoring of recording quality. In addition, it will provide data storage capabilities for subsequent analysis and, where feasible, support for timestamps (event markers) to synchronize recordings with experimental stimuli.

The tool can be used in laboratory experiments, educational demonstrations, and future research applications in the field of BCIs.



TOPIC 03 · EEG SIGNAL QUALITY

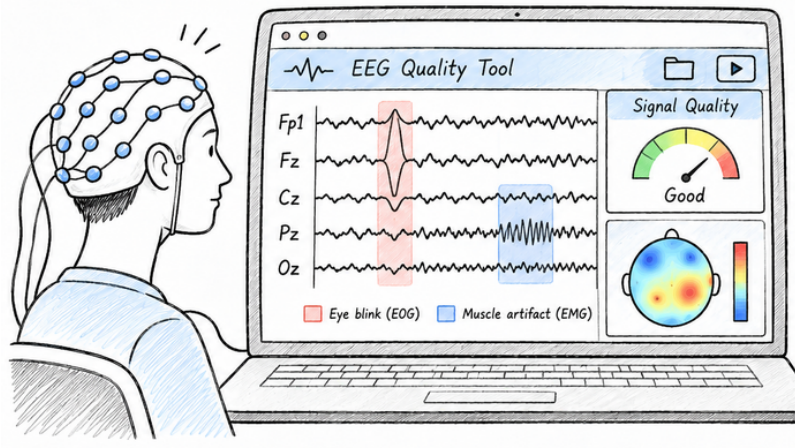
Design and Development of a Tool for Assessing EEG Signal Quality

MATLAB / Python · Artifacts · Quality Assessment

The aim of this undergraduate thesis is to design and develop a tool for assessing the quality of electroencephalographic (EEG) signals, using MATLAB or Python.

The application will enable the analysis and visualization of EEG data to identify noise, artifacts, and problems affecting recording quality. Basic methods for assessing signal quality will be examined, such as bad-channel detection, identification of artifacts caused by eye movements and muscle activity, and analysis of features in the time and frequency domains.

The tool will provide a graphical interface for presenting results and highlighting potential problems in recordings. It can be used to assess EEG data quality in laboratory experiments and future research applications in the field of BCIs.



TOPIC 04 · MOTOR IMAGERY & EXECUTION

Brain-Controlled Gaming: Development of a Game Using EEG and Imagined/Actual Movement

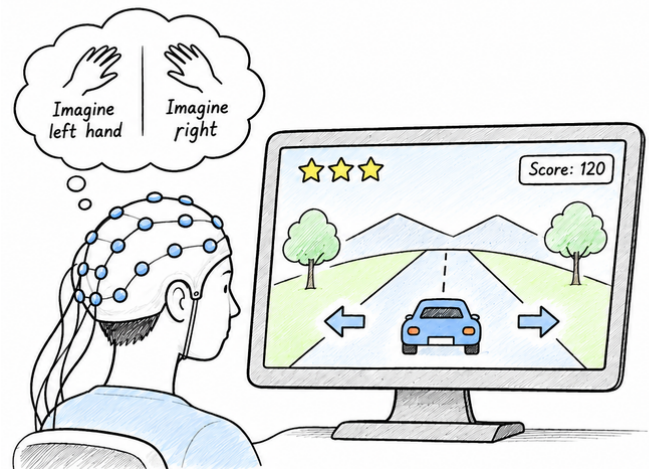
Unity · Python / MATLAB · Sensorimotor Rhythms

The aim of this undergraduate thesis is to design and develop an interactive game in which users can perform actions through brain activity associated with imagined (Motor Imagery) or actual execution of movements (Motor Execution), as recorded using electroencephalography (EEG).

The application will be developed using Unity and Python or MATLAB and will be based on the analysis of features of sensorimotor brain rhythms, such as the mu (8–13 Hz) and beta (13–30 Hz) rhythms, and their changes during imagined or actual movement execution. For example, users may move a virtual character, control the movement of an object, or trigger specific actions in the game through imagined or actual movement of the left or right hand.

The project will include designing and developing the game, creating an appropriate experimental protocol, interfacing with an EEG recording system, and implementing basic methods for processing and recognizing brain responses. The possibility of controlling the game in real time, based on features extracted from EEG signals, will also be examined.

The application will be evaluated in terms of accuracy in recognizing different motor states, response time, and successful completion of game activities. The final system can be used for educational demonstrations and future laboratory experiments in the field of BCIs.



TOPIC 05 · VR NEUROFEEDBACK

A Virtual World That Responds to Your Brain: Development of a VR Environment with Neurofeedback

Unity · Python / MATLAB · Virtual Reality · Neurofeedback

The aim of this undergraduate thesis is to design and develop an interactive virtual reality (VR) environment that changes dynamically based on the user's brain activity, as recorded using electroencephalography (EEG).

The application will be developed using Unity and Python or MATLAB and will include a virtual environment, such as a natural landscape or an interactive garden. By analyzing basic EEG signal features, such as the power of specific frequency bands, the environment will adapt in real time. For example, changes in brain activity may affect lighting, colors, the movement of virtual objects, or the growth of a virtual plant.

The project will include developing the virtual environment, connecting it to the EEG recording system, basic signal processing, and implementing a visual neurofeedback mechanism.

The application will be evaluated in terms of the system's response to changes in EEG features and the functionality of the interaction. It can be used for educational demonstrations and future research activities in the fields of BCIs and neuroadaptive virtual environments.

