# Development of a Brain-Computer Interface to Control a Robotic Arm

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**1. Introduction –** Brain-Computer Interface (BCI) is a communication system that uses brain signals to control external devices, and can be used specially for people with physical disabilities. This work presents an accessible and functional BCI based on open hardware and software solutions. The chosen tools were the Ganglion Board – OpenBCI and the software OpenVIBE. A robotic arm was controlled by motor imagery. Simulated and experimental results have shown feasibility for the developed BCI system. In particular, the average classification rate for three class BCI was 52.75%.

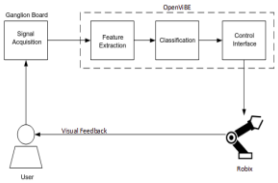


**Image 1. System overview**

**2. Experimental -** In this work, a BCI system based on open hardware and free software was developed. The goal was to control a robotic arm. In this system, the brain signals acquired by the hardware (Ganglion board), are sent to a computer and processed by using the free software platform OpenViBE [1]. Three scenarios were developed in the OpenViBE platform. The last scenario (shown in Image 1) shows the application. The Ganglion board is responsible for the Real-Time Signal Acquisition stage and the OpenViBE software performs the feature extraction, classification, and interfaces the robotic arm controller. The robot used in this work was the Robix [2], available in the Laboratory of Automation and Robotics.

**3. Results and Discussion** - The BCI signals were acquired and the system was trained. Data were recorded in a dataset according to a training protocol. Two classifiers were performed in the second scenario based on the recorded dataset. The output of this stage is a configuration file for further processing. Table 1 presents the results for the simulated experiment and the experiment with real motor imagery.

**Tabel 1. Results.**

| Classifier | Motor Imagery | Simulation |
|---|---|---|
| LDA | 51,99% | 100% |
| ANN | 53,51 % | 100% |

**4. Conclusions -**. This paper explored a low cost open source hardware acquisition (Ganglion board) and a free software platform (OpenViBE) as a BCI. The results showed an average classification rate of 52.75%. It was observed that the ANN classifiers performs slightly better. It is worth mentioning that the motor imagery classification rating could be increased, depending on the user training.

**5. References**

[1]. OpenBCI. https://shop.openbci.com/products/pre-order-ganglion-board.
[2] Robix Avalilable at: www.robix.com.