Ethical, Professional and Safety Issues Related to the MusEEG Project

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*Abstract*— In this paper, the ethical, professional and safety concerns tied to the MusEEG project are discussed. The safety risks of using a non-invasive EEG headset are evaluated, and suggestions are made to ensure user safety and comfort. Moreover, the ethical and legal implications of acquiring, processing, and storing a certain user’s EEG data in the MusEEG application are discussed. Finally, the ethical and professional ramifications of Open-Source Software are analyzed. Issues such as the quality of open-source software, collaboration, and developer interests are discussed.

*Keywords*— Electroencephalography (EEG), Open-Source Software (OSS), Brain-Computer Interface (BCI), GitHub

# Introduction

In order for the ethical, professional, and safety implications of the project to be discussed, a brief synopsis of the project itself must be provided. In short, the MusEEG project consists of a Brain-Computer Interface designed for music performance. EEG data is taken from a user and is processed and classified using feature extraction and machine learning algorithms. The classification process then refers a particular body/facial gesture to a MIDI event, thus creating music using EEG signals.

The project presents two primary concerns regarding its safety, legal, and ethical implications. The first concern is the acquisition of EEG data, as there are safety and ethical risks tied to the operation of an EEG headset, the acquisition of EEG data and the storage and usage of such data in machine learning applications. Moreover, because the software component of this Brain-Computer Interface is being distributed as an open-source package, the professional, legal, and ethical concerns related to open-source software are discussed.

In section II, the safety concerns related to the usage of EEG are discussed. Section III discusses the ethical and legal ramifications of EEG data acquisition and privacy, while section IV deals with open source software and it’s legal and ethical concerns such as quality, liability and collaboration.

# Concerning the Safety Risks of EEG

Because EEG is a noninvasive method of obtaining brain data, the risks involved with the usage of EEG equipment are fairly low. However, the EEG acquisition process still involves placing electrical equipment on a subject’s scalp, and thus proper electrical safety measures must be taken.

## Electrical Isolation

Electrical Isolation is of utmost importance when dealing with an EEG headset. EEG headsets are meticulously designed to provide a robust electrical isolation barrier between any high voltage circuits and the EEG electrodes themselves. Nevertheless, an isolation failure due to faulty equipment or an accident might leave the user at an imminent risk of electric shock, as oftentimes the user’s body may be the shortest path to ground.

The EEG headset that has been used throughout the project’s development and demonstration is the 14-Channel Emotiv® EPOC+. Because the EPOC+ communicates using Bluetooth technology, the risk of the electrode connections somehow connecting to the internal power rails of the Brain-Computer Interface system are nonexistent.

However, because of the MusEEG project’s open source nature, users of the project are allowed to use any EEG headset of their choice. This reintroduces concerns related to users being at risk of electric shock due to a short circuit between the Brain-Computer Interface’s power rails and the EEG headset electrodes. It is advisable that the user refrains from using an EEG headset when the user is wet and/or in rainy conditions, as well as thunderstorms or when the electrical power grid is unstable.

When using a wired EEG headset, higher care is required, as the risk of electric shock due to a short circuit is higher. [1] takes into concern the issues related to improper/double grounding that may result in leakage currents due to the existence of differences in potential between two grounds. The following safety measures are recommended by [1] when using a wired EEG headset:

* Always use a three-prong plug to ensure proper grounding. Do not use extension cords for EEG machines, as they may cause an imbalance between grounds.
* Establish EEG maintenance, including protection with proper fuses.

## Neurofeedback Risks

Recording training data can often be a long, tedious task. In addition to the unpleasantness produced by the repetitiveness of recording training data, wearing an EEG headset for extended periods of time may produce high levels of discomfort to some users, and side effects may include headaches.

# Concerning the Ethical and Legal Implications of EEG Data Acquisition

When obtaining and processing an individual’s EEG data, privacy is a major concern. Collected multichannel EEG data, even with a low number of sensors, raises issues regarding the individual’s privacy due to the dense amount of information contained in an EEG sample. EEG traces from multiple channels capture many important aspects of participants’ brain activity, such as diagnoses of mental diseases, traces of epilepsy, and personality traits [5]. Moreover, EEG data contains information that can be used as a unique personal identifier.

Because of the privacy risks involved with the collection and processing of multiple-subject EEG data, the MusEEG package has been designed in a way that the EEG data of a certain subject is handled and processed by that same subject only. The MusEEG package allows for a user to load and process their own EEG data locally, without ever having to upload or share their data with other users, and thus conserving the user’s privacy.

## Regarding the Data Acquisition, Processing, and Accessibility of User-Specific EEG Data in MusEEG

Because of the open-source, train-it yourself nature of the MusEEG project, a particular subject’s EEG data is handled by only the subject himself, as it is advised that the neural network model is trained for a single individual only for higher classification accuracy.

In order for a user to create their own personalized neural network model, the user must first download the MusEEG package from GitHub to their personal computer. The MusEEG eegData module’s training methods facilitate the data collection process, organizing and labeling the training data into processing chunks inside the MusEEG directory. The processed and labeled training data is then used to create and train a new neural network model customized to the user’s training data, which will also be stored inside the MusEEG directory.

It should be noted that all of the EEG data acquired by the user is processed and saved inside the user’s local MusEEG directory and is never uploaded to the web. Thus, each user’s EEG data and trained neural network models reside inside the same user’s computer, and are never shared, accessed, or viewed by any other subject without the original user’s consent and deliberate intent.

# Concerning the Ethical and Professsional Implications of Open Source Software

Open-Source Software (OSS) is rooted in academia. It is based on the foundation of sharing knowledge between individuals, creating one’s own projects and building upon others’.

## Ethical Issues Regarding OSS

Typically, the developers’ motives behind designing a piece of OSS software are rooted completely in utility, as there are no financial gains to be made from producing open source software. When software is created solely for commercial gain, there is always a danger that the customer is treated merely as a means to a financial end: financial enrichment of the software developer [2]. With no financial gain to be achieved in an open-source project, the developers’ interests are placed strictly in the development of a high-quality and stable product for users to enjoy.

## Regarding the Quality of Open-Source Software and MusEEG

Although a popular opinion regarding OSS revolves around the idea that “you get what you pay for”, this is necessarily not true. One may assume that if a developer isn’t paid to create a piece of software, the quality of said piece will not be good. However, [2] argues that developers who engage in open-source projects only work on projects that interest them, and, if one developer loses interest in a certain project, that project will be picked up by another developer with an interest in said project. Moreover, when contributing to the open-source community, developers’ reputations are at risk. In the hacker community, “one’s work is one’s statement… and there’s a strong ethos that quality should (indeed must) be left to speak for itself… Boasting or self-importance is suppressed because it behaves like noise tending to corrupt the vital signals from experiments in creative and cooperative behavior” [3].

Because the MusEEG project will not be distributed as an open-source package until its final revision is ready and debugged, a high-quality piece of software is guaranteed to be delivered. Open-source contributions to the project will have to be done in separate forks for liability purposes, so any modifications to the source code will be liable under the modifier’s name, not the original developer. If a contributor wishes to merge a fork to the master MusEEG branch, the contributions will be evaluated for quality by the MusEEG team before merging such contributions to the master branch.

# Conclusions

Overall, the MusEEG project presents a low risk in terms of user safety, and a medium risk in terms of user privacy. Electroencephalography’s non-invasive nature allows for safe operation of the MusEEG BCI without presenting any major health or safety risks, aside from the low-probability risk of electric shock due to EEG headset malfunction. Regarding ethics and legal implications, the MusEEG’s data acquisition and processing workflow is designed so users never have to disclose their EEG data to any other user or developer, allowing for optimal privacy. Finally, the open-source distribution of MusEEG will be handled by a master GitHub repository that will only accept high-quality contributions as decided by the MusEEG project leader, while still allowing for all contributors to fork the repository and create their own versions of the project under their own responsibility.

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