Streamlining Data Collection: A Platform Supporting the Design of Acquisition Protocols of Brain Signals

Hamza Amrani, Nicolae Alexandru Andrei, Daniela Micucci and Paolo Napoletano
Department of Informatics, Systems and Communication, University of Milano - Bicocca, Milan, Italy
Email: h.amrani@campus.unimib.it, n.andrei1@campus.unimib.it, daniela.micucci@unimib.it, paolo.napoletano@unimib.it

***Abstract*—Neurorehabilitation is essential for improving the quality of life for individuals with neurological disorders or conditions. Brain-computer interfaces (BCIs) have emerged as a promising tool for enhancing neurorehabilitation efforts. BCIs can be used for diagnosis, monitoring, cognitive rehabilitation, and as assistive devices, improving the quality of life for patients with neurological conditions. BCIs provide real-time feedback, enabling patients to better understand their brain activity and improve their performance during rehabilitation.**
The goal of our work is the definition of a platform that will simplify the collection of brain signals within the healthcare domain. The platform aims to enable the creation of customisable data collection protocols to study brain activity in response to specific stimuli or track changes in brain activity over time. Improved diagnosis, personalized treatment plans, and ultimately, enhanced quality of life for individuals undergoing neurorehabilitation are among the potential benefits of this platform. Moreover, this platform is being developed as an open-source initiative, with the aim of encouraging collaboration, knowledge sharing, and future developments.

***Index Terms*—brain-computer interfaces, biological signals, customizable protocols, data collection platform**

I. Introduction

Neurorehabilitation plays a crucial role in improving the quality of life for individuals with neurological disorders or conditions [1], [2]. The capability to restore lost or impaired brain functions and enhance cognitive abilities is a significant focus of research in this field. In recent years, Brain-Computer Interfaces (BCIs) have emerged as a promising tool for advancing neurorehabilitation efforts [3], [4]. BCIs enable direct communication between the human brain and external devices, offering a range of applications, including diagnosis, monitoring, cognitive rehabilitation, and assistive devices [5]. Techniques such as electroencephalography (EEG) [6] have demonstrated their efficacy in providing valuable insights into the functioning of the central nervous system and aiding in the diagnosis of neurological disorders.

Despite the availability of numerous data collection methods [7], a gap exists in the development of a comprehensive platform that enables researchers to design experimental protocols for data collection. The development of such a platform has great potential for advancing the field of healthcare and neurorehabilitation. By providing researchers with a platform for designing experiment protocols, the collection of brain signals can be optimized and streamlined. It would also empower researchers to adapt data collection protocols for their specific research requirements, enabling them to investigate a wide range of neurophysiological phenomena and explore the intricate dynamics of brain activity.

The development of this platform raises several important research questions. Firstly, how can an open-source platform be developed to facilitate the application of protocols for collecting brain signals for the diagnosis of neurological disorders? This question addresses the technical aspects of creating a platform capable of designing and applying data collection protocols.
Secondly, to support diverse experimental setups and research requirements, the platform needs to provide customization options and configuration parameters. Researchers require flexibility in defining the data collection protocols, specifying stimulus, timeframes, and other relevant parameters. Therefore, an important research question is what customization options and configuration parameters should be provided to ensure the platform satisfies the various necessities.
Lastly, user-friendliness must be prioritized in the design of the platform's user interface. Researchers should be able to easily navigate the platform, create and manage data collection protocols, and visualize the collected protocols. Therefore, an important research question is how user-friendliness can be prioritized in the design of the platform's user interface to simplify protocol design and visualization.

The article is organized as follows: Section II provides an overview of our platform; Section III outlines conclusions and future directions.

II. Platform

The platform architecture designed in our work aims to facilitate the collection of brain signals within the healthcare domain, with a specific focus on neurorehabilitation. The primary objective is to provide researchers and domain experts with a customizable and user-friendly tool for studying brain activity in response to specific stimuli and tracking changes in brain activity over time.

The architecture of the platform includes key components that enable efficient protocol design, analysis, and visualization. At the core of the platform architecture there is

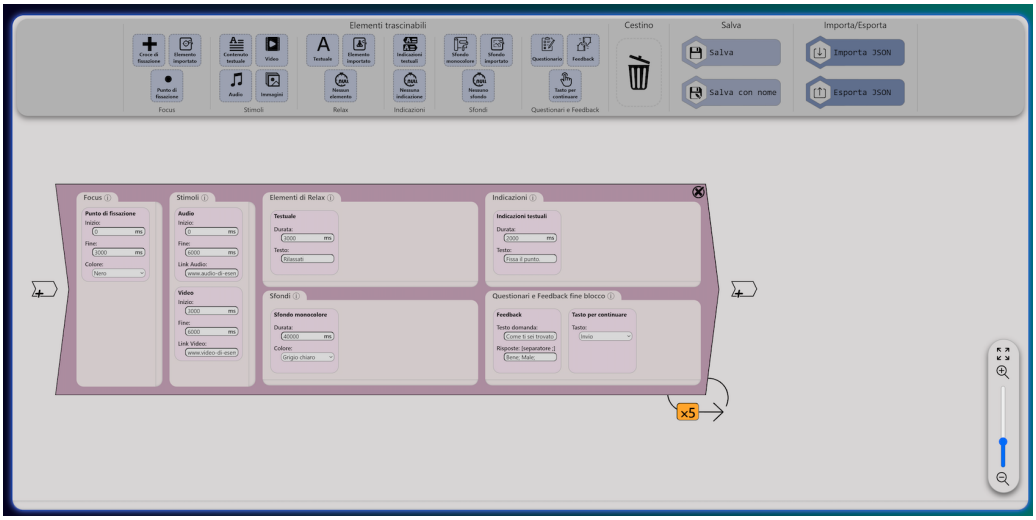

Fig. 1. Example of usage of the platform.

the capability to create customized data collection protocols. Researchers can define and adapt data protocol parameters, such as the duration and timing of data collection sessions, and the specific stimuli or tasks to be presented to the participants. This flexibility empowers users to design protocols that align with their specific research objectives or therapeutic interventions, enhancing the relevance and effectiveness of the process.

The platform provides an interface for designing and administering customized protocols. Researchers and clinicians can create protocols using a user-friendly "drag and drop" interface, where they can insert various elements, including textual, audio, and visual stimuli. The platform allows the inclusion of "focus" elements, such as fixation crosses or fixation points, to guide attention during the tasks. Moreover, researchers can incorporate relaxation elements for designated break times within the protocols. This flexibility in protocol design enables the creation of personalized rehabilitation programs that address specific cognitive conditions. The protocols are saved in JSON files so that they can be easily managed.

The platform enables the generation of comprehensive reports that capture the complete description of the protocols utilized, facilitating transparency in the research methodology. This transparency not only promotes the reproducibility of studies but also allows for better comparisons and meta-analyses across different research projects and institutions. It encourages the scientific community to critically evaluate and validate the findings obtained using the platform.

The open nature of the platform encourages researchers and clinicians to contribute to its improvement, enhancing its functionality and adaptability to evolving research needs.

III. Conclusions

Healthcare and neurorehabilitation are dynamic and rapidly evolving fields that aim to address the diverse challenges associated with neurological disorders and conditions. The integration of BCIs offers an interesting potential for transforming patient care, enhancing rehabilitation outcomes, and driving scientific discoveries.

The goal of this work is to develop a platform which addresses the need for a customizable and user-friendly tool for collecting brain signals in the field of neurorehabilitation. It aims to enhance research and clinical practices by providing transparent data collection protocols and promoting reproducibility.

Future works for the platform involve expanding its capabilities, integrating advanced analytics, and fostering collaboration for ongoing improvements in neurorehabilitation research and practice. Furthermore, the platform will be used for a signal acquisition campaign from a commercial headset with 8 dry electrodes to validate a new brain-to-text procesisng technique [8].

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