

Mobile system for collecting EEG/ERP data and metadata

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Abstract. A lot of laboratories deal with management of experimental data. When experiments are conducted inside the laboratory, their results and their data/metadata are immediately stored using a common computer connected to the Internet. On the other hand, situations when the computer is not available, are frequent. It includes e. g. work outside the laboratory or discussions during scientific meetings. This work describes an android-based system developed to enable management of experiments outside the laboratory. Collected experiments are synchronized with a system intended for a long term storage and management of experimental data/metadata - the EEG/ERP Portal.

Keywords: Electroencephalography, Event-Related Potentials, EEG, ERP, EEG/ERP Portal, Mobile Portal, experiments, data, metadata

1 Introduction

Our research group at the Department of Computer Science and Engineering at the University of West Bohemia is focused on measuring brain activity using the methods of Electroencephalography (EEG) and Event-Related Potentials (ERP). Experiments focused on driver's attention (e.g. impact of fatigue on attention) are performed in a neuroinformatics laboratory. The aim of these experiments is better understanding of brain functions. It can help to improve safety on roads. To deal with experimental data their well-defined description by suitable metadata is required. Well annotated data are then prepared to be shared between laboratories. Initiatives dealing with definition of data standards and development tools for data sharing are fostered by the International Neuroinformatics Coordinating Facility (INCF) [8] that released recommendations for handling with experimental data/matadata.

As a member of INCF Czech National Node (CINN) we work on definition of data standards for the EEG/ERP domain. A lack of tools for management of EEG/ERP data/metadata has been solved by development of a custom system called the EEG/ERP Portal [4], which has become a central part of complete hardware and software infrastructure [6]. Although the EEG/ERP Portal serves satisfactorily for experiments conducted inside the laboratory, there are many cases when a common computer connected to the Internet is not available (e. g. when experiments are conducted outside the laboratory, or an experimenter interacting with

a tested subject cannot operate a computer). In these cases, hand-written forms, later stored electronically are used. The next use case includes discussions of scientific results at meetings and congresses.

The aim of this paper is to introduce a mobile version of the EEG/ERP Portal that provides equivalent functionality as users know from a common EEG/ERP Portal. The remainder of this paper introduces the state of the art and overall architecture of the system, describes used synchronization mechanism and introduces security mechanism for ensuring data privacy.

2 State of the Art

Several initiatives and/or pilot studies try to provide a solution for researchers to efficiently work out of laboratories using portable devices as laptops, tablets or mobile phones.

Clinician Assessment and Remote Administration Tablet (CARAT) [7] is a Microsoft Windows tablet adapted to collect and administer clinical assessments in large scale demographic or neuropsychiatric studies. It uses an architecture with two modules. The first one setups the clinical study while the second one serves to data collection. Collected data are synchronized with a remote database.

Research Electronic Data Capture [2] (REDCap) is a software application and workflow methodology designed to collect and manage data for research studies. REDCap Mobile [1] is a solution that de-

scribes encrypted laptops with a push-pull relationship to the centralized REDCap database to allow data collection while off-line. Such solution is suitable in studies that need to be performed on places without an internet access as hospitals or jails.

Described solutions significantly reduce usage of paper forms during experimenting. It motivated us to provide a similar solution for the EEG/ERP Portal.

3 EEG/ERP Portal

The EEG/ERP Portal¹ is a mature web based system that enables researchers to upload, download or manage EEG/ERP experiments. The basic use-cases are shown in Figure 1. The system is designed to guide a user to fill metadata in accordance with internal ontology [3]. The metadata include information about length of experiment, descriptive scenarios, tested and testing people, surrounding conditions, etc. The data layer uses the Oracle database. Communication with a Spring core based application is ensured by the Hibernate framework. The output HTML is generated by the Apache Wicket framework. The privacy of stored data is ensured by the Spring security framework. The users credentials are required when users are accessing the system. Different users can have different roles in the system and the related level of authority.

4 Mobile Client

4.1 Requirements and Restrictions

Due to difficulties mentioned in Section 1 we decided to implement a system used for mobile devices such as tablets or mobile phones. A user interface of such system must enable to fill all metadata that the user can fill in the EEG/ERP Portal. Access to the system must be secured to ensure privacy of stored data. Communication with the EEG/ERP Portal must be ensured.

4.2 Architecture

Complex architecture of web-based and mobile-based systems use a client-server approach. The mobile client communicates with the EEG/ERP Portal using RESTfull web services. Data are stored on the server end, the client end handles them using HTTP requests. The server end fetches data from data access objects and translates them to a REST XML message. The client parses this message and stores it in an internal container. The data from this container are transferred to individual android *activities* and visualized on the mobile device screen. A preview of an *activity* is shown in Figure 2.

¹ available on: <http://eegdatabase.kiv.zcu.cz>

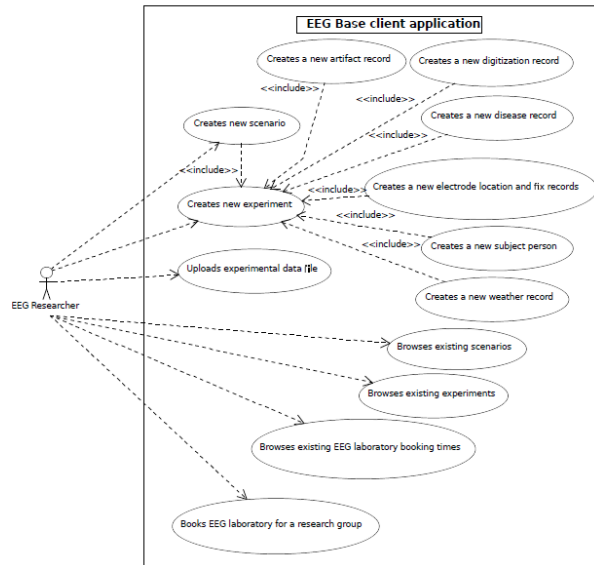


Fig. 1. Use-cases express individual activities that a user can perform in the EEG/ERP Portal. He/she can create or browse new experiments, create or browse experimental scenarios, upload raw data files or manage supplementary codebooks. The mobile system provides the same functionality.

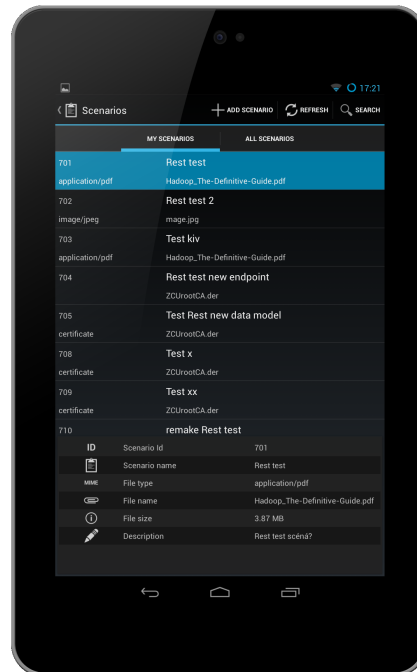


Fig. 2. The mobile system preview. The print screen shows a list of available scenarios. When a user clicks to a specific scenario, a detail piece of information appears. The top bar allows users to add a new scenario (using "+" button), search an existing item (using magnifying glass), or refresh the list.

4.3 Data Synchronization and System Security

The mobile client communicates with the server online. This approach ensures immediate synchronization with the server. Communication with the server is encrypted using SSL; data are sent via the HTTPS protocol. The connection is protected using basic authentication with users credentials. The users use the same credentials as when they registered in the EEG/ERP Portal.

5 Future Work

As the current mobile client is limited to online work, we investigate opportunities to use an embedded database that stores data locally. After providing initial tests, a NoSQL database WaspDB² seems to be a suitable solution. It is a key-value pair database that enables to store complete Java data objects. These data are synchronized with the EEG/ERP Portal when the client gets online. [5]. The next significant step is to provide the system independent on the EEG/ERP Portal. Such system will communicate with other domain independent electrophysiological databases. The layout of this system will be generated automatically as proposed in [5].

6 Conclusions

Since a lot of electrophysiology experiments are conducted outside the laboratory, we presented the android-based solution running on mobile phones and/or tablets. The goal of the presented system is to facilitate collecting of EEG/ERP experimental data and metadata when a common computer is not available. The system provides the user interface similar to the EEG/ERP Portal. The user fills metadata in the predefined forms. Metadata can be supplemented by raw experimental data. These data/metadata are immediately synchronized with the EEG/ERP Portal. The system is open source, users are welcome to download and test it³.

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² <https://code.google.com/p/waspdb/>

³ available on: <https://github.com/NEUROINFORMATICS-GROUP-FAV-KIV-ZCU/eeg-database-for-android>

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