EOGSTUDIO

Software platform for processing electrooculography recordings

Keywords: saccades, electrooculography, computational neuroscience

Abstract: Analysis of saccadic eyes movements is fundamental for study different neurological disorders. The Center of Research and Rehabilitation of Hereditary Ataxias (CIRAH) located in Holguín, Cuba; uses these techniques to study the evolution of many different ataxias. Current available software applications doesn’t fill the requirements needed by CIRAH’s staff to complete their processing protocol, doesn’t run in moderns operating systems or are poorly usable. EogStudio was created to fill the gap left by these applications. It’s an extensible plugins based processing platform that answer for requirements make by CIRAH’s researchers.

INTRODUCTION

The study of eye movements has been proved to be a useful tool to diagnose and evaluate the patient condition in many neurological disorders. In particular, saccadic tests for clinical proposals are usually applied in researches related to several diseases, like ataxia, Parkinson, schizophrenia, amongst many others (Rivaud-Pechoux, et al., 1998) (Jones & DeJong, 1971) (Schulze, et al., 2006). Embedded software in dedicated equipment, to record and analyse eye movements, behaves as a 'black box', since manufacturers don't use to give information related to the algorithms and mathematical methods involved in the computing of variables concerning the evaluation of the eye movements. Furthermore, these systems in general terms lack the necessary extensibility, and very often the reports don't accomplish the research needs.

In this work, a software developed in the University of Holguin, in Cuba, named EOGSTUDIO, is described. This software reads the saccadic records of an Ottoscreen electronystagmograph, and computes a set of significant variables, to study neurological disorders. A main goal to developers was the software capabilities for extension and upgrading.

This software was focused in ataxia, a disease with the international highest levels of prevalence in Holguín, where the Center of Research and Rehabilitation of Hereditary Ataxias (CIRAH for its Spanish acronym), is entirely dedicated to study and treat this disease.

Medical staff of CIRAH contributed to select the variables to be studied, collects patient records and validation tests to the software. CIRAH has been also the main user of the software, which has been used in this centre in the last two years.

DESIGN

Current software that’s performing similar tasks is very old or poorly usable. The equipment used at CIRAH to make EOG recordings is Otoscreen, a German electronystagmograph that’s have its own software designed to run on machines with Windows 95 Operating System and is very difficult to do certain tasks like saccadic point editing.

More modern software packages like EyeLink Matlab Toolbox (Cornelissen & Peters, 2002) or ILab (Gitelman, 2002) depends on big frameworks like Matlab and are focused in a very specialized audience.

The main intention with EogStudio was that medical staff with less computing background were capable to run and use the application as if they were using and office application like Writer or Calc. Thereby, the development team focus in creating a desktop application that’s help users to detect saccades automatically and to make corrections on these in a fast and easy way.

Other non-functional but not less important requirements was that the software application must be fast and run in all major platforms nowadays like Windows, Mac OS X and GNU/Linux. For all these
was necessary the use of Qt Toolkit Libraries and C++ Programming Language.

EogStudio was created to be extensible through plugins in order to support various file formats, reports and processing algorithms. Its structure is based on several libraries and plugins to separate and organize the functionalities. The following figure illustrates overall system design:

![EogStudio design](image)

**WORKFLOW**

EogStudio is a study centered application, where study is the document where all signals data and events are stored.

The workflow steps to use EogStudio are very simple, and can be split in the four following steps:

1. Create a study from an existing recording like Otoscreen CSV files.
2. Detect saccades using automatic detector,
3. Correct saccadic points using saccadic editor.
4. Report study saccadic results for further analysis.

The first step consist in create a study starting from a recording file from Otoscreen or other supported equipment. In the application, consist in a wizard that guides us through the process. After this, the study will be opened and show the saccade editor for the first test. Is important to remark the second step of this process, this allow us to get an initial approximation of the saccades present in the study. A detection algorithm proposed by (García Bermúdez, 2007) was used to fulfill this task. The algorithm use local polynomials to adjust a potential saccadic region of a stimuli signal window, to detect saccades start and end points, using the adjusted polynomial.

Having the first approximation of saccadic points, proceed to fix the saccades which points were not set well in the signal using a simple visual editor provided in the application with facilities for adding, removing and moving saccadic points.

Once corrected all saccades, study reports can be generated to different formats like: tabulated text (csv), Hypertext Markup Language (html) and Open Document Format (odf). This report contains all relevant data that medical team use for their researches.

**EXTENDING THROUGH PLUGINS**

A must need functionality for a good piece of modern software is that must have an extension mechanism to ease the task of adding new functionality. As seen in design section, EogStudio was build using plugins based architecture, feature that facilitate previously mentioned task.

This architecture enables independency between the application author and third parties developers which like to use for their own purposes.

The application provides four types of plugins detailed next:

- **File Format Plugins:** Allow supporting new type of equipment and storage formats.
- **Report Format Plugins:** Provides very simple interface to support new report presentation formats.
- **Report Plugins:** Bring the possibility to create new reports not only these ones supported by default in the application.
- **Processing Plugins:** Give the chance to implement new processing algorithms, for instance detect other ocular events not only saccades.

It’s planned to release very soon a Software Development Kit (SDK), for making easier the work of developers who wants to extend it. This consist in a set of well documented libraries used in the development of EogStudio, and a set of plugins for QtCreator which is the IDE employed to create the application containing wizards that guides the user in the process of creating new plugins.
CONCLUSIONS

EogStudy has been used at CIRAH for more than a year, been used to process hundreds of records of sick and control subjects, in various drugs clinical trials performed in this period, and for following the sickness evolution in many patients.

This tool has been conceit having into account the current status of neurophysiology, in relation with characterization and evaluation of saccadic eyes movements, adapted to fits CIRAH’s needs and using tools and technologies used commonly to build applications today.

EogStudio answer the expectations and needs of CIRAH’s researchers and can be used in other medical institutions with similar needs.

REFERENCES


