Master's Thesis

3DSlicer for Microscopy

MACbioIDi Project

August, 2018

Supervisor: María Dolores Afonso Suárez (PhD)

Student: Aziza Elmahjoub

Universidad de Las Palmas de Gran Canaria

GTMA Grupo de tecnología Médica y Audiovisual

Principal Investigator: Juan Ruiz Alzola (PhD)

3D Slicer for Microscopy

INDEX

INTRODUCTION

Neuroscience (or neurobiology) is the scientific study of the nervous system. It is a multidisciplinary branch of biology. Over the years the scope of neuroscience has broadened with new approaches. The study of the nervous system makes use of a wide range of techniques.

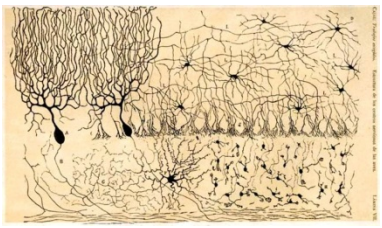

Figure 1. Drawing by Santiago Ramón y Cajal of Cells of the cerebellum of a chicken.

In this area –as in many others in biology-, the images analysis is a concept that defines a group of techniques with different objectives that may vary depending on the field of study:

Morphometry, is the quantitative analysis of forms. An example could be obtaining measurements of the perimeter of a neuron or the length of its dendritic tree.

Stereology is the three-dimensional interpretation of two-dimensional cross sections of materials or tissues. An example could be determining the presence of a certain molecule in the nervous tissue.

3D reconstruction means the creation of three-dimensional reconstructions of the objects of study.

There exist several medical specialties that specifically address the diseases of the nervous system. These specialties also refer to clinical disciplines involving diagnosis and treatment of these diseases. The microscopic observable alterations of some mechanisms of the nervous system are the main focus of research in some neuropathology studies.

The images to be studied in these areas are obtained through microscopes. The microscopes are intruments that allow us to see objects that can not be seen by the naked eye. The most common, and also the first to be invented, is the optical microscope. It uses visible light and a system of lenses to magnify images of small subjects.

Figure 2. Optical microscope.

The electron microscopes use a beam of accelerated electrons as a source of illumination. The two major types of electron microscopes are Transmission Electron Microscopes (TEM's) and Scanning Electron Microscopes (SEM's). They both have series of electromagnetic and electrostatic lenses to focus a high energy beam of electrons on a sample.

Another interesting microscope is the confocal that uses an optical imaging technique for increasing optical resolution and contrast of a micrograph. In this conventional fluorescense microscope the entire sample is supersatured with light from the illumination source. Due to the conservation of the intensity of light, all parts of the sample will be excited and the fluorescence detected by a photodetector or camera.

PROJECT

Framework

This *Master Thesis* proposal will be developed within the framework of the *MACbioIDi project*, an *Interreg Cooperation Project* (Europa regional, 2018), belonging to the cooperation program INTERREG V-A cross border, inside the subprogram INTERREG MAC for the Macaronesia (Interreg MAC, 2018).

The MACbioIDi project has two main work lines: research and education on medical imaging technologies. In both of them the core application used is 3D Slicer, an open source software platform for medical image informatics, image processing, and three-dimensional visualization. Built and

distributed over two decades under GPL, through support from the National Institutes of Health and a worldwide developer community, Slicer brings free, powerful cross-platform processing tools to physicians, researchers, and the general public (Slicer, 2018).

Theoretical foundation

The Slicer community maintains a website referred to as the Slicer Extensions Catalog (Slicer Extensions, 2018) to support finding, downloading and installing of extensions (Documentation, 2018). Access to this website is integral to Slicer and facilitated by the **Extensions Manager** functionality built into the distributed program (Download, 2018).

An extension (Extension list, 2018) could be seen as a delivery package bundling together one or more Slicer modules (Modules list, 2018). After installing an extension, the associated modules will be presented to the user as built-in ones

Description

This master's thesis work is intended to study and develop new functionalities for the microscopy extension of 3D Slicer (IASEM, 2018) in order to adapt the modules to both:

- The requirements of practical exercises developed for the subject of *BIOLOGY FOR HEALTH SCIENCE (CYTOLOGY AND HISTOLOGY)* that use microscopy techniques.
- The studies developed by the research group of *Neurogliociencia y Reparación Axonal* from the morphology department (Neurogliociencia y Reparación Axonal, 2018) at the university of Las Palmas de Gran Canaria (ULPGC).

All the results of this study will be presented during the next NA-MIC workshop (30^{th} NA-MIC Project Week) to be held at the University of Las Palmas de Gran Canaria in 2019. The final results will be transferred as a proposal project to other universities of the countries of Cape Verde, Mauritania and Senegal for both: educational programs and research.

The work will be developed at the Instituto Universitario de Investigaciones Biomédicas y Sanitarias (IUIBS), at the University of Las Palmas de Gran Canaria. The research group of *Neurogliociencia y Reparación Axonal* counts with optical, electronic and confocal microscopes for the images to study and the MACbioIDi with the computers and hardware needed for the development.

Objectives

The study of the 3D Slicer microscopy extension and the proposal of new functionalities.

A practical approach to educational and research projects, to be included in microscopy subjects.

The integration in a research group working in an international project, with a research line proposal.

Skills, according to the Dublin descriptors published under the European Higher Education Area (Joint Quality Initiative, 2004):

Acquire and communicate knowledge to be transferred to practice in an original way. Development of ideas in the context of research.

Apply the knowledge and science acquired in diverse environments.

Know how to deal with complexity, integrating knowledge and formulating critical judgments, always from the perspective of ethics and social responsibility.

Knowing how to communicate the conclusions, the knowledge and the theories on which they are based, to different audiences, in a clear and precise way.

Demonstrate, that the studies could be continued with new proposals. Study in a manner that may be largely self-directed or autonomous.

Final aspect

For each work line two research papers will be proposed. During the documentation phase different conferences and research journals, their scope and deadlines, will be studied in order to send this proposals.

Work plan

The proposed plan has been outlined according to the objectives and resources of the project. Figure 1. The possible deviations that may occur will be documented. These actions as well as the detailed phases will be included in the final master's thesis document.

P1. Framework installation and study. Review of IDE's, programming languages compilers and interpreters, or libraries among others.

P2. 3D Slicer compilation. First steps. Review of the process for windows or linux.

P3. Study of the 3DSlicer microscopy extension.

P4. Study of the subjects and new practical exercises to be proposed.

P5. Development of some new functionality (prototype for the detection or measure of elements in the image or some graphical element)

P6. Study and proposal of new functionalities to be developed.

P7. Preparation for the NA-MIC and MACbioIDi workshops

P8. Results presentation NA-MIC workshop

P9. Assistance, MACbioIDi workshop

P10. State of the art. Study a proposal of a research work in the education field

P11. State of the art. Study a proposal of a research work in the microscopy field.

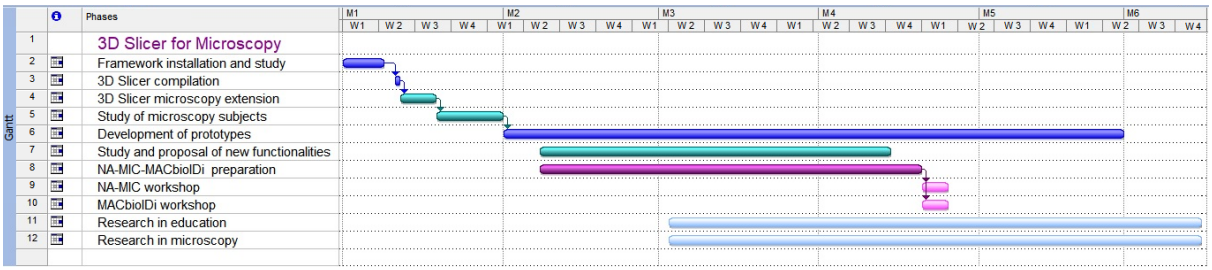

Figure 1. 3DSlicer for Microscopy Gantt Diagram.

3D Slicer for Microscopy.

REFERENCES

Europa regional (2018). Retrieved from http://ec.europa.eu/regional_policy/es/policy/cooperation/european-territorial/

Interreg MAC (2018). Retrieved from http://www.mac-interreg.org/

Slicer. (2018). Retrieved from https://www.slicer.org/

Slicer Extensions (2018). Retrieved from http://slicer.kitware.com/midas3/slicerappstore

Documentation (2018) Retrieved from https://www.slicer.org/wiki/Documentation/Nightly/SlicerApplication/ExtensionsManager#Installing_an_extension

Download (2018) Retrieved from http://download.slicer.org/

Extension list (2018) Retrieved from https://www.slicer.org/wiki/Documentation/Nightly/Extensions

Modules list (2018). Retrieved from https://www.slicer.org/wiki/Documentation/Nightly/Developers/Modules

IASEM (2018) https://www.slicer.org/wiki/Documentation/Nightly/Extensions/IASEM

Neurogliociencia y Reparación Axonal (2018) http://aplicacionesweb.ulpgc.es/gir/detalle/2712

ULPGC (2018) https://www.ulpgc.es/

Joint Quality Initiative (2004). Retrieved from http://www.aqu.cat/doc/doc_24496811_1.pdf