Electronic Design for a Optoelectronic Bioimplantable Device.

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Submitted in fulfilment of the requirements for the
Preliminary Report ofr MSc Project

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May 2019

Introduction

The treatment of some mental disorders have been always considered a special branch of the medicine, called neuroscience. This field involves the analysis, study and treatment of many mental disorders that affect both, the chemical and electrical problems of the brain performance. Those problems could be from malfunctioning of some chemical gates in the neural circuits' synapses to neural paths destroyed by external factors such as cancer, poisoning, strokes, infections, and so on. Thus, it is very important to develop new techniques and therefore, new devices using these techniques to recover the partial or whole brain health of a patient after having a mental failure.

Optogenetics is a relatively new field in the biotechnology industry. This technique uses the light for stimulating groups of genetically designated neurons optically, using different rhodopsins which are light dependant proteins (Zemelman et al., 2002). Since then, many research groups have shown their interest in developing devices that, using this novel technique, could stimulate specific areas of the brain in order to treat some mental disorder. The disease that is the most studied due to the high number of people related to it and the comparatively ease of design, is the epilepsy.

According to the National Health Service in England [1] epilepsy is a mental disorder that is cause by many factors such as: strokes, brain tumours, severe head injury, drug abuse, brain infection, lack of oxygen during birth. Despite what commonly known as epilepsy as a severe shaking, uncontrollable jerking, losing awareness and staring blankly into space, the epilepsy could be exhibited as many other symptoms like absences, headaches, twitches and jerks like an electric shock soon after waking up, and many others.

In addition, epilepsy is 4th most common neurological problem - only migraine, stroke, and Alzheimer occurs more frequently. It is considered to affects more than 50 million people worldwide [2].

For those reasons, epilepsy is a big issue nowadays and developing new devices and techniques for treating this disease could be a big improvement to many people's life.

[1] Website from NHS: https://www.nhs.uk/conditions/epilepsy/

[2] Website from World Health Organization: https://www.who.int/news-room/fact-sheets/detail/epilepsy.

Aims of the project

The aim of this project is to develop an electronic design for an optoelectronic bioimplantable device based on other previous designs.

At the first step, we will need to cnsider previous existing designs. We will base our project in the research of a wireless optoelectronic bioimplantable device proposed by the research group of John Rogers in NorthWestern University (Gutruf et al., 2018). The other design taken in consideration was the propose by Ada Poon's research group at Standford's University (The most considered designs for this project are from the Research group of John Rogers in NorthWestern University and Ada Poon's Research group in Standford University (Ho et al., 2014). Both designs are suitable as guidance for this project and they can be used as a base to design an improve our proposed device.

Then, the main purpose of this project is to develop the microelectronic circuit in a biocompatible and flexible substrate to turn on/off a LED that will be the source of light for the optogenetics therapy. This implant will be attached in the brain surface and connected inside the brain in the interest area.

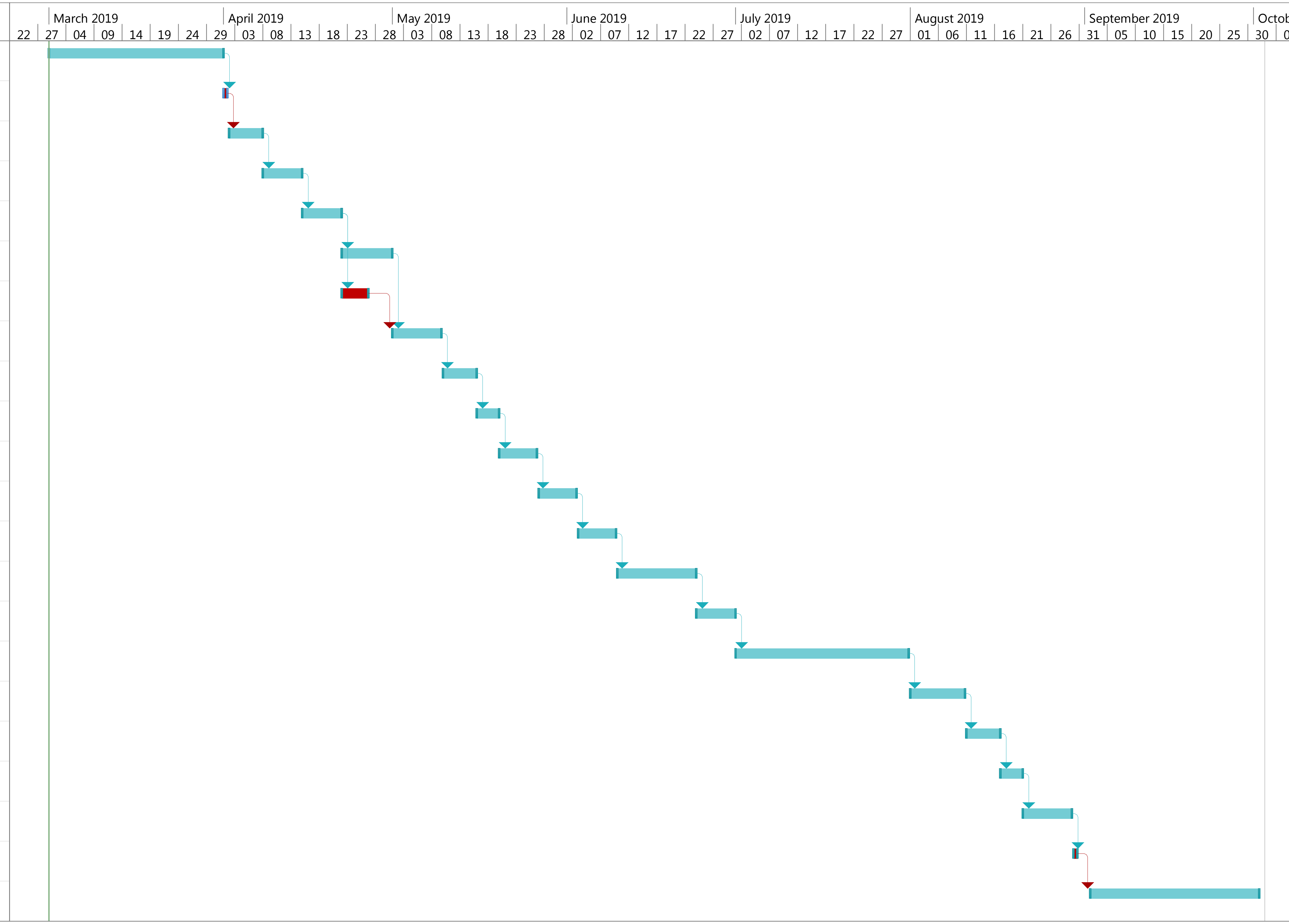
Resources Required

For this project, we will require several machinery to print, assemble and test the circuit. We would have to order specific electronic components and substrates for the electronic boards. Then, we will use some soldering methods as wire bonding and reflow that we may need an external company for that technology but we will try to avoid it. However, for achieving a very little size, we would need to use special technology.

Regarding simulation and design, we will use EAGLE for CAD design, Ansys HFSS for simulation and other softwares provided by the University of Glasgow.

Regarding the lab work, we will use Voltera Machine for fast prototyping, and laboratory machines available in the Microelectronics Lab for experiments. The PCB manufacturing will be carried out by the School of Engineering Technical Services and soldering will be done by using laboratory machines.

ID	Task Name	Scheduled Start
1	Bibliographic Review	Fri 22/03/19
2	Preliminary Work of Project	Mon 01/04/19
3	Similar Designs Research	Tue 02/04/19
4	Test Magnetic Coupling	Mon 08/04/19
5	Design 1st Prototype	Mon 15/04/19
6	Test 1st Prototype	Mon 22/04/19
7	Submission Project Outline Document	Mon 22/04/19
8	Design 2nd Prototype	Wed 01/05/19
9	Test 2nd Prototype	Fri 10/05/19
10	Design Final Design	Thu 16/05/19
11	Test Final Design	Mon 20/05/19
12	Assembly of Device	Mon 27/05/19
13	Testing and Characterisation	Mon 03/06/19
14	Data Collection for Report	Mon 10/06/19
15	Prepare Documents for Report	Mon 24/06/19
16	Report and Paper Writing	Mon 01/07/19
17	Possible Fixings on Lab	Thu 01/08/19
18	Poster Preparation and Submission	Mon 12/08/19
19	Report Submission	Mon 19/08/19
20	Poster Conference Preparation	Wed 21/08/19
21	Poster Conference	Fri 30/08/19
22	Preparation for Paper submission	Mon 02/09/19



MSc Project: Bioimplantable Device using techniques of optogenetics for the treatment of Brain Injuries.

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