1. Introduction

1.1 Background

Our client, Dr. John Enderle, is a researcher and professor at the University of Connecticut. Over the past thirty years, he has spent his time researching rapid eye movements and their corresponding neuronal activities. His research has led to the belief that there is a way to determine whether or not a person has suffered a mild traumatic brain injury based on their results from a visual/auditory combination eye movement test. His final goal is to build a device that is able to produce a combination of auditory and visual stimuli at several different locations in order to test as many different eye movements as possible. The device will use an EOG signal in order to track the eye movements and to get the most accurate readings possible. By recording the rapid eye movements of the patients in response to the visual and auditory stimuli, the device will be able to determine an accurate diagnosis.

In the United States alone, around one million people suffer at least one concussion every year. In today’s society, many people are at risk for concussions including people who partake in popular contact sports such as football and hockey, as well as active members of the military. If ignored or treated improperly, concussions can lead to very serious long term traumatic brain injuries and even death. Dr. John Enderle, along with previous senior design teams, has come up with a preliminary design for the auditory and visual stimuli system for tracking fast eye movements and has asked that we modify the design in order to implement an accurate way to record the response to the auditory and visual stimuli at several different locations.

1.2 Purpose of the Project

The auditory and visual stimuli system for fast eye movements will be used in order to help our client further pursue his goal of diagnosing patients with mild traumatic brain injury. The design for this system is necessary in order to achieve a way to safely, efficiently, and accurately diagnose a patient with mild brain trauma. The auditory and visual stimuli system will be able to test patients of all heights and weights and will be durable so that it will be able to run several tests. As previously mentioned, the device will be made so that the auditory and visual stimuli sources are activated in a randomized fashion so that the subject does not know the location of the stimuli prior to testing. This will assure that the recorded response of the subject’s eye movements are an accurate portrayal of the subject’s ability to react to the stimuli. Our client will be able to use the results from the auditory/visual stimuli tests done using our device and ultimately use them to accurately diagnose patients with potential mild traumatic brain injury. Once the device is properly modified to include clear auditory stimuli at each visual stimuli location, it will be able to accurately track the subject’s ability to respond to the different types of stimuli and ultimately determine an accurate diagnosis using the data from their eye movements.

1.3 Previous Work Done by Others

As previously discussed, in today’s society many people are at a high risk for concussions. There is a great need in the military and in contact sports such as football and hockey for an accurate and efficient way to test for concussions. Currently, there are several concussion tests available on the market. However, most of them involve a series of long cognitive tests
that require in depth baseline tests. There is a great need for a test that is more efficient while still accurate. The most commonly used computerized concussion test today is the ImPACT test. The ImPACT test is able to measure patient symptoms and help assist a doctor in making return-to-play decisions. However, the ImPACT test takes around 20 minutes to complete and is not supposed to be used as a stand-alone tool. Our client hopes that our design will be more efficient and that it will be able to be used as a stand-alone tool to diagnose mild traumatic brain injury.

1.3.1 Products
Dr. Laura J. Balcer of the Departments of Neurology, Ophthalmology, and Epidemiology at the University of Pennsylvania School of Medicine determined in 2010 that the King-Devick test is and accurate and reliable method for diagnosing athletes with head trauma. She is currently trying to implement the test into being used on the sidelines of contact sports for concussion testing. However, Dr. Balcer’s method does not involve the neurological response of the patient’s to auditory stimuli which our client feels is important in proper concussion testing. Dr. Enderle plans to be the first researcher to study eye movements in response to auditory and visual stimuli for the purpose of diagnosing concussions.

1.3.2 Patent Search Resultss
United States patent number 12/979,419 is held by David W. Hagedorn and James W.G. Thompon and is similar to the device we are building in that it uses an electrode system in order to analyze the brain’s response to auditory and visual stimuli. However, the device in this patent does not involve mechanical structure like our black board containing the visual and auditory stimuli sites. Our device is very unique in that Dr. John Enderle is the first researcher to study the possible diagnosis of mild traumatic brain injury using the data from rapid eye movements in response to auditory and visual stimuli. Due to this, this patent and other products on the market are not similar enough to jeopardize the originality of our design.

1.4 Map of the Rest of the Report
Background information of the client and project has been presented as well as the purpose of the project and previous work that has been done in the field of concussion testing. Section 2 will give details of the project design including the objective of the project and detailed descriptions of each subunit. Section 2 will also provide details of the prototype including a description of the prototype, its operation, and testing of the prototype. Section 3 will provide details of constraints including economic, environmental, sustainability, manufacturability, ethical, health and safety, social, and political. Section 4 will provide a more detailed description of potential safety issues such as electrical, mechanical, biological, chemical, radiation, and thermal hazards. Section 5 will include the impact of engineering solutions in a global, economic, environmental, and societal context. Section 6 will include a description of new material we have learned throughout the process of the project and will also provide a description of new skills and techniques we acquired. The seventh section will provide an updated budget and timeline for the project. A timeline will be provided using Microsoft Project planning software. Section 8 will provide a description of each team member’s contributions to the project. Section 9 will serve as a conclusion for the report. Sections 10, 11, and 12 will serve as the reference page, the acknowledgement page, and the appendix. The appendix will be split
into three sections: updated specifications, purchase requisitions and price quotes, and specific details such as part specifications, datasheets, communication protocol commands, etc.