HIT3061 – Software Team Project - Semester 2, 2013

Tremor Detection with Leap Motion

Project Report

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# Abstract

This document describes the outcome of over 3 months of work on the Tremor Detection with Leap Motion project. The aim of this project was to create an application that is able to prove whether or not it is possible to capture a tremor in a user’s hand by using the Leap Motion device. The processes used to develop the application are discussed, as well as any variations between the initial plans and final execution. This report will also discuss the results of testing and our final conclusions about whether our application has proven the possibility of using a Leap Motion device to correctly capture tremors in users.

# Acknowledgements

The project was able to succeed because of the time and support we have received from numerous resources and we would now like to acknowledge these peoples for their contributions.

In particular we would like to thank Caslon Chua, who has given a lot professional suggestions to our application and provided assistance throughout the project.

Our thanks also go to the following people for their comments and different ways to help our application:

* Dr Philip Michael
* Ryszard Kowalczyk
* Mark Schier

# Introduction

The Leap Motion device is a small sensor that is capable of capturing a user’s hand movements. This device is capable of tracking tiny movements in a user’s hand, measuring movements up to 1/100th of a millimetre and capturing data at up to 200fps. About one year ago, Dr Philip from the Royal Victorian Eye & Ear Hospital discovered the capability of the Leap Motion device and believed it may be possible to be used to improve his industry. His aim was to use a Leap Motion device to capture a tremor in a user’s hand, helping a surgeon test how steady their hand is, or even potentially checking if a Parkinson’s patient was improving with the continued use of medication. Philip submitted this project to Swinburne University and our team was chosen to develop a solution.

Our goal for this project was to prove whether it is possible for the Leap Motion device to be used to capture tremors, eliminating the need for expensive machinery and accelerometers. As this project is a proof of concept rather than a final solution, the outcome on this project does not rely on the success of our application to detect tremors accurately, instead it relies on us determining whether it is possible to use the device to detect tremors or not.

To ensure the success of this project we created a project plan to guide us in developing our solution. This plan outlined the specific stages of development and what we would be creating in each, giving us milestones that we strived to achieve as well as an ideal timeframe for the different stages of the project. We also aimed to ensure the validity of our application by following our own test plan and testing the various aspects of the application.

# Developing the solution

## The Application

The solution we have designed for Philip has been created as a Javascript web app. As the members of our team were all familiar with Javascript development and a Leap Motion Javascript API already existed it not only was easy for us to develop for, but also saved us a lot of time than if we had developed the application in a language we were not all familiar with. Another benefit of being a Javascript application is that it is runnable on both Mac and Windows Operating Systems and is easily executed if the user has already installed the Leap Motion drivers.

The application, once executed, will open in the web browser and display a set of options for the user, where they are able to select how many fingers to test for, the sensitivity of the test and the length of time they want the test to last. Once a user proceeds from there a screen will be shown which will display a visual representation of the user’s hand once they are holding it over the Leap Motion sensor. On the right side of the screen information about whether the hand is in an ideal position will be displayed and will give the user feedback on whether they have to move their hand left, forward, back etc. Another method that was implemented to let the user know if their hand is positioned correctly is the colour of the hand on screen. The greener the hand on the screen is, the more ideal the testing position, the redder it is, the less ideal, to a point where a test cannot be completed if the hand isn’t green. A test will be conducted automatically if the hand is in an ideal position and a progress bar will fill up for the duration of the test. Once the test is complete, the statistics gathered from the recording will be displayed to the user and they are able to see the attributes of their tremor, including frequency, amplitude, acceleration and velocity.

Our understanding of the project changed throughout the course of semester as well as some of the requirements that were given to us by the client. We initially believed that this application would be created to give a surgeon a rating on whether or not they should be operating or not and we at some stages believed we would be required to store the results of the user’s tests. Further meetings with our client were able to clear this information up and that allowed us to make a solid amount of progress on the development. However as we had cleared up some more information with Philip and were making good progress Philip requested we add in some more functionality to our application. This noise cancellation functionality was planned to reduce the noise produced from large movements while conducting a test, however due to knowledge and timing restrictions we were unable to implement it into the final version of the application.

## Project development

Our project plan was created to give us a structure to base the development of our application around. Throughout the development of the project we would always refer back to this plan for an idea of what we should be developing at what stages, however as some steps were taking longer than we had planned for and some steps were taking less time than we had planned we were not incredibly strict on when to have each step complete. Our supervisor Caslon was also very lenient with the hand in dates for our deliverables so that was something else that contributed to us not following our project plan strictly.

Some of the main areas that differed between plan and actual development were the development and testing areas. While the testing was actually started slightly ahead of schedule by about 1 week it was actually completed around the same time it was scheduled to finish. This was due to main stages of the functionality testing being completed, but other tests being conducted to assess the reliability of the application. This provided us with extra time to refine the application and fix any bugs. The process of testing was also not as planned out as the project plan had structured it. In reality there were multiple forms of testing all going on at the same time, however it was the preliminary usability testing that seemed to be completed separately from the other test types. We had planned for preliminary usability testing to be conducted with other tests, however due to the nature of our project and the requirement of the application to be designed for our client, we were in constant contact with Philip and were incorporating his input into the design from the start, getting a jump start on a lot of our usability testing.

The development of our application was something that at first was on track, but due to the additional requirement of the noise filtering functionality and difficulty incorporating some changes, we were almost pushed behind schedule. To allow ourselves to finish our project on time and not let the rest of our work suffer we decided to not include the noise filter functionality in the final application. When we first met Philip and discussed his needs for the project he asked for functionality that would allow a user to test for tremors in their hands with methods other than holding their stationary hand over the Leap Motion device. These test would allow a user to draw a straight line or write out their signature and determine the tremor in their hand, however we decided quite early it would not be feasible to include that functionality due to our limited time and skillset. Since we believed that it was highly unlikely we would be able to include this functionality we did not budget time for it, leaving us with perhaps slightly more time to refine our planned application. What we were also not expecting was Philip’s requirements to change, with his desired addition requiring a lot more work than we had initially planned. He wished for additional functionality to filter noise from movements to generate a better data set in which to determine the attributes of a tremor. Unfortunately this functionality could not be incorporated without the inclusion of some difficult maths equations. Despite our best efforts and help from the Swinburne maths and engineering departments and a contact of Philip’s who may have been able to help implement this feature we were unable to get it completed in time to deliver with the final product, so we decided instead to halt development on it and allow that functionality to be added in by another developer at a later stage by including all we had completed on this noise filter in the technical manual.

Another change that we had established throughout the project was that Philip didn’t actually want the results of the tests saved and instead required them to be displayed on screen to the user. This allowed us to save time in development areas such as report generating, allowing us to stay on schedule. This also allowed us to not need to worry about storing the reports, performing extra tests that ensure that these reports were being stored properly and adding information about data storage into our manuals.

The development stage of the project exceeded what we had initially planned for, however due to our allowance we had built into each stage of the project we were able to shave some time off of other areas in order to stay on schedule.

## Project testing

The testing of our application varied slightly from how we had initially planned since the results of our tests led us to believe that the Leap Motion device itself wasn’t accurate. This led us to complete functional testing on our application and then conducting some extra unplanned tests with multiple Leap Motion devices to ensure that the unexpected results we were sometimes receiving during regular use was due to the device and not our application. As we were testing the accuracy of our application and not the accuracy of the Leap Motion device, we went in with the assumption that the Leap Motion device was accurate. To test the validity of the 4 attributes our application outputs from a test we had to complete a lot of function testing using some generated test data. The functional testing provided us with results that suggested our application was correctly analysing the various directional changes and movement over time that would return the correct frequency, amplitude, acceleration and velocity for a user’s hand movement.

Additional methods that we had intended to use as functional testing was video recordings of team members conducting a test and showing these recordings together with their results to our client to check if the recorded hand movement was returning results that would be expected. We completed the video recordings for these test but never actually showed the results to our client as he had actually requested to use a version of the software which had the functionality for frequency, amplitude, acceleration and velocity already implemented. He was then able to conduct his own tests and gave us feedback based on his own results, believing that the application wasn’t consistently producing results that he would expect.

Even though we had tested the validity of our functions, it still seemed that we weren’t able to return consistent results from the tremor tests. The application was returning the values that we would expect for data that we were placing into the functions; however the data that the Leap Motion device passed into the functions didn’t seem to be returning valid looking results. Although we had reviewed journal articles that confirmed the accuracy of the Leap Motion device, it seemed obvious to all members who were using the device that it is not always able to capture movement precisely. Tests were conducted in which 2 machines running our application were set up next to each other, with 2 Leap Motion devices being placed between the machines. A test was conducted simultaneously on each machine and unfortunately the results returned by the two machines varied, further leading us to believe that the issues with results may exist because of the Leap Motion device rather than any fault in our application.

# Evaluation

The final outcome of the Tremors with Leap Motion project was able to be reached because of the hard work and effort put in by our team members, the client Philip and our supervisor Caslon. We were able to plan and develop a solution that has helped us to achieve our goal for this project. The goal of this project was to determine whether it was possible to be able to use a Leap Motion device to detect a tremor in a user’s hand and provide the information about this tremor to the user. The potential for such an application would be considerable, allowing surgeons the ability to determine how steady their hand is before surgery, or even allowing a Parkinson’s patient to test if the tremor in their hand is as severe after the use of medication, all with the use of a cheap and easy to acquire device that simply plugs into a computer.

In order to ensure the success of the project we planned the different steps of development, identified the risks involved and outlined the testing methods we will be implementing to secure the success of our application. The team worked together to try to ensure the project’s success, meeting weekly and dividing up the work required to spread the load between on another. We believe we approached this project as best we could, not only as a project we were completing for university, but as a rewarding and important contribution to aiding both doctors and patients who could potentially use something we developed.

Unfortunately, despite our best efforts we were not able to deliver an application that was correctly able to detect a tremor using a Leap Motion device. However, we believe that this is not due to any fault of our program but instead a lack of reliability in the Leap Motion device. The Leap Motion device is able to record a user’s hand movements and our application is able to return information about the tremor in the movements recorded; however the data recorded by the Leap Motion device is not always very accurate. This became more than apparent to us during the testing phase of our project when 2 Leap motion devices that were placed next to each other were not able to return the same recorded data. Our team was able to build an application that was able to detect a tremor in movement, but the application was only ever as reliable as the device that was being used to record the movements.

From the testing of this project we have determined that it is not possible for an application to be able to detect a tremor in a user’s hand by using the Leap Motion device. Our test results prove that our application would be able to accomplish this task; however it would require a reliable data capture method which the Leap Motion device simply can’t deliver. The data it captured and provided was inconsistent when tested on 2 separate machines when it should have been the same, leading to us believing that this is a device limitation not an issue with the application. Although we have deemed it not possible for an application to detect tremors by using the Leap Motion device, we believe that due to the continued development of the device and a developer community that is supporting it, there is a great possibility that this will be more than possible in the future.

# Bibliography

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