LAIDLAW UNDERGRADUATE RESEARCH AND LEADERSHIP SCHOLARSHIP

FINAL REPORT

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THE UNIVERSITY OF HONG KONG

University of
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OVERALL EXPERIENCE

As a Computer Science student, my knowledge in this field was confined to the lectures and tutorials that were delivered at my University. After taking a few interdisciplinary courses in Psychology and Human Geography out of curiosity, I started to develop an interest in learning more about the world and it's people in general. However, I never thought that I could pursue anything in this field along with my time-consuming major.

When I first heard about the Laidlaw Scholars program from a few of my seniors, I was fascinated to learn that they were giving out scholarships to support undergraduate students who wanted an early head start in their research journeys. Until now, I only came across projects that required Masters and Post-Graduate students because of their years of experience. This is the reason that I was drawn to the Laidlaw Undergraduate Research and Leadership Scholarship and applied for it. When I looked at the list of various projects available under this program, one of them really intrigued me. It was related to Human-Computer Interaction. After researching a bit about it, I felt that this discipline would help me find the perfect intersection between Computer Science and the human world. The program paired me up with Professor Aaron Quigley at The University of St. Andrews who was in my experience, definitely the best supervisor I could have asked for. He had a lot of experience in this field and was also the Director of the Scottish Informatics and Computer Science Alliance (SICSA). At the same time, my research work was supervised by Professor Loretta Choi at The University of Hong Kong. Both my supervisors helped me in every way possible and made this entire program very rewarding for me.

Human-Computer Interaction was very new to me and this scholarship really opened a door for me to gain first-hand experience in this field. My project was about Immersive Analytics which is a relatively new research initiative focusing on bridging the gap between people and data. Even the technology I used for this project, called the Magic Leap is very new and is not easily available for purchase. I was very lucky that I got the chance to work with such a new technology that has not be experimented with a lot till now. But at the same time, it posed to be a problem as well because I could not find a lot of relevant information on the internet. As a Computer Science student, I often find myself relying on websites such as StackOverflow and GeeksForGeeks to help me when I'm stuck on a problem. But in this project, I had to figure things out all by myself by trying and testing. Even though it took up a lot of time, at times I would spend days just to figure out a very simple problem; it really helped me learn a lot and improve my skills.

The program has already helped me in discovering my passion for the field of Cognitive Science. After it ended, I decided to minor in this field alongside my major in Computer Science. Currently, I'm doing an exchange semester at University College Dublin where my experience through the Laidlaw program has helped me become a part of the Human-Computer Interaction group here and become involved with their research projects. Two years ago, this field was completely foreign to me and never would have even thought of picking it up. Now, I want to get as much experience as I can in this field. Next year, I plan to continue my research as a part of my final year project under the guidance of my home university supervisor.

Besides the academic exposure, this program also contributed towards my collaborative process of learning. Studying in Hong Kong had already given me a great opportunity to delve into the Chinese culture which broadened my horizon. Working in Scotland helped me add another dimension to my personality by helping me gain a deeper insight into the lifestyle and working environment of an unexplored and undiscovered country. This was the first time I was travelling to a new country without any of my friends and family. I feel that it the entire journey helped me become a more responsible and an independent person. Hence, it was an academically rewarding as well as practically knowledgeable experience.

RESEARCH

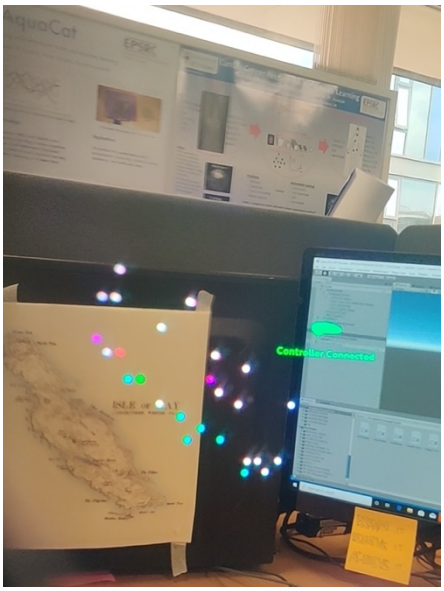
History has witnessed the emergence of different visualizations over time for better interpretation of quantitative data. One of the most famous visualization happens to be John Snow's map which helped control a serious cholera outbreak in London at a time when people didn't fully understand germs and assumed that cholera could only spread through air. The map he drew made it clear that the reason for the outbreak was a pump in Broadwick street which was supplying water contaminated with cholera germs. In a way, his data visualization altered the field of Science forever.
This is just a mere example of how important visualizing data sets can be to figure out patterns and trends which would benefit us in drawing conclusions. In the age of big data, companies are hiring more and more data scientists in an attempt to utilize as much data as they can. Artificial intelligence and machine learning models are also being used to derive insights. Using virtual and augmented reality as means of visualizing data in three-dimensional space can be the next big break for the world of technology. It can help in interacting with data in an efficient and collaborative manner.

I worked under Professor Aaron Quigley at the University of St. Andrews. My project involved building data visualizations in three-dimensional space using the Magic Leap system which is a relatively new technology. The main aim behind this was to understand the how the three-dimensional environment can facilitate the field the of data analysis. I developed two applications for the Magic Leap system from ground up that integrated computer generated data visualizations into the user's physical display to help one interact with data efficiently using hand gestures. The idea behind the two projects was the same: using three dimensional visualizations for interacting with data, processing it efficiently and extracting useful information from it in a collaborative environment. The only difference between the projects was that involved static data and the other one involved real time data.

1. **Isle of May**

   The Magic Leap system was used to build a 3D data visualization of the different species of birds that are present on the famous Isle of May in Scotland. The data is taken from *https://data.gov.uk* in the form of a Comma Separated Values file. This data from the file is loaded into a List through which it can be accessed directly. The graph is plotted as soon as the Magic Leap camera tracks the image of the Isle of May map in the physical world. The script for Image Tracking takes the picture of the map as input and tracks it in the real world using the Magic Leap's camera. As long as the image stays within the frame of the camera, the plotted map follows the image when it moves from

one position to another. This was a test case to check how reliable the Image Tracking of the Magic Leap is before trying to use a bigger map. Although the work was done, I felt that the tracking wasn't perfect and didn't work properly when the map was placed on a horizontal plane (like the table or floor). Along with this, another problem was that the graph would keep appearing and disappearing as the image would stop being tracked at random times (which was probably because the image being used was a little pixelated). Thus, relying on only the image tracker for plotting the graph on the map wasn't the best option. As a result, hand gestures were added to the project. Once plotted and placed properly on the map, the graph can be stabilized using the right fist hand gesture. This deactivates the image tracking. The data set can be brought closer to the camera for a better view using the left open back hand gesture and later, placed back onto the map. This is done by transforming the position of the point holder (the game object which contains all the plotted points once they are instantiated) from its original position to the wrist of the left hand.



Other hand gestures can also be used to interact with the data set:

a) Left.OpenHandBack – Zoom in to the data set
b) Left.Fist – Zoom out the data set
c) Left.Ok – Rotate the data set in order to change its plane

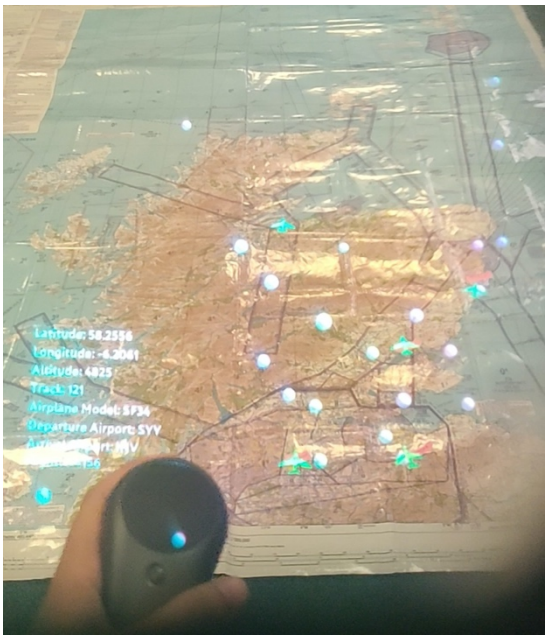
Possible future development of this project: When a data point is selected, it would enlarge and show the image of the species that it represents along with highlighting the other data points which represent the same species.

Real life usage: In the future, such applications can benefit the explorers who go to remote locations (which often do not have a reliable service reception) in the search of different species.

2. Airplane Tracker

The Magic Leap system was used to build a 3D data visualization of the airplanes that are currently in Scotland's airspace. Here, the white data points represent the different flights in the Scotland airspace, the red data point represents the flight's whose details are being shown and the fluorescent green airplanes represent the major airports in Scotland. The project involves similar scripts as the Isle of May project including Image Tracking, Data Plotter, Hand Gestures. The data is taken from *https://www.flightradar24.com/57.23,-4.23/7* at regular intervals using a script which acts as a json parser and provides the data in the form of a CSV file. This CSV file is loaded into a List from which it can be accessed directly. The graph is plotted as soon as the Magic Leap camera tracks the image of the map of Scotland airspace in the physical world.

The script for Image Tracking takes the picture of the map as input and tracks it in the real world using the Magic Leap's camera. The touchpad of the Magic Leap controller can be used to move the graph around in order to align it accurately with respect to the and longitude of the physical map. The axes are taken as follows:



a) X axis – Latitude
b) Y axis – Altitude
c) Z axis – Longitude

Once accurately aligned with the map, the plotted graph follows the physical map when it moves from position to another in the real world.

The following hand gestures are used to interact with the data:
a) Left.OpenHandBack – Zoom in to the data set
b) Left.Fist – Zoom out the data set
c) Left.Ok – Rotate the data set in order to change its plane

In addition to this, the bumper of the Magic Leap controller allows the user to access individual data points in the data set and presents the details of the particular data point to the user on the canvas. The canvas is directly connected to Magic Leap camera and thus, moves around with it. The details shown include:
a) Latitude of the current position of the plane
b) Longitude of the current position of the plane
c) Altitude of the current position of the plane
d) Track followed
e) Model of the airplane
f) Departure airport
g) Arrival airport
h) Name of the flight

Possible future development of this project: When a data point is selected, it would enlarge and show the image of the model of the plane.

Real life usage: In the future, such applications can benefit the Air Traffic Services to monitor the flights.

LEADERSHIP DEVELOPMENT

The Laidlaw program focused a lot on building each scholar's leadership capability. We had lunches every two weeks where we were taught about the importance of being a good leader through brief lectures given by individuals who were successful in their

respective fields. I have definitely been positively influenced by their journeys. In addition to this, we also had modules on leadership that needed to be completed before the start of the program. Although, I couldn't really understand the purpose of the modules until I actually started applying the lessons I learnt from them in real life. The entire process has contributed towards my collaborative process of learning and made me an even more motivated person which would further help me achieve my goals.

Since this program has benefitted me in many ways, I want my juniors to be able to receive the same opportunity as well and thus would be an active alumnus of the Laidlaw community by motivating others to apply for this scholarship. This March, I would be recording my first ever podcast with the Laidlaw foundation and I will be speaking on the topic of "Women in Technology". Apart from the research projects that the Laidlaw Foundation is helping undergraduates take up, they are also helping us document our journeys. I've already watched a few videos posted on the Foundation's website where fellow peers talk about their projects and it has really inspired me to continue working on mine. Same way, I would want my journey in this program to positively influence someone else and motivate them to step out of their comfort zone and apply for this scholarship.