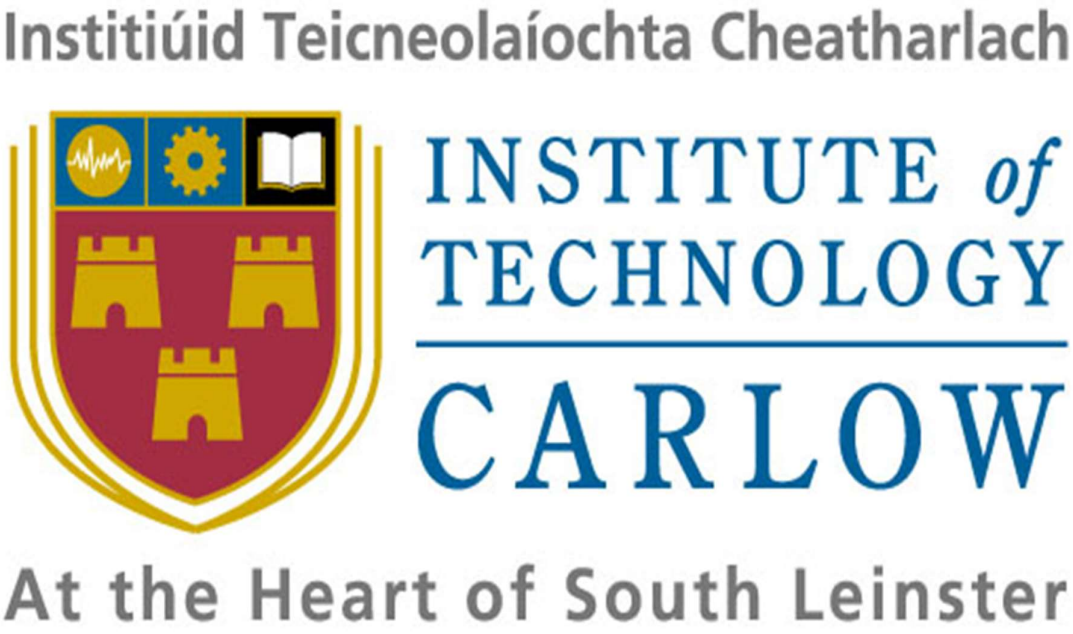

Department of Computing & Networking.

Bachelor of Science (Hons) in Software DevelopmentCW238

Final Project Report.

Activity Monitor for Children with Autism.

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Abstract.

This report will look back and reflect my final year project, an activity tracker for children who suffer from Autistic Spectrum Disorder. I have named final year project application auTracker. The target users of my application will be carers or parents of children who suffer from autism spectrum disorders. The purpose of this project is to develop an application and accompanying wearable device that would enable parents, guardians, teachers, or care home workers to track the activity levels of children who suffer from autism spectrum disorders. The hope is that the use and adoption of this application would help improve the physical and overall health of such children.

The users of the app, who are intended to be use the app are mentioned above and it would allow then to monitors the children's activity levels. The metrics that will be measured will be the total number of steps, the number of calories they burned and the total distance they have walked.

The app will allow the user the easily store in the apps local database and access previous sessions data by searching for sessions with a specific name. Searching a name will also allow the user of the app to view the average of each of the recorded metrics for each child and will allow them to display this data in the form of various graphs which will give them a better visual representation of the activity data and allow them to view any progression made more easily.

There are an estimated 14,00 school aged children who suffer from ASD in Ireland, or around 1 in every 65 children in the country. This equates to a quite sizable group of children, who tend to be much less physically active than there normally developed peers, who could positively from the use of this application.

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Project Overview.

My final year application, auTracker, is an activity monitoring application for children who suffer from autism spectrum disorder (ASD). The main function of my application is to monitor the daily activity levels of such children who tend to life much more stationary lives and be less physically active than children who are not on the autism spectrum.

Despite the vast amount of fitness and activity monitoring apps that are currently available on the market today, there are none which focus on the cohort of children with ASD. Where my application will differ from already existing applications is the physical design of the accompanying wearable device as many of the children who suffer from ASD also have sensory issues. This means that a child will not like the feel of certain materials and textures, and this can differ from child to child meaning there may not be a one for all material that could be used to cater for every child's liking.

The wearable device will be assembled using an Arduino Pro Mini micro-controller?????? An MPU-6050 6-axis accelerometer and gyroscope which is capable of measuring acceleration, velocity, orientation, and displacement which can be used to calculate how many steps the wearer of the device has made. The device will also have a HC-06 Bluetooth module which will allow the wearable to pair with the application and to send the data gathered by the MPU-6050 to the application for processing. The device will also be powered using a 3.7-volt Lithium Polymer (LiPo) battery along with a LiPo battery charging module to allow the device to be recharged.

The application will then be used to calculate the number of steps the wearer of the device has made, and from that, derive the number of calories burned and the total distance walked by the wearer and display them on the screen after each session. The user will also be able to store each sessions data into the apps SQLite database and easily search for previous sessions to view the progress of the child wearing the device.

Main Learning Outcomes.

Personal

With the completion of this project and ultimately my four years studying in IT Carlow, I feel like I've learnt a lot that will be tremendously useful to me once I start my Job with UNUM following the completion of my exams in May.

Time Management.

I think the main learning outcome from undertaking my final year project was the huge importance of good time management and skills when undertaking a project. This project was the largest was the biggest individual undertaking during the 4 year I have spent in IT Carlow. During my internship with UNUM last year, fellow interns and I took part in the Intern Innovation Challenge 2021. The briefly summarise, it involves 3 teams of interns undertaking a real-world business problem and having 8 weeks to come up with a solution to the given problem. During these 8 weeks, my team and I took part in various scrum ceremonies as backlog grooming and planning sessions. In retrospect I can clearly see the importance of such ceremonies to the development process . Poor time management and planning on my behalf, mainly between the return from the Christmas break, as before Christmas I felt as if I was in a reasonably good position in all modules. Following our presentations at the end of February I felt meant was in a race against time for the last weeks of the project. This combined with an ever-increasing workload throughout February and March meant that I constantly felt I was doing work for one module at the expense of work for another.

Planning

Before the beginning of this, I had never undertaken a project of this scale and did not know the need for or see the how critically important it is. During the development of this project as I was constantly moving back and forth between the two sides of my project, the wearable device, and the application itself. This led to little progress being made. Once I to plan out what work I was going to do beforehand and followed it properly, I began to make progress. I now understand the importance of this skill and I will certainly utilise it with every project I undertake in the future.

Technical

I was exposed to new technologies and programming languages that I had little or no previous experience with prior to beginning this project.

Android Studio & Arduino IDE.

Android Studio and the Arduino IDE for window were used as my development environments for the development of my project. Prior to developing my application, I had a brief exposure to Android Studio during 3rd year and no previous experience working with the Arduino IDE. They were both new to me and required me to spend time to get to know both environments.

SQLite.

SQLite was also a new technology to me. All my previous work involving databases was done using SQL. However, both are very similar, so it was a very smooth process to include SQLite into the development of my project.

Hardware

As I began 1st year in Carlow as a Games Development student, transferring to Software Development at the start of second year, I missed the module on hardware. This meant that I was starting from scratch in relation to the hardware aspect of my project. To help with this, my supervisor Oisin let me borrow his Arduino started kit. This kit contained various sensors and hardware that is compatible with the Arduino board provided and it allowed me to experiment with various circuits and connections. Following my exposure to working with Arduinos, sensors, and circuits it has sparked an interest in the area. I was also interested in the Internet of Things course in WIT before ultimately deciding to enrol in Games Development.

Project Review.

Technology Choices.

Throughout the development of my application, I used the following technologies.

Programming Languages.

- Java
- XML
- C++

IDE's

- Android Studio
- Arduino IDE

Database

- SQLite

Tools

- GitHub

Overall, I had no issues with technologies I had decided to use during the research phase of my project. Each technology, aside from GitHub which I have been using since 1st year in the college, and Java which we have used intermittently during 3rd & 4th year, were new to me, or I had little experience in using them, so each provided a new learning opportunity for me as I worked on my project.

Achieved.

- An Android platform application.
- All functionality related to starting a new session. This includes successfully inputting the users' settings on the settings page, pressing "Save" and being directed back to the Session Activity Page to begin a new session.
- All functionality related to resetting a currents sessions data. This includes pressing the "Reset" button during an active session and confirming by selecting "Yes" when prompted if you wish to continue. All session variables such as the child's name, weight, height, steps, calories burned, and distance walked are now reset.
- All functionality related to performing calculations after completing a session. This includes using variables inputted by the user such as the child's weight and height to calculate the total calories burned and distance walked during the session.
- All functionality related to saving the users session data to the apps SQLite database after each session.
- All functionality related to viewing previous sessions data which has been stored in the apps database. This includes entering the child's first and last names and querying the database which return each session which the first and last name entered by the user. It also includes calculating and viewing the average steps, calories burned, and distance walked of the name which has been entered by the user.
- Session data displayed in graph form to easily see progression.
- Easily navigable and understandable UI design.
- A prototype device which can send raw data to android app.

Not Achieved.

My wearable device never made it past the prototype phase. However, all components, except for the external power source, 3.3v LiPo battery, were successfully connected to prototype the device while connected to my laptop.

Ultimately, I was unable to successfully read the raw sensor data from my prototype device in my own application. Following soldering the components of my wearable device together I was able to use an existing application on the Android App store, called retroband, to read the accelerometer data and display it on a sine wave graph which show the changes along the x, y and z axis which were being recorded by the MPU-6050.

Prototype device development & related challenges.

The development of the device was the stickiest part of the development process, which I was talk more about later in this report.

The initial circuit for the device was connected using a bread board for circuits and the Arduino UNO from the starter kit I have mentioned previously.

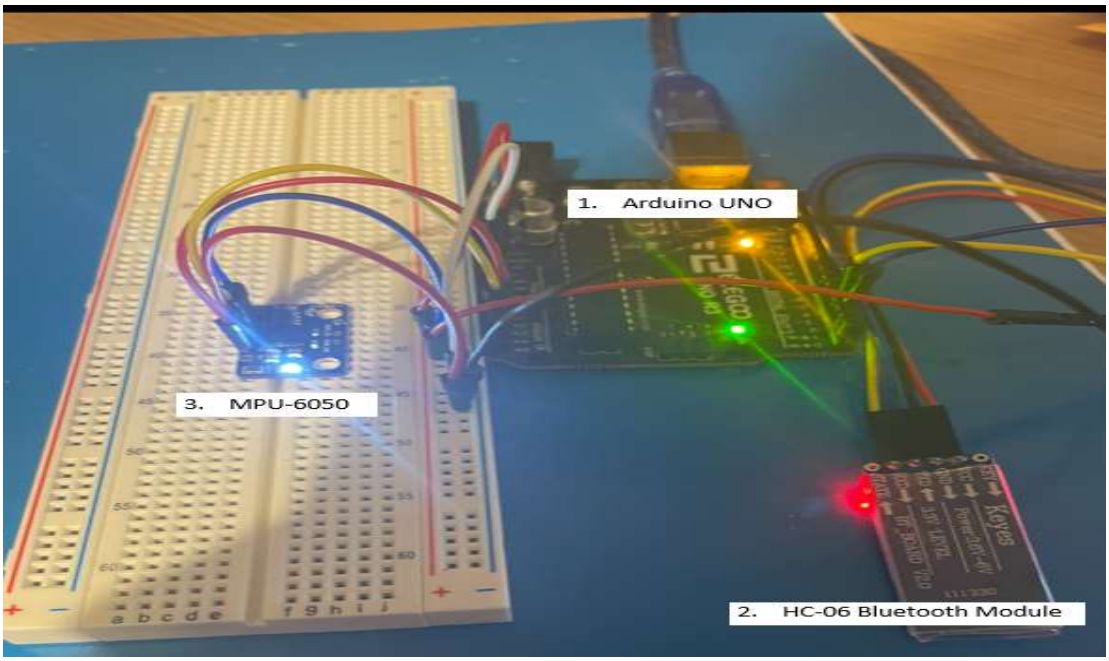

Figure 1. Initial prototype

This meant that none of the connections were soldered together which meant that an electrical connection between each of the components may not be successfully made, and if they were the connection was very unstable and the slightest movement would affect the connection. This resulted in the following output in the Arduino IDE's serial monitor:

```
nan/nan/77.80
nan/nan/77.81
nan/nan/77.81
nan/nan/77.82
nan/nan/77.83
nan/nan/77.83
nan/nan/77.84
nan/nan/77.84
nan/nan/77.85
nan/nan/77.86
nan/nan/77.86
nan/nan/77.87
nan/nan/77.87
nan/nan/77.88
nan/nan/77.89
nan/nan/77.89
nan/nan/77.90
nan/nan/77.91
nan/nan/77.91
nan/nan/77.92
nan/nan/77.92
```

Figure 2. Serial monitor output of MPU 6050 data

As you can see, only the Z axis values were being successfully recorded and printed in the serial monitor in the Arduino IDE.

After following the circuit diagram when attempting to upload test code onto the Arduino Pro Mini I constantly received the following error:

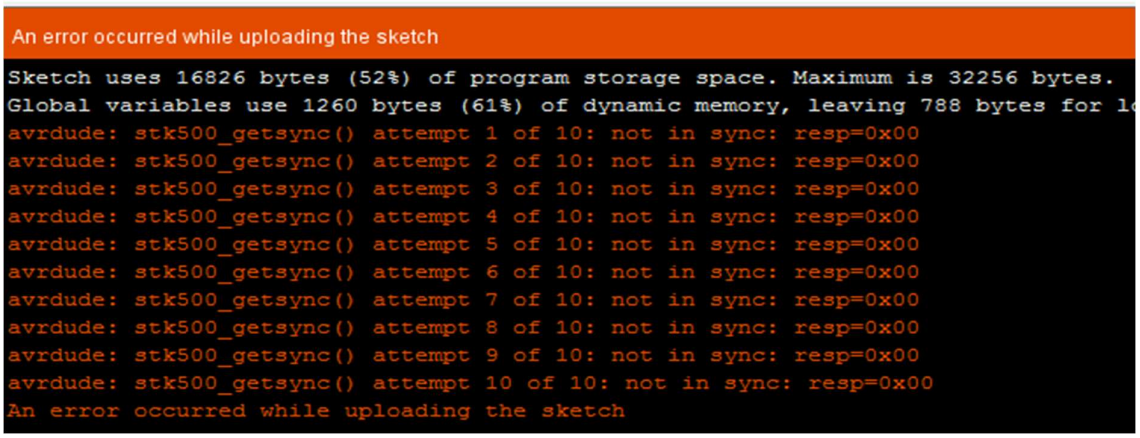

Figure 3. Error received when uploading Arduino code

Researching the error would also very tedious with none of the recommended actions from various Arduino forums providing a solution. This persisted for several days culminating with my supervisor Oisin and I spending several hours in the UNUM lab, making no progress. One post on one of the forums suggested that the only was the avoid this was to have all the connections soldered correctly, but this wasn't enough to solve the issue for others on the forum who were facing the same issue. Due to this, I was hesitant to solder the circuit together because once it was soldered, there was no going back.

I arranged a meeting with Laz Murphy, a technician from the Engineering department in the college. I explained my situation and he recommended soldering pin heads onto each of the components rather than soldering the connections directly into each of the pins. This meant that even if the aforementioned problem with uploading source code on to the Arduino continued, I would not be left with a malfunctioning circuit which is soldered together, and it would allow me to remove the connections between each of the components.

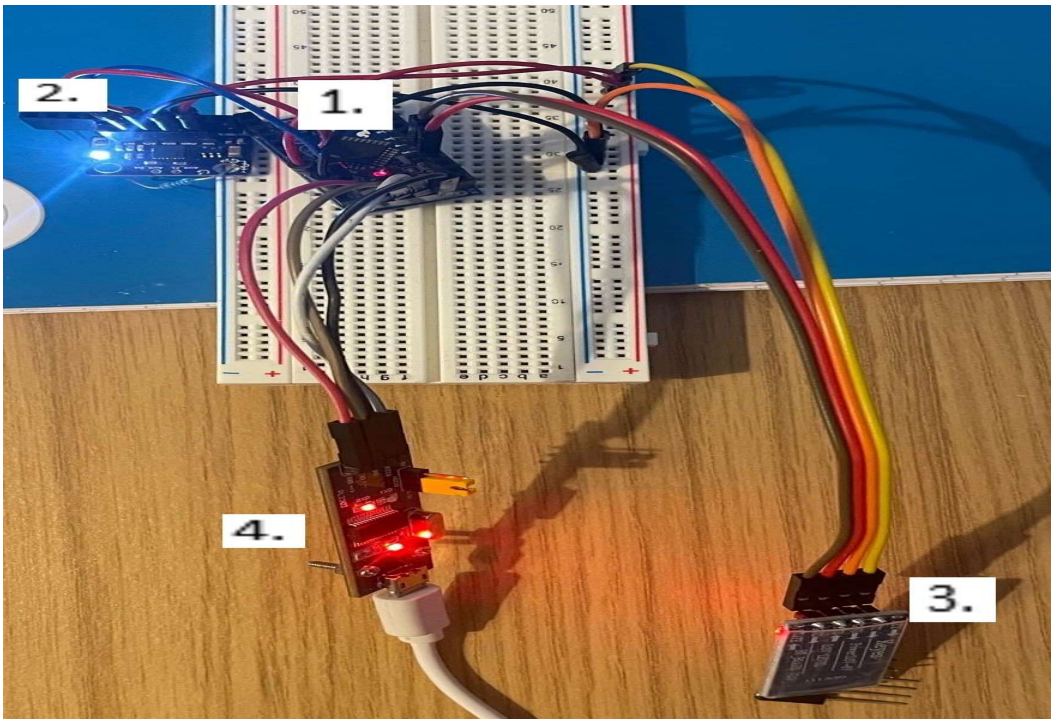

Figure 4. Prototype device connected

`1. Arduino Pro Mini 2. MPU-6050 3. HC-06 Bluetooth Module 4. USB-UART Interface

With the pinheads soldered onto the components labelled above, I attempted to upload source code again, but the error persisted, but not for long. Trying all the micro-USB cables in my house eventually allowed me to upload the source code successfully. With the source code successfully uploaded I was able to text the prototype. The following is the output in the serial monitor in the Arduino IDE, successfully recording movements on all 3 axis.

```
87.20/-322.17/122.30
87.20/-322.20/122.31
87.21/-322.22/122.32
87.22/-322.24/122.33
87.22/-322.26/122.34
87.23/-322.28/122.35
87.23/-322.31/122.36
87.24/-322.33/122.37
87.25/-322.35/122.37
87.25/-322.37/122.38
87.26/-322.39/122.39
87.26/-322.41/122.40
87.27/-322.44/122.41
87.28/-322.46/122.42
87.28/-322.48/122.43
87.29/-322.50/122.44
87.29/-322.52/122.45
87.30/-322.55/122.46
87.31/-322.57/122.46
```

Figure 5. Output from prototype

The final prototype meant that I was finally able to test the functionality of the wearable. However, it proved too late, and I was unable to incorporate it properly into my project. I was able however, to test it with an already existing app from the app store, Retroband.

Below is a screen shot of the movement data, the changes in angles along the x, y and z axis from the wearable being displayed on the app

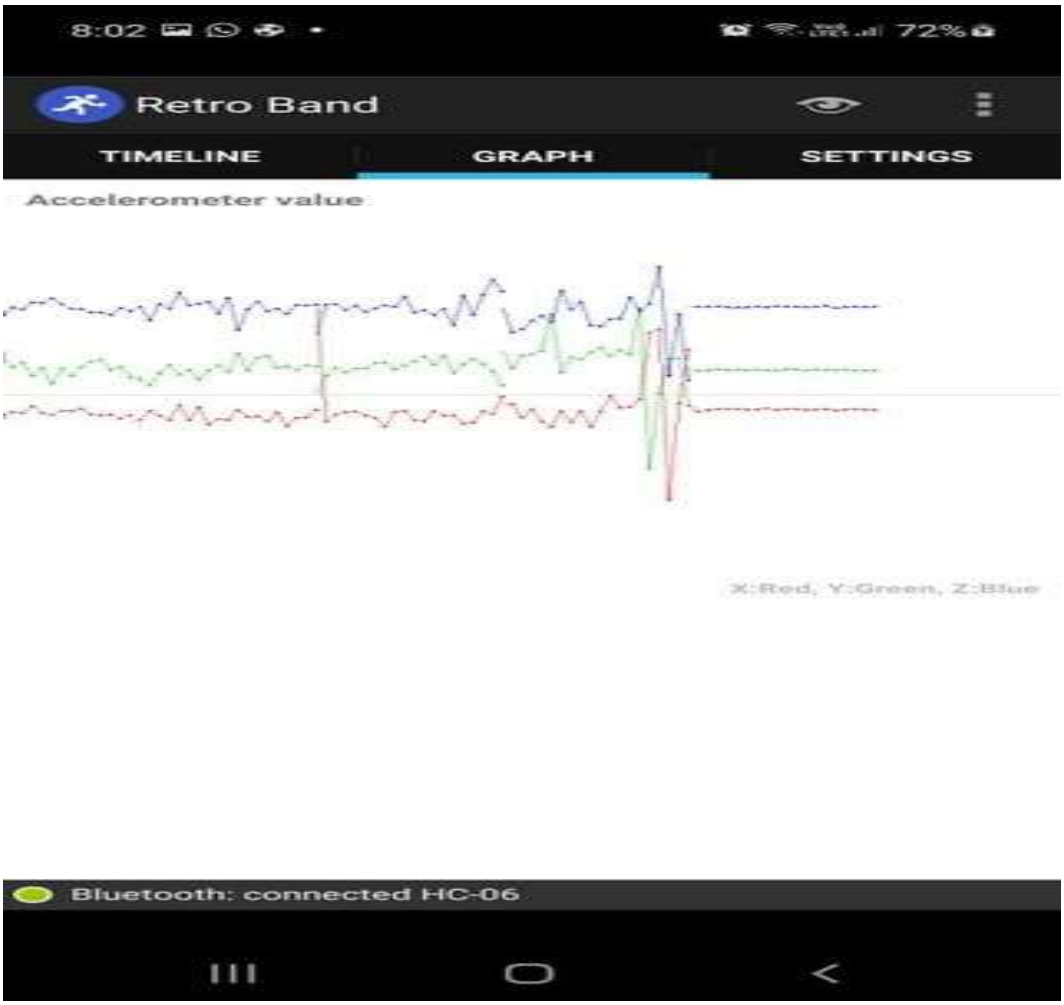

Figure 6. Accelerometer data successfully sent to app via BLE

Changes during development.

Most of the applications and wearable devices designed remained the same from the early stages of planning. One of the main changes made was to commit to designing the app for the carers or parents of a child with ASD. Early on, my initial ideas was for the app to be used mainly by the child themselves. It would involve the child creating an account, setting daily goals, and being rewarded for meeting each goal they set. I was basing this off my experience of my younger brother who is on the autism spectrum, who uses social media applications such as Snapchat and Tik-Tok, on both of which he created his own account.

It wasn't until the presentations in February when I decided to make the change. Feedback from one of the supervisors, Chris Muedec, highlighted an issue with the app. His issue was he believed it wasn't clear who the targeted users of the application were, whether it was the carer / parent or the child themselves. After taking this on board and thinking of it logistically, I decided to focus on developing the app for the use of the adult accompanying the child. This was also based on just because my own bother has no issues with creating accounts on various applications, that does not mean that is the case for other children with ASD who may use the application. This decision also led me to remove the register and log in functionality of the application as it provided no real value to the application as there was no need for the user to have an account. I replaced this with a settings system. Before each session, the adult will simply enter the name and the child, their weight, their height, and the targeted number of steps they wish to reach during the session. After ending and saving the sessions data to the database, or after resetting the session, the settings entered will be reset and the user simply inputs the name, weight, height, and target steps of the next child.

Other changes to the UI included a change to the colour scheme as I felt that the full purple theme was very dark and that a lighter background with purple components such as the toolbar and buttons was easier to read.

Another change that I was forced to make during the development of the project was to use android devices built in pedometer, this allowed me to test the functionality of the app without having the wearable working correctly.

What would I do differently ?

I would begin working on the wearable device earlier, and more consistently. After receiving the components for my wearable device in early March, I began by testing each of the components individually by using the Arduino Started kit provided to me by my supervisor Oisin along with sample Arduino stetches, which are C++ code files used to program Arduinos. Each component was confirmed to be working individually. However, I took this for granted and made a poor assumption that it would just be a matter of connecting the components together and it would work, and this was not the case.

In retrospect, I would also spend less time working with the Arduino Started Kit. Although it was a useful resource for me to help familiarise myself with circuits and electronics, a lot of what I was doing was not very helpful to me in the context of my project. I spent 2 full weekends playing around with it as well as several full afternoons during which only a minimal amount of what I learned was helpful to me and my project

Was my project a success ?

Being honest, my project was not a success. However, it could have been worse. During the development of my project. However, the actual application itself is running correctly and carries out the functionality laid out in the functional specification. I discovered that I could use the built-in pedometer in android devices. This allowed me to simulate the functionality of the app while not having the wearable device working. This enabled me to work on the features such as calculating the calories burned and distance walked, along with other values need for calculations such as stride length and velocity.

Late progress related to the wearable device also left me in a position where I have the app running, and the wearable the device is now working correctly and sending data to an application, however it is an application from the app store. I feel as if I got closer to the final product that I felt like I would at certain times during the year, with one last step to be completed before I could consider my project an overall success.

If I had more time what would I do ?

I believe that if I had more time, even 2 weeks, I would aim to get my application working fully with the wearable device. I am finishing with both a functioning app and functioning wearable device, with the last step being to connect the two.

Also, proper user testing would be valuable. As the wearable device never made it past the prototype stage, proper user testing was not an option. I would try to use it to get feedback on features that could be added to improve the app and implement them into my project.

Conclusion.

To conclude, I believe this project was a very challenging undertaking as a fourth-year project as it involved a lot of research and the development of hardware devices such as the wearable for my project. I believe I showed that I was not afraid to step outside of my comfort zone to attempt to take on and tackle a project such as this. Although it was not a success and did not turn out as I would have hoped I am happy that I choose it and have no regrets. I think that this will stand to me in the future when I begin my career with UNUM in May, and the experience I have gathered from undertaking this project, in both the failures and success will be extremely beneficial to me going forward.

My application code and APK can be found at:

https://github.com/dylanbora/FYP-

Plagiarism Declaration.

- I declare that all material in this submission e.g., Thesis/essay/project/assignment is entirely my/our own work except where duly acknowledged.
- I have cited the sources of all quotations, paraphrases, summaries of information, tables, diagrams, or other material; including software and other electronic media in which intellectual property rights may reside
- I have provided a complete bibliography of all works and sources used in the preparation of this submission.
- I understand that failure to comply with the Institute's regulations governing plagiarism constitutes a serious offense.

Student Name: Dylan Scott

Student Number: C00242050

Signature: