Project Report

Practical Project Management & Professional Development

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Abstract

The group decided to investigate developing an application alongside a device that incorporates an accelerometer that would alert the carer of a patient suffering from Alzheimer's disease. Research into this area of the medical field showed that there isn't a great deal of devices aiding AD through the use of assistive technology that can be worn at all times. As a result, patients with AD are continuing to struggle without receiving the necessary help.

For this project, the group used an existing wristband as well as creating an application that can detect when a patient with AD is suffering from an episode. Once the group had collectively decided on the project, the group researched current solutions with the intention of finding out what currently exists as well as what other researchers are currently working on. This investigation showed that researchers had used assistive technology such as a belt or an ankle monitor to track the whereabouts of a patient, however the most common way of executing this idea was through the use of a smartphone.

Once the group had completed investigation, the group began to lay out a list of requirements that would be aimed for. The various elements were designed using a variety of UML diagrams. The software used to implement the project was Android Studio and the language used to implement the project was Java. The group used the service Firebase in order to store basic account information about the patient or carer, allowing the application to communicate between devices in the event of an episode. To detect the episode, the program takes in a continuous input for a three hour period from a .csv file containing accelerometer data of average movements that the patient would typically do (e.g. sitting idly, taking a walk). Every ten seconds a value for the average variance of movement was calculated, which resulted in many values of variance ordered from lowest variance to highest. A threshold was calculated at the 95th percentile of variance values. From this point, if three consecutive values of variance exceeding the threshold value were detected then the application would consider this an episode, send a notification to the carer, and send the patient's location using Google Maps.

Following the completion of the project, the program was extensively tested. This entailed black box testing with the intention of checking whether the various features of the interface are successful/easy to use. Testing was carried out in the following order: functional, detection accuracy and testing against requirements/objectives. Initially, some tests were unsuccessful but this was rectified.

After the testing was complete, the product was evaluated, this incorporates discussing positive outcomes, further improvements and suggested features. Finally, professional, social, ethical and legal issues were all discussed in order to ensure that the project complies with the BCS Code of Conduct.

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1.0 Introduction

1.1 Background

Dementia is described as a "set of symptoms that includes memory loss and difficulties with thinking, problem-solving or language" (Alzheimer's Society, 2019). Alzheimer's is a progressive disease that can cause dementia. We aim to help carers and Alzheimer's patients with the symptoms of dementia as well as providing data for researchers to help create solutions to the problems Alzheimer's patients must face every day.

A problem that can occur when suffering from dementia is being out in public and suffering from memory loss. If there is no one around to support the patient in this situation it can be a major issue as there's a chance they won't know who to contact for help or how to find it around them. We need to find a way to help the patient get help from a carer or otherwise guide them to safety. However, an issue that we can expect to face is that the patient could forget almost anything and could be extremely distressed in this situation. The solution requires that it would work even when the patient forgets almost everything and is simple enough that it could be used with no prior knowledge and whilst the user is under stress. The solution should keep in mind that the patient could struggle to communicate and walk.

We need to create a solution that involves something easy to access and use for the patient. We should minimise how much the patient needs to do in the case of emergency including alerting carers when they need assistance. Solutions integrated with mobile phones are preferred as it minimises the solution cost and allows for easy data gathering and expansion to the solution in the future. Any data that can be retrieved from patients can be useful to researchers. We will need to store and format the data gathered so that it can be easily delivered and analysed.

1.2 Aims

The aim of the project is to develop an aiding system for patients diagnosed with Alzheimer's that will determine when a patient is lost. A mobile app will be linked to a small device that will always be on the patient's person which will provide live updates to the patient's carer(s).

1.3 Objectives

- An app must be developed in order to work alongside the mbientlab wristband.
- The app must automatically detect whether a patient is lost via the mbientlab wristband.
- The data collected from the mbientlab wristband must send live updates to the mobile app.
- The application must be able to take accelerometer data from an assistive device.
- The mbientlab wristband must be linked to the patient's mobile phone using the app.
- The carer must be able to communicate with the patient via the mobile app and mbientlab wristband
- The app and mbientlab wristband must help the patient when they are experiencing an episode whenever possible.
- The app must immediately provide the patient's GPS coordinates when requested by the carer.

2.0 Existing Solutions

2.1 Current Products

Once a feasible design idea has been chosen, it was vital for the group to do research into existing concepts as well as solutions. For this reason, the group decided to look at both existing systems and literature papers around the idea.

The aim of (Kirste et al, 2013)'s research was to establish a correlation in motion behaviour and diagnosis as well as determine whether the data gathered using motion sensors would be at least as accurate as using a standardised questionnaire. (Kirste et al, 2017) studied 23 dyads (46 subjects) of which 50% are healthy individuals and the remainder are patients suffering from Alzheimer's disease to assess early signs of cognitive decline in motion behaviour by using motion sensors. Each individual wore an ankle monitor which (using an accelerometer) gathered data in three axes. An envelope detector was used to distinguish the difference between an individual taking a footstep and behavioural changes. The severity of everyone's cognitive impairment was measured using a Mini-Mental State Exam (MMSE) and behavioural rating scales such as the Neuropsychiatric Inventory (NPI) and Cohen-Mansfield Agitation Inventory (CAMI) were used to detect behavioural changes. Each dyad was recorded over a continuous 50-hour period in order to ensure full 24-hour cycle(s) were obtained. In total, 2455.8 hours' worth of data were recorded. "The classification accuracy of motion features reached 91% and was superior to the classification accuracy based on the Cohen-Mansfield Agitation Inventory (CAMI). Motion features were significantly correlated with MMSE AND CAMI." Limitations of this research include taking a heuristic approach which can significantly reduce the ability to generalise the findings.

Similar to the research of Kirste et al, (Reyes et al, 2017) looked to study the relationship between a patient suffering from Alzheimer's Disease and wearing an accelerometer. This case study incorporated 35 patients. The patients were placed in one of three categories by the severity of their AD. Each participant was in a day-care centre and had an Android smartphone carefully placed in a small pocket on the patient's person by a neuropsychologist in order to record data using an accelerometer. Similar to the study mentioned earlier by Kirste et al, the accelerometer recorded data in the three spatial axes. This data was then automatically saved into a text file. 187 recordings were accumulated all with varying times in length, with no more than one recording per day over a week period. The functional data was analysed by using machine learning techniques such as an artificial neural network. The data is statistically analysed by using random variables such as mean, median, maximum and minimum. "We obtained a success rate of 83%, which is outstanding for this type of complex data".

Timeless

Timeless is a mobile application that acts as a way for Alzheimer's patients to remember events and help stay connected with friends and family (Timeless, 2019). The application acts as a clean and simple solution to some everyday issues that Alzheimer's patients face. It can send notifications of updates and reminders to both the carer and patient based on events logged in the app. The most notable and unique feature that application provides is its facial recognition of people logged in the contacts list. The ability to point the camera at a person and identify who it is if they exist in their contacts is extremely useful and it's paired with a great little bio on each person to remind the patient.

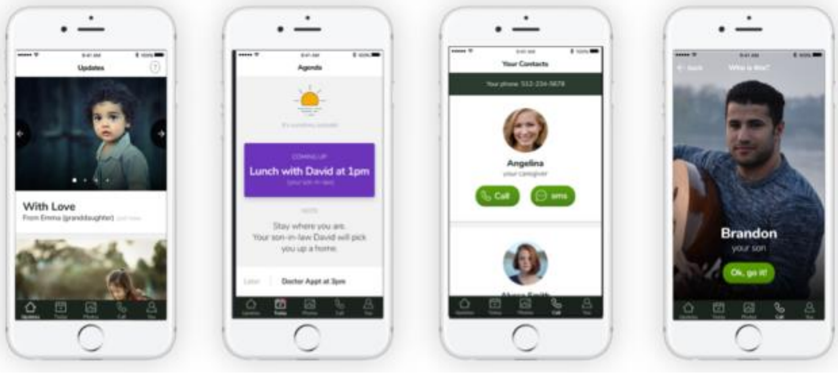

Figure 1- Timeless app

Location Services There are a plethora of applications and services that will stream the location of the user. AngelSense (AngelSense, 2019), ITraq (iTraq, 2019), Pocket Finder (Pocket Finder, 2019) to name a few, all use GPS to locate the user on a satellite map. This is a common solution for patients even beyond Alzheimer's, the basic needs of a carer are to know that the patient is safe and the quickest way to know that is to know where they are and what they are doing. Location services provide the very basic most carers need easily and effectively and will remain a staple of services to support patients.

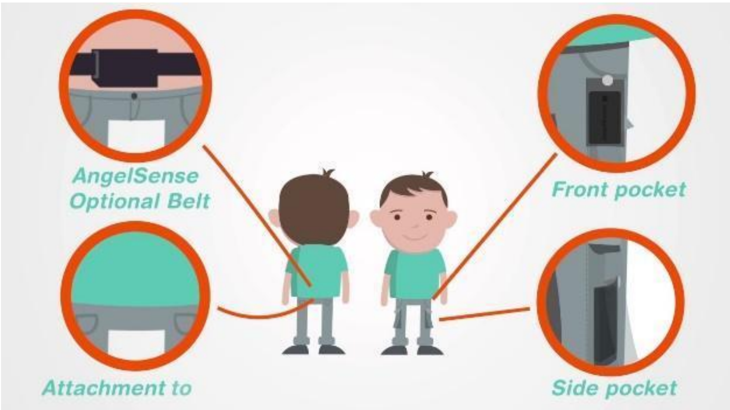

Figure 2 - AngelSense

2.2 Product Demand

The group became aware of the fact that there are not a great deal of applications in the smartphone market for the purpose of assisted living targeted at Alzheimer's patients. Although there has been steady growth in terms of the precision of wearable technology and the reliability of smartphones when compared with devices only ten years prior, the development of applications to take advantage of this from a consumer standpoint has been distinctly lacking. As part of whether there is a demand for this product, the group first researched whether the process was feasible as a basic groundwork. Should the product lack feasibility, it is unlikely that there will be any market demand for such an application to exist before the technology is in place to allow the program to function correctly. Another concern was that patients suffering from

Alzheimer's disease may not react well to the technology used and may respond with confusion or agitation, however technology acceptance among this group seems to be relatively high (Maier et al, 2015). With the project being feasible and there being very few, if any, existing solutions it is logical to assume that there will be demand for a prototype style application which could be built upon by future researchers and programmers.

2.3 Research Gap

Looking at these solutions, we can see there is a distinct lack in automatic threat detection and resolution. In a situation that a patient cannot remember how to get help these solutions do not help. The existing solutions also require close attention from carers to be able to detect and respond to an issue. We will try, where possible, to detect and allow for responses to problems quickly and effectively. An automated detection and contact solution would allow for carers to help patients before they are even fully aware of the issue.

2.4 Software Required

The next stage was to decide how to create the application itself. As the application is designed for Android phones, the most logical course of action was to use Android Studio. Within Android Studio, several programming languages such as Java, C++, Kotlin, and C# are used, therefore the team needed to decide which language to use, and therefore settled on Java due to it having strong support from Google (Android Authority, 2020) and the team being most familiar with Java from previous studies. Alongside this, Java's classes encourage modularity which in theory should provide a better code quality. This also necessitated each group member having access to either an Android phone or an Android emulator, and as Android Studio supports a native emulator this problem was circumvented with ease.

Due to Google changing their supported method of file handling for Android 10 (AndroidPub, 2020) and group members' phones not supporting Android 10, the decision was made to instead develop the application for devices running Android 9. This will likely need to be changed for the future market should a more commercial application be built on top of this project, however for the needs of this 'proof of concept' application, Android 9 will be sufficient.

3.0 New Ideas

3.1 Accounts

To allow the users to have a personalised experience and make sure personal connections between users are kept secure, an account system must be developed to store the data of users for the future. The system should use cloud storage so that the data is usable across various devices. The account must be secure and only accessible via the user who owns the account. If possible, third-party security measures should be used to keep the data safe to withhold the data protection act 2018 (Gov, 2018). The account should also allow for identification of other users for communication between users.

3.2 Communication Services

The application's main objective is to create a direct connection between a carer and a patient to allow for quick communication bespoke to a patient-carer relationship. The application needs to be able to notify the carer whenever the patient needs help. This should be done in a manner that is quick to notice and access by the carer in their everyday life. The most obvious solutions are to utilise communication methods commonly used on mobile devices such as text messaging, email or push notifications.

3.3 Location Services

To make responding to an emergency as quick and clean as possible, a location providing service could be implemented. Some way of communicating to the user quickly of the location of the user that needs help. This information may not always be necessary but will be incredibly useful to users if the user is in distress and cannot communicate on their own accord. Many existing solutions like what the group is aiming to achieve do this by showing their location on a map via services such as Google maps.

3.4 Personalisation

To make the application feel more personal and bespoke. The application could have a profile picture and bio system like popular social media applications. A picture that can be viewed by connected users completed with a short description of the user would not only make the application feel more bespoke but also have benefits for Alzheimer's patients. Seeing the face and a description of the user may make the carer more memorable and familiar in the situation of an emergency.

3.5 Live Detection

Sometimes a patient may not be in the position to alert their carer in the case of an emergency. To try to tackle this issue, the application could have the functionality to automatically detect when the patient is in distress or is lost. When it detects the patient is in this situation, the application could automatically alert the carer of the situation for a quick and clean response to help the patient. This system could be made more accurate by having a calibration system that sets up the system with the users movement patterns and tendencies in mind so that there is less chance of the system falsely detecting an episode.

4.0 Design and Development

4.1 Functional Requirements

Once a project idea had been selected, the group had to brainstorm what sort of functionality would be incorporated within the project. This includes the ability to extract accelerometer and GPS data from the phone in order to determine whether a patient is suffering from an episode. Once the group had a clear start to the project, a list of functional and non-functional requirements was established.

FR1 – The system must gather accelerometer and GPS data.

FR2 – The system must detect when the patient is suffering from an episode.

FR3 – The system must alert the carer when a patient needs help.

FR4 – The system must collect and compile research data.

FR5 – The system must display the patient's GPS coordinates when requested by the carer.

FR6 – The system must use timestamps.

FR7 – The system must incorporate a basic help button that the patient can manually press.

FR8 – The carer must be able to add more than one patient.

FR9 – The system should incorporate email functionality.

4.2 Non-Functional Requirements

NFR1 – The system must incorporate a clear and simple design.

NFR2 – The system must be easy to use.

NFR3 – The system must be able to support more than 1 user.

NFR4 - The user must be able to select whether they will be using the system as a patient or as a carer.

4.2.1 Maintainability

During the developmental stage of the system, the group must ensure that the application is coded in a way that enables the ability to easily maintain and upkeep the system in a way that is as simple as possible. This will be achieved by abstracting the code as much as possible, such as using functions which can be applied to both a carer and a patient, rather than writing specific functions with redundant code. Alongside this, the code must be as modular as possible, this necessary in the event that the code becomes deprecated (for instance, with Google changing the way file handling is achieved in Android) the function itself which no longer works correctly should be changed without that function breaking any others. This will therefore ensure that the application will be more robust and also much simpler to be built upon for any future developers.

4.2.2 Usability

The system has been designed with the aim of ensuring that the application is as simple and easy to use as possible for any patient that is suffering from Alzheimer's disease. This incorporates a minimalistic approach to the design of the application which incorporates large fonts, easy on the eyes colour scheme and a clear and concise layout.

4.3 Requirements for Development

For development we will need access to a **smartphone** and a **mobile application development suite**. This will allow us to develop the face of our solution and give us a platform to collect and send the data gathered from the patient. This will also allow integration with mobile communication methods such as SMS, voice calls and cameras if needed.

We will also require access to the **Mbientlab Wrist Band** (Mbientlab, 2019) with the same capabilities as a possible solution. Such a device can provide accelerometer, gyroscope and global positioning information which could allow for detection of emergencies and data for researchers. The device could be the most reliable and non-invasive way of providing the solution.

4.4 Requirements for Users

Users of the solution would need access to a **smartphone** and the **Mbientlab Wrist Band** of choice**.** The aim is to create a solution where the patient wears the **Mbientlab Wrist Band** so that the patient does not need to remember to do anything in case of emergency.

The device will be linked to the patient’s phone and the patient’s phone will relay information to a receiving carer of the patient. In case of emergency the carer can be alerted, and the carer will be able to communicate the patient through the smartphone.

4.5 Use Case Diagram

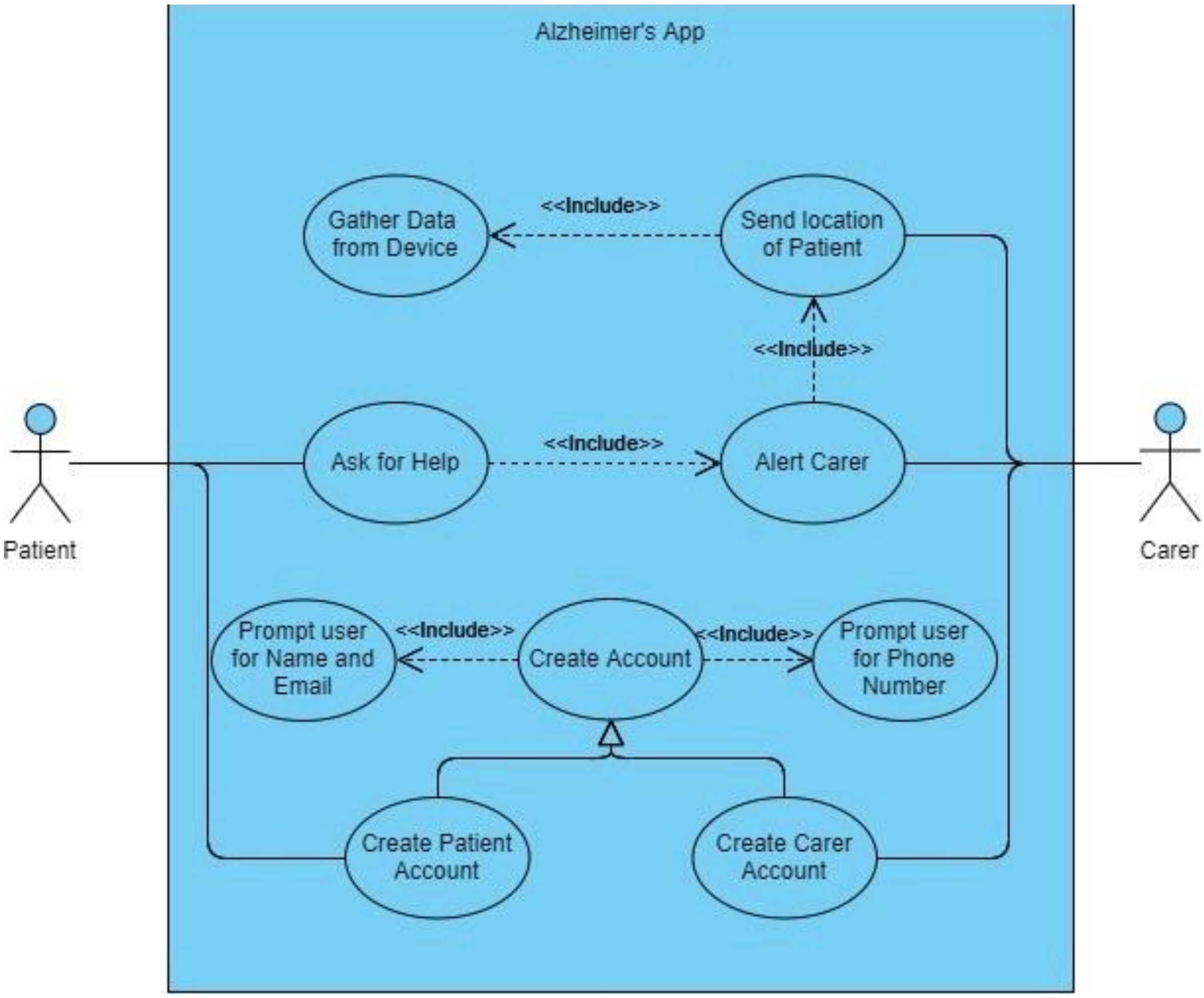

Figure 3 – Use Case Diagram

The above diagram describes the typical use cases the system will encounter. There are two 'actors', the patient and the carer. The patient can ask for help, which will then send an alert to the carer. Both the patient and the carer can create accounts, with a distinction between the type of account. The patient account will allow access to the patient view, which will show a screen with a help button which will send an alert to the carer. The carer can receive an alert from the patient and receive the patient's location so that they can either alert family members or provide healthcare if necessary. When sending the location of the patient, the device will gather the GPS data from the phone. Beyond the users' use cases, the program will passively measure accelerometer data and process the data in accordance with the research gathered which will detect the possibility of an episode due to erratic movements. In such a case, the caregiver will automatically be alerted of a potential episode.

4.6 Class Diagram

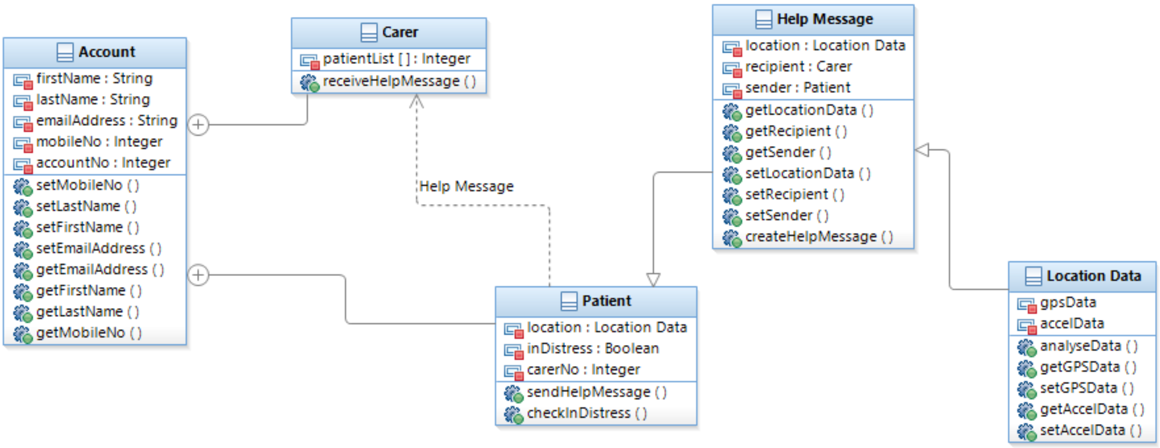

Figure 4 – Class Diagram

The above class diagram shows all relevant classes. These are Account, Carer, Patient, Help Message, and Location Data. The Account class will create an instance of an Account, either a Patient or Carer as both hold the same basic structure in terms of their accounts, and therefore the Patient and Carer classes both inherit from Account. As a basic overview, Patients' and Carers' accounts will both have the attributes firstName, lastName, emailAddress, mobileNo, and accountNo. These are all necessary basic and contact details which will allow alerts to be sent from the Carer to the Patient when in distress. This is only limited functionality as a proof of concept design, should this program be built on, a seamless communication directly between accounts within the application would be a much more suitable implementation. The Carer will have a list of patients as an attribute because a Carer may have multiple Patients. The Carer also has a method called receiveHelpMessage(), which will allow the Carer to have access to help messages being sent to them when necessary. The Patient will have their location as an attribute, a Boolean value stating whether they are currently in distress, and the ID of their carer. Patients can send a help message and will be checked periodically to see if they are in distress. Both methods will be performed using the Help Message class.

The Help Message class will handle the message sent when the Patient voluntarily sends a Help Message, or when the checkInDistress() method detects that the Patient is having an episode. The Help Message method contains the location data of the Patient from the Location Data class, the recipient, and the sender. The recipient will be a member of the Carer class, and the sender will be a member of the Patient class. The Help Message can gather location data from the Location Data class, gets the intended recipient, sender, and is able to apply those attributes to the Help Message created.

Help Message inherits from Location Data, which contains the attributes gpsData and accelData (acceleration data). The Location Data class is able to analyse the GPS data and acceleration data and will determine if the Patient is having an episode, this will use the getGPSData method which will retrieve the GPS data from the phone and will also use the accelerometer built into the accompanying wrist device. Upon analysis, it will send the data to the Help Message class to be sent to the Carer if necessary.

4.7 Sequence Diagram

Make Account Sequence Diagram

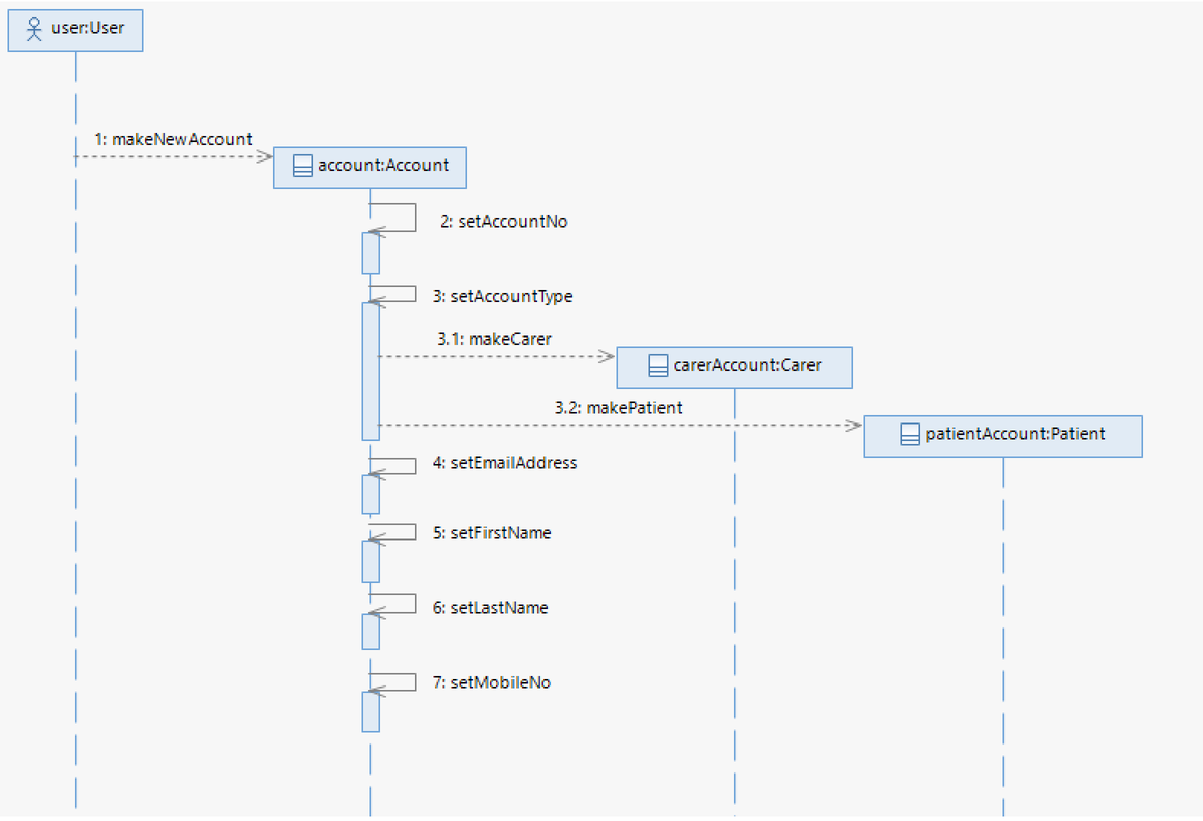

Figure 5 – Sequence Diagram A

A user can make a new account. Upon doing so, they will be assigned an account number and then will be prompted to select the account type. If the user selects the carer account, a carer account subclass will be created, if they select the patient account, the patient account subclass will be created. In either case, the user will need to enter their email address, set their first name, set their last name, and set their mobile number. All of these attributes will be vital to sending the required details and communication between the Carer and Patient.

Send Message Sequence Diagram

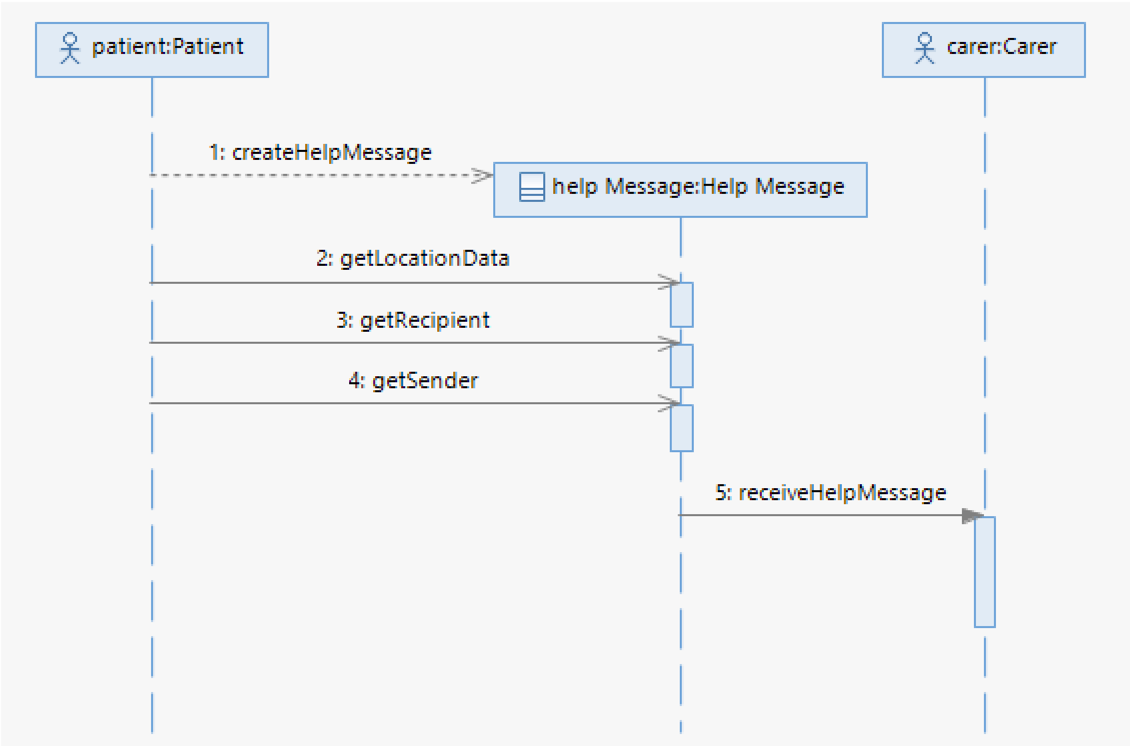

Figure 6 – Sequence Diagram B

The patient, an instance of the Patient class can create a Help Message The system will then gather all the relevant information and sets the object attributes. The system then creates the subclass object required to create and send the Help Message, for the carer actor (an instance of the Carer class) to receive the help message.

4.8 Flow Diagrams

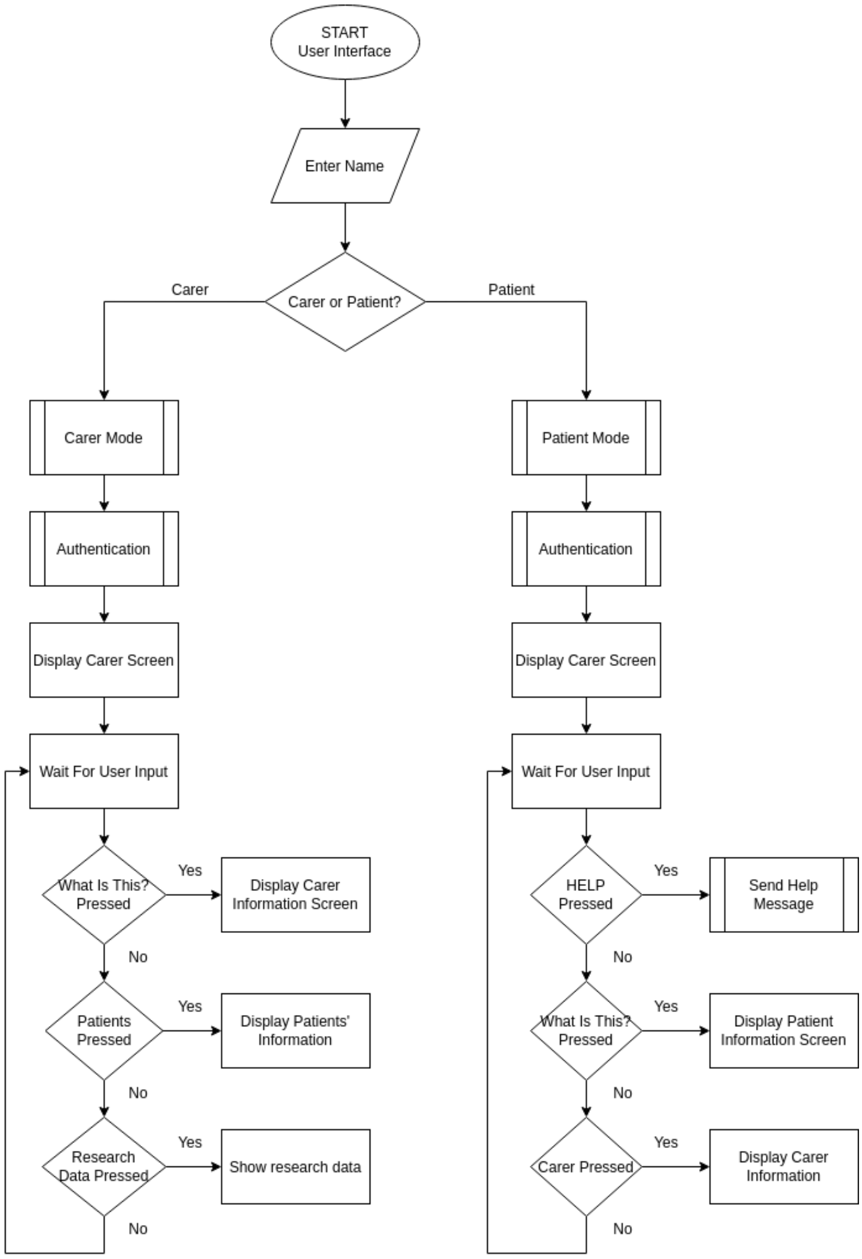

Figure 7 – Flow Diagram A

Flow diagram A shows the basic use scenario of the application when first started. The application will ask the user if they are a patient or a carer, depending on their answer the relevant home screen will be displayed. The user will need to authenticate with a valid Google account before the correct screen will display. For each button that is pressed, the relevant screen or dialogue will be displayed.

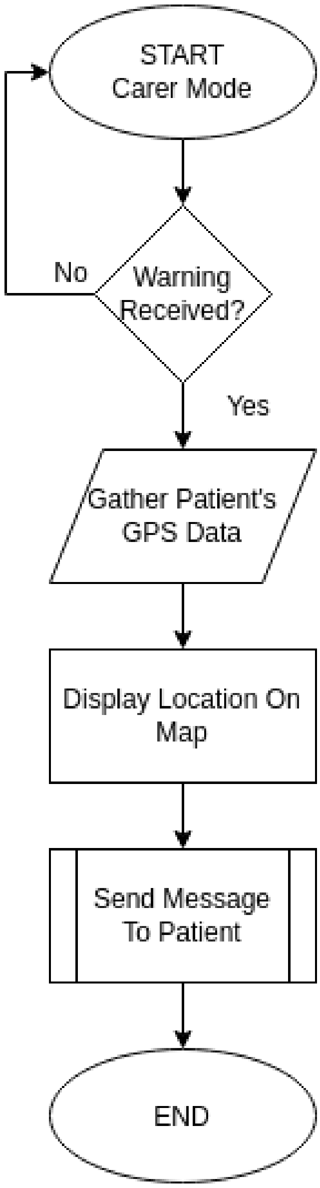

Figure 8 – Flow Diagram B

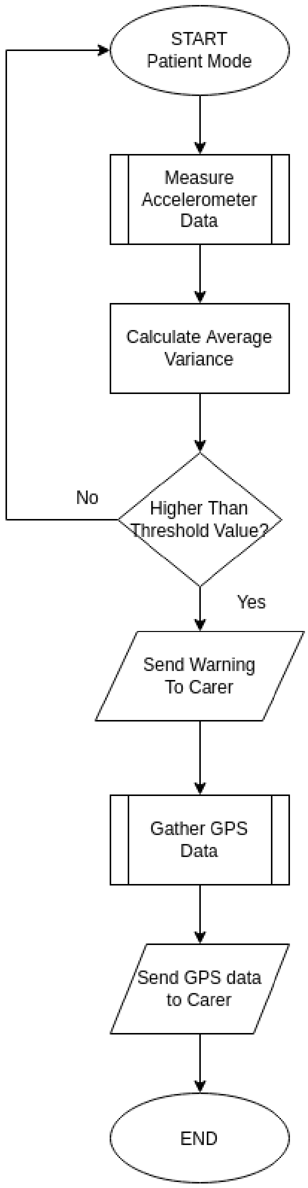

Figure 9 – Flow Diagram C

Flow diagram B shows the carer mode, which is enabled when the user selects 'Carer' on the login screen and then authenticates with a Google account. The application will wait in the background.

When an episode to be detected from the patient, and then send a push notification, allowing the carer to view the patient's location.

Flow diagram C shows the patient mode, which is enabled when the user selects 'Carer' on the login screen and then authenticates with a Google account.

After this, the program will calculate the average variance and measure against the threshold. If it is exceeded, an alert and the location will be sent.

4.9 User Interface Design

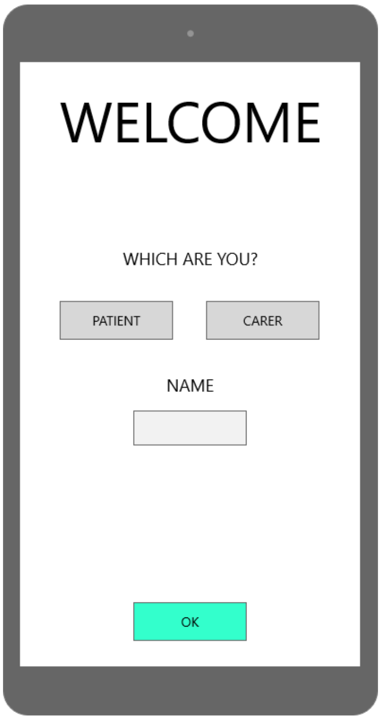

Figure 10 – System Setup

Figure 11 – Carer Details

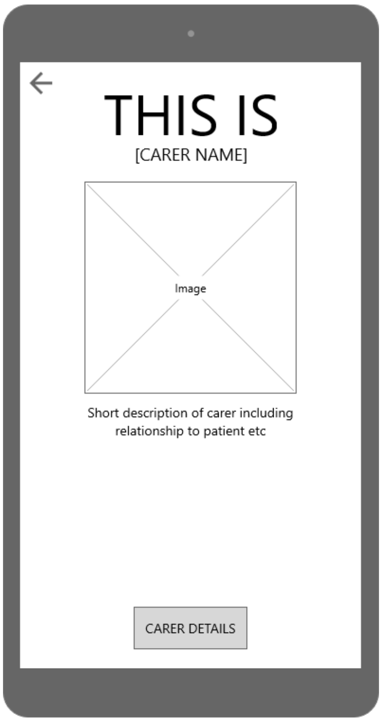

Figure 12 – Carer Image

Figure 13 – Patient Screen

Figure 14 – Patient Alert

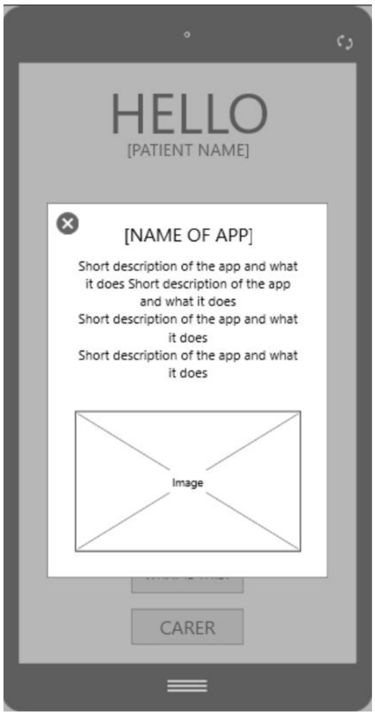

Figure 15 – App Information

When the user launches the system for the first time, they will be greeted with the account selection screen where each user will have to select whether they are a patient or a carer as well as enter their name (as seen in Figure 10). The following screen depends on whether the user is a patient or a carer. If the user is a patient, the following screen (Figure 11) will immediately display a pop-up window that will ask the patient to enter their carer's name and email. Email functionality will be incorporated in order to allow several patients to link to one or more carers. Once the carer's details have been entered and saved, the pop-up window will disappear, and the user will see a window that displays an image of their carer (Figure 12). This window will also display a short description of the relationship between the patient and carer. This window can be exited by the user pressing the small arrow in the top left corner of the screen. Figure 13 shows the patient's regular home display that incorporates a large 'HELP' button that the patient can press when they are suffering from an episode. Once the 'HELP' button is pressed, a pop-up window will appear as seen in figure 14 and the patient's carer will be alerted. As a result, this will display a message with the attention of calming the patient as well as instructing them on what to do/expect next. This pop-window can be exited by pressing the 'X' in the top left corner. Figure 12 can also be accessed through Figure 13 by pressing the 'CARER' button at the bottom of the display. If the patient presses 'WHAT IS THIS?' (Figure 13), the patient will then see a pop-up window (Figure 15) which will display the name of the application, a short description of the application as well as the purpose of the overall system and how it can help the patient. If the user were to select 'CARER' they would be greeted with a similar home display (Figure 16) to that of the patient (Figure 13). Pressing 'WHAT IS THIS?' will display the same screen as Figure 15.

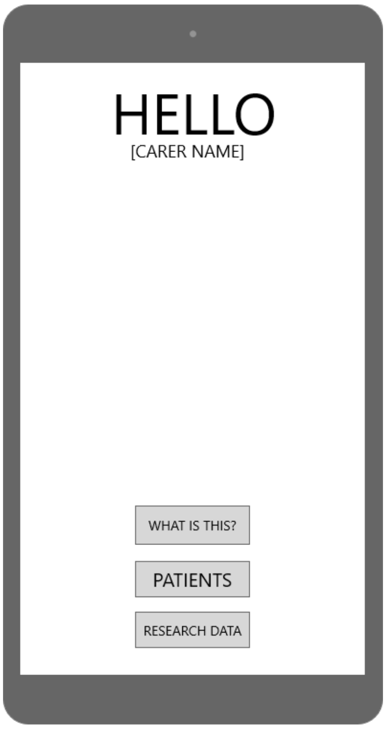

Figure 16 – Carer Screen

5.0 Product Evaluation and Discussion

After development has taken place, the application must go through testing in order to ensure that the application functions as it should and meets all requirements. Testing has been split into the following: GUI testing, functional testing, detection, and testing against the requirements and objectives. The relevant testing table can be found in appendix 3.

5.1 Functional Testing

5.1.1 GUI Functional Test

The first testing stage involved testing every aspect of the user interface to ensure that it functions as it should, while also being user friendly and logical. The testing was carried out on all screens of the application including all dialogue boxes. Black box testing was used and of 31 tests, 5 failed. For each failed test, this information was provided to the developers who then worked around the problem to develop solutions, which were implemented accordingly. The results concluded that overall, the GUI functioned as required for the scope of this project and overall, the GUI did not take too long to load in any aspect.

5.1.2 Features Functional Test

After testing the GUI, the next elements to be tested were to ensure that the file handling all worked as described, and that the alerts were correctly sent between the patient and the carer. The file handling was tested, and worked successfully on Android devices running Android 9 or lower, however as described in section 2.4 file handling will not be successfully handled for devices running Android 10, this test is therefore failed and should be improved when the application is built upon by other members of the scientific community.

When testing the database used, at first the application failed to set the correct carer, however this was resolved by adding the carer to the database and adding the ID of the carer into the application, this therefore did not require a programming fix but rather an external fix to firebase. A reported issue when testing the GPS location being sent from the patient to the carer was that the GPS location would occasionally be inaccurate if the episode was detected while the patient had low signal, this is simply a limitation of the current technology in place for GPS services and there is no simple fix for this issue.

The next failed test involved the use of a dialogue box upon pressing the ‘WHAT IS THIS?’ button which was not populated with any relevant information, as this had been shelved until later and never implemented when attempting to get other features working. This issue was resolved by adding a simple message to both dialogue boxes on the patient and carer sides with relevant details such as explaining how to calibrate the application, and that the application is designed to detect an episode and will provide their carer with all necessary information.

5.2 Usability Testing

For the usability testing stage of the project, a questionnaire was designed using Google Forms to gather the opinions of people who have used the application and had had the premise explained to them thoroughly. This questionnaire did not target the consumers of this product, as no Alzheimer’s patients or carers of those with Alzheimer’s were not readily available to the team. Rather, the questionnaire was designed to gain general feedback on the concept and the design of the application as a general smartphone application and to gain insight as to how the program may be built upon in the future as the current implementation is a proof of concept, not intended for the market. The questions and responses along with an analysis of the results can be found in appendix 4.

The first three questions specifically focus on the design of the application from a user friendliness perspective, with the general consensus being positive. Overall, responses agreed that the application was visually appealing, this is necessary as it provides a more professional appearance and means that the application is less likely to be disregarded as too difficult to understand due to the aesthetic choices made. In terms of the colour scheme, responses agreed that the colour scheme was appropriate and easy to read, thus should a patient who may be elderly or vision impaired use the application they are more likely to engage with the content and understand how to use it. This is important, as the application is not particularly useful if the layout is confusing or difficult to use, especially in regard to the potential age of the patients using the program.

As a concept, the questionnaire showed that the idea is generally strong and would work if built upon with correct funding and lack of time constraints, which would result in a more fleshed out product which can be assessed by the scientific community and potentially integrated into every day use for an Alzheimer's patient and their carer. Overall, participants agreed that in its current state the application would not necessarily be the strongest product for use with an Alzheimer's patient, however this project will be successful if it proves the idea to be successful and allows others to build upon the findings of this project.

The main suggestions from the participants of the questionnaire showed that data should be streamed from the device, rather than taken in advance and applied to the application. This is correct, and as a real-world implementation would be the method of implementation, however due to the constraints of the device in question, this cannot be implemented at this stage. Alongside this, using a more reliable method of detecting an episode was a valid suggestion, which would depend upon more scientific research into the field of Alzheimer's and peer-reviewed data repositories containing valid movements of Alzheimer's patients currently experiencing an episode. As this does not yet exist, it makes the detection of an episode difficult. In order to mitigate this, the team decided to calibrate the device to the user's normal movements, should any movements exceed their average movements (thirty seconds of movements with variances beyond the 95th percentile of their calibrated movements) then this would be considered an episode. A further suggestion was to make the login page less confusing, which is a valid concern which exists due to time constraints of the project. Should the project be built upon in future, this issue should be relatively simple to fix.

The only major concern raised from the questionnaire was the difficulty to navigate, which taken in conjunction with the suggestion that the login screen be made less confusing can be interpreted as that being the main issue, overall the responses indicated that the application was satisfactory in its navigation, but in the context of Alzheimer's patients, satisfactory is not necessarily the standard that the team should aim to meet.

Overall, the responses indicated that the application is a strong proof of concept that could be built upon in the future by a more experienced group of developers with correct time allocation and funding, along with the correct scientific research to back up the application.

5.3 Testing Against Requirements/Objectives

The final aspect that required testing was verifying that the application met the requirements and objectives set out in the analysis phase. This will therefore ensure that the application meets the standard that was laid out initially.

5.3.1 Requirements

The first requirement that was identified during the analysis stage was that the system must gather accelerometer and GPS data. This has been met, the acceleration data is handled by the wrist device as it provides the most accurate readings for specific movements, rather than handling both GPS and acceleration data on the smartphone as this will be very inaccurate, due to the phone mostly staying in a pocket or a bag.

The second requirement was that the system must detect when the patient is suffering from an episode, which has mostly been met with non-peer reviewed data, and thus it will not be as reliable as it could be. The application is however designed to accept any form of data, and will behave in the same way. Therefore, should peer reviewed data be used, it is able to simply be plugged straight into the system.

The next requirement states that the system must alert the carer when a patient needs help. This has been achieved, as the database used allows an automatic push notification to be sent to the caregiver when an episode is detected.

The fourth requirement was that the system must collect and compile research data. This was found to be unnecessary for the program, and was instead modified to be calibrated to each patient, which was successfully implemented using the .csv files containing accelerometer data from a three hour calibration session using every day movements from the patient.

The fifth requirement was that the system must display the patient’s GPS coordinates, this is done automatically and has been accomplished to a greater extent than the analysis phase initially outlined. Rather than simply gather the GPS data from the user, the application automatically integrates with Google Maps and will load into Google Maps and pinpoint the patient’s last known location to the carer.

The next requirement was to use timestamps, which was implemented to a certain extent, in that during calibration and episode detection, the system takes into account the amount of time that has elapsed in each session. For instance, the data is taken in ten second intervals and in that window the variance of the data points is calculated, which is the fundamental core of the detection.

Another requirement was to implement functionality that allows the user to press a help button which would send an alert manually to the carer, in the same way that the system does when an episode is detected. This was successfully implemented and functions in the same way as an alert being sent when movement variances exceed the threshold value in a normal use case, with the addition that the user can manually press the help button.

The eighth functional requirement specified that the program must allow the carer to add more than one patient, which has been implemented as the patient selects their carer on the patient side of the application. Multiple patients can select one caregiver, therefore a carer can be assigned multiple patients.

The final functional requirement is that the system should incorporate email functionality. Later on in development, this was changed to SMS functionality rather than email, however this was still not implemented due to the complex nature of the problem, particularly with permission issues and therefore time constraints concluded that this was impossible to implement.

In terms of non-functional requirements, the system incorporates a clear and simple design as demonstrated by the results of the usability questionnaire and is reasonably easy to use, other than the complication of the login screen which can cause some confusion. The system is able to support multiple users, including both patients and carers for which the user is able to select their role.

5.3.2 Objectives

The first objective listed was to develop an application which works alongside the mbientlab wristband, which has been achieved as all of the data used by the application was generated by the mbientlab wristband. As an extension of this, the application works not just with the mbientlab wristband but also with any .csv file containing acceleration data.

The second objective listed was that the application must detect whether a patient is lost via the mbientlab wristband. This was not possible within the scope of this project as the wristband does not provide GPS data. Although the phone does collect GPS data, due to time constraints it would be too difficult to implement this as calibrating the user’s normally visited locations alongside moving in strange patterns would be an enormous task.

The next objective listed was for the application to take in live updates from the mbientlab wristband. Due to limitations with the wristband, streaming is not supported however can be emulated by the use of a simple Thread.sleep() command to stagger the input of the data, however this is currently commented out for testing purposes.

The fourth objective listed states that the application must take accelerometer data from an assistive device. This has been achieved, as the application can in theory take in any comma separated value format file and analyse the data, therefore it does not matter what assistive device is used, assuming the accelerometer data is given in the form of g and provided in a .csv file format.

The fifth objective states that the mbientlab wristband must be linked to the patient's mobile phone using the app, however this is done externally using mbientlab's proprietary software as that is the only feasible method of linking the device to the smartphone.

The sixth objective was to communicate with the patient via the mobile application, which has been slightly revised. Instead, a push notification is sent to the carer alerting them of an episode. As communication applications already exist, the team decided that there was no need to 'reinvent the wheel', this, alongside time constraints necessitated the exclusion of this feature.

The seventh objective states that the application must help the patient when they are experiencing an episode where possible. As the application sends a help message to the patient's carer, this can be considered helping the patient to the extent possible with an application of this nature.

The final objective states that the application must provide the patient's GPS coordinates when requested by the carer. This has been achieved, as soon as an episode is detected and the carer opens the application, they will be presented with a Google Maps view pinpointing the patient's exact last known location.

5.4 Discussion

The main reason behind the idea of this project is to identify a in which assistive technology alongside a smartphone could be used to aid patient(s) with Alzheimer's disease as well as detect and notify their carer when they are suffering from an episode. This project was chosen because it allowed the group to produce an application that would help benefit the lives of many patients suffering from Alzheimer's especially in extreme cases when patients are in distress as they are currently experiencing an episode and may not be familiar with their surroundings. In order to make the application as successful as possible, an investigation had to be carried out into existing solutions with the intention of determining what was successful in the past and where researchers may have not been so successful. Once this was complete, the members of the group had a clear idea of what needed to be done in order to make a desired product. A wearable device alongside an application will not only benefit patients with Alzheimer's but also their respective carers and the medical field.

When looking at development throughout the course of this project, the team came across several hurdles but were able to resolve them in a timely fashion. One key element of the implementation process that worked for the group was a continuous string of discussion whether working on their respective task or helping out a group member, this was done with the intention of staying on track and not losing sight of the main aim. The project was split into several key aspects which were: the graphical user interface, the carer's side of the application, the patient's side of the application and the database to communicate between devices. On the patient's side of the application, it enabled the patient to calibrate the data as well as press the 'HELP' button whenever suffering from an episode or are in need of urgent help. The database is a key element within the application as it communicates between devices, for example, when a patient is in distress, the application will alert the patient's carer by sending them a notification as well as the patient's location by opening Google Maps and displaying the patient's whereabouts. On the carer's side of the application, when called upon, will allow the user to access research data, which enables the user to compare calibrated data to the actual values and see how accurate it is. Ensuring the success of all of these elements was a key aspect of the project as inaccurate detection of a patient suffering from an episode or lack of communication between patient(s) and carer(s) would hinder the success and real world applicability of this concept.

Another key element that needed to be taken into consideration in order to ensure the success of the project was to ensure that all acts and regulations were closely followed. To ensure this was executed correctly, the group did some investigation and identified the BCS Code of Conduct as the most appropriate approach for the duration of this project. Next, the group broke down the BCS Code of Conduct and identified the most likely issues/concerns that may arise throughout this project. These issues were focused upon and elaborated with the intention of ensuring that every group member is on board and understands the significance of following these rules and regulations. As a result, this enabled the group to develop the project in a professional manner and replicate that of a real life setting. Furthermore, this enabled the group to stay up-to-date with the most relevant information as well as ensure a well-thought out approach to the group members and the project. If the project was to continue with development past what the group has already implemented, the BCS Code of Conduct would have to be revisited and further potential issues would have to be raised as well as addressed.

As a result of this project, each member of the team was able to gain an insight into a variety of new software as well as features and project management skills. Having completed this project, as a group and individually, the group has gained a greater insight into the significance behind helping patients suffering from Alzheimer's disease as it negatively impacts the individual's life as well as friends and family around them. Having worked with mbientlab wristband, Android Studio as well as Google's APIs and Firebase and combining these elements together to make a usable application has allowed the group to gain an understanding of how the rapid advancement of technology can aid the everyday lives of patients around the world.

6.0 Conclusion and Future Work

6.1 Project Achievements

Overall, the project had many successful features. For example, the group created an application that is a proof of concept. Many of the implemented features include the ability to calibrate data from a .csv file. This was incorporated with the intention of improving the ability of the application to detect when a patient is suffering from an episode. The detection system behind the application is based on mathematical values and three consecutive values exceeding the threshold (which was calculated at the 95th percentile) will result in the patient of the carer being notified. An additional successful feature is when the application detects that a patient is suffering from an episode, it will automatically notify that patient's carer, this is achieved by both sending a notification and alerting the carer as well as sending the GPS coordinates of the patient in distress. If the carer were to open the notification within the application or outside, they would be redirected to Google Maps which will pinpoint the current location of the patient in distress. A further successful feature includes the application providing a minimal user interface. This interface consists of a clean-cut design as well as a simplistic colour scheme with the intention of not being harsh on the eyes as well as being easy to understand and navigate. Based on the carried out usability testing, the majority of user responses suggested that the application is visually appealing as well as easy to navigate.

6.2 Further Improvements

Having completed this project as a group, time was taken to consider what features throughout the product could be revised in order to ensure that the application is reaching its full potential with the intention of aiding patients suffering from Alzheimer's disease as much as possible. As well as discussing these potential features as a team, the group took time to reflect upon the user feedback that was provided via the questionnaire. This allowed an insight into further improvements if the group were to return to the application or had more time been an option. Features that could be improved upon include using peer reviewed data from real life Alzheimer's patients and streaming the data in real time.

6.2.1 Peer Reviewed Data

The first and main feature that could be improved upon if further work were to be carried out in regards to the application is using peer reviewed data. Currently, the group used the mbientlab wristband to generate what the group would call everyday/normal movements such as drinking a glass of water or waving goodbye and erratic movements such as a patient demonstrating frantic and panicked movements. These movements were defined using (Kirste et al, 2013) research paper called 'Detecting the Effect of Alzheimer's Disease on Everyday Motion Behaviour', as they stated there is a strong correlation between "diagnosis and unconstrained motion behaviour". The group gathered their own data using group members within the team. This data is then collected and a variance for every ten seconds within a three hour period of movements was calculated. The collected data is then rearranged in ascending order and the 95th percentile value is extracted. If three consecutive ten second periods exceed this value, this is considered as the patient suffering from an episode. The best way to rectify this in the future is to gather more readily available data from the scientific community. As a result, this would make the data vastly more reliable as well as significantly increase the applicability of the said data.

6.2.2 Real Time Data

An additional feature that could be improved upon in streaming the data in real time. Currently, the application gathers data for a three hour period when prompted by the user and pressing 'Calibrate Data'. An improved implementation of this feature would incorporate the data being continuously streamed from the patient's device. Furthermore, this would also include a 'Start/Stop' feature although it could be implemented to stream during all hours of the day. As a result, this would produce more reliable data as well as help the patient's carer aid the patient in a much quicker fashion.

6.2.3 Suggested Features

As part of the usability testing, the group carried out a questionnaire in order to gather both quantitative and qualitative data in regards to the application. One of the suggested features included 'Allow a text message notification to be sent rather than an in-app notification'. Currently, the application only sends a notification to the carer which redirects the user to Google Maps and pins the patient's location. Other features included 'Make the login page less confusing' and 'Using a more reliable way of detecting an episode'.

User experience is extremely important when it comes to an application designed to improve the day to day life of the user. The ability to display profile images of users would allow for easier recognition by the patient. It is important to understand that a typical user of such an app could easily forget how to perform more complex interactions on a mobile device and even forget names of close friends and family. An image displaying the patient's carer always gives an immediate anchor for the user to focus on. It can also help deepen the existing carer-patient relationship. Displaying the images of patients can also be useful to carers that may have to look after many patients. To expand upon this, simple user created bios could also contribute to making the apps connection feel stronger.

Carer-patient relations can differ massively and that means that one notification system may not always fit all. Expanding the variety of communication systems integrated would allow for greater flexibility to users and thus lead to the application being useful in more cases. Methods that have been previously discussed such as mobile SMS and email and perhaps more experimental solutions such as a simple desktop application that alerts users that operate on a desktop often. Implementing as many notification outlets as possible then allows for the user to toggle each method in the app to their personal requirements.

Currently the application is more suited to family and friend carers that will typically only have to look after a single patient. Despite the functionality to be able to receive notifications from multiple users, there is no system in place to know what patients are connected to a single carer. To broaden the usefulness of the application, the ability to see the details of each patient connected to the carer would allow for easier management and more professional standards of caring.

Currently, the app lacks some level of connectivity between users. Having options that can be enabled by the carer that affects both the carer and patient as well as features such as showing when the user is online would help make connections feel closer and more personal. One feature that could contribute to this would be to have a check-in system that can be enabled by the carer. This would make the patient regularly check in to the app during certain hours and intervals that are determined by the carer. The ability to manage notification and monitoring hours would also be a useful feature for personalising experiences between different users.

An easier method of registering the user’s carer would be ideal. Currently the system is very much for demonstration purposes. A possible end solution would be to have either the carer or patient request to connect to a user by entering an easy to remember identifier such as username or email address. To make it more secure the requested user would have to accept the user before any further functionality would progress. Another method would be to have a randomly generated pairing code that can be entered by another user to connect the two users.

At present day, the application is extremely focused on delivering this one key functionality. However, the application could easily steer more towards an all in one carer app that embodies all the functionality that an Alzheimer’s patient would need in their day to day life. Integrating Outlook's calendar system and introducing a messaging system with bespoke features useful to carer-patient relations would be just some of the functionalities that could be implemented. It would be important to remember that emergency situations are the highest priority and so should always be the easiest and most obvious feature to access inside the application.

To summarise, the application's current state serves more to demonstrate the ability to have a carer-patient connection designed specifically for allowing quick and easy notification and responses to emergency situations. This is the foundation to an extremely strong idea for an application that seems to be underdeveloped in the mobile application world. There are currently not many user-friendly functions but can easily be added with this base design. The application also has the potential to be expanded upon to an even higher degree to make it an all in one application for Alzheimer’s patients or even be altered to accommodate different patients with different struggles in day to day life.

7.0 Professional, Social, Ethical and Legal Issues

All aspects of this project will be in accordance to the British Computer Society Code of Conduct (BCS, 2020) with regards to public interest the group will ensure to be mindful of public health, privacy, and wellbeing of others and the environment, the group will be free of discrimination on any grounds as this will be enforced by the Project Manager and Deputy Project Manager. No group member will undertake any tasks within the context of the project that is beyond their own skillset or capability, and if a member feels too heavily burdened or unable to complete a task, they will be offered help at every opportunity, this will be executed by having agreed roles prior as shown in the team responsibilities section, and being able to ask for help from a more confident member of their specific section. Each member will ensure to maintain a healthy level of awareness of relevant technological development, as this will ensure a better product and experience for Alzheimer's patients using the software developed by the group. All legislation will be followed and complied with at all stages.

Alternative viewpoints from any member of the group or otherwise will be valued, considered, and encouraged particularly with regards to criticism of the work, this will be ensured by consistently asking each member of the team for their input, and at no point will a member be belittled for their contribution. No group member or otherwise will come to harm either physically or mentally as a result of this project, and all unethical practices will be rejected, no testing will take place on an Alzheimer's patient as this could potentially cause harm and confusion to the patient. All professional responsibilities will be carried out in accordance to the relevant authority of our project, and a conflict of interest between the team and the relevant authority will be avoided and minimised, this may be for example between the team members and the Project Manager, or between the team and the Supervisor of the project.

No confidential information will be disclosed throughout the project as this will be a severe violation of any member of the group's privacy and will likely result in an ineffective team. No aspect of the project will be misrepresented from the supervisor of the project, for example test data which could therefore endanger an Alzheimer's patient if falsified or exaggerated test data if used in a real-world application. No vital information will be withheld, unless lawfully bound by confidentiality not to disclose the information in question.

As a duty to the profession, the group will uphold the reputation of the IT field and attempt only to improve the standards by adhering to the code of conduct particularly regarding discrimination and harm to others. All members will be treated with respect and should never feel belittled for expressing their opinion, but rather should be encouraged.

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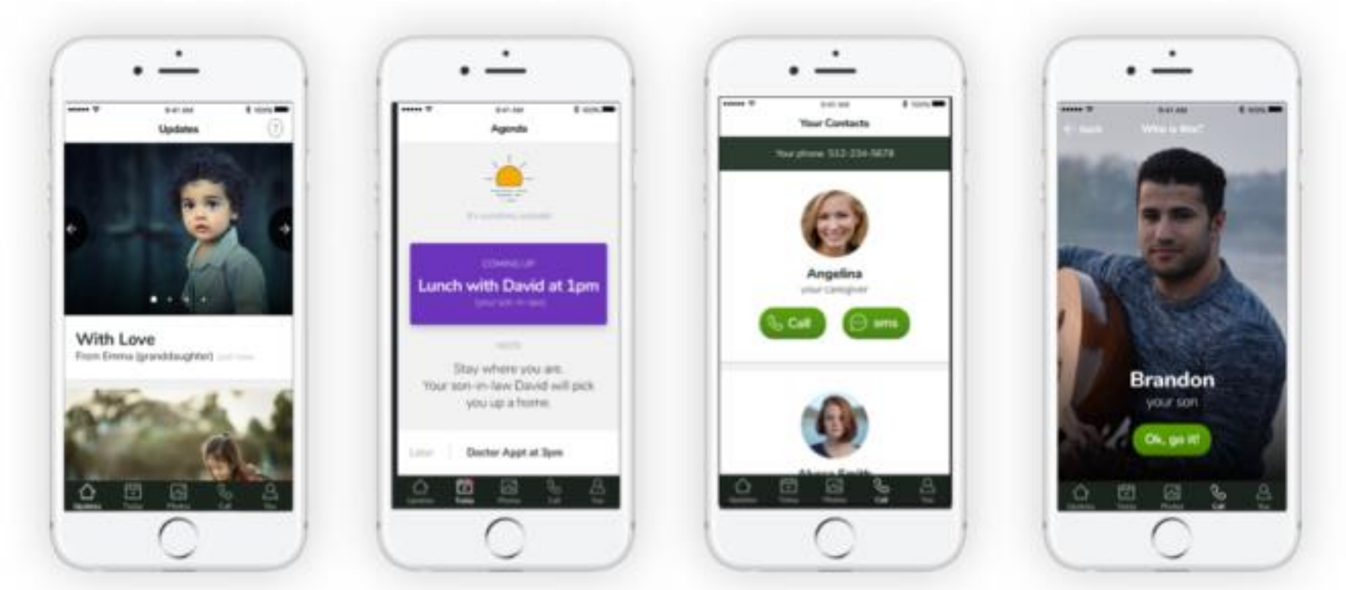
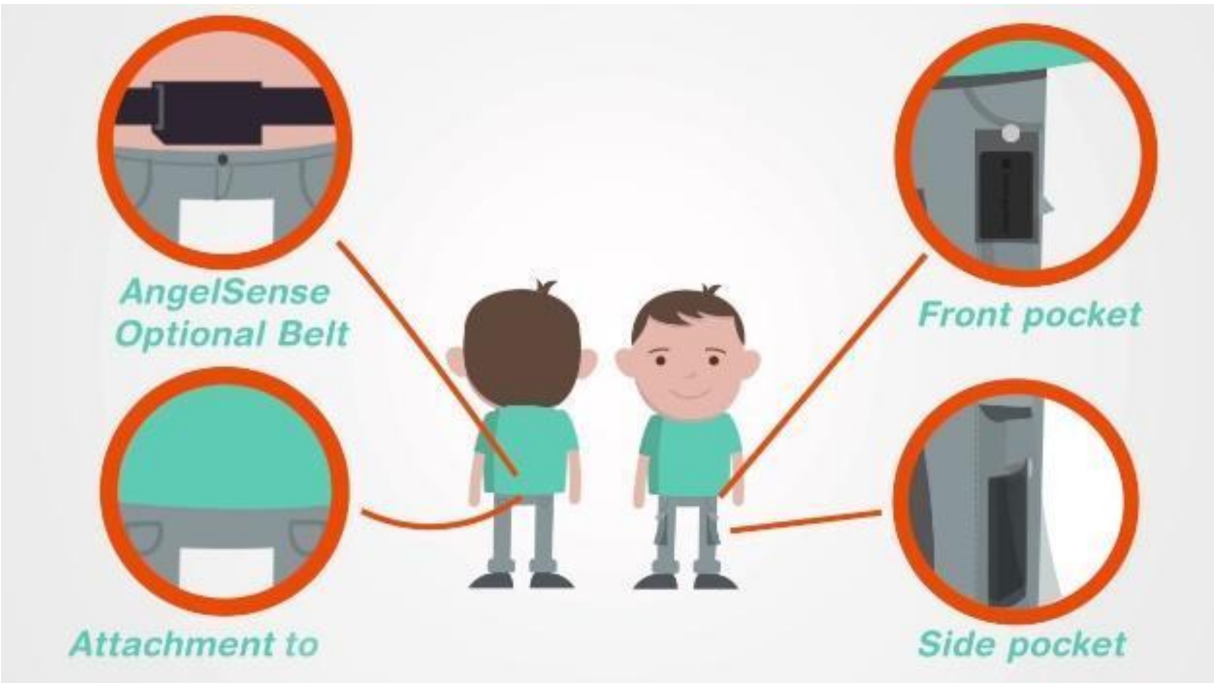
Appendices

Appendix 1 - Current Products





Appendix 2 - UML Diagrams

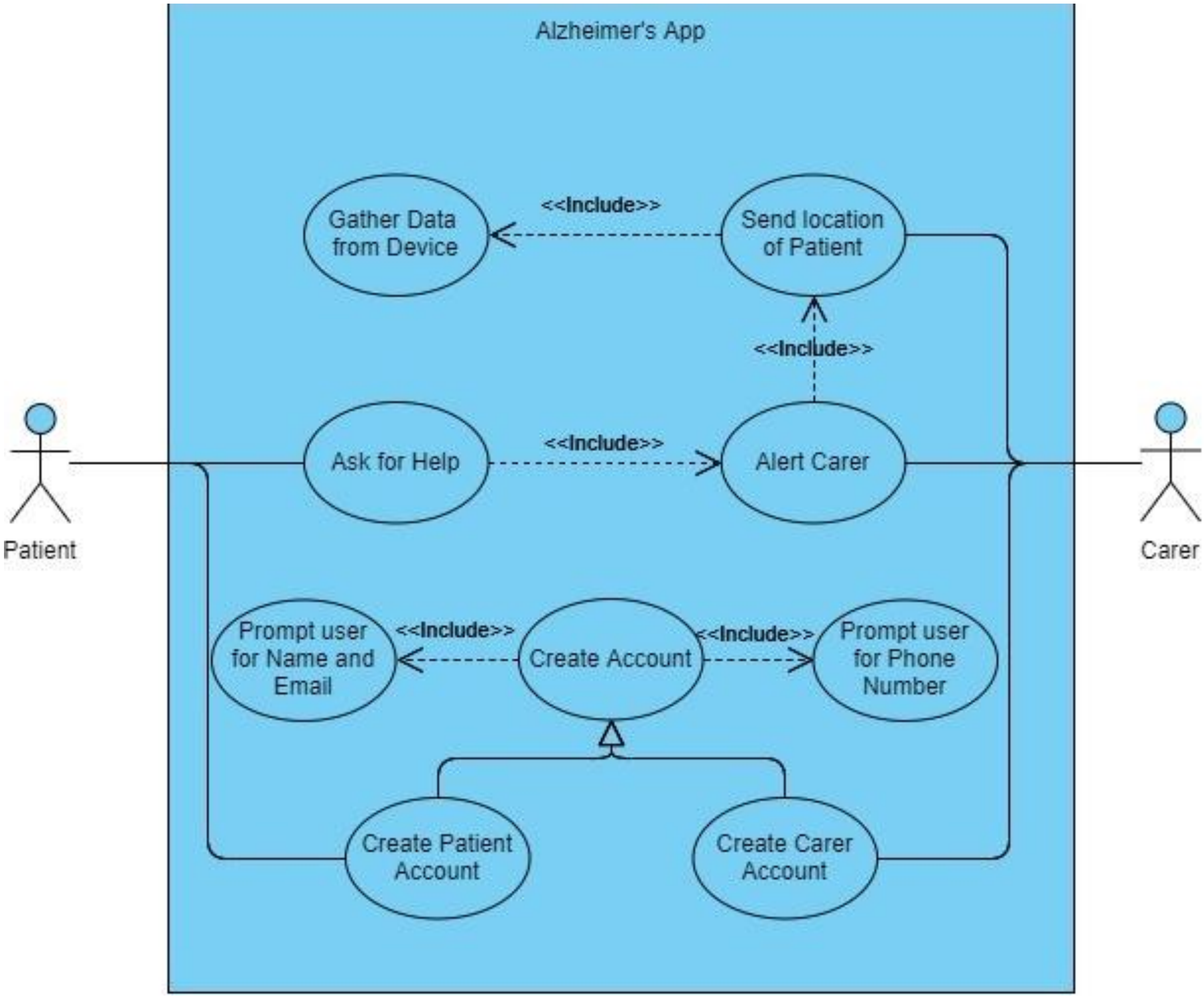


Figure 3 - Use Case Diagram

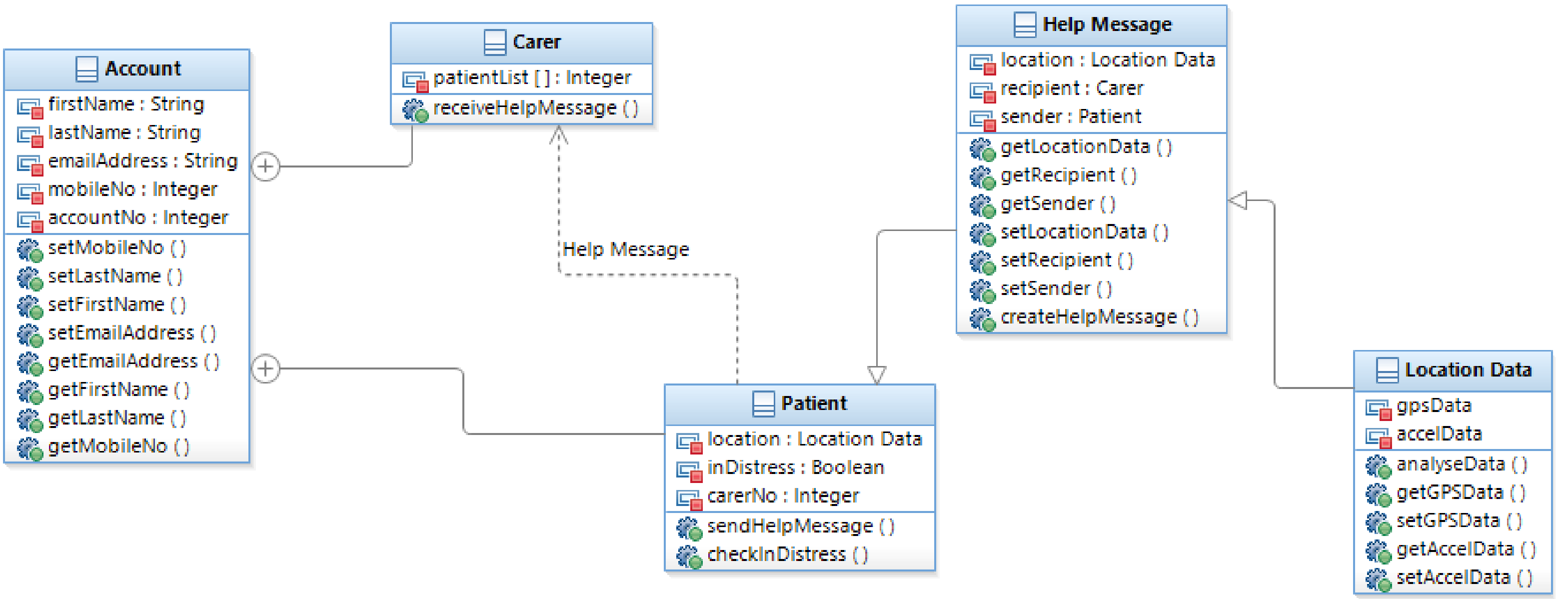


Figure 4 - Class Diagram

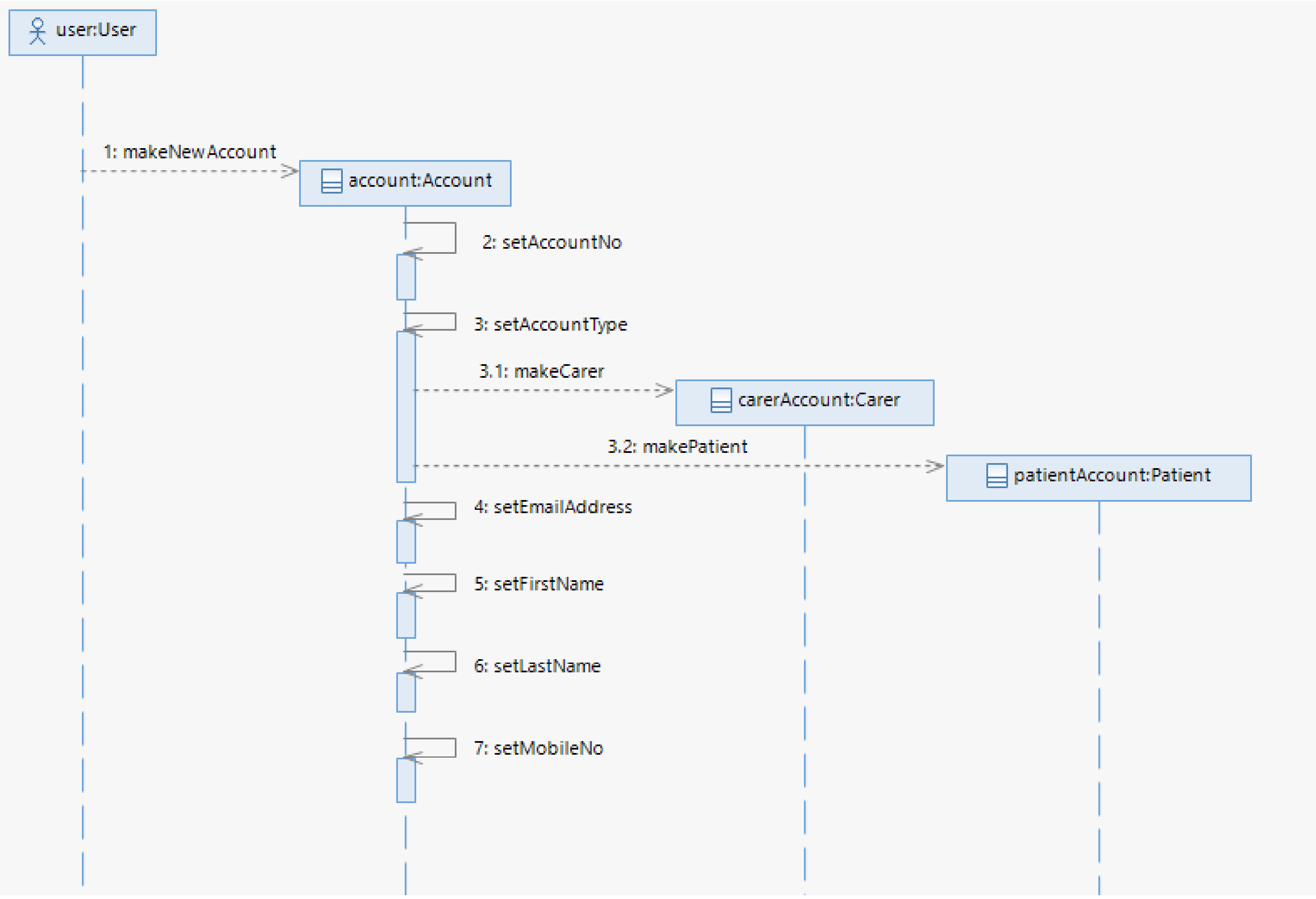


Figure 5 - Sequence Diagram A

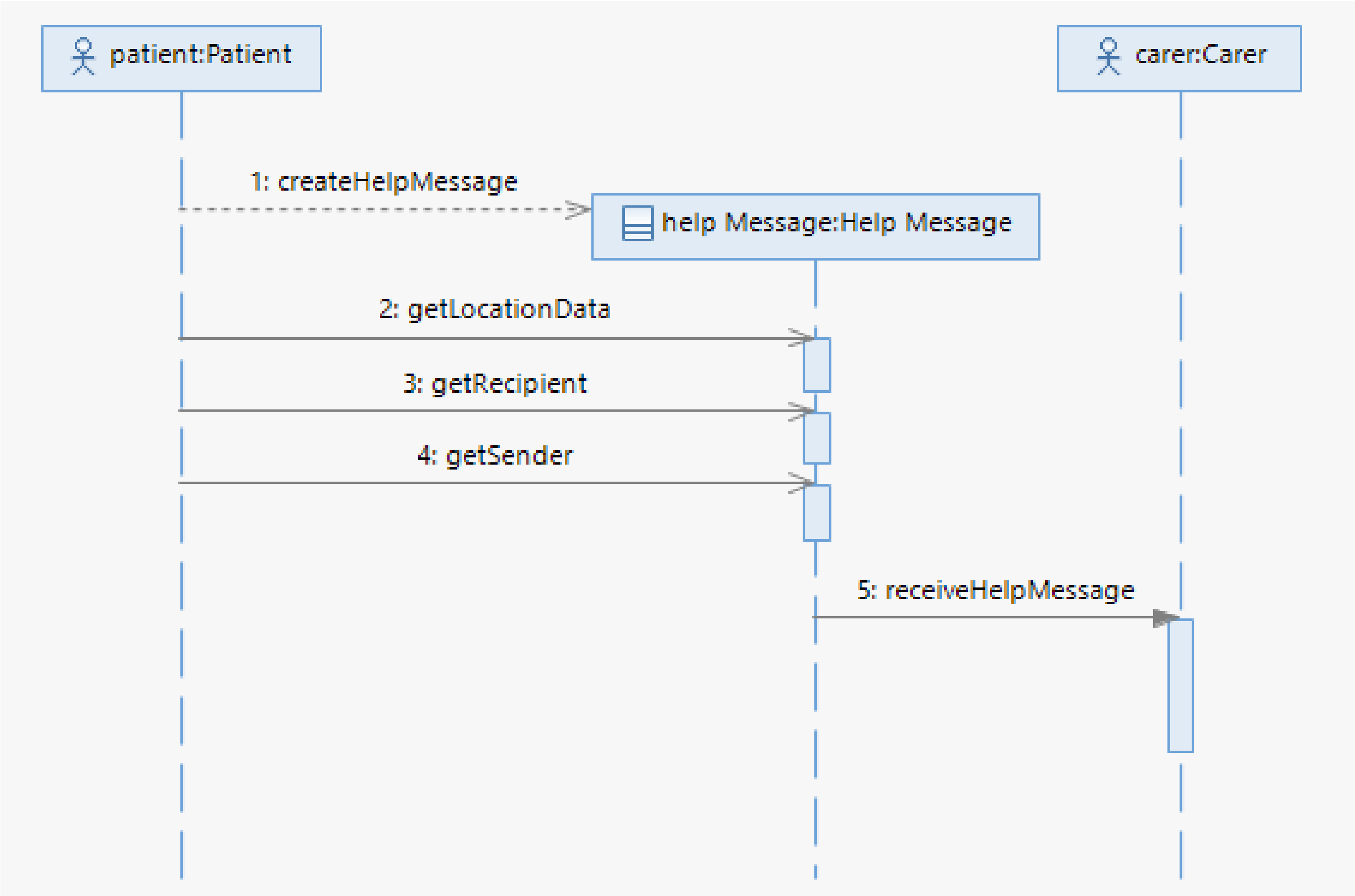


Figure 6 - Sequence Diagram B

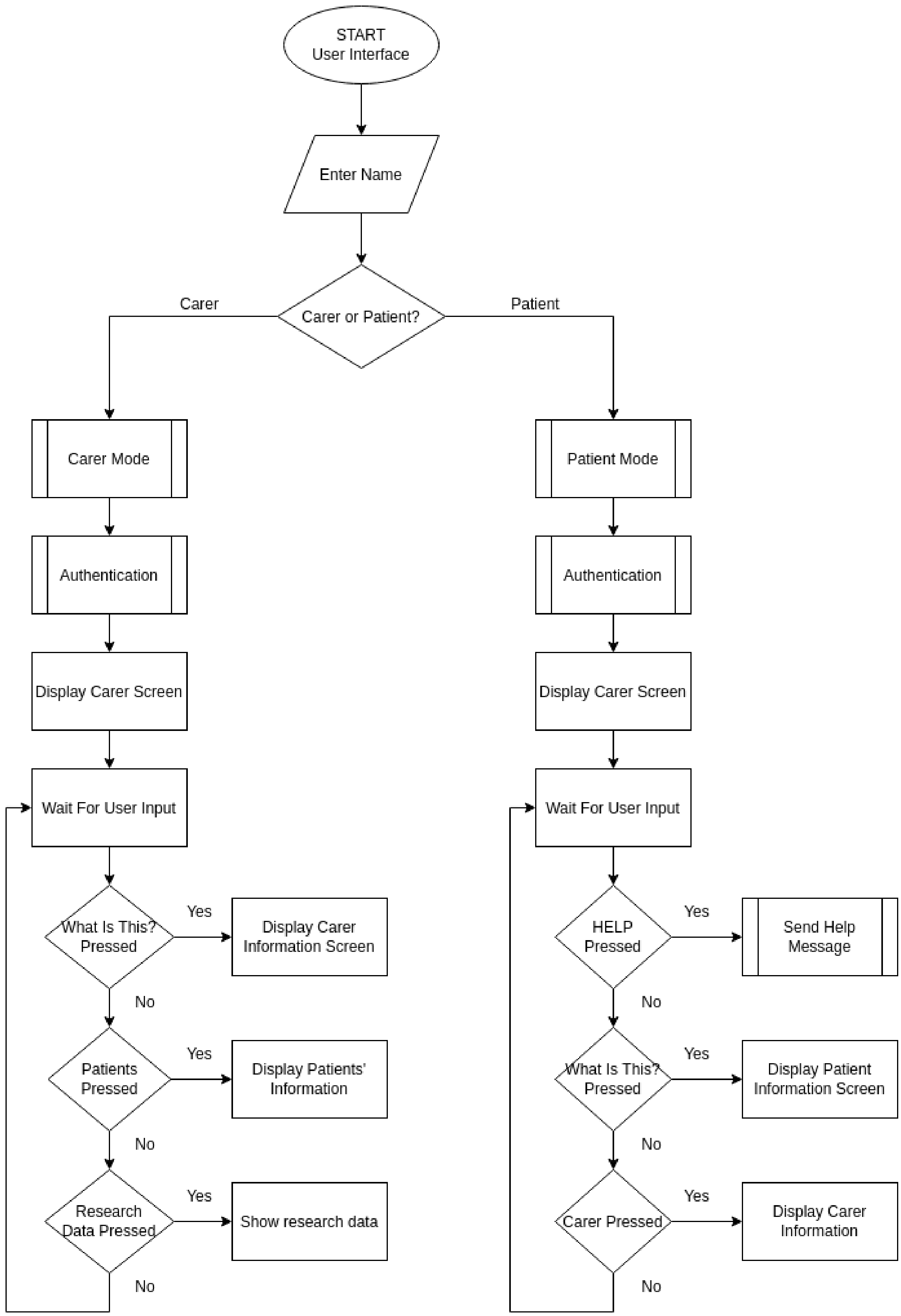


Figure 7 Flow Diagram

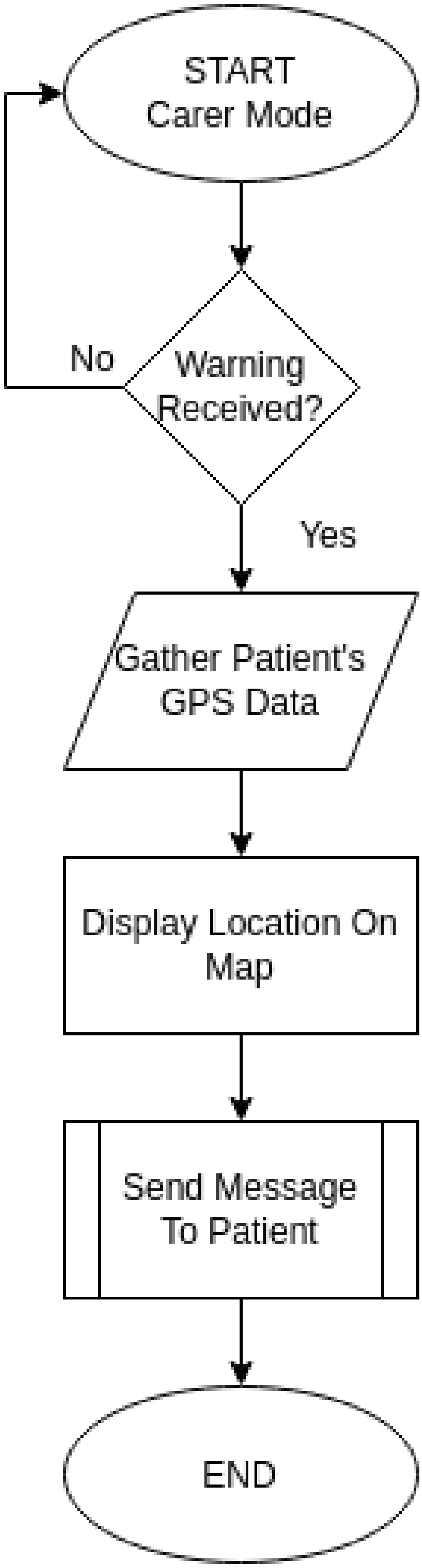


Figure 8 - Flow Diagram B

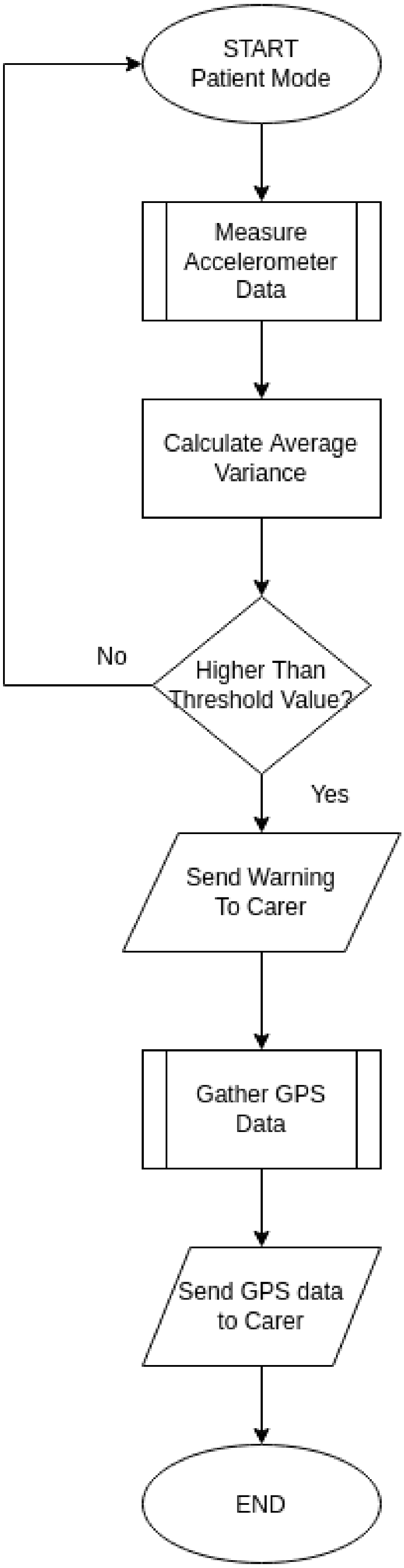


Figure 9 - Flow Diagram C

Appendix 3 - Black Box Testing

Functional Testing

#	Test	Expected Result	Actual Result	Pass/Fail	Fix
1	Home screen loads when first opening the app.	The home page should load when the app is first launched.	The home screen successfully loaded when launching the app.	Pass	N/A
2	Tapping the Google sign in button.	Upon tapping the Google sign in button, the user will be prompted to log in.	The Google sign in page successfully loaded, prompting the user to log in.	Pass	N/A
3	Signing in as a patient.	Upon entering a Google account, the user can sign in as a patient which will then display the patient home screen.	The patient home screen was successfully displayed.	Pass	N/A
4	Signing in as a carer.	Upon entering a Google account, the user can sign in as a carer which will then display the carer home screen.	The carer home screen was not successfully displayed, instead the patient home screen was displayed.	Fail	Solved a merge conflict which prevented the carer side from being accessible.
5	Pressing the ‘HELP’ button without a valid carer.	The ‘HELP’ button should then display a dialogue box informing the patient how to set their carer.	The ‘No Carer’ dialogue was correctly displayed with information on how to set the user’s carer.	Pass	N/A

6	Dismissing the ‘No Carer’ dialogue.	Upon pressing the ‘OK’ button on the dialogue, the ‘No Carer’ dialogue box should close, returning the patient to the patient home screen.	The ‘No Carer’ dialogue was correctly dismissed when the ‘OK’ button was pressed.	Pass	N/A
7	Pressing the ‘WHAT IS THIS?’ button.	Pressing the ‘WHAT IS THIS?’ button should display a dialogue box showing information about the application.	The ‘WHAT IS THIS?’ dialogue box was correctly displayed.	Pass	N/A
8	Dismissing the ‘WHAT IS THIS?’ dialogue.	The ‘WHAT IS THIS?’ dialogue box should be dismissable upon pressing the ‘OK’ button.	The ‘OK’ button was not present and therefore the dialogue box was not dismissable. However, pressing the back button on the device closed the dialogue. A patient may find this confusing.	Fail	Changed the dialogue to be dismissable.
9	Displaying a greeting message.	Upon logging in, the patient home screen should show “HELLO [patient name]” at the top of the patient home screen.	The patient home screen successfully displayed ‘HELLO Richard’ upon logging in.	Pass	N/A
10	The patient home screen should display all relevant buttons.	The patient home screen should show five buttons: Research Data, Help, Calibrate, What Is This?, and Carer.	The patient home screen correctly showed all buttons.	Pass	N/A

11	Pressing the ‘CARER’ button.	Pressing the ‘CARER’ button while on the patient home screen should show the carer information screen.	The carer information screen was successfully displayed.	Pass	N/A
12	Pressing the ‘CARER DETAILS’ button without an assigned carer.	Pressing the ‘CARER DETAILS’ button should prompt the patient to enter their carer’s ID number.	Pressing the ‘CARER DETAILS’ button prompted the patient to enter their carer’s ID number.	Pass	N/A
13	Dismissing the ‘Enter carer ID’ dialogue box.	Pressing the ‘Cancel’ button should dismiss the ‘Enter carer ID’ dialogue box.	Pressing the ‘Cancel’ button dismisses the dialogue box correctly.	Pass	N/A
14	Entering the carer ID into the ‘Enter carer ID’ dialogue box.	Typing in the carer ID and pressing the ‘OK’ button should set the current carer.	Typing in the ID did nothing, the current carer was not set.	Fail	Added the carer ID to the database and then set the ID in the application.
15	Navigating back to the patient home screen from the ‘Carer details’.	Tapping the back button to return from the ‘Carer details’ screen back to the patient hoe screen.	Tapping the back button returns the user to the patient screen.	Pass	N/A
16	Pressing the ‘CALIBRATE’ button.	Pressing the ‘CALIBRATE’ button should open a file selection menu which will only load .csv files.	Pressing the ‘CALIBRATE’ button successfully opened the file selection menu, showing all possible .csv files.	Pass	N/A

17	Selecting a .csv file to calibrate.	Selecting the calibration .csv file should display a dialogue box showing that the calibration is taking place.	The dialogue box was correctly displayed, showing that a file was being loaded for calibration.	Pass	N/A
18	Pressing the ‘RESEARCH DATA’ button.	Pressing the ‘RESEARCH DATA’ button should open a file selection menu which will only load .csv files.	Pressing the ‘RESEARCH DATA’ successfully opened the file selection menu, showing all possible .csv files.	Pass	N/A
19	Pressing the ‘WHAT IS THIS?’ button on the carer home screen.	Pressing the ‘WHAT IS THIS?’ button should show useful information about the application in the context of the carer.	Pressing the ‘WHAT IS THIS?’ button displayed the dialogue box correctly.	Pass	N/A
20	Pressing the ‘PATIENTS’ button on the carer side of the application.	Pressing the ‘PATIENTS’ button should show the carer a dialogue box with a list of their assigned patients.	Pressing the ‘PATIENTS’ button did not show a dialogue box at all.	Fail	Added a dialogue box which showed assigned patients.
21	Opening a .csv file for calibration.	The application should open a premade .csv file and calculate a threshold value of 1.1125 (5 significant figures) based on this data.	The application correctly calculated the threshold value with a suitable degree of accuracy.	Pass	N/A

22	Opening a .csv file with normal movement.	The application should open a premade .csv file containing typical movements which should not trigger an alert to be sent to the carer.	The application successfully loaded the .csv file and did not detect an episode, and therefore did not send an alert.	Pass	N/A
23	Opening a .csv file with erratic movement.	The application should open a premade .csv file containing atypical movements which would be considered erratic. This should trigger an alert to be sent to the carer.	The application successfully loaded the .csv file and detected an episode. The application then informed the patient that the alert was sent to the carer.	Pass	N/A
24	Receiving an alert from the carer side.	The application should receive the alert on the carer side after an episode is detected and/or the 'HELP' button is pressed.	The carer side successfully received the alert from the patient when an episode was detected or the 'HELP' button was pressed.	Pass	N/A
25	Receiving the GPS position of the patient.	The carer side should receive the GPS data from the patient in the form of a dialogue box.	The carer side successfully received the GPS data from the patient when an episode was detected.	Pass	N/A
26	Loading Google Maps when an episode is detected.	When an episode is detected, the carer side should launch straight into Google Maps when opened.	The application successfully launched into Google Maps when an episode was detected.	Pass	N/A

27	Placing a pin for the location of the patient in Google Maps	When an episode is detected and Google Maps is opened, the exact location of the patient should be pinpointed on the map.	The application successfully placed a pin in the exact location of the patient, though sometimes this was inaccurate and only showed the most recent known location.	Partial	No fix available, this is simply a limitation of the technology involved in GPS location services. Should a patient not have signal, location will be inaccurate.
28	Opening a .csv file on a smartphone running Android 10.	When attempting to open a .csv file on a smartphone running Android 10, the application should successfully read the data as with other versions of Android.	The application caught an exception when attempting to open a .csv file on Android 10.	Fail	Use Android 9 or previous, This can be resolved by changing the file handling to the newer version, however this is not appropriate in this situation as most developers use devices running Android 9.
29	Pressing the 'HELP' button from the patient's side.	Pressing the 'HELP' button should alert the carer that the patient is having an episode.	Pressing the 'HELP' button successfully triggered an alert, sending the GPS data as when an episode was detected using the .csv files.	Pass	N/A

30	Pressing the 'WHAT IS THIS?' button on the patient's side.	Pressing the 'WHAT IS THIS?' button should display relevant information to the patient, such as how to use the application.	Pressing the 'WHAT IS THIS?' button displayed an unpopulated dialogue box.	Fail	Populated the dialogue box with relevant information that the patient would find useful.
31	Pressing the 'WHAT IS THIS?' button on the carer's side.	Pressing the 'WHAT IS THIS?' button should display relevant information to the carer, such as how to use the application.	Pressing the 'WHAT IS THIS?' button displayed an unpopulated dialogue box.	Fail	Populated the dialogue box with relevant information that the carer would find useful.

Figure 17 - Functional Testing Table

Appendix 4 - Survey Responses

How visually appealing is the application?

8 responses

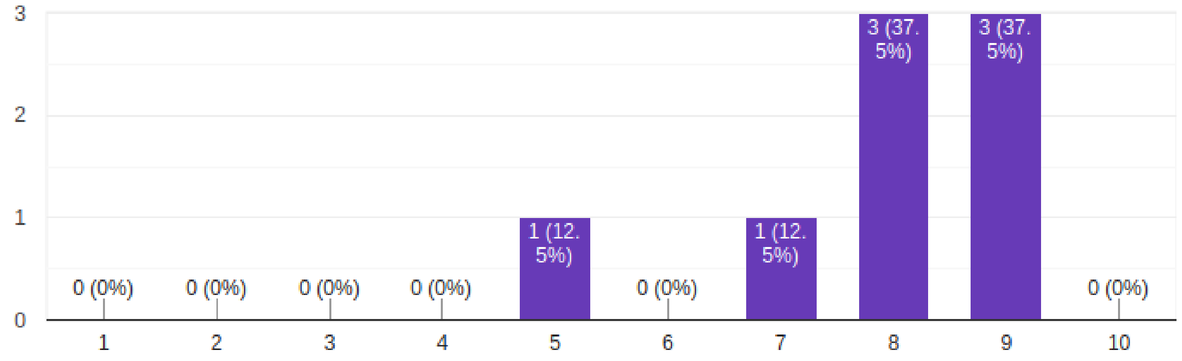


Figure 18 - Question 1

The first question that was asked was "How visually appealing is the application?", this was asked on a scale of one to ten with one being visually unappealing and ten being very visually appealing. The above responses show that overall, the visual aspect of the application received praise. With 87.5% of all responses falling in the seven and above range of the scale, the median response being eight. This shows therefore that other than the singular outlier of five, the overall consensus is positive for the visual aspect of the application.

How easy to navigate is the application?

8 responses

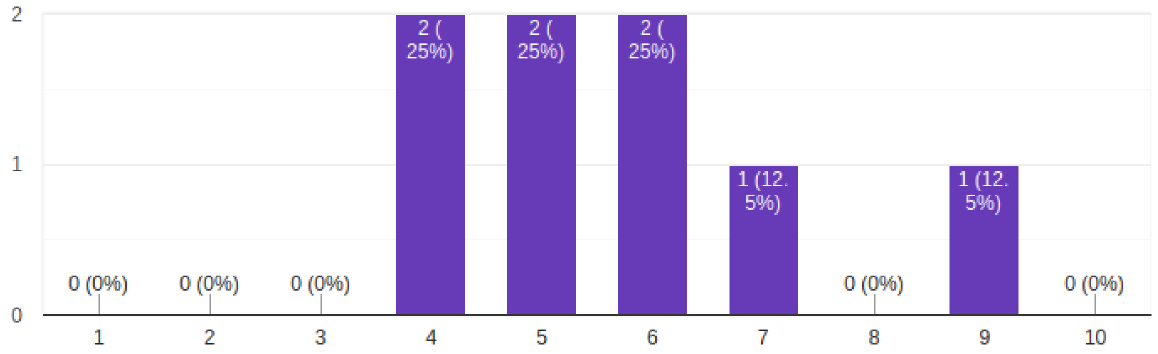


Figure 19 - Question 2

The next question asked was “How easy to navigate is the application?” on a scale of one to ten, with one being extremely difficult and ten being very simple. The overall responses indicated a lukewarm reaction to the user friendliness of this application, showing that the application layout is in need of revision. This in conjunction with the answer to question 7 which states that the login page should be less confusing indicates therefore that the login page may be the culprit, and thus further investigation should be taken into this. The mean response to this question was 5.75, and the median response was 5.5, further demonstrating that the usability of the application requires improvement.

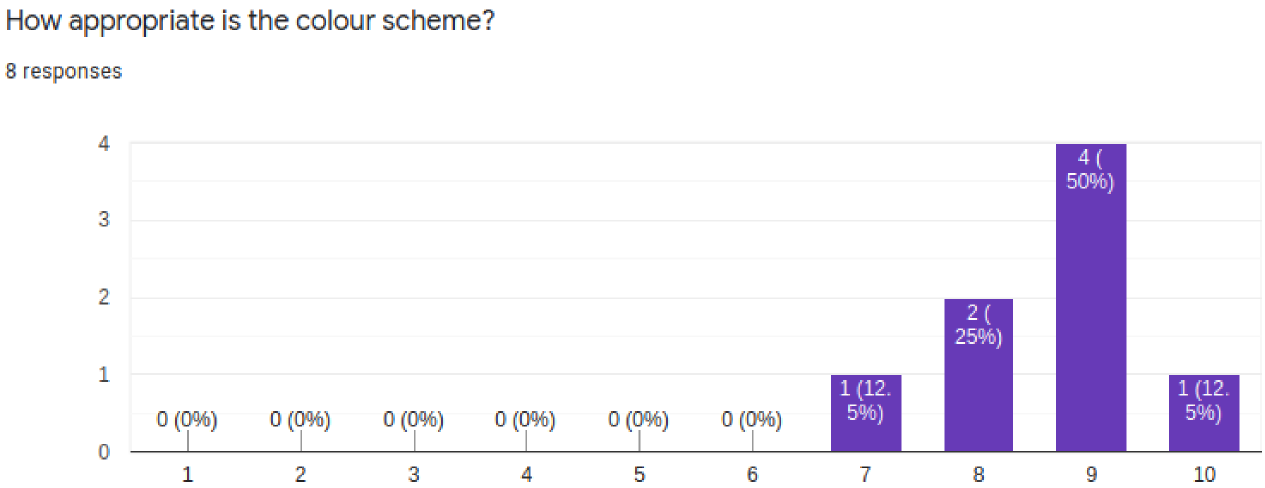


Figure 20 - Question 3

The next question asked was “How appropriate is the colour scheme?” on a scale of one to ten, with one being extremely inappropriate and difficult to view, and ten being very suitable and easy to view. All responses fell within the seven and above category, with the mean average result being 8.625 and the median result being 9. This overall showed that the colour scheme was user friendly and simple to use, while also being visually appealing.

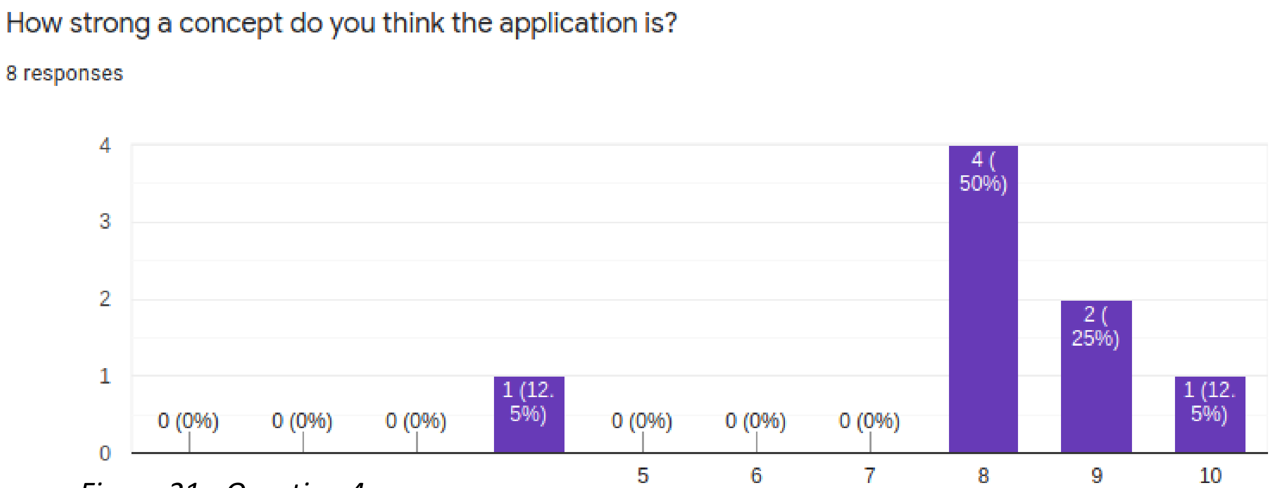


Figure 21 - Question 4

The fourth question asked “How strong a concept do you think the application is?” on a scale of one to ten, with one being a very weak concept and ten being a very strong concept. Overall, the responses tended to be very enthusiastic about the potential for this type of application, with all but one response falling in the range of 8 and above. One response gave a score of only four, indicating that the idea may not be very strong, however as the vast majority of responses indicated the contrary, it can be concluded that this is a more than reasonable concept. The mean average response was 7.625, and the median response was 8.

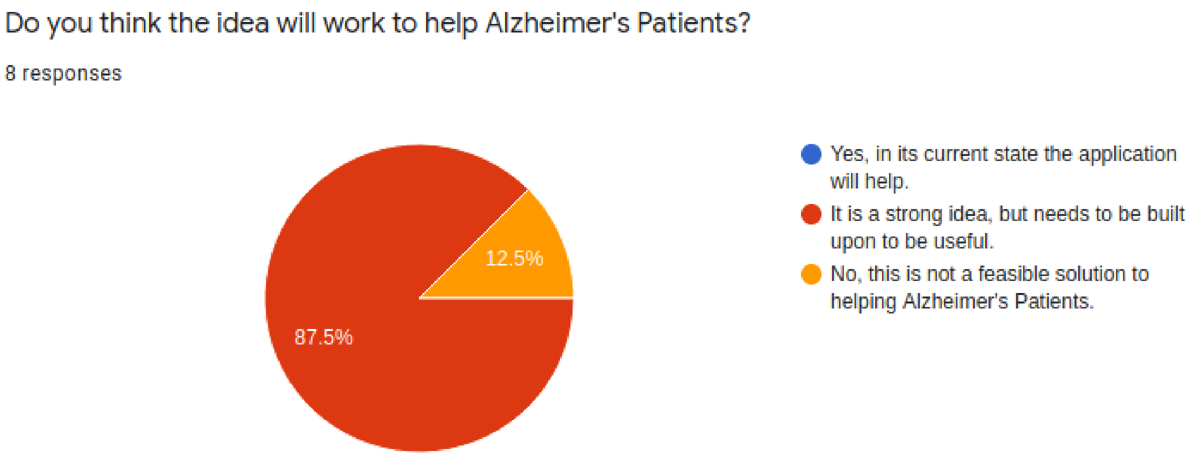


Figure 22 - Question 5

The fifth question asked “Do you think this idea will work to help Alzheimer’s Patients?”, with a choice between: yes, no, and yes with some improvements. The vast majority of responses stated that the idea will work, however the current implementation of the application is not suitable for use. This is a fair response, as the application is a proof of concept.

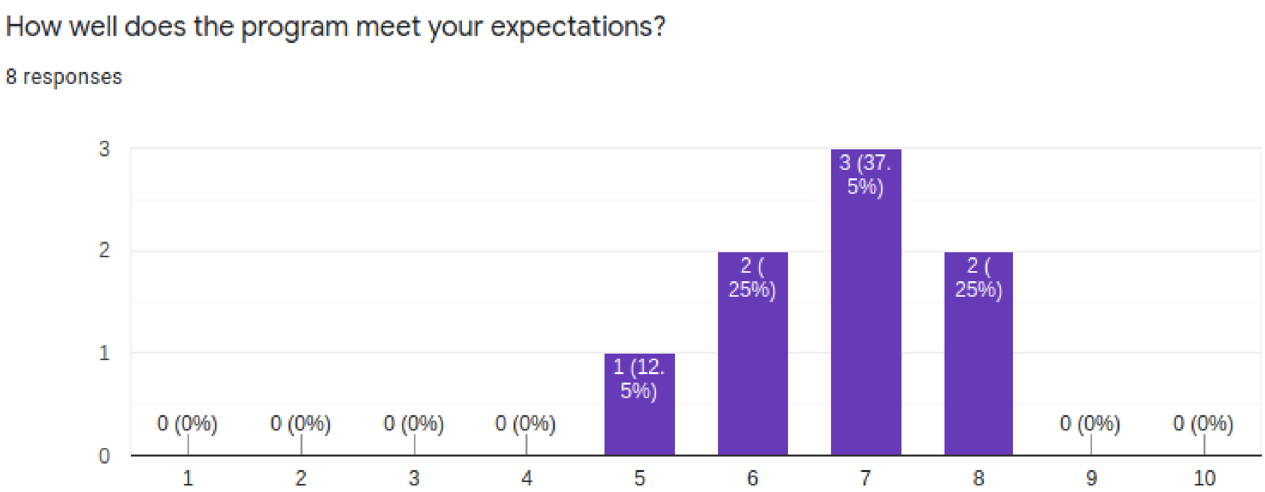


Figure 23 - Question 6

The next question asked "How well does the program meet your expectations?", asked on a scale of one to ten, with one being not at all, and ten being absolutely meeting or exceeding. This overall received positive responses, with a general consensus leaning towards positivity. This can likely be explained by the current limitations of the technology, as data with the device used cannot be streamed in real time between the patient and carer. This is further indicated by the responses to question 7, which suggest streaming data live from the device to the application, however as the program is a proof of concept the implementation is satisfactory.

Are there any features of the application you would change or add?

5 responses

The ability to stream data live between the patient and carer.

Allow a text message notification to be sent rather than an in-app notification

using a more reliable way of detecting an episode

should send live data on the alzheimer's patients' movements not just loading a premade file

Make the log in page less confusing

Figure 24 - Question 7

Overall suggestions for the application were valid responses which raise legitimate concerns. The program is currently a proof of concept application intended to be built upon by the scientific community when more advanced technology and peer-reviewed data can be used, rather than the current implementation.

Appendix 5 - Meeting Minutes

Meeting 1 - Supervision Session		
Date: 18/11/19	**Time:** 5pm-5:30pm	**Location:** ABK215
Attendees: Richard, Irena, Stephen, Nathan		
Discussion: Decided on an initial topic in the field of neurology, with specific reference to Alzheimer's patients and helping them with assisted technology. Sent away each member to research the task and produce a presentation with research into each area.		

Meeting 2 - General		
Date: 21/11/19	**Time:** 12pm-1pm	**Location:** Library
Attendees: Richard, Irena, Stephen, Nathan		
Discussion: Caught up with each group member, created a group chat and put initial ideas into a group presentation on Google docs. Continued to work on each initial idea.		

Meeting 3 - Supervision Session		
Date: 02/12/19	**Time:** 5pm-5:30pm	**Location:** ABK215
Attendees: Richard, Irena, Stephen, Sam, Nathan		
Discussion: Delivered presentation, deepened understanding of the task ahead and became familiarised with the device that we will use for the future of this project.		

Meeting 4 - Discord Meeting		
Date: 21/12/19	**Time:** 1pm-2pm	**Location:** Home
Attendees: Richard, Irena, Stephen, Sam, Nathan		

Discussion: Assigned sections for the project definition according to the specification. Introduction & research: Nathan Aims & objectives: Irena Team members & responsibilities: Emerson Sources of information: Stephen Risk assessment: Irena Project Plan: Sam Project management: Richard Legal, social, & ethical issues: Richard

Meeting 5 - Supervision Session		
Date: 13/01/20	**Time:** 5pm-5:30pm	**Location:** ABK21
Attendees: Richard, Irena, Stephen, Sam, Nathan, Emerson		
Discussion: Delivered project definition, discussed how to proceed in terms of development. Laid a basic groundwork to have everyone focus on a specific aspect of either documentation or development. All members informed to install and familiarise themselves with Android studio.		

Meeting 6 - General		
Date: 30/01/20	**Time:** 12pm-1pm	**Location:** The Point, Upstairs
Attendees: Richard, Irena, Stephen, Sam, Nathan		
Discussion: Richard clarifies project goals, including that we are aiming to only use accelerometer data from the device which is a priority and GPS is the next priority. States that it is time to start the design phase and distributes tasks. Assigns Nathan UI Mock-UP. Assigns GPS data gathering techniques research to himself and Stephen. Assigns extrapolation of the research papers to Irena and Nathan and the use case diagram to Sam. Assigns ERD to Emerson and tells everyone to use Android Studio. Stephen needs to gather examples of accelerometer data of everyday movements. Nathan clarifies that GPS needs to be used to send location to carer. Suggests step 1 should be creation of UI and basic help button that the patient can press manually. Says that the group needs to understand what they are using for app development and to understand limitations before UI mock-up can be created. Suggests that it's important to research technical solutions. Sam clarifies that what the group is aiming for is proof of concept. Irena gathers all UML diagrams and so they can be distributed throughout the group. Irena emails the supervisor to clarify milestones as well as what is expected in the interim review.		

Meeting 7 - General		
Date: 06/02/2020	**Time:** 1pm-2pm	**Location:** Library
Attendees: Richard, Irena, Stephen, Sam, Nathan, Emerson		
Discussion: Richard says that the group should make a start on developing the program. He asks the group members to do the following: Sam and Stephen to oversee developing the backend, Nathan if he would like to do the GUI, Irena to continue working on the documentation; Emerson to create a flow diagram; group members to join the Slack and suggests using GitHub for development. Nathan suggests working on the frontend and backend simultaneously. Stephen suggests splitting backend functionality into gathering data, the email system and the account system. Irena says she will research the best method for the carer contacting.		

Meeting 8 - General		
Date: 13/02/20	**Time:** 1pm-2pm	**Location:** The Point, Upstairs
Attendees: Richard, Irena, Stephen, Nathan		
Discussion: Richard checks to see whether every member of the group has signed up for overleaf and asks for an update in regards to the literature review. Irena says that she has completed one of the papers given for the literary review. Stephen asks if anyone would like to attend the press conference. Nathan confirms that the UI is being worked on and aims for the UI to be done for the end of the week. Confirmation from the last two members is needed as to whether they are going for the conference.		

Meeting 9 - Supervision (Interim Review)		
Date: 24/02/20	**Time:** 5pm-5:30pm	**Location:** ABK215
Attendees: Richard, Irena, Stephen, Sam, Nathan		
Discussion: Talked through progress on development, showed that the application is in a working state and can detect when an episode is occurring. Mufti suggests that we should include calibration, simulate data being streamed as it is not currently possible with the device, showing the location of the patient on the map, SMS and push notification functionality when an episode is detected, and a database allowing the details of the patient and carer to be stored. Tasks were divided accordingly: Maps and locations: Stephen Calibration and stream simulation: Richard SMS and push notifications: Sam Database: Nathan		

Meeting 10 - Supervision		
Date: 05/03/20	**Time:** 3:30pm-4pm	**Location:** ABK215
Attendees: Richard, Irena, Stephen, Sam, Nathan		
Discussion: General updates on progress, demonstrating the current state of the application. Maps successfully load, calibration works successfully along with hardcoded file handling. Nathan is still working on the database, Sam is still working on push notifications. Conference likely to be extended due to outbreak of coronavirus, deadlines established as programming finished on March 15th, and draft report to be handed in April 14th. File handling will be fixed by Richard, Stephen, and Irena. Simulated streamed data will be created by Richard, Sam and Nathan will continue working on notifications and accounts.		

Meeting 11 - Supervision		
Date: 16/03/20	**Time:** 5pm-5:30pm	**Location:** ABK215
Attendees: Richard, Irena, Stephen, Sam, Nathan		
Discussion: All features of the application work, just need merging with each other. Deadline extended due to COVID-19, face to face lectures suspended for the time being. Continue working on report (Richard, Irena) and merge program (Nathan, Stephen, Sam)		

Meeting 12 - Supervision		
Date: 06/04/20	**Time:** 5pm-5:30pm	**Location:** Microsoft Teams
Attendees: Richard, Irena, Stephen, Sam, Nathan		
Discussion: General update on the current state of affairs, decided that the conference paper should not be submitted alongside the module report due to other deadlines and time constraints, however will be completed before the 1st of June. Generally positive report in terms of how far development has gone, continue working on accounts (Nathan/Sam), merging (Stephen), and report (Irena/Richard)		