

**PUBLIC TRANSPORTATION SYSTEM ASSISTING THE ELDERLY AND  
HANDICAPPED (GUIDANCE AND MONITORING MODULE)**

By

Tan De Zhern

A REPORT

SUBMITTED TO

Universiti Tunku Abdul Rahman

in partial fulfilment of the requirements

for the degree of

**BACHELOR OF COMPUTER SCIENCE (HONS)**

Faculty of Information and Communication Technology

(Perak Campus)

JAN 2016

UNIVERSITI TUNKU ABDUL RAHMAN

**REPORT STATUS DECLARATION FORM**

**Title:** Public Transportation System Assisting the Elderly and Handicapped (Guidance and Monitoring Module)

**Academic Session:** Jan 2016

I \_\_\_\_\_  
TAN DE ZHERN  
(CAPITAL LETTER)

declare that I allow this Final Year Project Report to be kept in

Universiti Tunku Abdul Rahman Library subject to the regulations as follows:

1. The dissertation is a property of the Library.
2. The Library is allowed to make copies of this dissertation for academic purposes.

Verified by,

\_\_\_\_\_  
(Author's signature)

\_\_\_\_\_  
(Supervisor's signature)

**Address:**

5, Jalan Pengkalan Barat 42

Taman Pengkalan Jaya

31650, Ipoh, Perak

\_\_\_\_\_  
Supervisor's name

**Date:** \_\_\_\_\_

**Date:** \_\_\_\_\_

**PUBLIC TRANSPORTATION SYSTEM ASSISTING THE ELDERLY AND  
HANDICAPPED (GUIDANCE AND MONITORING MODULE)**

By

Tan De Zhern

A REPORT

SUBMITTED TO

Universiti Tunku Abdul Rahman

in partial fulfilment of the requirements

for the degree of

**BACHELOR OF COMPUTER SCIENCE (HONS)**

Faculty of Information and Communication Technology

(Perak Campus)

JAN 2016

## **DECLARATION OF ORIGINALITY**

I declare that this report entitled “**PUBLIC TRANSPORTATION SYSTEM ASSISTING THE ELDERLY AND HANDICAPPED (GUIDANCE AND MONITORING MODULE)**” is my own work except as cited in the references. The report has not been accepted for any degree and is not being submitted concurrently in candidature for any degree or other award.

Signature : \_\_\_\_\_

Name : \_\_\_\_\_

Date : \_\_\_\_\_

## **ACKNOWLEDGEMENTS**

First off, I would like to express my heartfelt thanks to everyone who has supported me during the development of this project. I would like to appreciation to my supervisor, Mr.Tan Teik Boon who has guided me throughout the course of development of this mobile application project. His insights and inputs has played a huge influence in guiding me towards the completion of this project.

Next, I would like to thank my family, especially my mother for the unconditional support and encouragement she has given to me during my years of pursuing of my higher studies. Lastly, I would like to extend my sincerest gratitude to UTAR and my fellow comrades who had supported me during the development of this project.

## ABSTRACTS

In this project, the author explored various technologies to develop a smartphone application that greatly benefits the elderly and handicapped community all over the world. The elderly and handicapped faces several problems in their daily lives such as being unable to travel independently, prone to wandering out of their homes and getting lost and also unable to receive help immediately when in an emergency situation. This project consists of three core modules, each designed to tackle each of the problems mentioned.

The first module is the Voice Guided Navigation module that lets the users plan their journey to a specific destination using public transportation. This module generates the optimal route and travel times as well as display the buses' names and buses' arrival times and so forth. This module will also guide the user to their destination and notify them when the bus arrived or when to get off the bus.

Next, the Automated Boundary Monitoring module serves to track the user as they move out of a pre-defined geographical location such as their home. The location of the user will be tracked and an alert will be sent to their family members along with their current location. This will allow the family members of the user to find them easily if they are lost or uncontactable.

The third and last main module is the Fall Detection module that attempts to detect if the user has fallen down or unconscious with the accelerometer sensor of the user's smartphone. When an unusual movement is detected, the module will ask the user to respond if they are all right within a certain period. Otherwise, the module will automatically send a distress message along with the location of the user to the family members of user. The user can also send the distress message manually.

In a nutshell, the final deliverable of this entire project will greatly benefit the elderly and handicapped in many areas of their lives.

# TABLE OF CONTENTS

TITLE .....	i
ACKNOWLEDGEMENTS .....	v
ABSTRACTS .....	vi
TABLE OF CONTENTS.....	vii
LIST OF TABLES .....	x
LIST OF FIGURES .....	xi
CHAPTER 1 INTRODUCTION .....	1
1.1 Problem Statement .....	1
1.2 Background .....	2
1.3 Motivation .....	2
1.3 Project Objectives .....	3
1.4 Proposed Approach .....	3
1.5 Achievement.....	5
1.6 Report Organization .....	5
CHAPTER 2 LITERATURE REVIEW .....	6
2.1 Overview .....	6
2.2 Public Transportation Needs .....	6
2.3 Fall Detection Systems.....	8
2.4 Review of Existing System .....	10
2.4.1 GeorgiePhone .....	10
2.4.2 RayApp.....	12
2.4.3 Simple Senior Phone .....	14
2.5 Strength and Limitation of Existing System .....	16
2.5.1 Georgie Phone .....	16
2.5.2 RAY APP for Visually Impaired.....	16
Bachelor of Computer Science(Hons)	
Faculty of Information and Communication Technology (Perak Campus), UTAR	vii

2.5.3 Simple Senior Phone .....	16
2.6 Conclusion.....	17
CHAPTER 3 SYSTEM DESIGN.....	18
3.1 User Requirements.....	18
3.2 System Overview .....	20
3.3 System Architecture Diagram .....	20
3.3 Use Case Diagrams .....	21
3.4 Use Case Descriptions.....	22
3.4 System Flow Diagram.....	30
3.4.1 Voice Guided Navigation Module.....	30
3.4.2 Automated Boundary Monitoring Module .....	31
3.4.3 Fall Detection Module .....	32
3.5 System Functionality and Overview .....	33
3.5.1 Voice Guided Navigation Module.....	33
3.5.1.1 Guide Module .....	33
3.5.1.2 Screenshots of Module .....	35
3.5.2 Automated Boundary Detection Module.....	38
3.5.2.1 Track Module .....	38
3.5.2.2 Screenshots of Module .....	40
3.5.3 Fall Detection .....	41
3.5.3.1 Alert Module.....	41
3.5.3.2 Screenshots of Module .....	43
CHAPTER 4 METHODOLOGY AND TOOLS.....	44
4.1 Methodology.....	44
4.2 Tools to Use .....	45
4.2.1 Software.....	45
4.2.2 Hardware .....	45



CHAPTER 5 IMPLEMENTATION AND TESTING .....	47
CHAPTER 6 CONCLUSION.....	54
6.1 Project Review, Discussions and Conclusions.....	54
6.2 Novelties and Contributions.....	55
6.3 Implementation Issues and Challenges .....	55
6.4 Future Work .....	56
BIBLIOGRAPHY .....	57
APPENDIX A WEEKLY REPORT.....	A-1
APPENDIX B SUPERVISORS COMMENTS ON TURNITIN ORIGINALITY REPORT .....	B-1

## **LIST OF TABLES**

<b>TABLE</b>	<b>TITLE</b>	<b>PAGE</b>
2.1	Comparison table for existing systems	15
3.1	User requirements for Navigation module	18
3.2	User requirements for Tracking module	19
3.3	User requirements for Alert module	19
4.1	Computer Hardware Specification	45
4.2	Smart Device Hardware Specification	46
5.1	Features to be Tested	47
5.2	Testing Table of Navigate New Location	48
5.3	Testing Table of Navigate Recent Locations	49
5.4	Testing Table of Start Boundary Monitoring	50
5.5	Testing Table of Set Boundary Monitoring Settings	51
5.6	Testing Table of Start Fall Detection	52
5.7	Testing Table of Set Fall Detection Settings	53

## **LIST OF FIGURES**

<b>FIGURE</b>	<b>TITLE</b>	<b>PAGE</b>
1.1	System Functionality	4
2.1	Screen Shot of the Fall Detection Application	9
2.2	Screen Shot of the False Alarm Cancellation Mechanism	9
2.3	Screen Shot of the Home Screen of GeorgiePhone	11
2.4	Screen Shot of the Home Screen of Ray App	12
2.5	Screen Shot of the Home Screen of Simple Senior Phone	14
3.1	System Overview	20
3.2	System Architecture Diagram	20
3.3	Use Case Diagram of Voice Guided Navigation module	21
3.4	Use Case Diagram of Automated Boundary Monitoring module	21
3.5	Use Case Diagram of Fall Detection module	22
3.6	System flow chart of Navigation module	30
3.7	System flow chart of Automated Boundary Monitoring module	31
3.8	System flow chart of Fall Detection module	32
4.1	The model of the evolutionary development	44

## **CHAPTER 1 INTRODUCTION**

### **1.1 Problem Statement**

According to surveys done in recent years, it is estimated that there are over 1.4 million senior citizens in Malaysia (National Statistics Department Malaysia, 2010) and over there are over 258 918 disabled persons who are registered in Malaysia (Social Welfare Department, 2009). A senior person is normally defined as people who are 65 years old and above whereas a disabled person is defined as people who have physical impairment such as missing limbs or loss of sensory ability or mental impairment. These two segments of society face several problems that poses difficulties for them to live independently such as the difficulties to travel independently, tendency to get lost while wandering out of their homes and also being unnoticed in an emergency. The problems mentioned may not be noticeable to the majority of the society but it is faced by the elderly and handicapped on a daily basis.

Conventionally, the public transportation system does not cater for the elderly and visually handicapped. The signboards, charts and maps which displays route and pricing information about the public transportations are not made for the visually impaired. This can be seen from the absence of Braille versions of those sources of information. Therefore, the visually impaired cannot take public transportations independently without asking help from other people or face tremendous difficulties in doing so. Currently, there is no effective system of tracking the location of the elderly and handicapped. The elderly, especially those with dementia, tend to wander off on their own and out of many of them, goes missing every day. The same goes for the visually handicapped due to their disability, they are prone to getting lost without even realizing it. Every day, many incidents occur where the elderly and handicapped fell down or unconscious and went unnoticed by anyone until several hours later. Some of these victims could not get help or contact their family members immediately due to the injuries they sustained.

## **1.2 Background**

In recent years, the rapid advancement of smartphones technologies has enabled the prices of smartphones to go down at the same time packed with an array of sensors. These sensors can be utilized in tandem to create assistive technology for the elderly and handicapped to help them in living independently. Imagine if there is a smartphone application that allows voice-based interaction and provides voice guidance navigation can help the elderly and handicapped to travel independently via public transportation. Besides that, the application can automatically track the location of the elderly and handicapped if they leave their homes at unusual hours. The application can also monitor if the user falls and alerts the family member when necessary. In this paper, the author shall demonstrate a smart guidance and monitoring system designed to assist the elderly and handicapped.

## **1.3 Motivation**

There is a significant increase in the population of elderly and visually handicapped in this world (Robin & Arlene, 2002). This has prompted efforts to be directed at discovering solutions to help this group of people. There is an urgent need to explore the various means of utilizing technology to assist the elderly and handicapped.

According to statistics (Transportation Research Board,1994), older drivers are more susceptible to accidents due to medical complications, medication intake and functional impairments. Additionally, it is estimated that there are around 125,000 cases of elderly dementia patients who wander every year (DeMarco, 2009). Hence, the family members of elderly tend to impose stricter rules on them, limiting their outdoor activities. Because of this, people who are denied leisure activities and social interactions will eventually cause increased levels of isolation and depression (Marottoli et al., 1997; Kaplan, 1992, 1995) as a person's psychological well-being is dependent on receiving quality interactions in their lives. Therefore, this motivated the author to come up with this solution to tackle the various problems faced by these often neglected, overlooked members of society.

### **1.3 Project Objectives**

The deliverable of this project is to enable the elderly and handicapped to live more independently using the various technologies of the smartphone. The system shall be able to perform the following actions:

1. Able to provide graphical and voice guidance navigation for the elderly and handicapped using the existing public transport system.
2. Able to automatically track location of the elderly and handicapped if detected to have went out of home at unusual hours.
3. Able to detect the emergency of elderly handicapped (fall down, unconscious etc.) and alert family members if necessary.

### **1.4 Proposed Approach**

This mobile application project consists of three modules which are “Voice Guided Navigation”, “Automated Boundary Monitoring” and “Fall Detection”. Each designed to tackle a problem that the elderly and handicapped faces.

The Voice Guided Navigation module allows the users to get directions to get from their current location to the destination they want to go to. The system will automatically get the user’s current location using the GPS chip to simplify things. Then, the user just needs to key in their desired destination and as well as preferred mode of transport. The route to get to the user’s destination is generated on a map as well as a list of steps that can be read aloud to the user. Lastly, when the user press on start navigation, the voice guided navigation will begin.

Next, the Automated Boundary Monitoring module lets the family members of the user know when the user has wandered out of their homes. The system first lets the user’s family members to set the size of the boundary and as well as who to notify when the user is detected to have left the boundary. When this module is activated, whenever the user leaves the boundary, an SMS alert will be sent to the predefined contact. This will allow the family members of the user to find them easily if they are lost or uncontactable.

Third, the Fall Detection module alerts the family member of the user when the user is detected to have fallen or became unconscious. The system detects a fall once the 2

characteristics of a fall is detected which are free-fall and impact. The system will prompt an alert, sound an alarm and ask the user whether are they alright. If the user is injured or has fallen unconscious and is not able to respond to the system, the system will send an SMS alert to the predefined emergency contact with their current location coordinate.

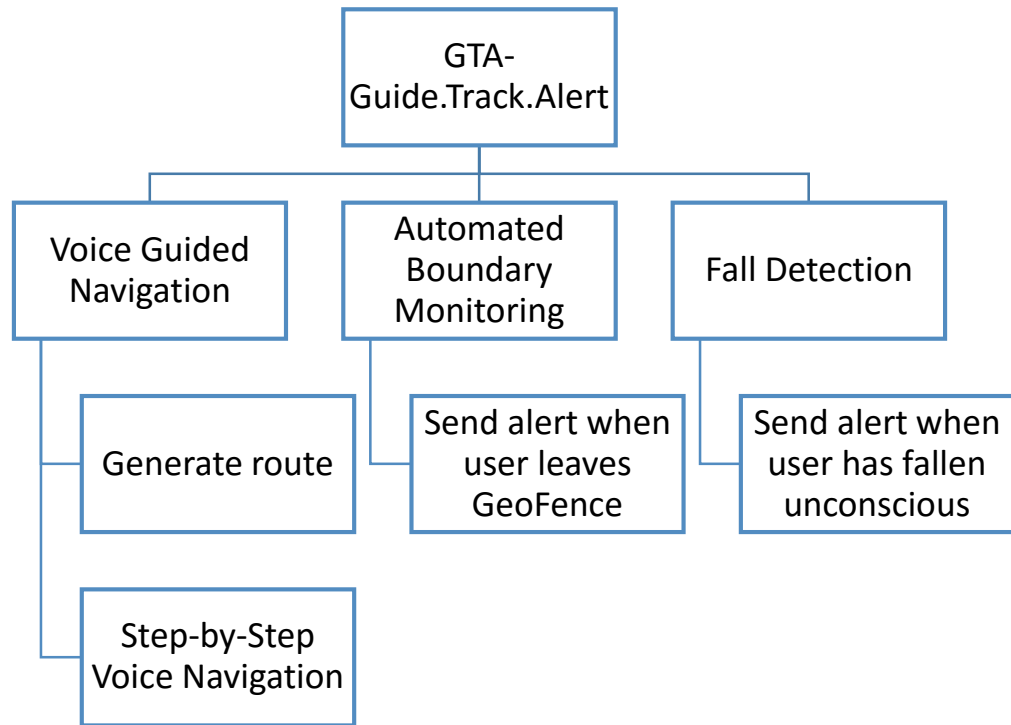


Figure 1.1 System Functionality

### **1.5 Achievement**

The main deliverable of this project is to become the one-stop-solution that provides various functions that will greatly benefit the elderly and handicapped community. This application will be designed to have a user interface catered for the elderly and handicapped. It allows the elderly and handicapped to commute independently using public transportation. It will provide user friendly graphical and voice based interaction for the user.

This application will also allow family members to know where their elderly or handicapped family members where they have travelled and where they are at in real-time when they leave the house at unusual hours. With this, the cases of elderly and handicapped going missing is expected to be reduced. An accelerometer-based fall detection system will also be implemented which will allow the smartphone to detect if the user have trip and fallen down or fell unconscious and send a distress signal to their family members. This will allow the family members to be alerted of the user's situation and arrange to help the user immediately.

### **1.6 Report Organization**

The paper is organized as the following: The problem statement, project background, motivation, objectives and proposed approach are introduced in Chapter 1. In Chapter 2, the related studies and systems are briefly reviewed.

Next, the author will describe the design and architecture of the guidance, monitoring and detection system for the elderly and handicapped in Chapter 3. Meanwhile, in Chapter 4, the author will elaborate the proposed solution in detail together with methodology used, tool to use and requirement.

Chapter 5 shall display the implementation and test result of the system and discuss how well each module fulfilled the real-world use case. Subsequently, Chapter 6 will discuss the future research direction to improve the system. Lastly, this paper will be concluded in Chapter 7 along with novelties, challenges faced and future work.



## **CHAPTER 2 LITERATURE REVIEW**

### **2.1 Overview**

According to recent statistics, there is an estimated of over 1.4 million senior citizens in Malaysia (National Statistics Department Malaysia, 2010) and over there are over 258 918 disabled persons who are registered in Malaysia (Social Welfare Department, 2009, not taking into account of the unregistered ones as the registering process is optional. A senior person is normally defined as people who are 65 years old and above whereas a disabled person is defined as people who have physical impairment such as missing limbs or loss of sensory ability.

A person is considered to high mobility if they fulfil the following criteria:

- i) having access to transport services to places were a person wants to travel when they need it
- ii) is informed about the services
- iii) have knowledge about how to use them
- iv) having the ability to use them (Suen & Mitchell, n.d.)

On the other hand, a person can be limited in mobility when they cannot travel between places due to various external or individual factors. Recent studies have shown that, as the age of a person increases, their mobility suffers as well and this will impact their quality of life (Metz, 2000). One of the main reason for this is because senior person has sight impairment as they grow older and this will eventually cause them not able to drive and or travel alone.

### **2.2 Public Transportation Needs**

According to (Transportation Research Board,1994), older drivers are more susceptible to accidents due to medical complications, medication intake and functional impairments. Because of this, senior person will be denied leisure activities and social interactions that will eventually cause increased levels of isolation and depression (Marottoli et al., 1997; Kaplan, 1992, 1995) as a person's psychological well-being is dependent on receiving quality interactions in their lives. Hence, an accessible public transportation is important to ensure equal opportunity for the whole society even for the elderly and handicapped.

However, the current public transportation system does not cater to the constraints faced by the elderly and handicapped users. This has caused these users to face many all sorts of challenges while using the public transportation system. In a study done by Hine & Mitchell in 2001, they studied the various challenges faced by different people by conducting interviews. For example, elderly or handicapped people with walking frames faced problems getting on to public bus as the frame could not get the walking frame into the bus. Next, some people are rushed to enter and get down from the bus quickly by the bus driver despite having physical limitations.

Another challenge faced by them is the irregular schedule of the public transportation coupled with inaccuracy of information given by the drivers caused them to waste time to wait for the next bus. This problem is especially prominent for the visually impaired as they are unable to read the information such as destination maps or route number at bus stops. Most of them also faced another problem which is they do not know where to get information about the public transportation schedule if they are not displayed at the bus stop.

Based on the challenges that the elderly and handicapped users faced as mention above, their needs in the context of public transportation systems are identified:

1. There is a need for a centralized, aggregated source of information to get information about public transportation such as fares, routes and schedules
2. There is a need for the information to be updated constantly
3. There is a need for the users to be notified when to get on the bus and when to get off the bus
4. There is a need for the public transport drivers to know which of their passengers are elderly or handicapped who is in need to extra attention or help.
5. There is a need for non-visual display of public transportation information for the visually impaired.

### **2.3 Fall Detection Systems**

As for the next part of my project, an accelerometer-based solution is required to be implemented to track the falling of the user. Detecting falls of elderly quickly is crucial as one of the main health risk that elderly face is falling especially for those living independently. By doing so, the victim will be able to received medical attention much sooner. However, in more serious cases, the victim could fall unconscious and is unable to call for help.

Most recent works on the automatic fall detection systems involves mainly 3 major categories namely: acoustic-based methods, video-based methods and wearable sensor-based methods help (Luo & Q. Hu, 2004). The first type of implementation, the acoustic-based methods, mainly depends on the detection of vibration caused by the impact of the victim falling to the ground. [6] Next, the video-based method works by analysing the changes of the video footage captured by cameras installed in a limited environment [5]. Lastly, the wearable sensor-based method requires the user to wear a sensor on their body. Each of these methods has major flaws that prevents them from serving as good methods of automatic fall detections. For the acoustic based method, it is highly affected by ambient noise, the video based method can intrusive on the user's privacy and the wearable sensor approach only works as long as the user wears the sensor.

Yavuz and et al. did a study on the implementation of an automatic smartphone based fall detection system with online location support. Their main aim for the study is to compare wavelet transform's accuracy in detecting falling with the other techniques of fall detection. A unique feature of the implementation done by Yavuz and his team, is that the location of the fall victim will be sent automatically to their family members upon detection that the victim has fallen down. One of the main challenges faced in the implementation of this system is to gather accelerometer signal in different daily life scenarios such as walking, jumping, sitting, and so forth.



Figure 2.1 Screen Shot of the Fall Detection Application

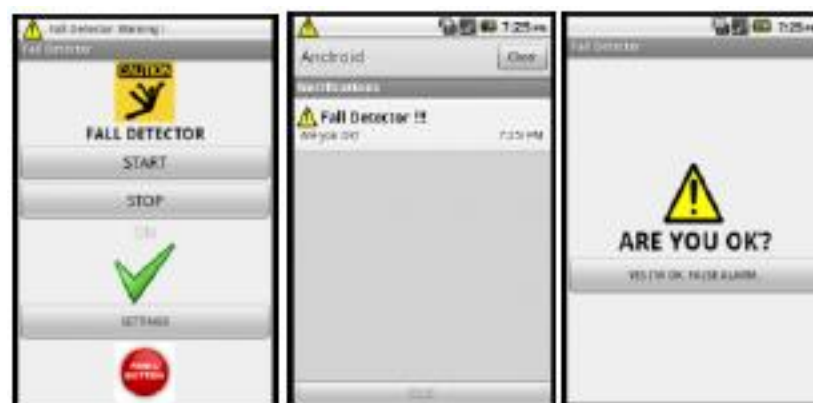


Figure 2.2 Screen Shot of the False Alarm Cancellation Mechanism

The accuracy of the system is tested by conducting experiment by asking 5 subjects to fall 20 times. As a result, out of the 100 falls in the experiment, they found that wavelet transform yields better results with a higher true positive rate by 37% and reducing the rate of false negative. Overall, it is verified that wavelet transform is the best method for a smartphone accelerometer based implementation of fall detection system.

## **2.4 Review of Existing System**

### **2.4.1 GeorgiePhone**

This project is developed to enable the blind or visually impaired to use their smartphone in ways they never able to before. For a long time, the blind and visually impaired has been neglected by the smartphone makers. The typical smartphones of today does not come with an interface that the blind or visually impaired can use comfortably or effectively. GeorgiePhone aims to solve this problem and as well as enhance the lives of the users.

The target audience this application aims to serve is very wide. It aims to serve the following five groups: the visually impaired and blind, people who can't read and depend on auditory input, elderly seniors, people who prefers big buttons and words on a simple screen or even people with other special needs.

The user interface of GeorgiePhone features a simple interface design with bright and high contrast colours for visibility and big buttons that has voice guidance to guide the user to use their smartphone. For the visually impaired users, the phone will read out the name of the button their finger is touching and to register a click, the user is required to release the button after a long hold. This method of interaction allows for very effective no-eyes navigation.

In addition to enabling the visually impaired and blind to interact with their smartphones, GeorgiePhone has 7 main categories of apps which are Internet, Travel, Navigation, Entertainment, Information, Utilities and Miscellaneous which consists of a total of 22 sub-apps which each provides a completely different function but have to be purchased separately. This app is well known for the functions provided by the Georgie Bus, Georgie Taxi, Georgie Finder, Georgie Place, Georgie Helper, Georgie Directions and GeorgiePhone sub-apps.

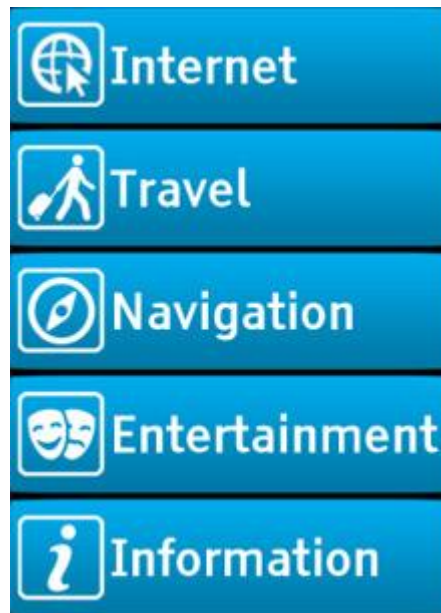


Figure 2.3 Screen Shot of the Home Screen of GeorgiePhone

The Georgie Bus sub-app is by far the most well-known and useful one. It tells the user exactly when the next bus will be arriving, the name of the bus, when to get off the bus and other crucial information of buses accurately. Georgie Places enables the user to instantly know their location through the Where Am I feature. The phone will tell the user their current location at a click of a button. Georgie Finder allows the family member of the user to instantly locate the user's position on a map.

Georgie Directions lets the user input their destination and then guide the user to their destination by providing step-by-step voice guided navigation. Georgie Helper gives a way to the user to request assistance from their family or friend. When the user presses the request button, the app sends a message to the user's family or friend along with a map with the exact location where the user requested help. (Georgie Phone, v4.2, 2012)

### **2.4.2 RayApp**

This project is a software based solution that serves as a multi purposed assistive tool with the aim to help the blind and visually impaired to live independently and enhance their social lives. Users will be able to do their everyday tasks with only touch and sound. The application is designed to let the blind to access the features on their smartphone without involving vision.

Moving on, the user interface design of this application lets the user operate the phone eye-free by using only touch and sound to guide the user. The interface is consistent across all the functions in this application. The user interfaces consist of 8 big buttons that fills up the screen completely at a time. The reason for this is that it makes it easier for the user to click the buttons correctly. Finger gesture is the main form of interaction of the user with the app and it even allows single gesture to access frequently used functions. Overall, this has allowed easy one-handed handling of the application.

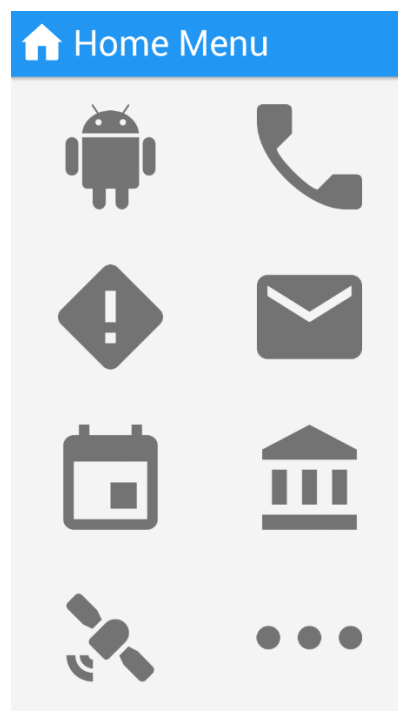


Figure 2.4 Screen Shot of the Home Screen of Ray App

Ray App allows the blind and visually impaired to perform a wide range of function such telephony, messaging, audio book reading services, recordings,

navigation and location. The Ray Navigation and Ray Assistance sub-apps are the well-known one among their many sub-apps. Ray Navigation has the following functions:

- Trip planner: Generates the most optimal routes to the user's destination, across your various modes of transportation.
- Near me: Retrieves information about nearby public transportation routes and optional destinations, check schedules and see the next arriving bus.

This sub-app is designed to make it easy for blind people travel safely using public transportation. They can plan their route in advance, get to bus stop safely and get information about the next bus and other information.

As for the Ray Assistance, it allows the user's family members to actually provide real-time support to the user. This sub-app lets the user's family members check the location of the user's device in real time and provide directions to them. Other than that, it also allows the user's family member to get high resolution images and even get real-time video streaming from the user's phone. (RAY App for Visually Impaired, v3.01, 2014)



### **2.4.3 Simple Senior Phone**

This project is developed to become an all-in-one replacement to the smartphone's original user interface so that people with bad eye sight or visual impairment especially the elderly can use the phone. Smartphones of today comes with a user interface that displays small text and icons which makes it not user friendly to the senior citizens as the things displayed are illegible to them. This app also helps the user keep in touch with their family.

The user interface design of this application is optimized for seniors and people with bad eyesight. It comprises of big buttons and colourful interface which makes simple, easy to see and navigate. It simplifies the interface of the current smartphone to make it simple enough for elderly to use as the built-in interface of the phone is cluttered with many things.

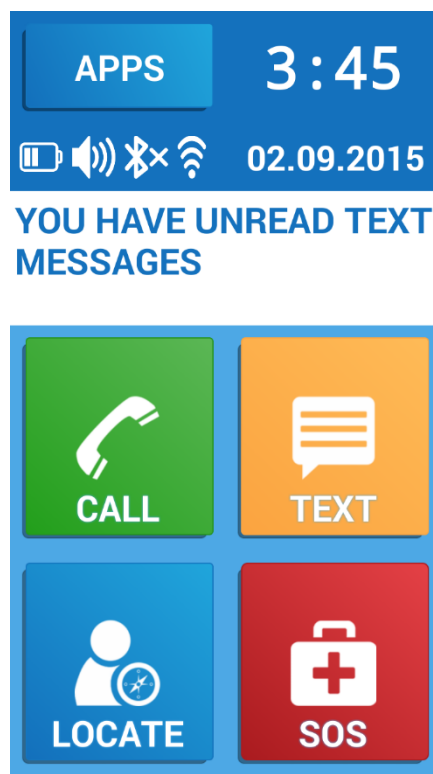


Figure 2.5 Screen Shot of the Home Screen of Simple Senior Phone

Simple Senior Phone has several functions. One of its first main function is an integrated 2-way location service for both users and their predefined contacts. This function allows the user to check on the location of their close friends instantly and vice versa. It is useful as it gives the elderly a way to know where their family members are

## CHAPTER 2 LITERATURE REVIEW

at too instead of only the family members knowing where the user is at. Additionally, Simple Senior Phone also have an SOS alert sender. This function allows the user to send out a distress signal together with the user's location when the user is in trouble. The signal can be sent out automatically or manually as well. This is especially useful as the user's family know instantly whether the user is okay and her location in case of emergency so that they can respond faster to the emergency. (Simple Senior Phone, v0.7.15251, 2014)

Table 2.1 below shows the differences of the existing system that is reviewed.

Table 2.1: Comparison table for existing systems

Application Features	GeorgiePhone	RAY App for Visually Impaired	Simple Senior Phone
User Interface	Moderate	Best	Poor
Target Audience	Senior Citizen, Blind, Visually Impaired	Blind, Visually Impaired	Senior Citizen
Route Planner	Yes	Yes	No
Step by Step Navigation	Yes	Yes	No
Real Time Bus Information	Yes	Yes	No
Voice Feedback	Yes	Yes	No
Emergency SOS Sender	Yes	Yes	Yes
Location checker	Yes	Yes	Yes
Two way location checker	No	No	Yes
Fall Detection	No	No	No
One-handed Usage	No	Yes	No

## **2.5 Strength and Limitation of Existing System**

### **2.5.1 Georgie Phone**

This application has the most functions among the 3 applications. It consists of a total of 22 sub-apps which each provides a different function for the user. This application is the most stable as it has been around the longest.

One downside about this application is that the full functions of this app have to be purchased and downloaded separately. This makes the user feel that the application is not unified and inconsistent. In addition, the user experience of this application is not as good as the others.

### **2.5.2 RAY APP for Visually Impaired**

This application has the most attractive GUI among the 3 reviewed. The user experience on this application is great as it is smooth and user can easy navigate with one hand.

This application falls short on the navigation design. The gesture input were confusing and not easily understood by users. Besides that, the full functions of this app are also required to be purchased and download separately. This gives the app a very non-unified impression to the user.

### **2.5.3 Simple Senior Phone**

This application has two-way location checking. This function not just allow the family members or caretakers of the user to know the location of the user at any time, it also lets the user does the same. This way it helps to reduce the worries of elderly who does not know where their family members are.

The weakness of this application is that it has the least attractive GUI among the 3 reviewed. The user interface is not elegant and is very basic.

## **2.6 Conclusion**

In short, the project shall adapt some features of the application reviewed and enhance upon them. The user interface of the project is very critical, as it is required to be designed for two groups of users, which are people with good to poor eyesight as well as people who have no eyesight. For the first group of people, the buttons and words shall be large and clear in order to be legible for them whereas for the second group of people, the user interface will have to rely more on touch and audio based interaction. This way, the application will be able to cater for both groups of people.

As for the accelerometer-based fall detection, it is similar to the wearable sensor approach. The weakness of the wearable sensor approach becomes its strength as a smartphone is always with the user most of the time. Hence, this approach will work very effectively. The wavelet transform is the best method for a smartphone project involving accelerometer-based implementation of fall detection system. The data output from the accelerometer will be continuously analysed to detect if the user has fallen down using the wavelet transform method.

**CHAPTER 3 SYSTEM DESIGN**

This mobile application project consists of three modules which are “Voice Guided Navigation”, “Automated Boundary Detection” and “Fall Detection”.

**3.1 User Requirements****3.1.1 Voice Guided Navigation Module**

<b>Requirement ID</b>	<b>Requirement Description</b>
1.1	System must be able to let user search for new destination
1.1.1	System must be able to locate user using GPS
1.1.2	System must be able to generate a map plotted with optimal route based on user input
1.1.3	System must be able to display list of steps to take based on optimal route generated
1.1.4	System must be able to guide user to their destination using voice interaction
1.1.7	System must be able to allow user to end navigation
1.2	System must be able to let user select recently search destination
1.2.1	System must be able to generate a route upon user selection of recently searched destination
1.3	System must be able to perform all of the above using voice command
1.4	System must be able to interact with user via voice interaction

Table 3.1: User requirements for Navigation module

**3.1.2 Automated Boundary Monitoring Module**

<b>Requirement ID</b>	<b>Requirement Description</b>
2.1	System must be able to let user set a Geofence
2.1.1	System must be able to let user set radius the geofence
2.1.2	System must be able to let user set phone number of family member to notify

2.1.3	System must be able to let user save the Geofence settings.
2.2	System must be able to let user activate geofence.
2.2.1	System must be able to let user deactivate geofence.
2.2.2	System must be able to alert family member via SMS if user leaves geofence
2.2.3	System must be able to let family member view the current location of user on map

Table 3.2: User requirements for Tracking module

### **3.1.3 Fall Detection Module**

<b>Requirement ID</b>	<b>Requirement Description</b>
3.1	System must be able to detect if user has fallen down
3.1.1	System must be able to prompt user for response upon detection of fall (as stated in Requirement 3.1)
3.1.2	System must be able to send alert with location of user to family member of user via SMS if user does not respond within predefined amount of waiting time.
3.1.3	System must be able to let user cancel the auto alert if user is responds
3.2	System must be able to let user set Fall Detection settings.
3.2.1	System must be able to let user set predefined amount of waiting time.
3.2.2	System must be able to let user set phone number of family member to notify
3.2.3	System must be able to let user save Fall Detection settings.
3.3	System must be able to let user send alert manually

Table 3.3: User requirements for Alert module

### 3.2 System Overview

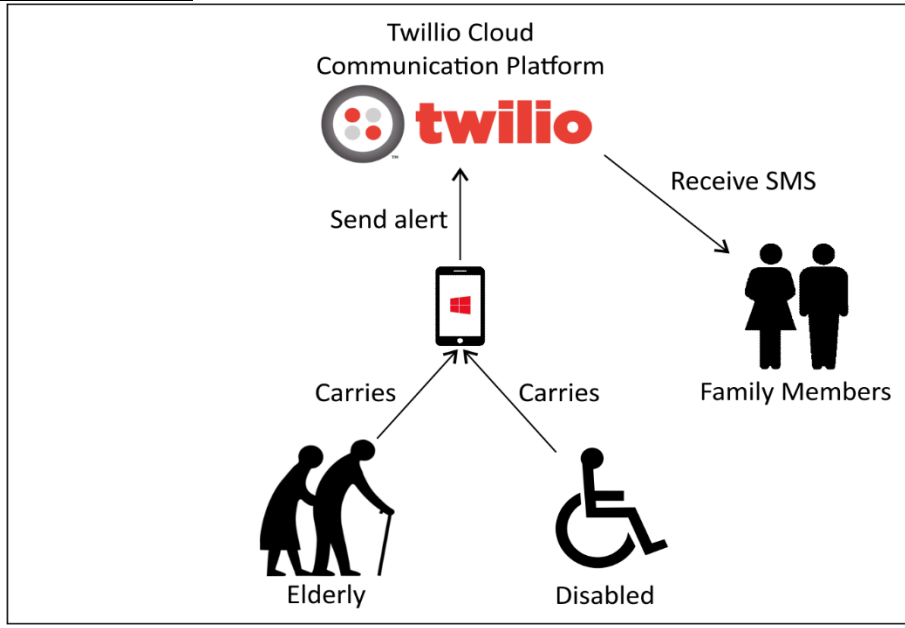


Figure 3.1 System Overview

### 3.3 System Architecture Diagram

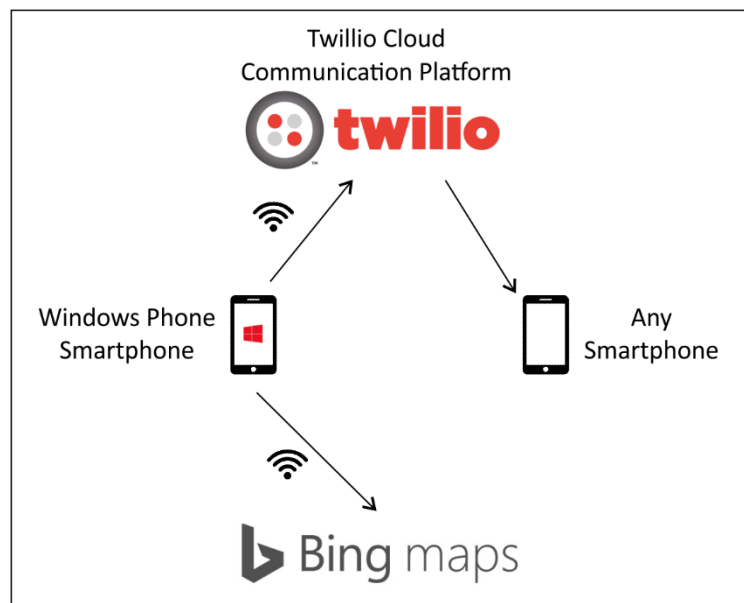


Figure 3.2 System architecture diagram

### 3.3 Use Case Diagrams

#### 3.3.1 Voice Guided Navigation Module

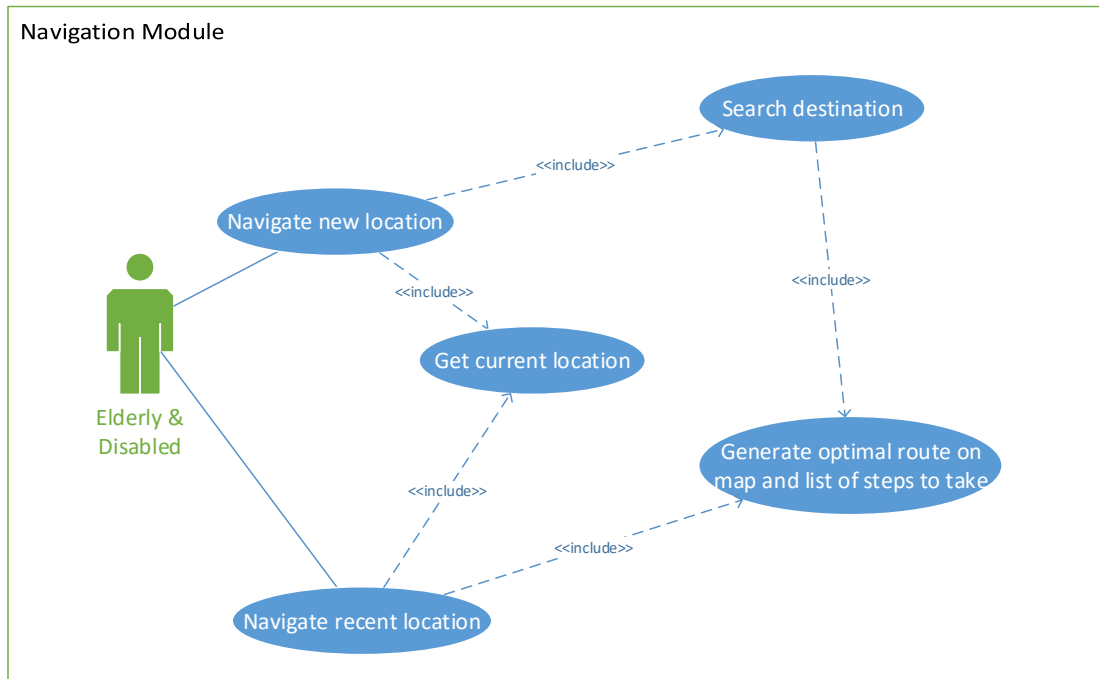


Figure 3.3: Use case diagram of Voice Guided Navigation module

#### 3.3.2 Automated Boundary Monitoring Module

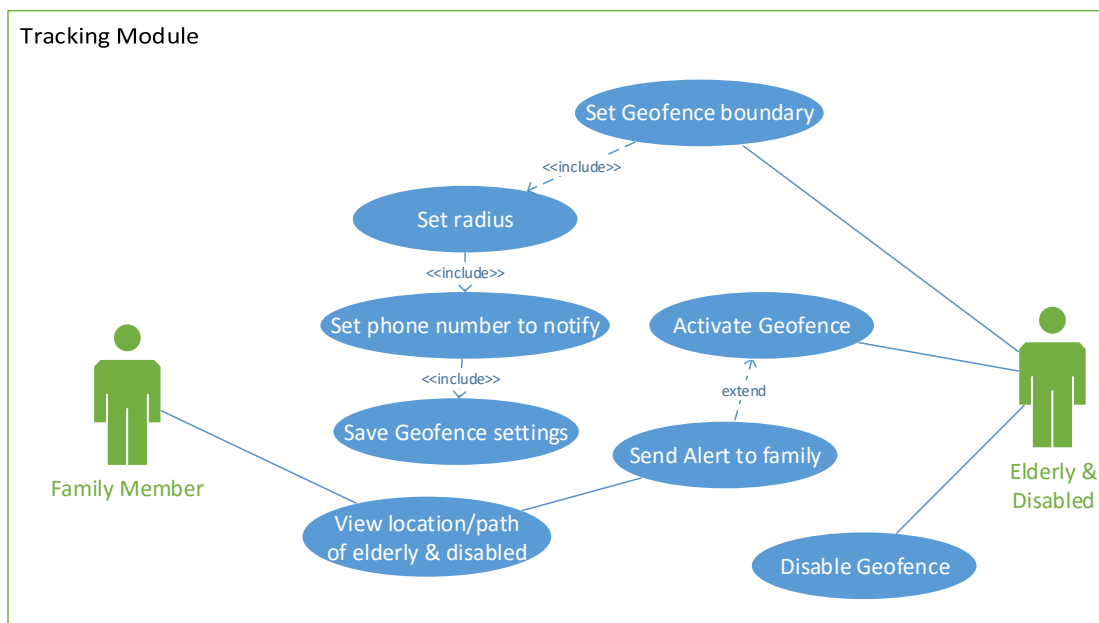


Figure 3.4: Use case diagram of Automated Boundary Monitoring module



### 3.3.3 Fall Detection Module

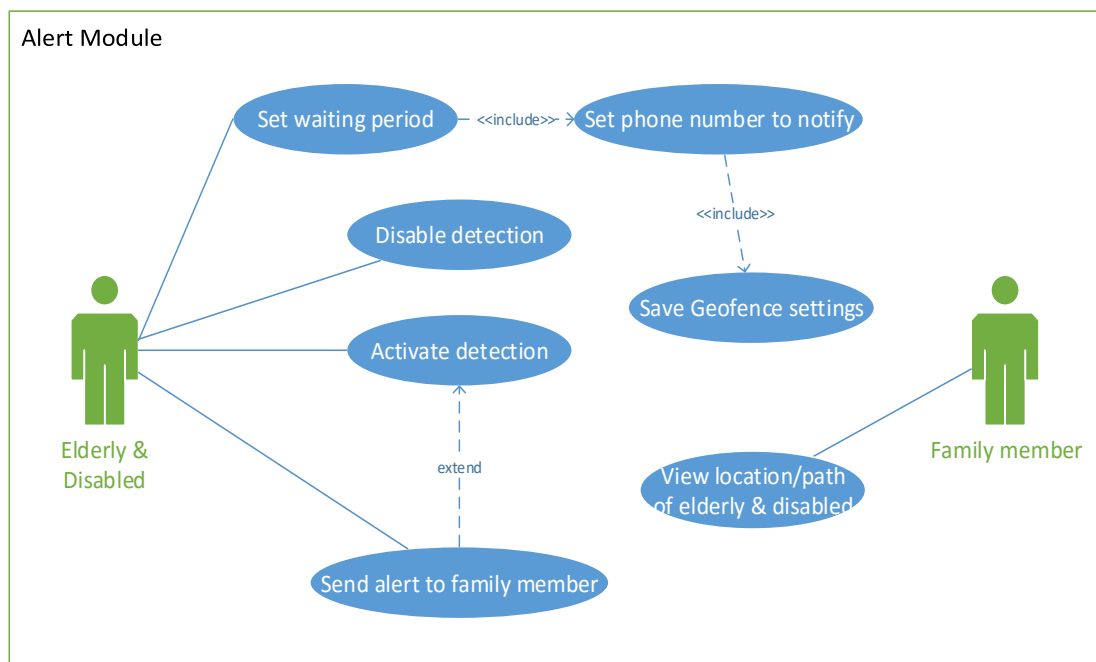


Figure 3.5: Use case diagram of Fall Detection module

### 3.4 Use Case Descriptions

#### 3.4.1 Voice Guided Navigation Module

<b>Use Case ID</b>	UC001	<b>Version</b>	1.0
<b>Feature</b>	F001 Navigate new location		
<b>Purpose</b>	To allow user to generate route and voice navigation to a new destination		
<b>Actor</b>	Elderly & Handicapped		
<b>Trigger</b>	User taps on “New Destination” button		
<b>Precondition</b>	i. The application is running. ii. The device’s Location functionality must be turned on. iii. The device must be connected to Internet.		
<b>Scenario Name</b>	<b>Step</b>	<b>Action</b>	

	1	User taps on “New Destination” button
	2	System gets user’s current location and displays user’s current address on “From” button.
	3	User taps on “To” button
	4	User input destination address
	5	System displays autocomplete suggestion
	6	User taps on “Next” icon button
	7	System displays route and list of steps to take
	8	User taps on “Start Navigation” button
	9	User taps on “End Navigation” button
<b>Alternate Flow – Location functionality not turned on</b>	1.1	System displays “Location not turned on” error message
<b>Alternate Flow – User leaves “To” field empty</b>	4.1	System displays “To field is empty” error message
<b>Rules</b>		<ul style="list-style-type: none"> <li>i. The application is running.</li> <li>ii. The device’s Location functionality must be turned on.</li> <li>iii. The device must be connected to Internet.</li> </ul>
<b>Author</b>		Tan De Zhern

<b>Use Case ID</b>	UC001	<b>Version</b>	1.0
<b>Feature</b>	F002 Navigate recent location		
<b>Purpose</b>	To allow user to generate route and voice navigation to a recent destination		
<b>Actor</b>	Elderly & Handicapped		
<b>Trigger</b>	User taps on “History” button		

<b>Precondition</b>	<ul style="list-style-type: none"> <li>i. The application is running.</li> <li>ii. The device's Location functionality must be turned on.</li> <li>iii. The device must be connected to Internet.</li> </ul>	
<b>Scenario Name</b>	<b>Step</b>	<b>Action</b>
	1	User taps on "History" button
	2	System displays recently navigated destinations
	3	User selects recently navigated destinations
	4	System displays route and list of steps to take
	5	User taps on "Start Navigation" button
	6	User taps on "End Navigation" button
<b>Alternate Flow – Location functionality not turned on</b>	1.1	System displays "Location not turned on" error message
<b>Alternate Flow – User leaves "To" field empty</b>	4.1	System displays "To field is empty" error message
<b>Rules</b>	<ul style="list-style-type: none"> <li>i. The application is running.</li> <li>ii. The device's Location functionality must be turned on.</li> <li>iii. The device must be connected to Internet.</li> </ul>	
<b>Author</b>	Tan De Zhern	

### **3.4.2 Automated Boundary Monitoring Module**

<b>Use Case ID</b>	UC002	<b>Version</b>	1.0
<b>Feature</b>	F001 Activate Geofence		
<b>Purpose</b>	To allow user to activate Boundary Monitoring		
<b>Actor</b>	Elderly & Handicapped		

<b>Trigger</b>	User taps on “Start Tracking” button	
<b>Precondition</b>	<ul style="list-style-type: none"> <li>i. The application is running.</li> <li>ii. The Boundary Monitoring settings must be set first.</li> <li>iii. The device’s Location functionality must be turned on.</li> <li>iv. The device must be connected to Internet.</li> </ul>	
<b>Scenario Name</b>	<b>Step</b>	<b>Action</b>
	1	User taps on “Start Tracking” button
	2	System registers the Geofence Monitor to background task
	3	System displays “Tracking Started” Notification
<b>Alternate Flow – User exits Geofence boundary</b>	2.1	System sends SMS message to pre-defined family member contact with user’s current location
<b>Rules</b>	<ul style="list-style-type: none"> <li>i. The application is running.</li> <li>ii. The Boundary Monitoring settings must be set first.</li> <li>iii. The device’s Location functionality must be turned on.</li> <li>iv. The device must be connected to Internet.</li> </ul>	
<b>Author</b>	Tan De Zhern	

<b>Use Case ID</b>	UC002	<b>Version</b>	1.0
<b>Feature</b>	F002 Deactivate Geofence		
<b>Purpose</b>	To allow user to deactivate Boundary Monitoring		
<b>Actor</b>	Elderly & Handicapped		
<b>Trigger</b>	User taps on “Stop Tracking” button		
<b>Precondition</b>	<ul style="list-style-type: none"> <li>i. The application is running.</li> <li>ii. The Boundary Monitoring is activated</li> </ul>		
<b>Scenario Name</b>	<b>Step</b>	<b>Action</b>	
	1	User taps on “Stop Tracking” button	

	2	System un-register Geofence Monitor background task
	3	System displays “Tracking Stopped” Notification
<b>Rules</b>	i.	The application is running.
	ii.	The Boundary Monitoring settings must be set first.
	iii.	The device’s Location functionality must be turned on.
	iv.	The device must be connected to Internet.
<b>Author</b>	Tan De Zhern	

<b>Use Case ID</b>	UC002	<b>Version</b>	1.0
<b>Feature</b>	F003 Set Geofence settings		
<b>Purpose</b>	To allow user to set Boundary Monitoring settings		
<b>Actor</b>	Elderly & Handicapped		
<b>Trigger</b>	User taps on “Set Tracking” button		
<b>Precondition</b>	i.	The application is running.	
	ii.	The device’s Location functionality must be turned on.	
	iii.	The device must be connected to Internet.	
	<b>Step</b>	<b>Action</b>	
	1	User taps on “Track Settings” button	
	2	System displays user’s current location on Map display	
	3	User inputs Geofence radius	
	4	System displays Geofence on Map display	
	5	User input family member’s phone number	
	6	User taps on “Save” icon button	
	7	System displays “Settings Saved” Notification	
<b>Alternate Flow – Fields empty</b>	6.1	System displays “Empty Fields” error message	
<b>Rules</b>	i.	The application is running.	
	ii.	The Boundary Monitoring settings must be set	

	<ul style="list-style-type: none"> <li>iii. first.</li> <li>iv. The device's Location functionality must be turned on.</li> <li>The device must be connected to Internet.</li> </ul>
<b>Author</b>	Tan De Zhern

### **3.4.3 Fall Detection Module**

<b>Use Case ID</b>	UC003	<b>Version</b>	1.0
<b>Feature</b>	F001 Activate Fall Detection		
<b>Purpose</b>	To allow user to activate Fall Detection		
<b>Actor</b>	Elderly & Handicapped		
<b>Trigger</b>	User taps on "Start Detection" button		
<b>Precondition</b>	<ul style="list-style-type: none"> <li>i. The application is running.</li> <li>ii. The Fall Detection settings must be set first.</li> <li>iii. The device's Location functionality must be turned on.</li> <li>iv. The device must be connected to Internet.</li> </ul>		
<b>Scenario Name</b>	<b>Step</b>	<b>Action</b>	
	1	User taps on "Start Detection" button	
	2	System registers the Fall Detection to background task	
	3	System displays "Fall Detection Started" Notification	
<b>Alternate Flow – User falls down</b>	3.1	System displays a countdown timer with alert tone and prompts for user's response	
	3.2	User taps on timer and cancel countdown	
<b>Alternate Flow – Countdown timer reaches zero</b>	3.1.1	System sends SMS message to pre-defined family member contact with user's current location	
<b>Rules</b>	<ul style="list-style-type: none"> <li>i. The application is running.</li> <li>ii. The Fall Detection settings must be set first.</li> <li>iii. The device's Location functionality must be turned on.</li> <li>iv. The device must be connected to Internet.</li> </ul>		

<b>Author</b>	Tan De Zhern
---------------	--------------

<b>Use Case ID</b>	UC003	<b>Version</b>	1.0
<b>Feature</b>	F002 Deactivate Fall Detection		
<b>Purpose</b>	To allow user to deactivate Fall Detection		
<b>Actor</b>	Elderly & Handicapped		
<b>Trigger</b>	User taps on “Stop Detection” button		
<b>Precondition</b>	<ul style="list-style-type: none"> <li>i. The application is running.</li> <li>ii. The Fall Detection is activated</li> </ul>		
<b>Scenario Name</b>	<b>Step</b>	<b>Action</b>	
	1	User taps on “Stop Detection” button	
	2	System un-register Fall Detection background task	
	3	System displays “Detection Stopped” Notification	
<b>Rules</b>	<ul style="list-style-type: none"> <li>i. The application is running.</li> <li>ii. The Fall Detection is activated</li> </ul>		
<b>Author</b>	Tan De Zhern		

<b>Use Case ID</b>	UC003	<b>Version</b>	1.0
<b>Feature</b>	F003 Set Fall Detection settings		
<b>Purpose</b>	To allow user to set Fall Detection settings		
<b>Actor</b>	Elderly & Handicapped		
<b>Trigger</b>	User taps on “Set Detection” button		
<b>Precondition</b>	<ul style="list-style-type: none"> <li>i. The application is running.</li> <li>ii. The device’s Location functionality must be turned on.</li> <li>iii. The device must be connected to Internet.</li> </ul>		
	<b>Step</b>	<b>Action</b>	
	1	User taps on “Set Tracking” button	
	2	User inputs waiting time	

	3	User input family member's phone number
	4	User taps on "Save" icon button
	5	System displays "Settings Saved" Notification
<b>Alternate Flow – Fields empty</b>	5.1	System displays "Empty Fields" error message
<b>Rules</b>		<ul style="list-style-type: none"> <li>i. The application is running.</li> <li>ii. The Boundary Monitoring settings must be set first.</li> <li>iii. The device's Location functionality must be turned on.</li> <li>iv. The device must be connected to Internet.</li> </ul>
<b>Author</b>		Tan De Zhern



### 3.4 System Flow Diagram

#### 3.4.1 Voice Guided Navigation Module

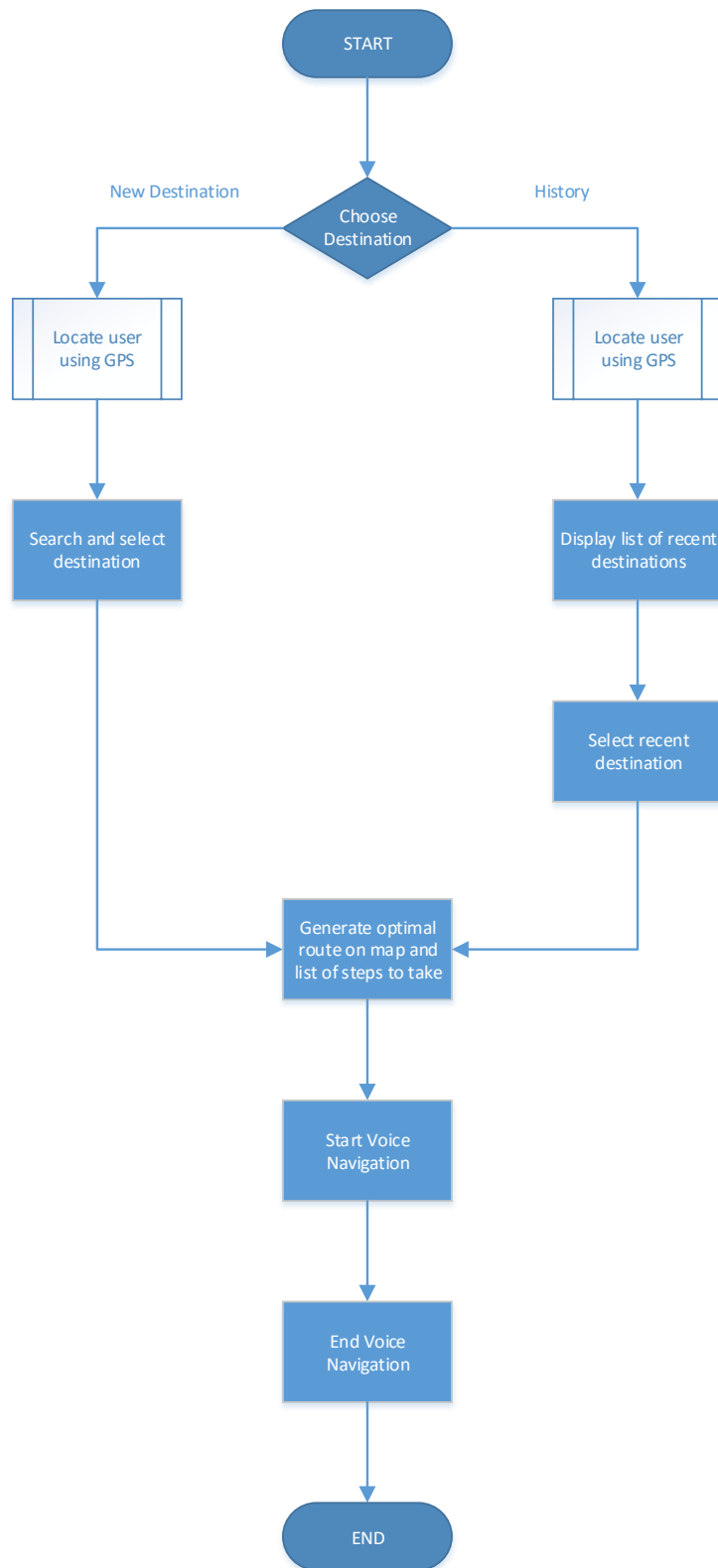


Figure 3.6 System flow chart of Voice Guided Navigation module

**3.4.2 Automated Boundary Monitoring Module**

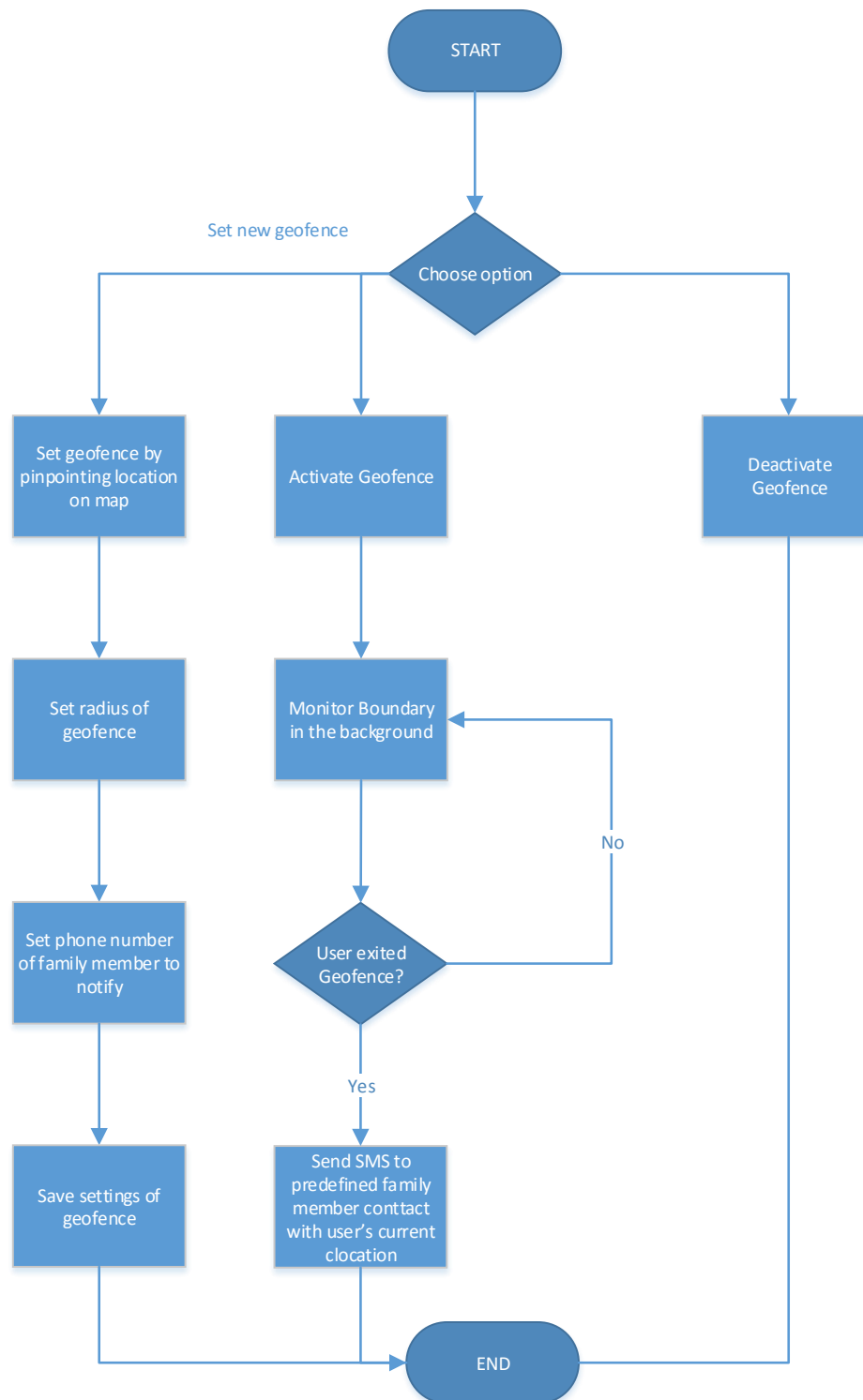


Figure 3.7 System flow chart of Automated Boundary Monitoring module

**3.4.3 Fall Detection Module**

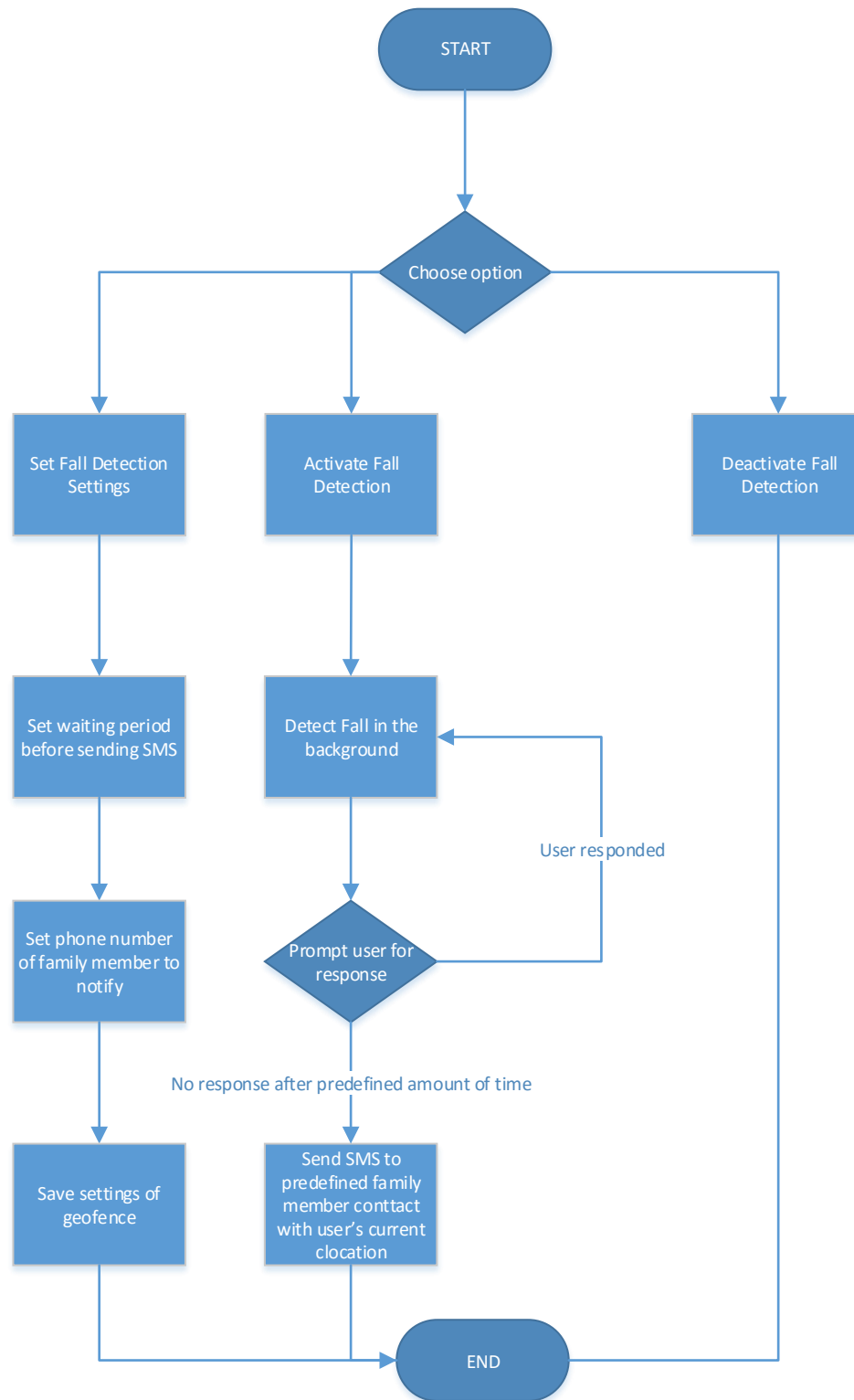


Figure 3.8 System flow chart of Fall Detection module

### **3.5 System Functionality and Overview**

#### **3.5.1 Voice Guided Navigation Module**

##### **3.5.1.1 Guide Module**

The Voice Guided Navigation module contains several processes such as getting current location, retrieving Point of Interest(POI), generating route in map and Steps and turn by turn Voice Navigation. The details of each process is as the following:

- Getting current location

```

Geolocator gl = new Geolocator
{
    DesiredAccuracy = PositionAccuracy.High
};
Geoposition gp = await gl.GetGeopositionAsync(
    maximumAge: TimeSpan.FromMinutes(1),
    timeout: TimeSpan.FromSeconds(20));

position = gp;

MapLocationFinderResult FinderResult =
    await MapLocationFinder.FindLocationsAtAsync(gp.Coordinate.Point);

```

In this process, the system will create a Geolocator which will get the phone's current location information using the phone's built-in GPS and store it into a Geoposition variable. The user's current location and address is found by querying `MapLocationFinder.FindLocationsAtAsync` function from the Windows Location API with the location information found earlier and stored into a `MapLocationFinderResult` variable.

- Retrieving Point of Interest(POI)

```

MapLocationFinderResult result =
    await MapLocationFinder.FindLocationsAsync(address,
    dialog_position.Coordinate.Point, 10);

    if (result.Status == MapLocationFinderStatus.Success)
    {
        List<string> locations = new List<string>();
        foreach (MapLocation mapLocation in result.Locations)
        {
            // Create a display string of the map location
            string display = mapLocation.Address.Street +
                Environment.NewLine +
                mapLocation.Address.Town + ", " +
                mapLocation.Address.RegionCode + " " +
                mapLocation.Address.PostCode + Environment.NewLine +
                mapLocation.Address.CountryCode;

```

```

        // Add the display string to the location list.
        locations.Add(display);
    }
    // Bind the location list to the ListView control.
    suggestListBox.ItemsSource = locations;

```

A Listbox is populated with list of possible entries of POIs when a user starts typing their desired destination. This is done by using `MapLocationFinder.FindLocationsAsync()` function which takes in the destination address, user's current location coordinates and also number of POIs to return nearest to the user's current location. The result is stored into a `MapLocationFinderResult` variable and the content is populated onto the Listbox.

- Generating Route in Map and Steps

```

MapRouteFinderResult routeResult = await
MapRouteFinder.GetWalkingRouteAsync(startPoint, endPoint);

if (routeResult.Status == MapRouteFinderStatus.Success)
{
    //Draw PATH ON MAPCONTROL
    // Use the route to initialize a MapRouteView.
    MapRouteView viewOfRoute = new
    MapRouteView(routeResult.Route);
    viewOfRoute.RouteColor = Windows.UI.Colors.Blue;
    viewOfRoute.OutlineColor = Windows.UI.Colors.Blue;
    // Add the new MapRouteView to the Routes collection
    // of the MapControl.
    MyMap.Routes.Add(viewOfRoute);
    // Fit the MapControl to the route.
    await MyMap.TrySetViewBoundsAsync(
        routeResult.Route.BoundingBox,
        null,
        Windows.UI.Xaml.Controls.Maps.MapAnimationKind.Bow);
}

```

After getting the user's current location and their desired destination, the system generates the best route for the user and plots the route on the map and also a list of steps to take to reach the desired destination. `MapRouteFinder.GetWalkingRouteAsync()` function takes in a `startPoint` and `endPoint` and the result is stored in a `MapRouteFinderResult` variable. The variable is then converted into `MapRouteView()` which will be used to plot the route to the map display by using `MyMap.TrySetViewBoundsAsync()`. The `MapRouteFinderResult` also contains step by step instructions on how to get to the user's destination.

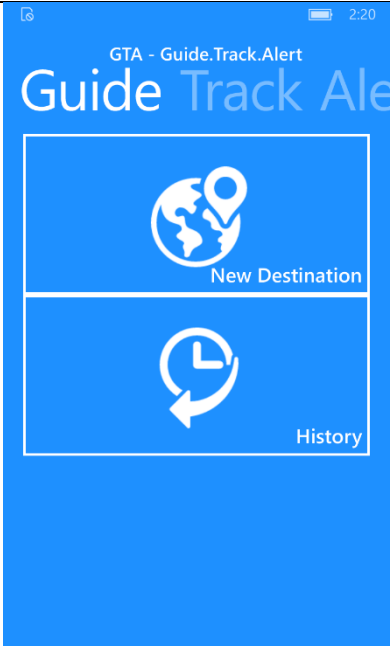
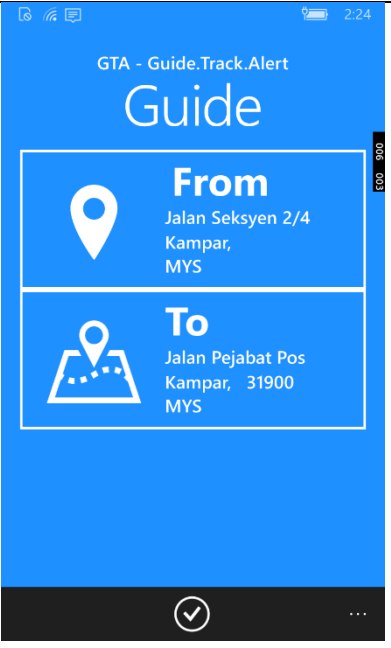
```


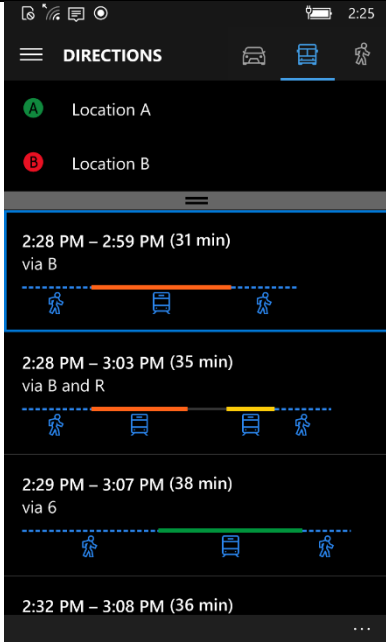
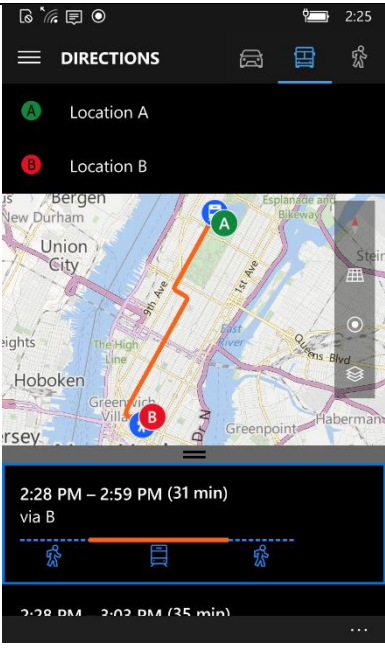
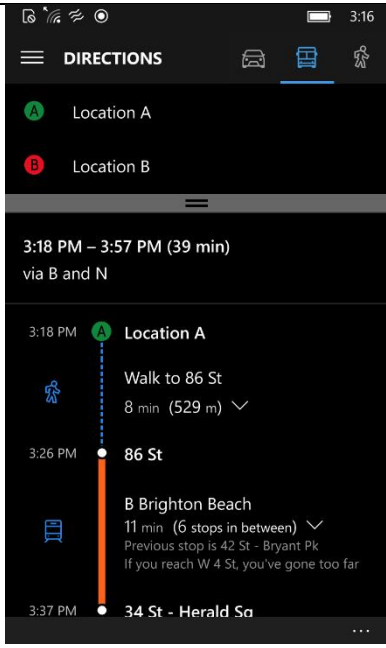
//POPULATE ROUTE
MapRoute MyMapRoute = routeResult.Route;

foreach (MapRouteLeg leg in MyMapRoute.Legs)
{
    foreach (MapRouteManeuver maneuver in leg.Maneuvers)
    {
        directionsList.Text += maneuver.InstructionText +
Environment.NewLine;
    }
}

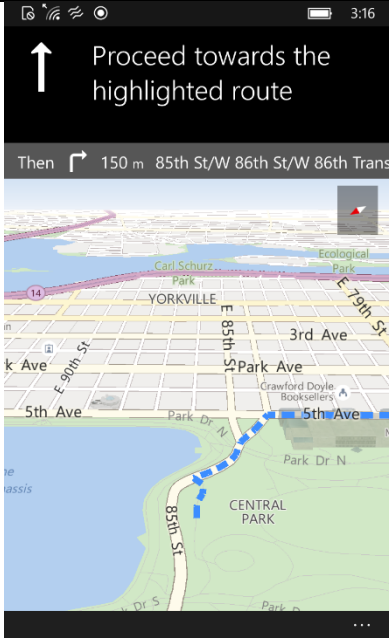
```

**3.5.1.2 Screenshots of Module**

	
<p>Voice Guidance Navigation Module Submenu</p>	<p>Get user's current location and destination</p>

	
<p>Enter destination to go with autocomplete suggestion</p>	<p>Display several available bus routes</p>
	
<p>Display selected route on a map</p>	<p>Display list of steps to take to reach destination</p>

## CHAPTER 3 SYSTEM DESIGN

	
<p>Start voice guidance navigation</p>	



### **3.5.2 Automated Boundary Detection Module**

#### **3.5.2.1 Track Module**

Next, the Automated Boundary Detection module contains several processes such as getting current location, radius and phone number, creating Geofence, start tracking in Background and notifying family member user has left home using SMS with coordinate of user. The details of each process is as the following:

- Get current location, radius, phone number

```
int radius = int.Parse(RadiusTextBox.Text);
string id = "myHome";
Geopoint myGeopoint = position.Coordinate.Point;

if (!GeofenceMonitor.Current.Geofences.Any())//IF non-Existing
{
    Fence.AddFence(id, myGeopoint, radius);//myHome, myGeopoint
    DrawGeofences(); // Actual implementation deferred to none
                    shared portion
}
else//IF Existing
{
    GeofenceMonitor.Current.Geofences.Clear();
    RemoveGeofences(); // Actual implementation deferred to none
                    shared portion
    Fence.AddFence("myHome", myGeopoint, radius);//myHome,
                                                myGeopoint
    DrawGeofences(); // Actual implementation deferred to none
                    shared portion
}
```

In the settings page, users current location is retrieved and showed on a map. After the user keys in the desired radius of boundary, the boundary will be plotted onto the map automatically. Once the user clicks save, the user's current location, boundary radius and phone number will be stored in the app settings file.

- Create Geofence

```

int radius = int.Parse(RadiusTextBox.Text);
string id = "myHome";
Geopoint myGeopoint = position.Coordinate.Point;

if (!GeofenceMonitor.Current.Geofences.Any())//IF non-Existing
{
    Fence.AddFence(id, myGeopoint, radius);//myHome, myGeopoint
    DrawGeofences(); // Actual implementation deferred to none
                        shared portion
}

```

A Geofence is created by passing the fence id, user's current coordinates and the radius into the Geofence() function. The desired response when the user Exits the Geofence is set as showed below.

- Start Tracking in Background

```

case GeofenceState.Exited:
{
    var toastXmlContent =
ToastNotificationManager.GetTemplateContent(ToastTemplateType.ToastText02);

    var txtNodes = toastXmlContent.GetElementsByTagName("text");
    txtNodes[0].AppendChild
(toastXmlContent.CreateTextNode("You are OUTSIDE of your home!"));

    txtNodes[1].AppendChild
(toastXmlContent.CreateTextNode(report.Geofence.Id));

    var toast = new ToastNotification(toastXmlContent);
    var toastNotifier =
        ToastNotificationManager.CreateToastNotifier();
    toastNotifier.Show(toast);
    break;
}

```

Once the user clicks on Start Tracking button, the Geofence monitoring task is put into the background task. It will run and check whether is there any changes in state every two minutes. If GeofenceState.Exited state is detected, family member will be alerted.

- Notify family member user has left home using SMS with coordinate  
If there is a change in state of Geofence, the system will send an SMS to the phone number that was set in the settings. This is achieved by using the Twillio API which will takes in a message a phone number.

**3.5.2.2 Screenshots of Module**

	
<p>Automated Boundary Detection Module Submenu</p>	<p>Set location and size of boundary(Geofence) as well as family member's phone number.</p>
	
<p>Family member receives alert when user leaves boundary</p>	

### **3.5.3 Fall Detection**

#### **3.5.3.1 Alert Module**

Third, the Fall Detection module contains several processes such as getting preferred waiting time and phone number, detecting a fall, start detection in Background and notifying family member user has not respond after falling down using SMS with coordinate of user. The details of each process is as the following:

- Get preferred waiting time and phone number

In the settings page, the user is required to key in the desired wait time before sending the alert and the emergency contact's phone number. Once the user clicks save, the user's preferred waiting time and phone number will be stored in the app settings file.

- Detecting a fall

```
private async void ReadingChanged(object sender,
    AccelerometerReadingChangedEventArgs e)
{
    AccelerometerReading reading = e.Reading;

    //Vector Formula to calculate force in m/s(1 unit of gravity (G))
    double f = Math.Sqrt(reading.AccelerationX * reading.AccelerationX
    + reading.AccelerationY * reading.AccelerationY +
    reading.AccelerationZ * reading.AccelerationZ);

    await Dispatcher.RunAsync(CoreDispatcherPriority.Normal, () =>
    {
        var rectangle = new Windows.UI.Xaml.Shapes.Rectangle();

        if ((f < 0.5) && (!lowerThresholdHit)) //Free fall
        {
            lowerThresholdHit = true;
        }
        else if ((f > 2.5) && (lowerThresholdHit)) //Impact
        {
            Utilities.message("Fall Detected!", "Alert");
            lowerThresholdHit = false;
            this.Frame.Navigate(typeof(FallAlertPage));
        }
    });
}
```

This is achieved by monitoring data obtained from the accelerometer of the device and using a vector formula to calculate the force in m/s. To be classified as a fall there has to be 2 states which are free fall and impact. The first part of the fall is the free fall, where there is an acceleration towards the ground which

causes the gravitational force acting on the user (and hence the phone) to decrease to less than 0.5. This is when the lower threshold is hit.

When the user hits the ground, the sudden halt and impact causes the gravitation force acting on the user (and the phone) to increase significantly.

Therefore, when the system detects a sharp spike following freefall the lower threshold hit, a fall is detected.

- Start Detection in Background

Once the user clicks on Start Tracking button, the Geofence monitoring task is put into the background task. It will run and check whether there are any changes in state every two minutes.

- Notify family member user has fallen using SMS with coordinate

```
public async System.Threading.Tasks.Task<bool> SendMessage(string from,
string to, string message)
{
    //API Credentials
    var accountSid = "AC53e2822f203a654eba8ae8f81c911002";
    var authToken = "890d3e60a3168447eb2d674031f4b68a";
    var targeturi = "https://api.twilio.com/2010-04-01/Accounts/{0}/SMS/Messages";

    var client = new System.Net.Http.HttpClient();
    client.DefaultRequestHeaders.Authorization =
CreateAuthenticationHeader(accountSid, authToken);

    var dict = new Dictionary<string, string>
    { { "From", from }, { "To", to }, { "Body", message } };
    var content = new FormUrlEncodedContent(dict);
    content.Headers.ContentType = new
MediaTypeHeaderValue("application/x-www-form-urlencoded");
    //Make POST request
    var response = client.PostAsync(string.Format(targeturi,
accountSid), content).Result;
    //Return status of POST request
    return response.IsSuccessStatusCode;
}
```

If there is a change in state of Geofence, the system will send an SMS to the phone number that was set in the settings. This is achieved by making a POST request to the Twilio API which will take in “From” number, “To” number and “Body” of the message. The “To” number is taken from the predefined family member’s contact number.

**3.5.3.2 Screenshots of Module**

	
<p>Fall Detection Module Submenu</p>	<p>Set waiting duration as well as family member's phone number.</p>
	
<p>Fall Alert page will be displayed and ask for user's response. If user does not respond when countdown time ends, SMS is sent to family member.</p>	<p>Family member receives alert if user does not respond to the alert.</p>

## **CHAPTER 4 METHODOLOGY AND TOOLS**

### **4.1 Methodology**

The evolutionary development (prototyping) approach is chosen as the most suitable methodology for the development of this project. The evolutionary development model is shown in Figure 4.1(Elfira Nureza Ardina, 2010)

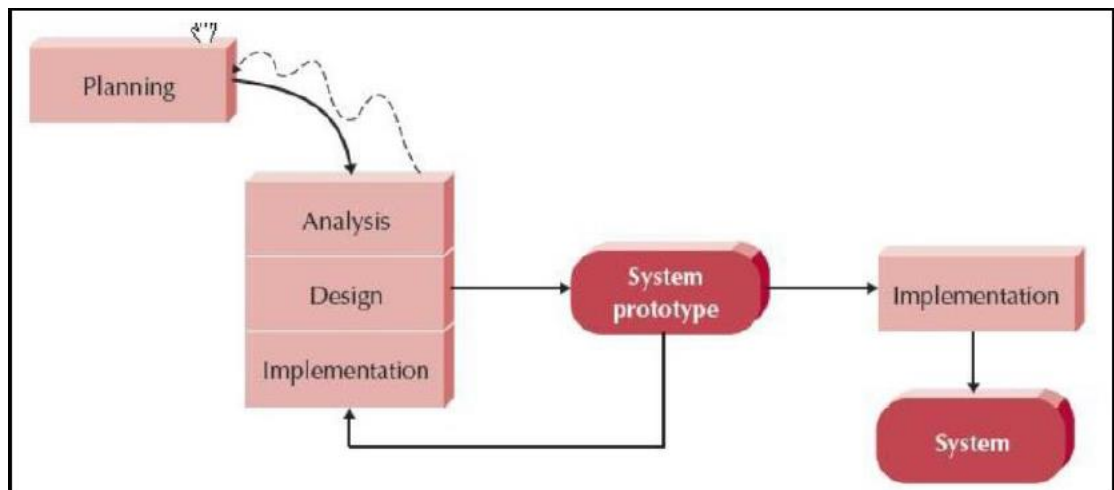


Figure 4.1: The model of the evolutionary development (Elfira Nureza Ardina, 2010)

In the planning stage, the issues that elderly and handicapped have with the public transportation system as well as certain aspects of their lives are gathered. The scope of this project is to develop a system that will help improve the life of the elderly and handicapped in the world in various aspects. At the analysis phase, several existing smartphone applications for the elderly and visually impaired was reviewed and a comparison of their strength and weaknesses was done. Their strength and weaknesses of each application as well as the features they offer are clearly listed in the table so that improvements based on the weaknesses to make an even better application. The weakness of the existing applications will be improved on in the project.

The development process starts at the same time as the design phase. A prototype version of the application will be developed on a smartphone, which will include some of the basic functions that were mentioned in the proposed solution. The journey planner and public transportation information system will be done first. As for the remaining features, location checker and fall detection with distress signal sender will be implemented in the second stage of development. Prototype versions of the

application will be developed and sent out to be tested by elderly and visually impaired users in order to get their feedback at the end of each iteration of the development phase. This process will be repeated in order to improve the app until it fulfils all the user requirements. The last stage of this development lifecycle is implementation stage where the final version of the prototype, which has undergone rigorous testing, is developed into the final application.

## **4.2 Tools to Use**

### **4.2.1 Software**

- Microsoft Visual Studio Community 2015  
Integrated Development Environment (IDE) used to develop application for smart devices
- Windows Phone SDK  
Windows Phone Software Development Kit used to develop Windows Phone based application which comes with many useful tools for development.
- Windows Phone Emulator
- Windows Phone Location API
- Windows Phone Accelerometer API
- Windows Phone Speech Synthesis API
- Twilio Cloud Communications Platform

### **4.2.2 Hardware**

- Computer

To develop the mobile application

Operating System	Windows 10 Pro 64-bit
CPU	Intel Core i5 2450M @ 2.50GHz
GPU	NVIDIA GeForce 610M 2GB
RAM	8.0GB Dual-Channel DDR3

Table 4.1 Computer Hardware Specification

- Smart Device running Windows Phone



To test the mobile application

Operating System	Windows 10 Mobile
Chipset	Qualcomm MSM8960 Snapdragon S4 Plus
CPU	Dual-core 1.5 GHz Krait
GPU	Adreno 225
RAM	1 GB RAM
Wi-Fi	Wi-Fi 802.11 a/b/g/n
Positioning	GPS, A-GPS, GLONASS

Table 4.2 Smart Device Hardware Specification

### 4.3 Requirement

In order to run this applications, the mobile device have to fulfil several requirements. These requirements can categorised into two type which are hardware requirement and software requirement.

- Minimum hardware requirements
  - Qualcomm Snapdragon S4 dual-core processor or Snapdragon 800 series
  - Display with at least WVGA (800 x 480) resolution
  - 512MB of RAM
  - Accelerometer sensor
- Minimum software requirements
  - Windows Phone 8.1 or above
  - Location service
  - Internet connectivity

**CHAPTER 5 IMPLEMENTATION AND TESTING**

A test has to be conducted on the application to ensure that all objectives are met. Black box testing validates application works as intended when used by the actual users in the real-world environment. The testing will be conducted by the tester who will use the system and observe the output without taking into account the internal code and application structure.

<b>Function ID</b>	<b>Function</b>	<b>Function Description</b>	<b>Module</b>
F001	Navigate new location	To allow user to generate route and voice navigation to a new destination	Voice Guided Navigation
F002	Navigate recent location	To allow user to generate route and voice navigation to a recent destination	Voice Guided Navigation
F003	Start Boundary Monitoring	To allow user to activate Boundary Monitoring	Boundary Monitoring
F004	Set Boundary Monitoring settings	To allow user to set Boundary Monitoring settings	Boundary Monitoring
F005	Start Fall Detection	To allow user to activate Fall Detection	Fall Detection
F006	Set Fall Detection settings	To allow user to deactivate Fall Detection	Fall Detection

Table 5.1 Features to be Tested

**F001 Navigate New Location**

<b>Feature</b>	<b>Input</b>	<b>Output</b>	<b>Expected Output</b>	<b>Anomaly</b>	<b>Traceability</b>
Get user's current location	-	User's current address is displayed	User's current address is displayed	-	-
Enter destination	Enter address of destination	Destination is entered	Destination is entered	-	-
Display dropdown list with autocomplete suggestion when user enters destination	Enter address of destination	Dropdown list with autocomplete suggestion is displayed	Dropdown list with autocomplete suggestion is displayed	-	-
Display generated path of route on map	Press next button	Path of route is displayed on map.	Path of route is displayed on map.	-	-
Display list of steps in route	-	List of steps are displayed	List of steps are displayed	-	-
Read out list of steps in route	-	List of steps is read out	List of steps is read out	-	-
Start navigation	Press start navigation button	Navigation is started	Navigation is started	-	-

Table 5.2 Testing Table of Navigate New Location

**F002 Navigate Recent Locations**

<b>Feature</b>	<b>Input</b>	<b>Output</b>	<b>Expected Output</b>	<b>Anomaly</b>	<b>Traceability</b>
Display list of recently travelled locations	Tap on “History” Button	List of recently travelled location is displayed	List of recently travelled location is displayed	-	-
Display generated path of route on map	Press next button	Path of route is displayed on map	Path of route is displayed on map	-	-
Display list of steps in route	-	List of steps are displayed	List of steps are displayed	-	-
Start navigation	Tap on start navigation button	Navigation is started	Navigation is started	-	-

Table 5.3 Testing Table of Navigate Recent Locations

**F003 Start Boundary Monitoring**

<b>Feature</b>	<b>Input</b>	<b>Output</b>	<b>Expected Output</b>	<b>Anomaly</b>	<b>Traceability</b>
Start boundary monitoring.	Tap on “Start Tracking” button	i) Boundary monitoring started message is displayed ii) “Start Tracking” button is changed to “Stop Tracking” button	i) Boundary monitoring started message is displayed ii) “Start Tracking” button is changed to “Stop Tracking” button	-	-
Stop boundary monitoring	Tap on “Stop Tracking” button	i) Boundary monitoring stopped message is displayed ii) “Stop Tracking” button is changed to “Start Tracking” button	i) Boundary monitoring stopped message is displayed ii) “Stop Tracking” button is changed to “Start Tracking” button	-	-
Detects when user have the boundary	User leaves the boundary		Sends alert to family member	-	-

left the boundary					
----------------------	--	--	--	--	--

Table 5.4 Testing Table of Start Boundary Monitoring

**F004 Set Boundary Monitoring Settings**

<b>Feature</b>	<b>Input</b>	<b>Output</b>	<b>Expected Output</b>	<b>Anomaly</b>	<b>Traceability</b>
Display current location and boundary	Tap on “Set Tracking” button	Current location and boundary is displayed on map.	Current location and boundary is displayed on map.	-	-
Set boundary radius	Enter radius	i) Radius is entered ii) Size of boundary displayed on map changes	i) Radius is entered ii) Size of boundary displayed on map changes	-	-
Set boundary radius	Enter invalid radius	Invalid radius error is displayed	Invalid radius error is displayed	-	-
Set phone number	Enter phone number	Phone number is entered	Phone number is entered	-	-
Set phone number	Enter invalid phone number	Invalid phone number error is displayed	Invalid phone number error is displayed	-	-
Save settings	Tap on “Save” icon	Settings saved message is displayed	Settings saved message is displayed	-	-

Table 5.5 Testing Table of Set Boundary Monitoring Settings

**F005 Start Fall Detection**

<b>Feature</b>	<b>Input</b>	<b>Output</b>	<b>Expected Output</b>	<b>Anomaly</b>	<b>Traceability</b>
Detect when user has fall	User falls	Alert Countdown page is displayed	Alert Countdown page is displayed	-	-
Prompt user whether is the user alright	User falls	Alert Countdown page is displayed	Alert Countdown page is displayed	-	-
Countdown before send alert to family member	User falls	Countdown with time set is displayed	Countdown with time set is displayed	-	-
Cancel the alert manually	User taps on “I’m Okay” during Alert Countdown	Alert Countdown page is closed	Alert Countdown page is closed	-	-
Sends alert to family member automatically	No input received during Alert Countdown	i) Alert sent message is displayed ii) Family member phone receives	i) Alert sent message is displayed ii) Family member phone receives	-	-

		the message	the message		
Sends alert to family member manually	User taps on “Send Alert” button	Alert sent message is displayed	Alert sent message is displayed	-	-

Table 5.6 Testing Table of Start Fall Detection

**F006 Set Fall Detection Settings**

Feature	Input	Output	Expected Output	Anomaly	Traceability
Set phone number	Enter valid phone number	Phone number is entered	Phone number is entered	-	-
Set phone number	Enter invalid phone number	Invalid phone number error is displayed	Invalid phone number error is displayed	-	-
Set countdown time	Enter valid countdown time	Countdown time is entered	Countdown time is entered	-	-
Set countdown time	Enter invalid countdown time	Invalid countdown time error is displayed	Invalid countdown time error is displayed	-	-
Save settings	Tap “Save” icon	Settings are saved	Settings are saved	-	-

Table 5.7 Testing Table of Set Fall Detection Settings



## **CHAPTER 6 CONCLUSION**

### **6.1 Project Review, Discussions and Conclusions**

This project is a smartphone application project for the elderly and handicapped that will greatly benefit the elderly and handicapped all over the world in many aspects of their lives. This mobile application project consists of three core modules, each designed to tackle a problem that the visually impaired faces.

The first problem this project tackles is in aids the visually impaired to travel via public transportation independently. The Route Planning module lets the users plan their journey to a specific destination using public transportation. This module generates the optimal route and calculate the estimated fares and travel times as well as display the buses' names and buses' arrival times and so forth. This module will also guide the user to their destination.

Next, elderly and handicapped tends to wander out of their homes on their own and become lost. This problem is solved through the Location Tracking module which tracks the user as they move out of a pre-defined geographical location such as their home. The location of the user will be tracked and plotted on a map as they travel outside at a certain interval. Family members of the user will be able to check and watch the movement of the user on a map. This will allow the family members of the user to find them easily if they are lost or uncontactable.

The third problem that elderly and handicapped face is that there is no system to detect and alert their family members in situations of emergency. The Emergency Detection module attempts to detect if the user has fallen down or unconscious with the accelerometer sensor of the user's smartphone. When an unusual movement is detected, the module will ask the user to respond if they are all right within a certain period. Otherwise, the module will automatically send a distress message along with the location of the user to the family members of user. The user can also send the distress message manually.

In short, I believe that the deliverable of this entire project will greatly benefit the visually impaired community in many areas of their lives.

### **6.2 Novelties and Contributions**

The main deliverable of this project is to become the one-stop-solution that provides various functions that will greatly benefit the elderly and handicapped community. The Voice Guided Navigation will be designed to have an interface for the elderly and handicapped. It allows the elderly and handicapped to commute independently using public transportation. It will provide graphical and voice based interaction for the user.

The Boundary Detection system will also allow family members to know where their elderly or handicapped family members have travelled and where they are at in real-time when they leave the house at unusual hours. With this, the cases of elderly and handicapped going missing is expected to be reduced.

An accelerometer-based Fall Detection system was also implemented which allowed the smartphone to detect if the user have fallen down or fell unconscious and send a distress signal to their family members. This will allow the family members to be alerted of the user's situation and arrange to help the user immediately.

### **6.3 Implementation Issues and Challenges**

There were several challenges that the author faced in this project. One of the main challenges was creating a user interface that is catered for the elderly and handicapped. This is because elderly and handicapped are either partially or fully visually impaired. Therefore, the conventional methods of touch input and design is not effective as it is reliant on the sight of the user.

Another challenge unique to this project was to detect falling motion using accelerometer sensor of the user's phone. The application of accelerometer in this manner is rarely implemented in a smartphone. Hence, it posed some difficulty in coming up with the implementation as there are limited sources to refer to.

Furthermore, the system must not mistake the user for falling down while the user is walking or swinging the phone.

### **6.4 Future Work**

This project can be improved further in several areas. Firstly, detection of bus and bus stop presence could be added to this project. This means that the application will know when a bus is within few hundred meters and notify the user that their bus is approaching. The application can also know which bus stop the user is supposed to get down at and notify the user in advance to prepare to get down the bus.

Next, the routes can be calculated without Microsoft Maps API. The reasons for this is because this will allow the application function offline, without the reliance of Internet connection. This will allow the application to be used in places without Internet connection. Besides that, the SMS alert that is sent to the family members can include list of nearby hospital phone numbers to call. This will make it easier for the family members of user to arrange for help to the user.

Lastly, the application should also include a first time user setup and tutorial process. When the user launches the application for the first time, the application asks user for the required settings before the user can start using the application. Then, the application can do walkthrough tutorial that teaches user its features.

## **BIBLIOGRAPHY**

Aguiar, B. et al., 2014. Accelerometer-based fall detection for smartphones. *Medical Measurements and Applications (MeMeA), 2014 IEEE International Symposium on*, pp. 1-6.

Anon., n.d. *Unit Testing*. [Online]

Available at: [https://msdn.microsoft.com/en-us/library/aa292197\(v=vs.71\).aspx](https://msdn.microsoft.com/en-us/library/aa292197(v=vs.71).aspx)

Frank Sposaro, G. T., 2009. iFall: An Android Application for Fall Monitoring and Response. *Conference proceedings: ... Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE Engineering in Medicine and Biology Society. Conference 09/2009*; , pp. 119-122.

Hansen, J. E., 2011. *Test Cases Based on Use Cases*. [Online]

Available at: <http://www.allaboutrequirements.com/2011/10/test-cases-based-on-use-cases.html>

Hine, J. & Mitchell, F., 2001. Better for Everyone? Travel Experiences and Transport Exclusion. *Urban Studies*, 38(2), pp. 319-3332.

Luo, S. & Q. Hu, 2004. A Dynamic Motion Pattern Analysis Approach to Fall Detection. *IEEE International Workshop on Biomedical Circuits and Systems*, pp. 5-8.

Metz, D., 2000. Mobility of older people and their quality of life. *Transport Policy*, 7(2), pp. 149-152.

Ning, J. (2009). Detecting Human Falls with a 3-Axis Digital Accelerometer [Abstract]. *Analogue Dialogue*, 43(07), 3.

Pangbourne, K., Aditjandra, P. & Nelson, J., 2010. New technology and quality of life for older people: exploring health and transport dimensions in the UK context. *IET Intelligent Transport Systems*, 4(4), pp. 318-327.

Rouse, M., 2007. *unit testing definition*. [Online]

Available at: <http://searchsoftwarequality.techtarget.com/definition/unit-testing>

SUEN, S. L. & MITCHELL, C., n.d. *Accessible Transportation and Mobility*, s.l.: s.n.

Bachelor of Computer Science (Hons)

Faculty of Information and Communication Technology (Perak Campus), UTAR

Wasfi, R., Levinson, D. & El-Geneidy, A., 2012. Measuring the transportation needs of seniors in the Twin Cities region.. *Journal of Transport Literature*, 6(2), pp. 8-32.

Yavuz, G. et al., 2010. A Smartphone Based Fall Detector with Online Location Support. *International Workshop on Sensing for App Phones*, pp. 31-35.