COMP4801 - Final Year Project

Blackbox System For The Elderly

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Date: 23/01/2016

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Abstract

The elderly in our society are prone to getting lost, because of old age and even diseases like Alzheimers. This can lead to serious and even fatal repercussions like dehydration, traffic accidents and falling prey to criminal activities. However, as smart phone technology permeates across different sections of society, there is an opportunity to provide a mobile solution that can help increase the security of the elderly in case they get lost. The "Blackbox System for the Elderly" is a mobile app that aims to accomplish exactly that. The app primarily provides a platform for family members and/or caretakers of the elderly to locate them and reach out to them easily in case they get lost. This report explains the problem that this project aims to solve in detail. It also proceeds to discuss the features that will be part of the app and the methodologies adopted during the process of development. Finally, the report describes the progress made till date, the problems encountered and the work to be completed in the future.

Acknowledgements

First, I would like to thank my advisor Dr. T.W.Chim for his time, guidance, and insightful feedback, as I planned all features of my project and began execution. I would also like to thank my parents who advise and encourage me at every step. Next, a big thank you to my boyfriend Aditya for always listening to me, supporting me and helping me find a way through all challenges. In the end, I would also like to thank three of my closest friends at HKU, Disha Jain, Anisha Garg and Manasi Jayaraman who have been a constant source of support and motivation. Thank you all so much !

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1. Introduction

Dementia describes a set of symptoms that include memory disorders, personality changes and impaired reasoning. According to WHO's report on dementia in 2015, nearly 47.5 million people in the world today, suffer from some form of dementia [1]. Every year nearly 7.7 million new cases of dementia are diagnosed [2]. It is a serious and possibly fatal disease being faced by people all over the world. The two earliest seen and most common symptoms of any form of dementia are memory loss and a failing sense of direction. Consequences of poor memory can be as small as simply losing track of time, to more serious problems like not even recognising one's own family, in the advanced stages of the disease. Apart from dementia patients, many senior citizens across the globe also face the problem of declining memory due to the process of ageing.

The most common repercussion of poor memory is getting lost. In Hong Kong, according to a local telephone survey conducted by the government in 2007, nearly 30% people suffering from dementia (or their caregivers) had reported having gotten lost at least once [3]. Losing one's way can have serious and possibly fatal consequences. These include problems like, dehydration, starvation, falling prey to criminal activities and possible traffic accidents. However, it would be inhuman to stop the elderly from going out alone especially, if their condition is not very serious. There are GPS devices and name tags, that family members or caregivers make the elderly wear to locate them in case they get lost. While these are useful, they often create a belittling and even possibly humiliating feeling among the elderly. Many feel like they are being equated with criminals, who are fitted with GPS trackers. Also, currently there are almost no mobile applications designed specifically for the elderly to increase their safety when they step out of their homes.

There is need for a solution designed to ensure the safety of the elderly on the go. Thus, I decided to build the Blackbox System for the Elderly. It is an application that can help family members locate the elderly easily in case they lose their way. This report discusses in detail the aim of the application, its features, implementation details, the progress made till date and the work to be done in the future.

2. The Problem

Consider Lynda, a hypothetical person who is 78 years of age and lives in Hong Kong. She is an active lady who enjoys meeting friends, walking to remain fit and even buying her own groceries. She lives life independently despite her old age. Lynda represents a growing section of senior citizens globally, who are not always dependent on their family or caretakers for everything. However, she faces a small problem i.e. memory loss.

Lynda does not suffer from a serious disease like Alzheimers, which is a form of dementia specifically relating to memory loss and cognitive decline, but because of age she tends to get confused about routes and ways. This has resulted in her getting lost a couple of times, even in short outings like that to the wet market. In such a situation she calls up her family to find her however, as she is confused, she often finds it hard to even explain where she is, at that point. This makes it difficult for her family members to locate her. While there have not been any serious consequences of her getting lost as yet, she and her family fear that something bad might happen. At the same time, her family does not wish to restrict her independence and stop her from going out. They have tried GPS tracking devices however, she does not like them as they make her feel like a prisoner or a criminal who needs to be constantly tracked.

2.1 Current Solutions and Drawbacks

Currently, two methods are used to ensure the safety of the elderly. First, is using GPS tracking devices that are worn around the wrist or neck. The most commonly used one in Hong Kong is called Mobile Link (隨身寶) (see Figure 1). While these are useful, as mentioned previously, they often have a demeaning impact on the elderly. Therefore, many even refuse to wear it.

The second method is using general purpose safety and tracking mobile applications like Life360 and GPS Phone Tracker. While these also serve the purpose, they have a major problem i.e. they are not directed towards the elderly. Hence, they do not take into consideration basic requirements that the elderly might have like bigger text, simplicity etc.

Figure 1 - Mobile Link - GPS tracker for the elderly

3. The Solution

The Blackbox System For The Elderly is being built to help people like Lynda live an independent and safe life. The Blackbox System is an Android application that will run

continuously in the background and will routinely log the position of the elderly into a database. This position can then be viewed by a family member or caretaker, to locate them in case they get lost. It will also provide added features to help the elderly reach safety in case of an emergency. This application is being built for Android as it is the most widely used smartphone platform and hence will ensure maximum reachability.

3.1 Features and Flows

To better understand how Lynda and her family members will sign up for the application and use it to ensure her safety, the following sections will look at the application flows.

3.1.1 Sign Up

The sign up process of the application begins by asking the user to choose a role - elderly or family. The process involves entering the following personal details - name, phone number, address and emergency contact number (see Figure 2). Family members are additionally asked to enter the elderly's phone number and their email-address. Once the elderly has registered, they are given a common password (see final screen of Figure 2). The family members need this common password and the elderly's phone number to register and view the elderly's location. This has been done to prevent any kind of unauthorised access to the elderly's location information.

To ensure maximum ease of use for the elderly, the user is asked to enter only one input per screen . Also, whenever input is required, the keyboard is automatically displayed (see red circle in Figure 2). The text in the app is also of a larger font size to allow easy readability, in case of weaker eyesight.
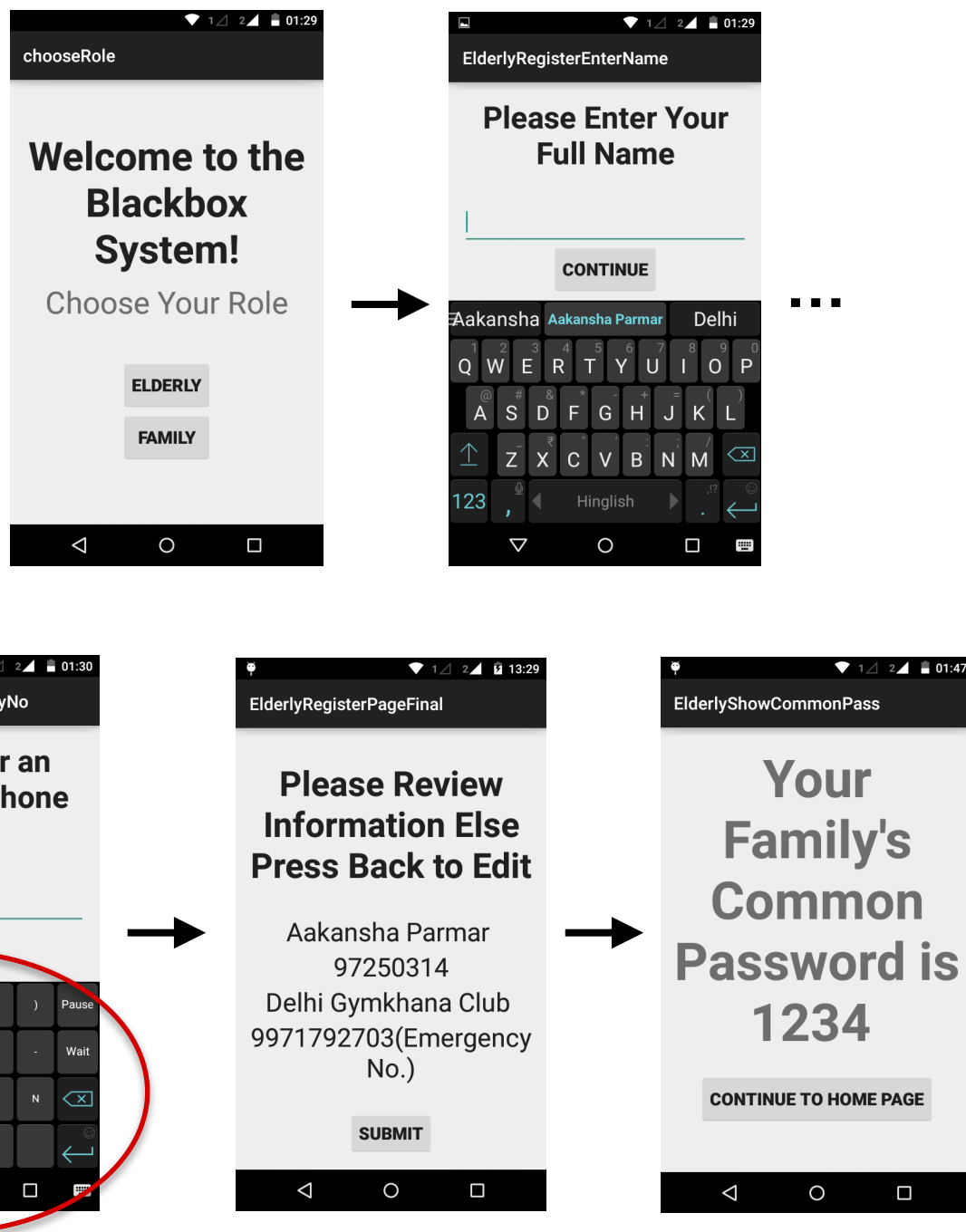
Figure 2 - Flow for elderly's signup (Partial)

3.1.2 Logging the Elderly's Location

Once the elderly register for the app, their location and current time automatically gets stored

in a database every 10 minutes. If the app is open, then a message gets displayed to indicate that the
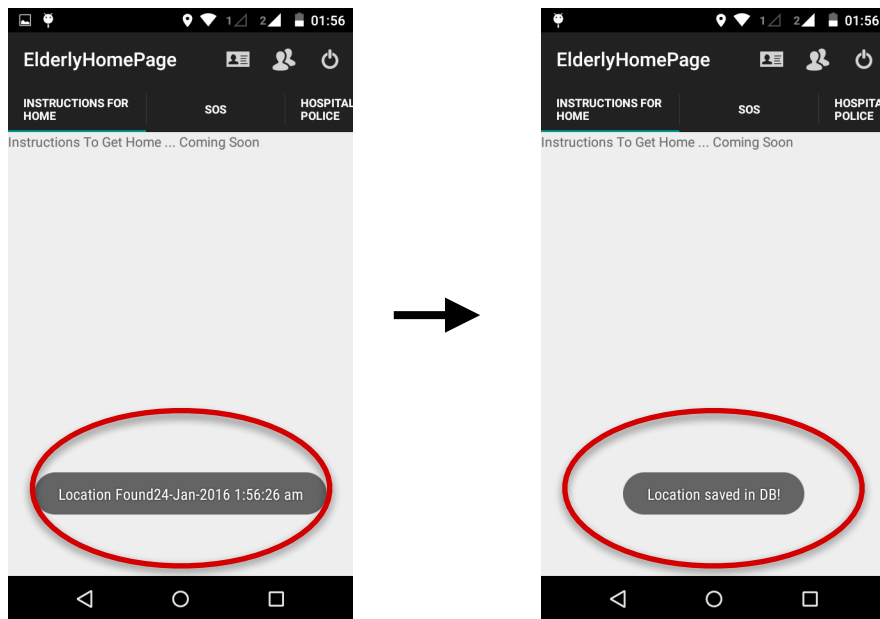
location was saved (see Figure 3).

Figure 3 - Elderly's location gets saved automatically

3.1.3 Emergency Features for the Elderly

The application also provides 4 services to help the elderly in case of an emergency. They are -

- Instructions about how to reach the closest transport system to get back home.

- Location of the closest hospital and police station.

- An SOS button which will immediately send an emergency message to the family members with the elderly's current location. The elderly can also add a photo of his surroundings and send with the message if he/she wants (see Figure 4).

- An ID page with all personal particulars and medical information of the elderly is also there in the app. This can be used by someone to help the elderly get home, in case they forget their address (see Figure 5) .
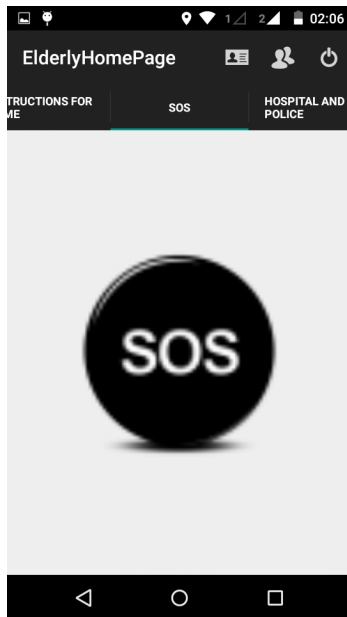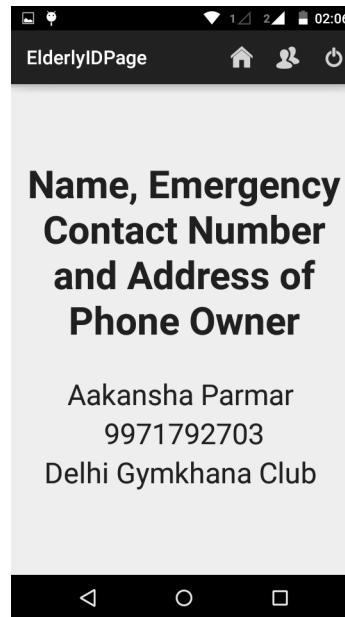
Figure 4 - SOS button for the elderly   **Figure 5 - ID page for the elderly**

3.1.4 Battery Low Notification for the Elderly

The app will also give a notification on the elderly and their family members' phones if his/her phone's battery is low. While this feature is not directly linked to tracking, it is important because older people, especially dementia patients, might not understand or pay much attention to the battery low notifications on their phone. Therefore, it will help ensure that the elderly don't go out when their phone battery is low and avoid the risk of getting lost, without any way of contacting their family.

3.1.5 Location Viewing by Family Members

Family members can view the time and location of the last logged position saved in the database. (See Figure 6).

Figure 6 - Map showing elderly's last location to family

3.1.6 Advanced Features

Advanced features are those that will be included in the application depending on the availability of time.

- For dementia patients the app should be able to raise an alert if they stray too much from a pre-defined path. While this is an extremely restrictive feature it can be essential for people with early stage dementia who do go out alone.

- All instructions on the app will be made voice based as well. This is to accommodate people who might have weaker eyesight.

- It has been seen that the elderly are usually more comfortable in their local language. Thus the app will be made multilingual i.e. in English, Cantonese and Hindi.

3.2 Implementation Details

The Blackbox System has been developed for smartphones that run the Android operating system. Its backend runs on a Google App Engine (GAE) instance that is connected to Google Cloud SQL, a MySQL database that lives in Google's cloud. The connection between the Android client and the App Engine mobile backend is done using Google Cloud Endpoints (GCE). GCE enables generation of APIs and client libraries from the backend, thereby simplifying client access to data from other applications (in this case, Google Cloud SQL) [4]. GCE also enables the extension of the same API to iOS and web as well, thereby providing the flexibility to expand to other platforms in the future (as seen in Figure 7). The app is being built using Android Studio platform. The entire source code of the application can be viewed here - https://github.com/aakanshaparmar/ BlackBoxSystem.
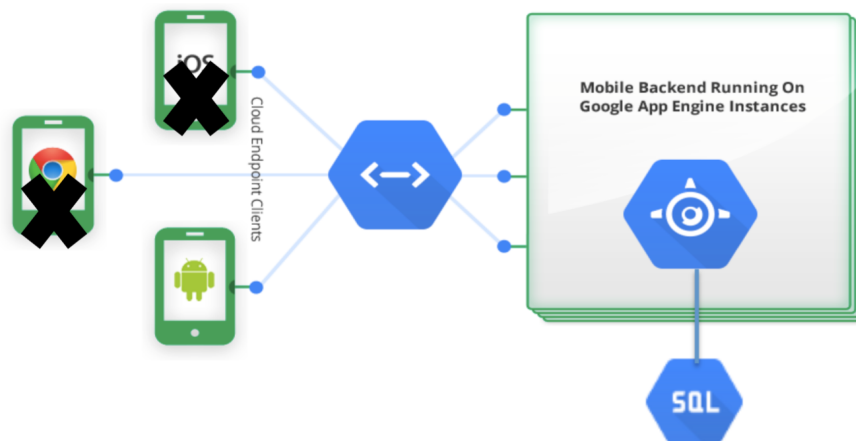

Figure 7 - System Design Overview [4]

3.3 Major Areas of Focus

The development of this application is not just about programming its features and functionalities, it is also about doing it in a way that ensures maximum penetration and best experience. Keeping these in mind, there are four major areas of focus.

3.3.1 Platform

As mentioned previously this application will be built for Android. This is because it is the most popular smartphone operating system today, with nearly 78% share of all users globally (as per 2014 records) [5]. In addition, its open source nature has allowed for many companies to release cheap Android phones, that are affordable by majority of the population, irrespective of their economic background. In many countries including India one can buy an Android phone for as low as HK$195 (as seen on Indian e-commerce websites). Therefore, using Android will ensure maximum user reachability. This is vital to ensure that anyone who needs the app can use it, irrespective of their financial background. The app will also be built adaptable to maximum possible Android versions. This is in line with the project's maximum user reachability principle. Currently, the proposed minimum supported Android version is 4.0 (Ice cream Sandwich), API level 14. This is because, all versions below 4.0 are known to have a low market share of 0.4% or less individually [6]. In the future however, if it is possible to use lower API levels to support the application efficiently, without much need for customisation and depending on the availability of time, lowering the API level will also be considered.

3.3.2 Usability

The app also must be user friendly for the elderly. While there are many safety apps present in the market today, none of them cater specifically to the needs of the elderly. This is important because, their requirements are slightly different. They are not always as adept to using technology and smartphones. There are additional factors as well like, visual capabilities of the elderly, that need to be kept in mind while designing the user interface of the app. To ensure best user

experience for the elderly, extensive research and a survey have been conducted, the results of which can be read in section 4 on Customer Focus.

3.3.3 Efficiency

Another important aspect of the application, is the need for efficiency. As mentioned in the third section, this is a background app i.e. it will be running continuously on the phone. Such an app can immensely drain a phone's battery and increase its data usage. While newer phones might still function normally despite the load on their battery, the performance of older phones may definitely suffer. In the survey conducted as part of this project, it was seen that most senior citizens have older phones, thus this is definitely an important consideration. Too much data usage can also be extremely costly for the user. To combat these issues, additional features will be required. One such feature will be, varying the frequency at which the user's location is logged into the database, depending on his/her speed. Thus, if they move faster the location will be logged more frequently and if they are moving slowly it can be logged less frequently.

3.2.4 Security

The last and possibly most important consideration and requirement for this application is security. GPS tracking has always been under scrutiny for creating a huge security and privacy risk. A person's location and movement details are private and must not get misused. Thus, it needs to be ensured that the location being stored in the database remains secure and only authorised people are permitted to view it. This will be achieved through a password based verification procedures as mentioned in 3.1.1.

4. Customer Focus

As mentioned in section 3.3.2, it is necessary to design the application in such a way that it is usable by the elderly. To learn more about their requirements, two methods were adopted.

- Research through papers and articles available about this subject, on the internet.

- Survey conducted among some senior citizens living in Kwun Lung Lau, Kennedy Town, Hong Kong.

The details and the conclusions drawn from these methods can be seen below.

4.1 Online Research Method

There are a lot of online resources available today, that helped understand problems that the elderly face while using smartphone applications and possible ways to tackle them. For the purpose of this project, four main online resources were used. They were -

- Mobile Application Development For Senior Citizens by Jing Gao and Andy Koronios, School of Computer and Information Science, University of South Australia, Adelaide, Australia. (http://www.pacis-net.org/file/2010/S05-03.pdf)

- Tips to Design Innovative Digital Products for Senior Citizens, Volume1 and 2. (http://mobisoftinfotech.com/resources/blog/tips-design-innovative-digital-products-senior-citizens/)

- Designing Apps for the Elderly. (http://littlemoore.tumblr.com/post/49502903876/designing-apps-for-the-elderly)

- Designing For The Elderly: Ways Older People Use Digital Technology Differently by Olie Campbell. (http://www.smashingmagazine.com/2015/02/designing-digital-technology-for-the-elderly/)

4.1.1 Findings from online research

Using the above mentioned resources, the following conclusions were drawn.

- The elderly often have weaker eye sight, hence the text on the screen must be big and well spaced out.

- Text should also preferably be left aligned because it is easier to read as compared to other alignment formats.

- Similarly, buttons must also be big in size.

- There should not be too many tasks on one page as that tends to create confusion and it is often considered difficult.

- Either voice or text instructions are preferred on every screen for guidance.

- Minimum text input should be there, as the elderly often find it hard to type on the small keyboards that phones have.

- It is preferable to not have usernames and passwords as the elderly have a tendency to forget them.

- If a task requires the users to remember what they entered previously, avoid splitting it across different screens, as they might forget what they had entered previously.

- Avoid animations and keep the user interface as simple as possible, with basic colours.

4.2 Customer Focus Group

The online resources provided a lot of insight into the considerations that need to be kept in mind while building an app for the elderly. The purpose of this customer focus group was to validate the conclusions drawn from the online research and to gain first hand knowledge about how the elderly use smartphone applications. This survey was conducted at Chi Sun College, JCSV III, HKU on 24th October 2015, where close to 20 senior citizens from Kwun Lung Lau, Kennedy Town come twice a month to learn how to use smartphones and smartphone applications.

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For the purpose of this survey three practices were adopted. First, the elderly's interactions with their smart phones were observed from a distance. Second, they were asked a set of questions that had been prepared previously. These survey questions were asked orally in the form of an interview. The interview included questions like which phones they used, what problems they faced with commonly used apps like WhatsApp etc. These questions were basically meant to understand the kind of difficulties they faced while using their phones and applications. Finally, they were shown three screens of the app. They were allowed to use the app for sometime and feedback was taken from them on two main criteria - comfort of use and understandability. A complete list of the survey questions and the app screens can be viewed in the Appendix.

4.2.1 Survey Results Summary

The survey's findings were in line with those of the online research. All the elderly except one used Android phones. However, it was clear that their phones have relatively older Android versions as they do not change their phones often. Thus, it reinstates the need for the application to be functional on maximum possible Android versions as mentioned in section 3.3.1. The second point that became apparent was that the elderly prefer phones with bigger screens. With a weaker eyesight, it helps them see the contents on the phone better. Therefore, the user interface must be built for bigger screen sizes as well, in addition to the standard screen sizes.

Most of the elderly, especially those who were slightly older in age, clearly did not prefer typing text. Even while using WhatsApp they preferred to send voice messages. When asked about applications like WhatsApp, almost all of them said that they found them a bit confusing. This was especially because they thought that there was a lot happening on each screen and the text on the screen wasn't very big. The idea of having instructions on each screen was very popular.

However, they were not too keen on having voice instructions. This is because, they felt that the sound from the phone wasn't always loud enough to clearly hear and understand. The idea of having passwords or anything similar was widely unacceptable. All of them unanimously said that they found remembering passwords difficult. The family members of many of the elderly had tried to make them use a safety device. However, as mentioned in section 2.1 on current solutions and their drawbacks, they found the idea of using this tracking device demeaning, and they had gotten rid of it. They liked the idea of the Blackbox system however, they did not like certain words used in the application like "follower" (used initially to refer to the family members), as it reminded them of the tracking device.

When shown the screens, most people liked the big size of the text and the fact that the screens were simple and clear. However, they found one major problem. The second and third screens shown to them had multiple text fields on each screen, to accept user input. The elderly found it difficult to shift from one text field to another, especially when the keyboard had to be closed and opened again. To solve this, the best way will be to make the user enter only one value per screen and open the keyboard automatically when the user has to input.

5. Current Progress

Building the Blackbox System has not only involved writing code, but also understanding the requirements of the target customers and shaping the product in accordance with that. A timeline of the process followed by me is as follows -

Finalized set of features.	**Sept '15**
Studied requirements of the elderly.	**Mid Sept'15 – Beginning of Oct'15**
Designed UI and made wireframes.	**Mid Oct'15**
Held Customer Focus Group. (section 4)	**24th October '15**
Built signup process. (section 3.1.1)	**Mid- End Oct'15**
Setup backend and database. (section 3.2)	**Nov - Dec'15**
Built location saving feature. (section 3.1.2)	
Built location viewing feature. (section 3.1.5)	
Built ID page for the elderly. (section 3.1.3)	

6. Difficulties Encountered

Two main difficulties have been encountered since the start of the project. These were -

- At the beginning of the project, it was decided that the frequency of location logging will be based on the user's speed. However, during the online research and customer focus group, it was revealed that the elderly have relatively older phones. These phones may not be able to recognise movement of the user and hence may not be able to support this feature. Therefore another way needs to be thought to ensure efficient location logging.

⬤The emergency features for the elderly mentioned in section 3.1.3 require displaying a map to view the closest hospital or police station. However, the elderly often find it difficult to read the maps shown on small smartphone screens. Therefore, it is necessary to find a way to display at the maps in a user-friendly manner.

7. Future Work

While a lot of groundwork has been established in the previous semester, a lot of work is still to be done to build a well rounded safety application for the elderly. The tentative timeline for the coming semester is as follows-

Display instructions for home.	**Jan'16 – Feb'16**
Display closest hospital & police station	
Notifications for SOS & Battery Low	
Work on optimizing efficiency	**Mar - Apr '16**
User testing	
Work on advanced features	

8. Conclusion

The Blackbox System is an attempt to ensure that the elderly and people suffering from serious diseases like Alzheimers can live a safe and independent life. It is being developed with the main purpose of ensuring maximum penetration among people. The foundation for the development of this application has been laid through the customer focus survey, UI design. Some of the features have also been built successfully. However, a lot of work is still to be done, to ensure maximum features can be implemented well within the provided time frame.

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Appendix

1. Complete List of Survey Questions

⬤ Which phone do you use?

⬤ If Android, which one is it ?

⬤ Are you comfortable typing out text on the phone?

⬤ What do you think about apps like WhatsApp (The major app all of them used)

⬤ Would you like it if apps you used had voice/text instructions?

⬤ Are you comfortable having passwords?

⬤ Are you using any application to ensure your safety when you go out?

⬤ What do you think about an application like the Blackbox system?

2. App Screens Shown During Customer Survey