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Happy Gramps: Senior Citizens Safety App - Using Fall Detection Mechanism And Miscellaneous Functionalities

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Abstract

With the ever-growing population of senior citizens in the world, it is becoming more and more necessary to build solutions for the problems they regularly face. Even though many problems have been cleverly addressed and smart solutions are technically available in the market, they don't seem to have much impact on the life of an average senior citizen. Most of the available solutions focus on solving one problem, without addressing the other common ones. Moreover, only a small subset of these solutions is readily available to everyone. The problem is that these solutions are rarely affordable and accessible. Even with the booming IT sector, there are very few application software that address the needs of the elderly. For this very reason, we are introducing a way in which smartphones- a device that has become an everyday companion- can be used to address the needs of the senior citizens. We propose a smartphone application, which can provide precautionary measures in case of emergency, and also aid senior citizens in their day-to-day activities by providing different functionalities such as fall detection, emergency alert, reminder alert, as well as ability to store important information and contacts.

Keywords— *Smartphone, Health Care, Mobile Application.*

1. Introduction

For most of our nations, senior citizens constitute the fastest growing population segment and, in order to provide different health and safety services, a lot of capital is invested by both the government and the senior citizen's family. [2] Innovations in the IT sector have helped to make the lives of people more comfortable and convenient, however, there are only a few solutions that address the needs of senior citizens efficiently.

Perhaps it is reasonable to assert that senior citizens usually don't require intricate features on their mobile phones and the facility to install third-party software is not relevant for this demographic. However, considering the vast upsurge in smartphone technology and its usage, it should be noted that the next generation of senior citizens (in the next 5~10 years), as well as a proportion of present generation of senior citizen users, are indeed proficient mobile phone users.

This led us to come up with a solution that uses smartphone technology to address the needs of the senior citizens. Our project aims to develop a smartphone application that can aid in preventive measures while also providing emergency health care to the senior citizen.

1.1 Need and Motivation

For the elderly population, which accounts for a substantial part of spending on social and health care services, it means most of the time living alone and independently in their homes, with various risks involved.

Accidents can happen at any time, and the older we get, the harder it is to bounce back from them. Recovering from surgery or injury as a senior can be a long and arduous process. [3] A good medical alert system can provide a sense of comfort and security during recovery. This is especially important if the individual is recovering at home and a caregiver is not present around the clock. A negative reaction to

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medication, choking, chest pains, dizziness, memory loss and even something as simple as being locked out of the home are reasons seniors living alone could benefit from a device.

This project aims to ideate and develop a smartphone application to assist senior citizens in case of any emergency situation and also help them retain their independence, at the same time reduce the demand on caregivers and provide patients with the freedom to walk outside independently.

1.2 Existing Systems

There are different dedicated devices available in the market to help senior citizens. One such device on a dedicated SOS phone. This phone is developed especially for senior citizens with provision of a senior-friendly user-interface, reminder alert and SOS alert to emergency contact. While meeting basic needs (call, texting and SOS emergency contact), these mobile phones typically lack features (in comparison to the smartphones currently available in the market) and are very expensive. Moreover, the functionality to install third party (or additional) software applications isn't available on this phone.

Another device available is a Medical Guardian Pendant. For using this system, you wear a device (pendant) with a button around your neck or wrist. Once it is pressed, it sends a signal to a larger base system, which calls a pre-programmed number. However, the drawback of this system is that the large console (base system) that sends an alert is not portable. In case if a user wants to do some outdoor task, it would be an inconvenience for him to carry the console with him. Thus, this system is not suitable for outdoor activities.

Lastly, a popular device – Apple Smartwatch 4, also provides fall detection and SOS functionality. However, to use this watch, the user will have to spend a lot of money. Hence, it is not a feasible solution to the people who have a limited budget.

Thus, the above discussed devices do address the needs of senior citizens to some extent, however, they do not provide a cost-efficient and effective solution to the problem.

1.3 Proposed Solution

Smartphone technology has experienced vast upsurge in the last decade in both, developed as well as developing countries. Additionally, people are becoming increasingly reliant on this multifunctional device and nowadays, smartphone devices have become our day to day companion to aid in our mundane activities. This is due to the fact that, there have been considerable improvements in mobile phone's processing capacity, memory size, and the number of in-built sensors (e.g. GPS, accelerometer, gyroscope, magnetometers) as well as the operating systems used. It is also important to note that the location-based services are also becoming an area of focus for the developers. Most of the applications rely on either using GPS or network (GSM or Wi-Fi)-based localization techniques to estimate the location of the user, which is why we choose mobile devices as our key equipment for monitoring and keeping the caretaker informed at regular intervals of time.

[2][7] Consequently, rather than developing a dedicated device with cutting edge features, the approach of developing mobile applications on available smartphone platforms by offering a well-designed user-interface and leveraging all the capabilities that mobile technology provides, is perceived to be more advantageous and cost-effective in order to fulfil a range of senior citizens' needs in the long-term.

The proposed smartphone application includes following functionalities:

- SOS Button - Quickly request help when needed. Clicking this SOS button will send a text alert to multiple emergency contacts. If internet connection is available, the alert may also include user's current location.
- Fall Detection - It will use mobile's in-built accelerometer and gyroscope for fall detection and send text alerts to emergency contacts. Similar to SOS button, this alert may also include user's current location if internet connection is available.

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- Emergency Contact List - An address book with photos of individuals who can help in case of any emergency. List of individuals may include – family members, neighbours, friends, doctor, police, plumber, electrician, etc. Each contact will be categorized into three categories- SOS, Family and Others.
- Information Notebook - It provides a functionality to store personal, financial as well as medical information. Personal information may include Aadhaar number, pan number. Financial information may include insurance number, bank account number whereas medical information may include name of the doctor, hospital or medical prescription. Each note is associated with one of the three priorities – High, Medium and Low.
- Scheduled Reminder - [4] It provides a customizable scheduled reminder. This is further divided into two modules: a to-do task list for day to day activities and a medicine reminder list for daily medicines.

2. Literature Survey

Through our literature survey, we were able to get an idea about what kind of system would be best suited for senior citizens. References [2], [7] and [8] talk about the various points that need to be kept in mind while developing an application for senior citizens with respect to the User Interface. We learned that the most basic requirement is to keep the navigation within the application as simple as possible, so that it is easier for the users to use the application. Simple navigation means reducing the number of steps required to perform a specific task.

Second important thing we learned was the importance of colours. [7] Using high-contrast colours within the application provides better visual aid to senior citizens who do not have good eyesight. Also, using different colours makes the User Interface much more attractive, which is another plus point. Thus, simple navigation and high-contrast colour scheme form the basis of our User Interface implementation for Happy Gramps. Furthermore, the user is also provided with helper text within text boxes, so that they know what they need to fill in the given text box. This also provides a good User Experience as it removes ambiguity, making it easier for the user.

[5] and [6] tell us about the use of sensors that are already present within a smartphone, such as accelerometers, gyroscopes, etc. With the help of [1] and [3] we were able to understand how the data from the sensors could be used in order to detect fall. The fall-detection mechanism uses data from the accelerometer to calculate the acceleration of the device, while gyroscope data tells us about the orientation of the device. Using the data from these sensors, we can detect fall of the device, which would then trigger a notification to the emergency contacts of the user.

For our miscellaneous functionalities, such as Task Reminder, [4] provides us with the basic understanding of how the system actually works. The user can schedule reminders in the application for a specific date and time. On the specified time, a notification would be triggered to the user, informing them about their scheduled tasks. This same idea can be further expanded for the implementation of Notebook and Medicine Reminder features, both as separate modules within the application.

3. Workflow of the System

The working of our system is represented by the control flow diagram. First, the user needs to create an account and register himself. After that the user can start using the application. [3] The fall detection system will work in the background to check for a fall. If a fall is detected then the user is given some buffer time to deactivate the alarm (in case the user is able to get up). If the alarm is not deactivated, then an SOS message will be sent to a pre-programmed number.

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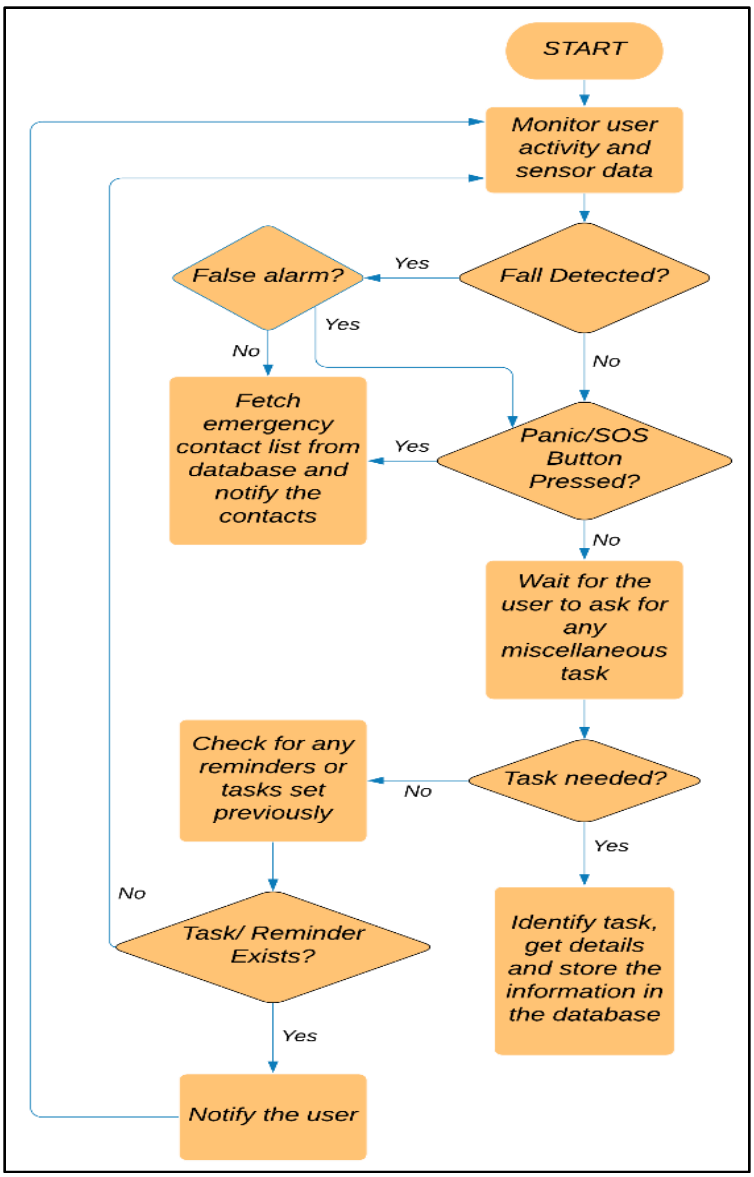

Figure 1. Flowchart of the system

Similar functionality will be provided by the SOS button. If a user needs some help in case of an emergency, pressing the SOS button will send a text message. Apart from this, the user can also perform some miscellaneous tasks such as storing emergency contacts, setting up a reminder for future activities or using the information notebook to store and retrieve important information. All this information will be stored in a local database on the user's smartphone.

4. Methodologies

We will be using the existing hardware and software features provided with the smartphone itself. A well designed and a user-friendly UI will be provided to the user to interact with the application.

4.1 Fall Detection

[1][3] For fall detection, the smartphone's inbuilt gyroscope and accelerometer sensor will be used.

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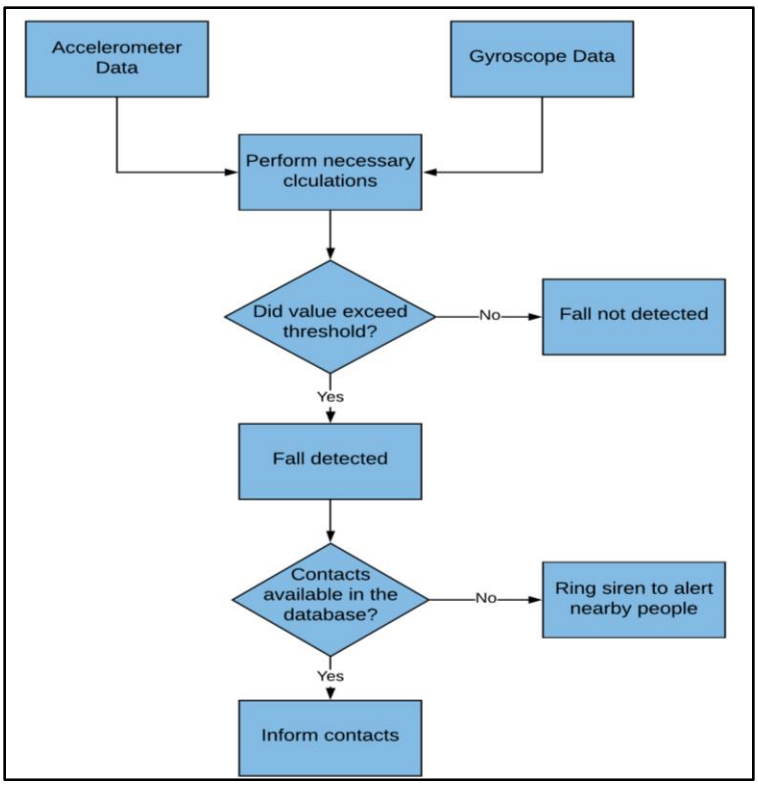

Figure 2. Fall Detection

An accelerometer is a sensor which measures acceleration, tilt, tilt angle, incline, rotation, vibration and collision. An accelerometer can be used, when embedded in a smartphone, to automatically change the screen orientation of the device vertically or horizontally. When an object with built-in accelerometer goes from a standstill to some velocity, the accelerometer is designed to provide response to the vibrations and oscillations associated with such movement.

Gyroscopic sensor is used to monitor and control the position of the device, its orientation, direction, angular motion and rotation. A gyroscopic sensor, when connected to a device, typically performs tasks for gesture recognition. Furthermore, in smartphones, gyroscope sensors help to assess the position and orientation of the phone.

The input values captured by gyroscope and accelerometer will be compared with a predefined threshold. If the input value crosses the threshold then a fall is detected. [8] This detection system utilizes the data which is collected from both accelerometers and gyroscopes in smartphones. These fall events are informed to the pre-specified caretaker by alert messages.

4.2 Scheduled Reminder

[4] First, the users will have to create a new reminder if it does not exist and in the case of reminder list entries users can update it. Now, for the medicine reminder the user has to input some data such as medicine name, dosage, type of medicine, reminder interval and start time while in case of task reminder the data includes task name and due date. For the to-do task reminder, the due date is in the focus. If all the required data is valid, then the reminder is eligible for the next procedure, otherwise an alert dialog is shown describing the error. Finally, the last step is to insert the created or updated reminder in the reminder list.

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5. Experimental Results

After implementing the various features discussed, we obtained the following results:

5.1 Home Page

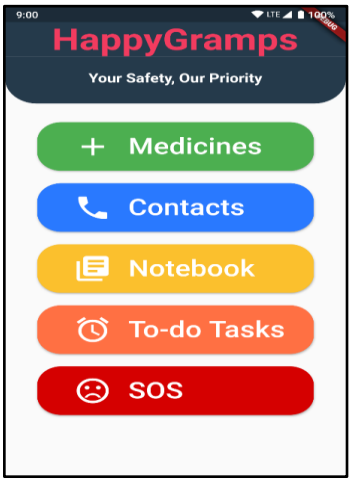

Figure 3. Home Page

The UI was kept clean and simple for easy navigation for use by senior citizens. Different colours were used for better differentiation between functionalities. The homepage layout was designed to be self-explanatory. Just by looking at the screen the user will understand the purpose of the different buttons provided. The different buttons provided will give access to different modules such as – Medicine Reminder, Emergency Contacts, Information Notebook, To-do Task List and finally SOS Alert.

5.2 Medicine Reminder

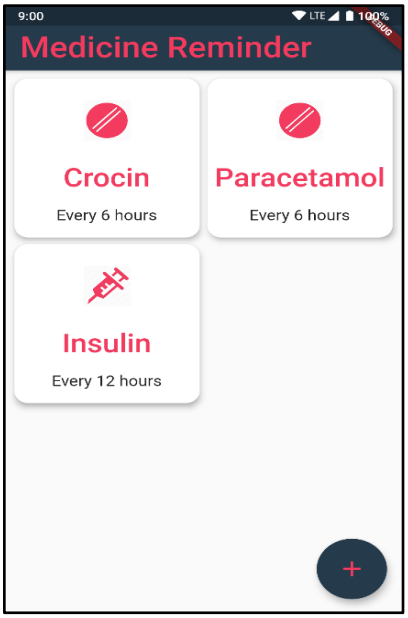

Figure 4. Medicines Page

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The medicine reminder page displays all the set medicines, along with the type of medicine as well as the name of the medicine and the interval for reminder.

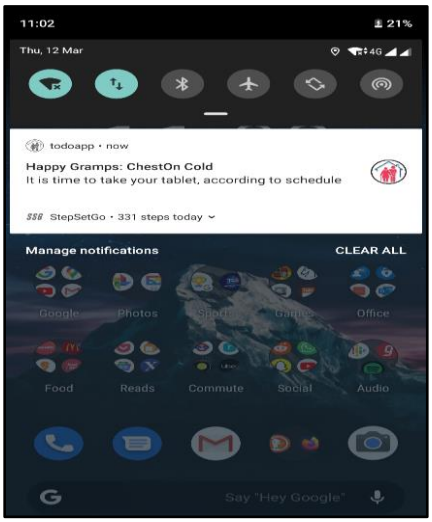

Figure 5. Medicine Reminder Notification

The user is reminded of the medicine with a notification alert. The notification contains name and type of the medicine to be taken

5.3 Contacts Page

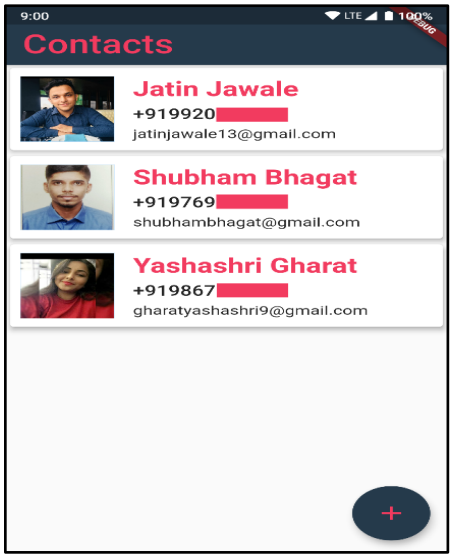

Figure 6. Contacts Page

The contacts page displays all the contacts that were saved within the application. The list has names in huge font, along with an option to add pictures of the person.

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5.4 Notebook Page

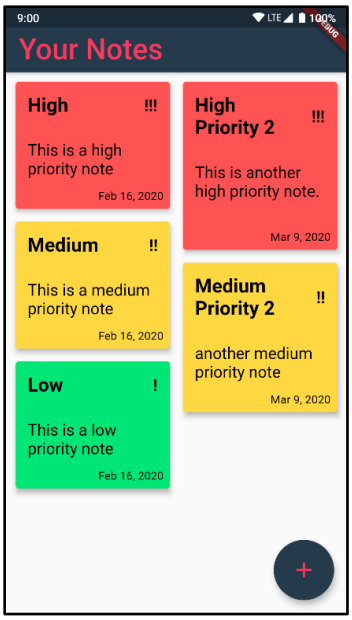

Figure 7. Notebook Page

The notes are grouped by their importance. High priority notes are coloured red, medium as yellow and low as green for better visual aid.

5.5 To-Do Task List

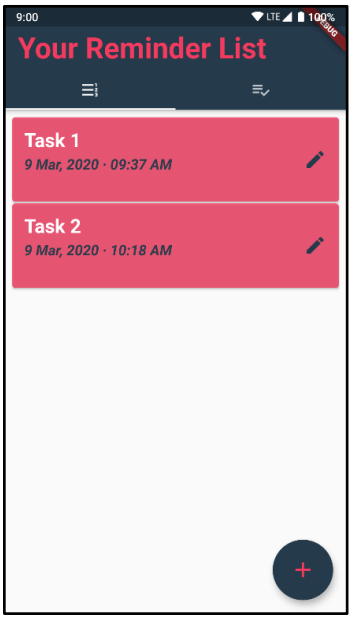

Figure 8. To-do Task List

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The to-do list shows all the reminders set by the user. The title and the date of the creation of the reminder as displayed for the user, with an option to edit anytime.

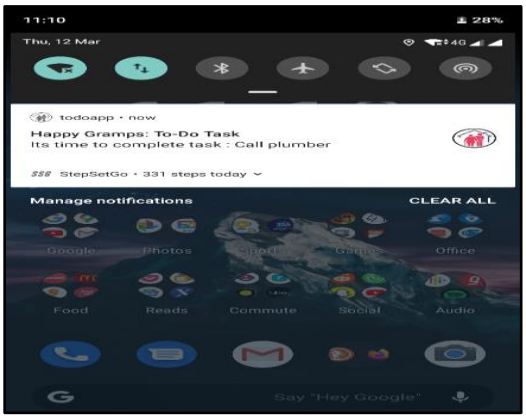

Figure 9. Task Notification

The user is reminded of the task with a notification alert. The notification contains the name of the module- To-do Task and also the name of the task to be performed.

5.6 Emergency Alert Message

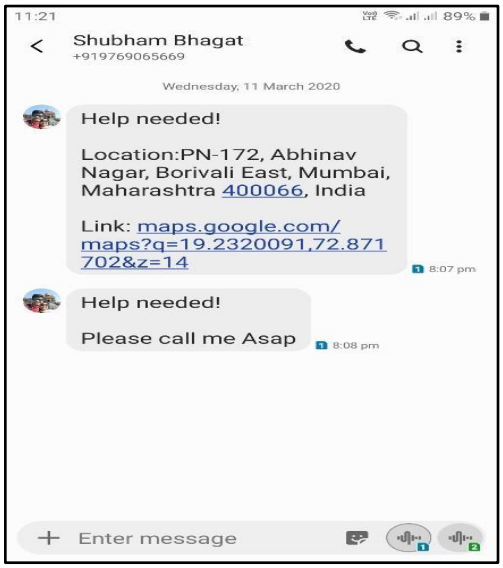

Figure 10. Alert SMS

When fall is detected or if the SOS button is pressed, an emergency alert is sent to the emergency contact in the form of an SMS. If the internet is available then the SMS is sent with the location of the user otherwise a simple SMS alert message is sent.

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6. Future Scope

For the future versions of this smartphone application, a language support functionality can be added to support the user's native language.

Another feature that can enable a user to use the app more efficiently is voice recognition. This feature can be used to deactivate the fall detection alarm and also to locate the phone itself (in case the user forgets where he kept his phone).

In the future version of the app, machine learning can be incorporated in the fall detection algorithm to reduce the rate of false positive and increase the efficiency of fall detection.

7. Conclusion

The aim of this project is to explore the possible strategies for monitoring the patient, to fulfil the everyday requirements without any interruptions and discuss the implementation of a system that will alleviate the caretaker's burden.

In contrast to the approach of developing dedicated hardware devices for senior citizens, with respect to the exponential development of smartphone technology, this project undertakes a new research perspective on how to develop desirable multifunctional mobile applications to improve senior citizen's way of life.

Acknowledgements

It gives us incredible joy in introducing 'Happy Gramps', an application for the safety of senior-citizens.

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