ECE1778 Final Report

<u>safeMedicare</u>

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1. Introduction

Problem of medication adherence

Every year, new medications have been developed by pharmaceutical companies and academic researchers. Medical research has been constantly evolved and we can now save a lot of patients who could not be saved without the current medical technology. However, people are still dying from diseases even though we have enough medical technologies and medications to treat their diseases. One of the major reasons is the problem of medication adherence. Because a patients does not take a medication according to the prescribed time, frequency, and dosage, a break down in any of these elements could cause unanticipated side effects. In the United States, medication non-adherence is estimated to cause 125,000 deaths annually.

Drug-related problems among seniors

In our community, the elderly population is more susceptible to the problem of medication adherence. Almost 20% of community-dwelling seniors take 10 or more medications. However, studies have shown that between 40% and 75% of seniors don't take their medications at the right time or in the right amount because of complicating factors such as the number of medication prescribed, as well as other physical and cognitive challenges the elderly face. Another major drug-related problem in the elderly is drug interactions. If a patient takes more two medications, there will be a chance of interaction among drugs, and the interaction may change the effectiveness of a medication. Seniors are especially susceptible to drug interactions because of the large number of medications they are taking. Adverse effects from drug interactions account for about 7% of emergency hospitalizations for patients above 65 years old.

Protect seniors from drug-related problems

To protect seniors from these drug-related problems, we developed a mobile application called safeMedicare. safeMedicare is a medication reminder which connects the elderly patient with their family members to protect seniors from drug-related problems. safeMedicare will allow family members to manage and schedule drug regimens for senior patients. The app will notify senior patients to take medications and keep track of their medications. It aims to reduce the risk of missing a dosage and the risk of taking a double dose. In case the elderly patient misses a

medication, the app sends a text message to family members, offering them to remind the patient to take the medication.

Additionally, safeMedicare has a database to detect potentially harmful drug interactions. The app monitors the interaction between drug classes, such as warfarin, insulin, oral antiplatelet drugs, and oral hypoglycemic drugs, which are related to 67% of drug-related hospitalizations for senior patients. If safeMedicare detect any harmful drug interactions, it will notify both the patient and family members about harmful drug interactions, and they can consult with a physician or pharmacists about the potential risk.

2. Overall Design

Following is a block diagram of safeMedicare:
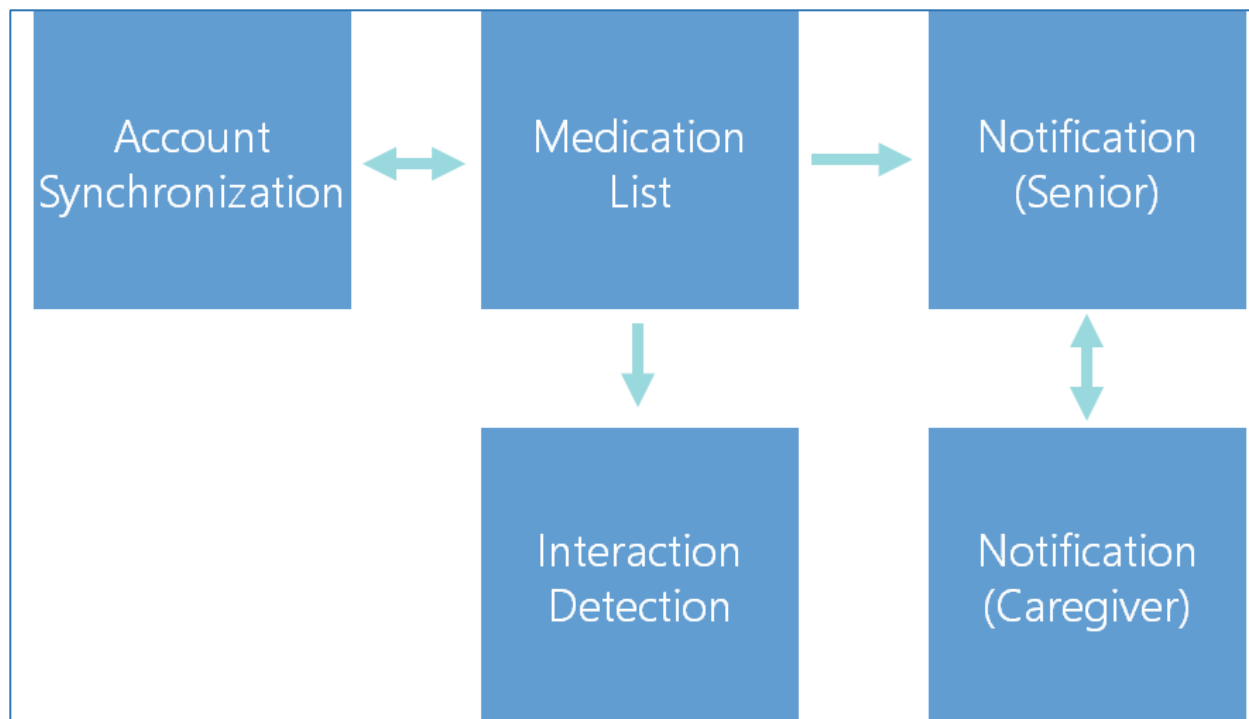
safeMedicare contains the five major components, including an account synchronization module, a medication list module, an interaction detection module, a notification module (for seniors) and another notification module (for family members). Following are the detailed description of the five modules:

1.   Account Synchronization Module: A module used to manage different users and synchronize the medication list between seniors and the family members.

2.   Medication List Module: Users can medication notifications including the name of a medicine and the time to take the medication.

3.   Interaction Detection Module: When a new medication is added, the module will analyze the new medication with the other medication to detect if there is any interaction between these medications when they are taken together. If a drug interaction exists, a notification will be sent to alarm the users that these medications should not be taken together.

4.   Notification Module (for seniors): According to the list scheduled by the family members, notifications will be sent to seniors when they need to take a medication, senior r could cancel the notification if he had already taken the medicine (just like how we cancel the alarm in the morning).

5.   Notification Module (for family members): if seniors do not cancel the notification 15 minutes after it alarms, a notification will be sent to their family members so that they can call the seniors to confirm if they have taken the medication.
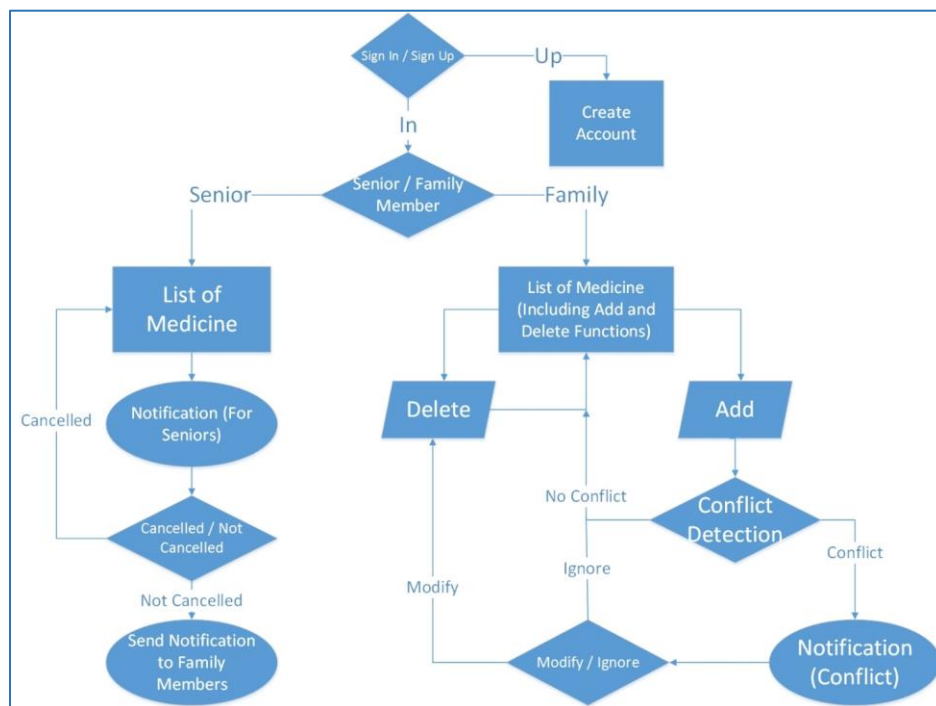

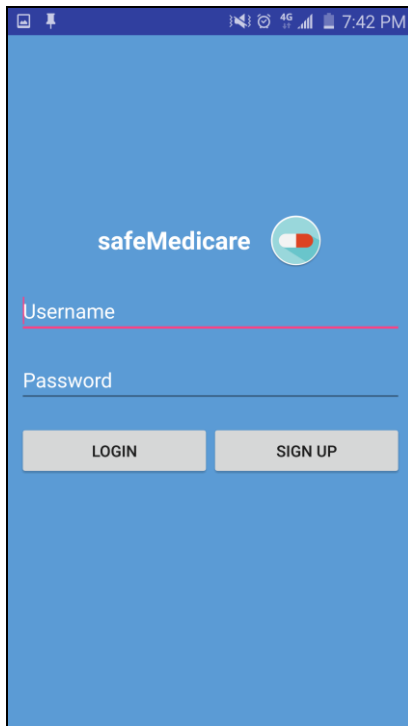Figure 1. Workflow of the app

2. Statement of Functionality

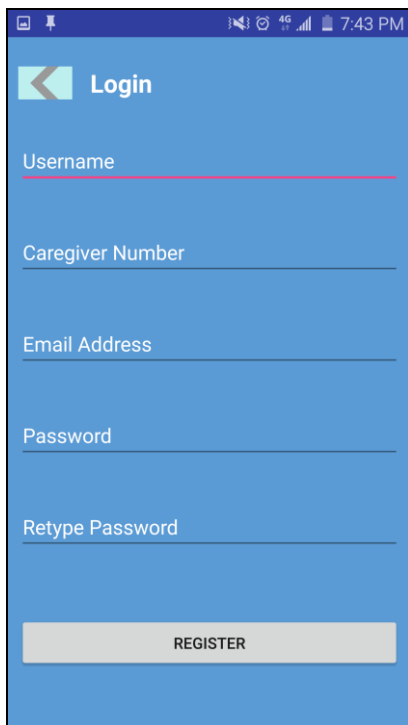Figure 2. Initial screen to log in or sign up.

Figure 3. Create a new account page. You can add a caregiver's phone number and the app will send a message to the caregiver's device if a senior patient misses a medication.
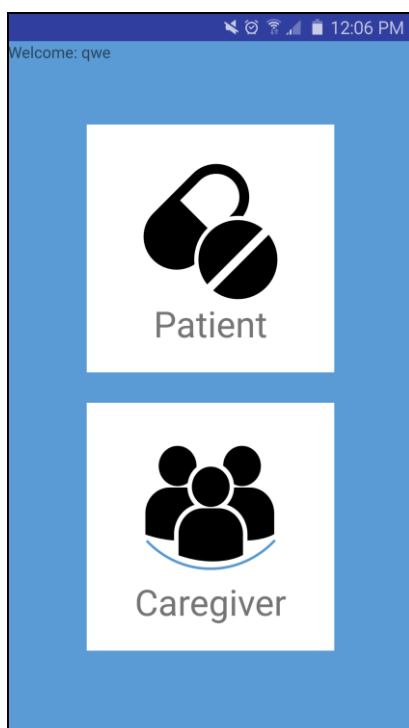

Figure 4. After logging in, you need to select whether you are a senior patient or a caregiver
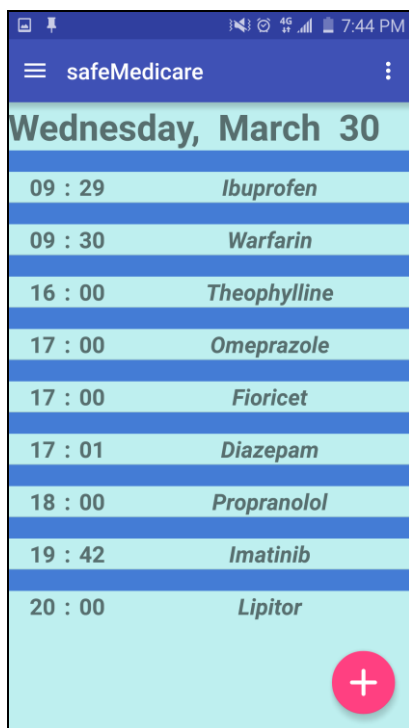
Figure 5. The initial screen if you log in as a family member. You can control senior's account by adding or changing medications. You can also add new medications.
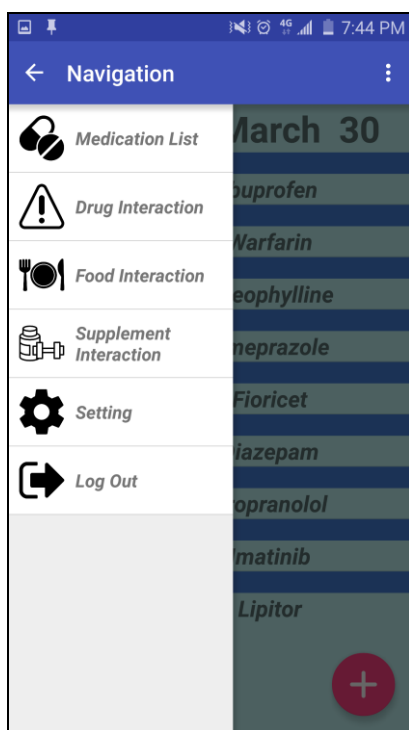

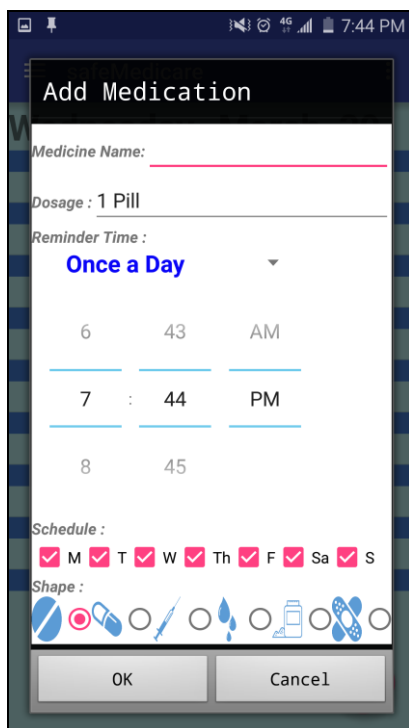Figure 6. From the drawer you can navigate to different features.

Figure 7. You can customize the notification of a new medication. Caregiver can edit the dosage, reminder time, schedule, medication shape, and information of the medication.
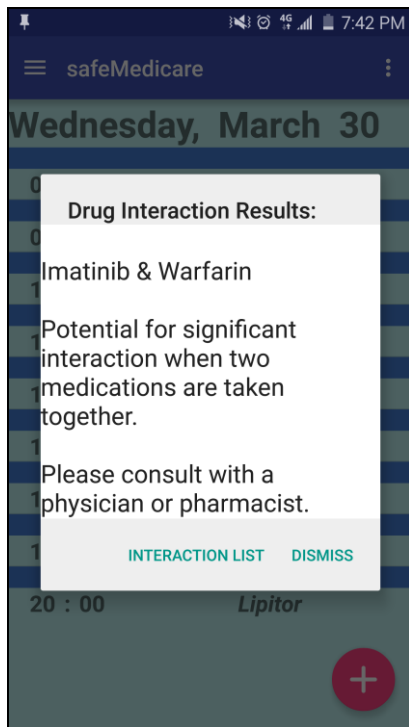
Figure 8. When a new medication interacts with an existing medication, the app sends a message that there is a potential for an adverse drug-interaction. The app does not give a medical advice but suggests that the caregiver needs to take a senior patient to a physician to discuss about the potential risk.

Figure 9. From the drawer, the caregiver and patient can access the drug-interaction result. After counselling with a physician, the drug-interaction list can be deleted.

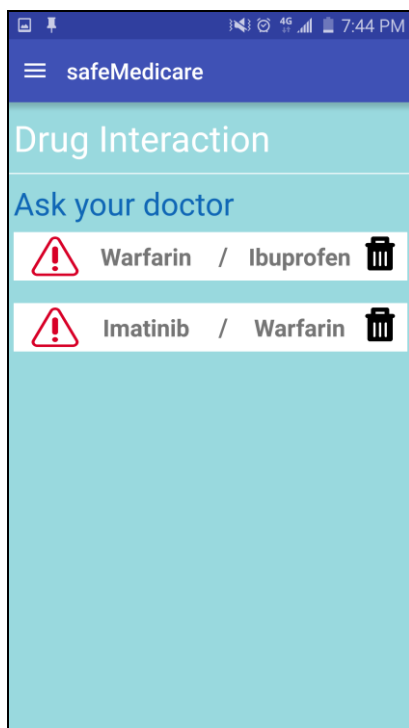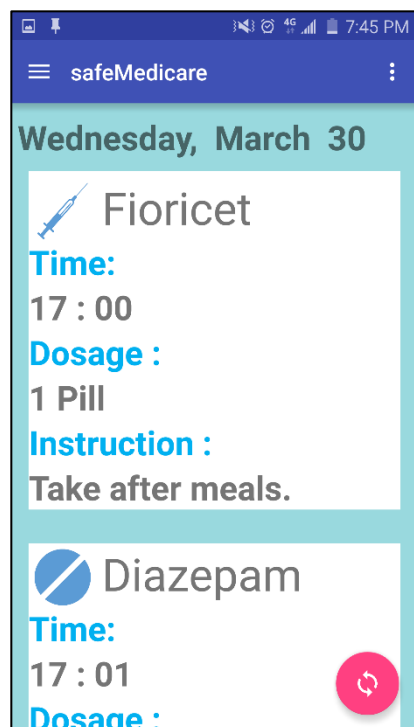Figure 10. The patient UI contains more details relevant for a senior patients including the shape, schedule, dosage, and instruction of a medication. We used big fonts which are easier on the eyes. The medication list can be synced by touching the sync button.
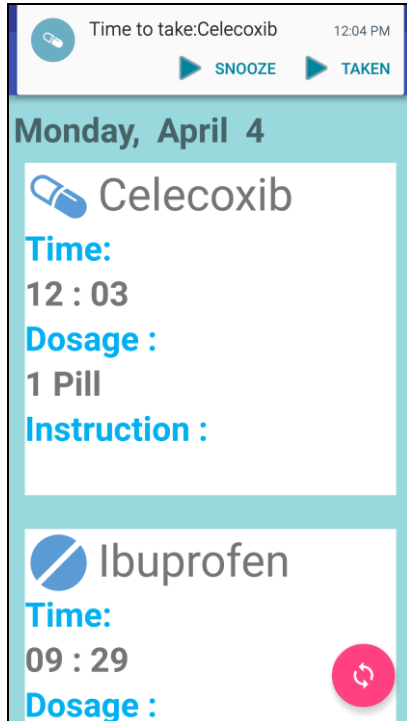
Figure 11. A notification is sent when a patient needs to take a medication. If the patient cannot take the medication at the moment, the snooze button will resend the notification after 15 minutes. But if the patient dismisses the second notification, a message will be sent to the family member.

Figure 12. A message is sent to a family member when a patient missed to take a medication.

We have implemented many features for this mobile-application safeMedicare. While this application is in production stage, there are still some features did not perform as intended due to some limitations or still not yet implemented during the development timeline.
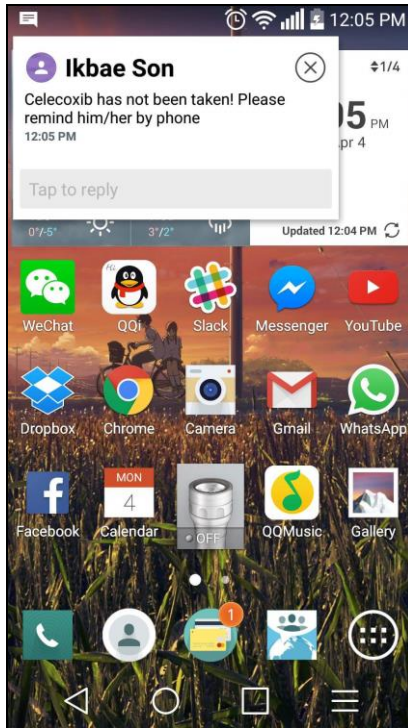
- Due to the limitation of the alarm API provided by Google, the alarm cannot be accurately scheduled, but this inaccuracy is quite minor as the inaccurate interval is only within one minute in length

- Currently, safeMedicare is using the database that we have created ourselves, which it is very limited and only for demonstration purpose. Ideally, a third party database (drug list) should be linked, as there are too many medications to populate manually. Further research and work should be done in this aspect

- We were supposed to implement a medication delete function to let user delete certain previously added medication if needed. While this is an important feature of this mobile application, for the purpose of this course and demo, we decided to spend the time onto the development of other features. We can always implement this feature in the future if necessary

- Similar reason also applied for the feature where if a user wants to schedule multiple times within a day for an added medication. This feature is considered an add-on and can be implemented in the future if necessary

4. Key Learning

We could not have come this far without the collaboration from each team member and the countless team meetings. Our project's user-friendly interface and usability is a direct reflection of the amount of effort we spent developing this mobile application.

For the whole process from beginning of the project to the end, we simulated Agile Development Process as our planning strategy to evolve the development of the safeMedicare application. We were connected using Facebook messenger to share progress update on a regular basis, and every week we had team meetings to share and discuss what we had achieved as well as our next goals.

One of the key successes for safeMedicare application development was that the programmers always let specialist to get hands on the up-to-dated application, this way the programmers would immediately receive meaningful feedback for any design improvements and usability suggestions. On the other hand, specialist always updated with programmers for the latest design mockup, this way the programmers got the idea of what the intention of this application should be.

As this project involved two programmers to work on the same application, there were some unavoidable code conflicts, which slowed down the source code implementation and required much effort in resolving this obstacle. Even though we started to use the source code management tool (GITHUB) to reduce the code conflict in the later phase of development, we should've utilized this technique right from the beginning of the project if we could restart our project.

5. Contribution by Group Members

Ikbae Son:

As a specialist, I was responsible for creating a database for drug-interactions. I identified adverse drug-interactions commonly observed among senior patients. Additionally, I created a database for drug-food and drug-supplement interactions for additional features. I also researched the functionality of the app by a senior patient. The main challenge is the UI of the app. Most of the elderly patients are not skillful enough to operate mobile applications. We need to build an application that is easy for family members to manage the complex medication regimens, while providing another simpler user interface for elderly patients to use. We made the fonts bigger for seniors and seniors can access to all relevant information (especially dosage and note) without navigating the app. These findings have been implemented in the overall UI of the app.

Qi Jian Huang:

As a programmer, my main responsibilities were to build an Android mobile application based on the design requirements from the specialist. I also gave suggestions and share ideas for any potential design changes and feasibility in feature implementation.

By broken down into details, some of my main responsibilities can be summarized below.

- User authentication and account management (user sign in and sign-up pages)
- Local Database for drug interactions
- Functionalities and user-interface for drug interactions
- Other feature implementation including drawer menu, data sync
- Database interactions between devices (senior and family member), which it is managed on the server
- Many other involvements such as helping peer to implement additional features and resolve defects
- Overall coding structure and practices to keep consistency between peers and accelerate development process

Lang Qian:

- All the notification related functions:

  Medicine Notification;

  "Taken" function;

  "Snooze" function;

  Message sending function used when medicine have not been taken in specific

  amount of time.

- Suggestion List function:

  Show a list of suggested medicine names based on what users typed according to the

  local database.

- Most UI and related functions:

  Welcome Page and related functions;

  Patient Interface and related function;

  Caregiver Interface and related functions;

  Add Medication Interface and related functions;

  UI of Drawer;

  Drug, supplement, food interactions main UI;

  Notification UI.

- Most local databases implement:

  Transferred the documents offered by specialist into suitable databases for the APP;

  Databases allocated locally for specific users.

6. Specialist Context

With my expertise in pharmaceutical sciences, I developed a database to identify potentially harmful drug interactions. The app primarily monitors the interaction between four drug classes, such as warfarin, insulin, oral antiplatelet drugs, and oral hypoglycemic drugs, which are related to 67% of drug-related hospitalizations for senior patients.

Moreover, prescription medications interact adversely with a wide range of over-the-counter (OTC) products, including vitamins, minerals, and medicinal herbs. This information may not be evaluated by health care practitioners, which increases the risk of harmful drug interactions. After a discussion with a pharmacist, she mentioned that if a patient received a prescribed medication from a pharmacy, the medication history of a patient is not shared with other pharmacies. Therefore, if a patient receives medications from different locations, pharmacists could not examine harmful drug interactions in your drug regimen. For example, taking aspirin with the anticoagulant warfarin can increase the risk of abnormal bleeding. Additionally, taking a multiple vitamin and mineral supplement can interfere with the action of some prescription drugs. With the database, a patient can identify how drug interact with other OTC products.

Studies have shown that between 40% and 75% of seniors don't take their medications at the right time or in the right amount because of complicating factors such as the number of medication prescribed, as well as other physical and cognitive challenges the elderly face. safeMedicare helps senior patients to take their medications at the right time. With the app, family members become more aware of the patient's medication adherence. The connection between family members will enhance the medication adherence of their senior patients.

7. Future Work

After this course, we will still work on this app and continuously optimize it by improving the UI and adding related functions.

First of all, we will finish the idea we figured out in the last spiral but had not accomplished yet since the lack of time that food and supplement interaction should also can be detected by this app. In these functions, the structure of the process of how information is collected and showed

to users will be totally different from the current drug interactions detection function as according to the specialist's suggestion, this part of information is different from users to users, which means the data should be able to be edited by users themselves after they ask their doctors, including add and delete.

Secondly, as mentioned above, all the three interactions detection functions and the suggestion list function showed when users typing the name of medicine are all implemented on the base of specific databases. Hence, the more information is contained in the databases, the more interactions detections can be supported by the app. As currently, we have achieved the functions by using small databases that only include the most important drug interactions and most common drug names, we need to enlarge them to make the app more powerful. We already found several websites that contains this kind of information, so maybe in the future, we will try to achieve the functions by using the information on the websites.

Finally, we might add a camera function that allows seniors to take a picture of the medicine they just take and send it to family members' sides so that they can make sure the seniors do have taken the specific drug instead of actually just clicking the "Taken" button. We are now not sure whether this function should be added as it might be annoying to users although it is a great way to help the app achieve its goal.

Besides, we also have figured out some additional useful functions for this app. For example, a location information can actually be contained in the message sent to family members so that they might can figure out the reasons why the seniors have not taken the medicine and decide whether to call them or not.