The Edward S. Rogers Sr. Department
of Electrical & Computer Engineering

UNIVERSITY OF TORONTO

Final Report: Healthy Mind

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ECE 1778: Creative Applications for Mobile Devices

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Introduction: What is Healthy Mind & Why is it Needed?

The goal of Healthy Mind is to help patients remember and manage the abundance of information they receive when discharged from the hospital. This app achieves this goal with the following features:

- Login & Homepage
- Recording & Keyword Extraction of Information Provided by Doctor via:
  a. Audio recording
  b. Photo
  c. Filling out a form
- Storage & Review of Doctor's Notes
- Independent Appointment Creation & Reminder System

Please note, these features are described in detail below.

Why

Despite the importance of discharge education, research has shown that it can be difficult for patients to absorb information at the time of discharge (Jeffs et al., 2017). Patients report that the "volume of information and number of interactions" with clinicians in such a short period of time makes it challenging to retain important information (Jeff et al., 2017, p. 6). Assuming patients will remember important and potentially life saving information is an unrealistic and, largely, ineffective expectation. In a study conducted by Kangovi and colleagues (2012) feeling unprepared for discharge

was the most commonly cited reason for hospital readmission. Hospital readmissions are costly and can be an unpleasant experience for the patient, especially if they are not necessary.

In addition to patients feeling overwhelmed during this time, information sharing between healthcare institutions in Ontario is poor. In a recent Health Quality Ontario report 25% of survey respondents reported that their family doctor was not informed regarding the care they received in hospital after they were discharged (2018). Primary care providers are not always notified when their patient leaves the hospital and this can cause unnecessary test repeats or confusion regarding the patient's care (Kudhail, 2016). Patients managing their own health information, through apps and patient health records can help bridge this important gap (Colpas, 2013).

There is a clear need for an innovative and effective technological solution that addresses this pervasive gap. This is the aim of our app, Healthy Mind. Specifically, our app focuses on those patients that are discharged from the Psychiatric Emergency Department as this is a stressful environment and the area of expertise for our specialist. Additionally, Healthy Mind utilizes the new and evidenced-based tool PODS which stands for Patient-Oriented Discharge Summary. PODS is a standardized paper-based discharge summary that has been adopted by 27 hospitals across Ontario. Research has shown that PODS has been effective in improving patient's understanding of medications, appointments and other pertinent healthcare information at the time of discharge (Hahn-Goldberg et al., 2016).

Statement of Functionality & Screen Shots from App

1. Login & Homepage

After a standard login or signup process (Figures 1-3) the user is directed to the homepage. This where all of the most relevant information is stored (Figure 4).

2. Recording & Keyword Extraction of Information Provided by Doctor

The user has three methods that can be used to add a new doctor's note. The user is presented with these three options as outlined in Figure 5. These three methods are described in detail below.

2.1. <u>Audio Recording & Transcription</u>

The user can record the instructions the doctor gives (Figure 6). The app indicates that the audio is being recorded and working properly by displaying the icon above the time (shown in Figure 7). The user has the ability to replay the audio to ensure accuracy and has the option to record again (Figure 8). The user then has the option to click "create a new doctor's note" or "only create an audio and transcription file" (Figure 9). In both processes, the app transcribes the audio

recording (Figure 10 & Figure 16). We found this transcription to be fairly accurate if the surrounding environment is not noisy.

2.1.1.   Creating a New Doctor's Note & Keyword Extraction

If the user has selected the option to create a new doctor's note then the app provides them with the option to edit the audio transcription once the transcript is produced (Figure 10). This is to ensure that the transcript is accurate. The app then begins the keyword extraction. This was by far the most challenging aspect of the app's functionality. First, the app prompts the user to select the sentence that contains the medication name (Figure 11). Once the proper sentence is selected, the medication name is extracted and the user is prompted to delete any irrelevant information (Figure 12). This process is then repeated for the medication dose (Figure 13). To facilitate this process we have maintained lists of keywords related to i) most commonly used medications for treating depression, anxiety and insomnia. ii) standard dose for those medications. The app can also extract appointment-related information such as the doctor's name, time, date, address and phone number (Figure 14). To achieve this, we used an algorithm that matches certain patterns or formats for different types of information, e.g. doctor's name (begins with Dr.), appointment date (the keywords in the month) and time, phone number (long consecutive number sequence) and address. Lastly, the app prompts the user to select the time the medication should be taken (Figure 15). All of this information is then stored in the "Doctor's notes log" which is explained further below.

2.2.   PODS Photo

The user can create a new doctor's note by taking a photo of their PODS. If the user is unfamiliar with PODS they can refer to the description provided by the app (Figure 28). After taking a photo of the paper PODS, the user then has the option to retake the photo or to use it for transcription (Figure 17). As the PODS is a standardized form, the app uses the keywords found on the form to create a digitized version (Figure 18 & Figure 19). The user is able to edit the information that is displayed in order to ensure accuracy. Once the user clicks submit, the note is then saved in the "Doctor Notes Log".

This feature does have some limitations as it only works if the PODS provided to the patient is typed (which is the case for most hospitals) and one page. In an event where the user's PODS is filled out by hand or is more than one page, this feature will not work.

2.3.   Filling out the Form

The user can also create a new doctor's note by inputting the information manually by filling out a form. The information in this form is based on the PODS format. This feature is outlined in Figures 20-26. Once the user is done filling out the requested information a summary is provided. The user can then review the information in the summary to make sure it is correct and has the option to edit the information (Figure 27).

3.   Storage & Review of Doctor's Notes

The user can use the Doctor Notes Log to review all the notes they have created to date (Figure 29 & Figure 30). From this page, the user can review a cumulative list of the medications (Figure 31) and appointments (Figure 32). By clicking on a specific note in the list (Figure 20) the user can view all the information from that note including the medications and appointments discussed at that specific time (Figure 33-35). At any point, the user can click on a specific appointment to view a map of the appointment location compared with their own (Figure 36).

4.   Independent Appointment Creation & Reminder System

The user is able to create an appointment independent of creating a new doctor's note (Figure 37). The user can also choose to be notified of this appointment 1 day and 2 hours before the appointment (Figure 38).
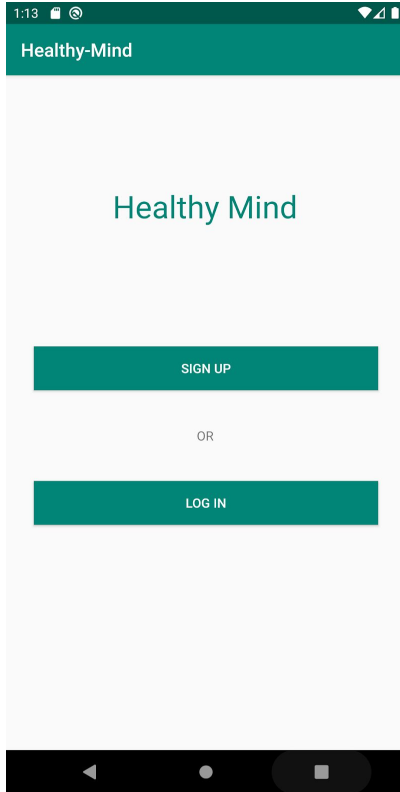
Figure 1: Sign up/Login page
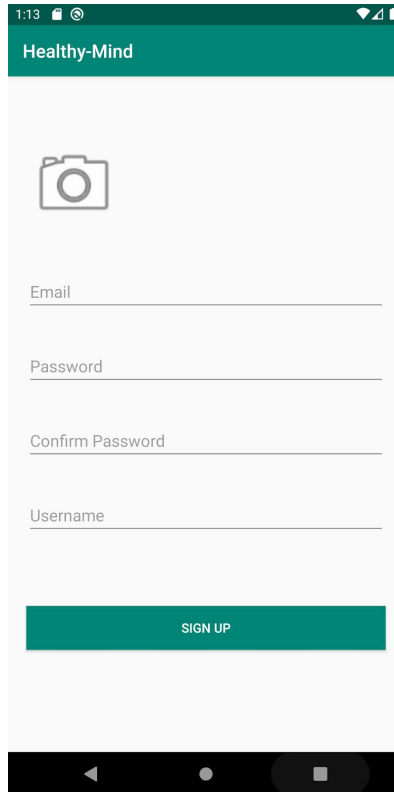
Figure 2: Login
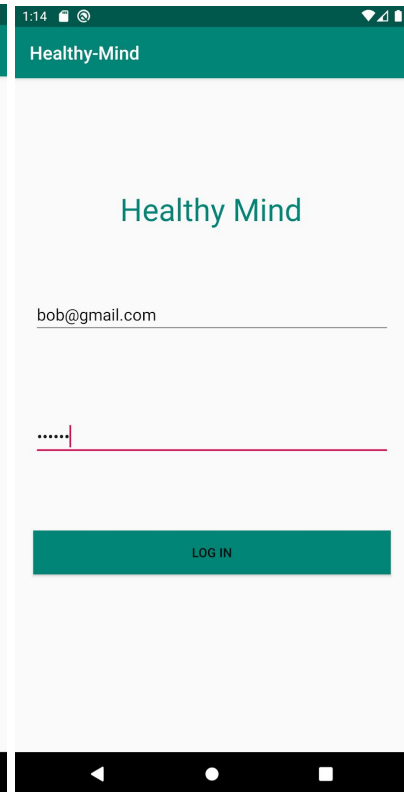
Figure 3: Login
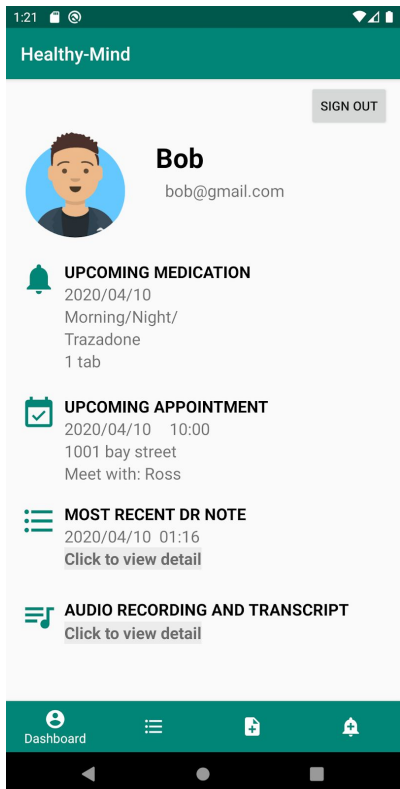
Figure 4: Homepage
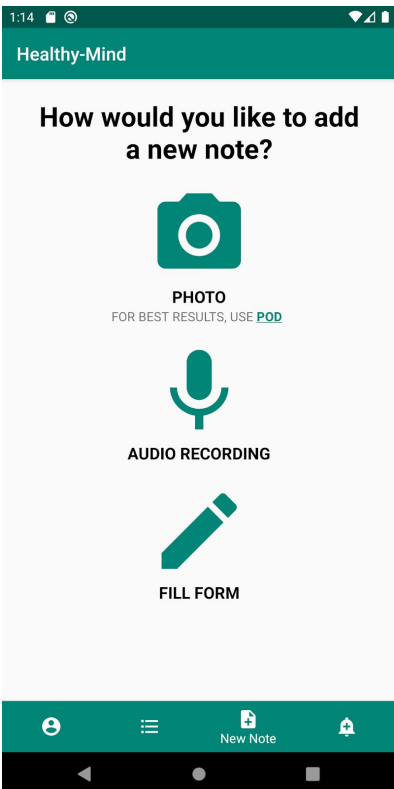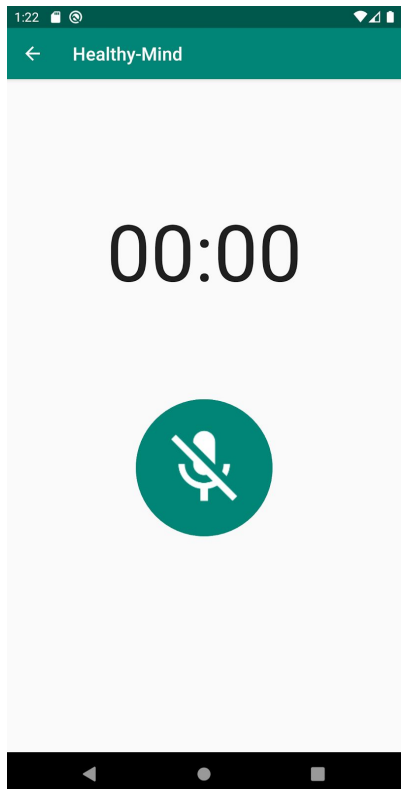

Figure 5: Adding new note
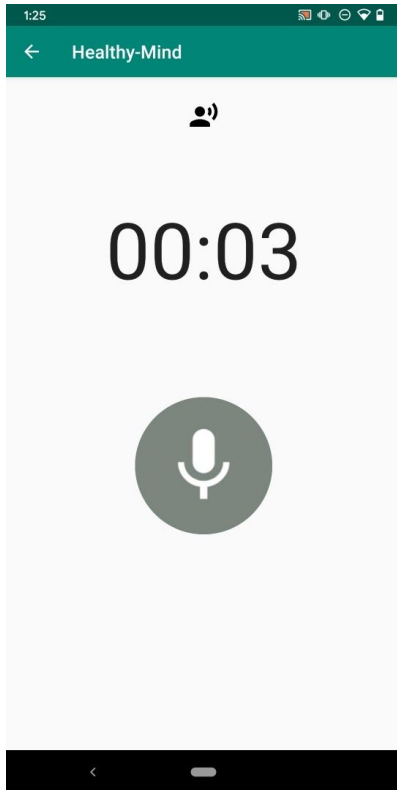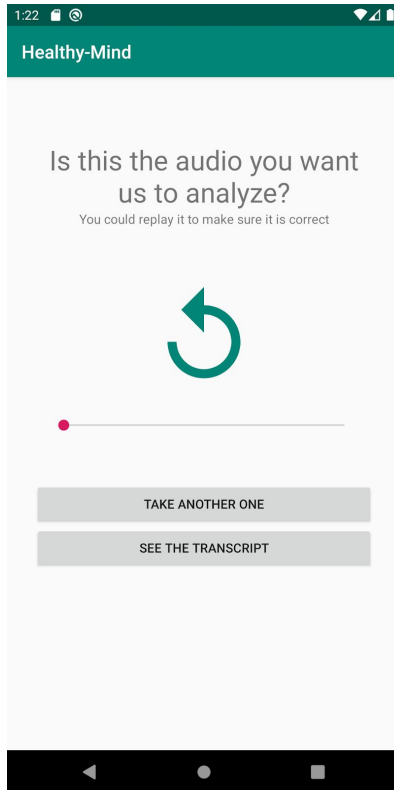

Figure 6: Audio Recording

Figure 7; Audio Recording
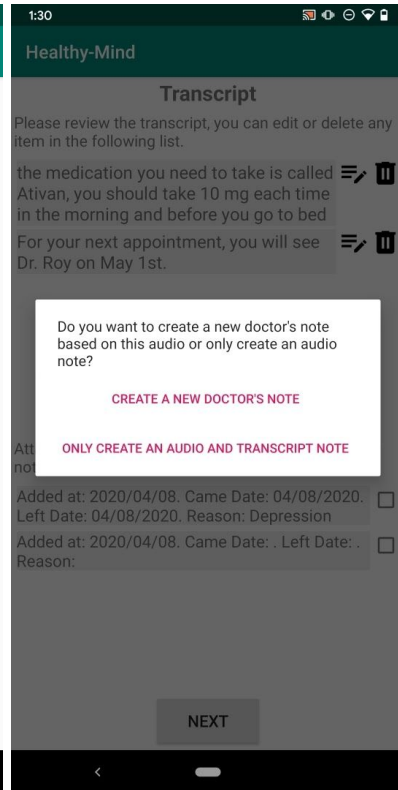

Figure 8: Audio Recording
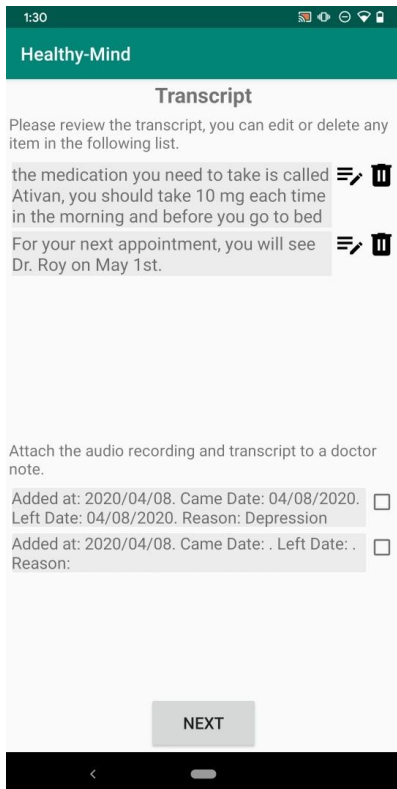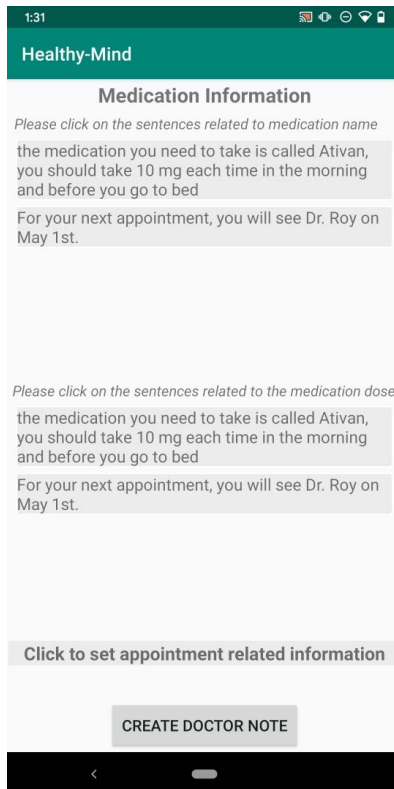

Figure 9: Audio Recording

Figure 10: Transcript

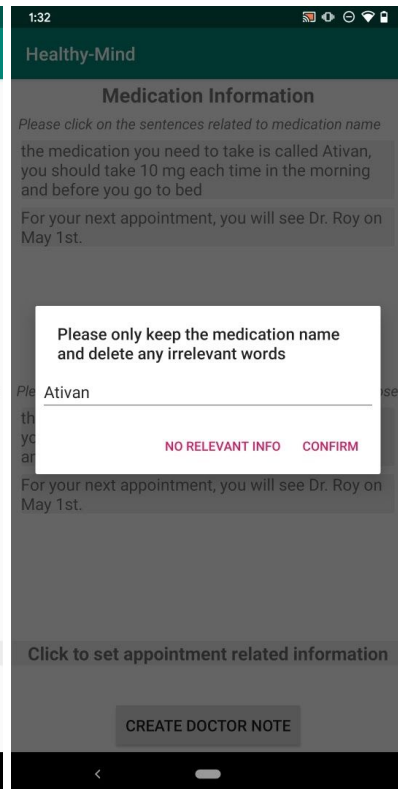Figure 11: Keyword Extraction

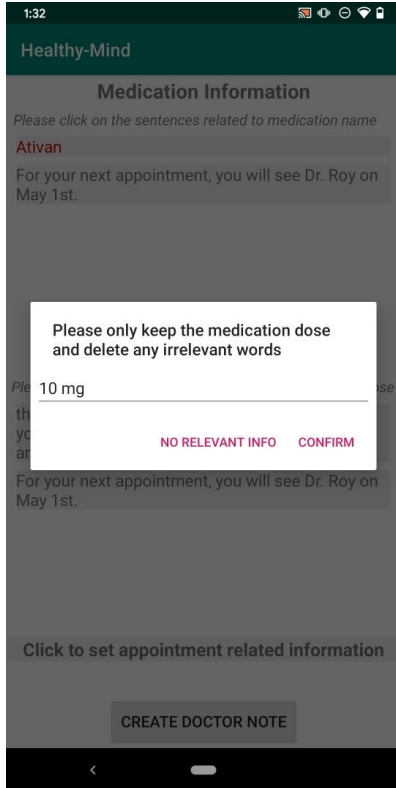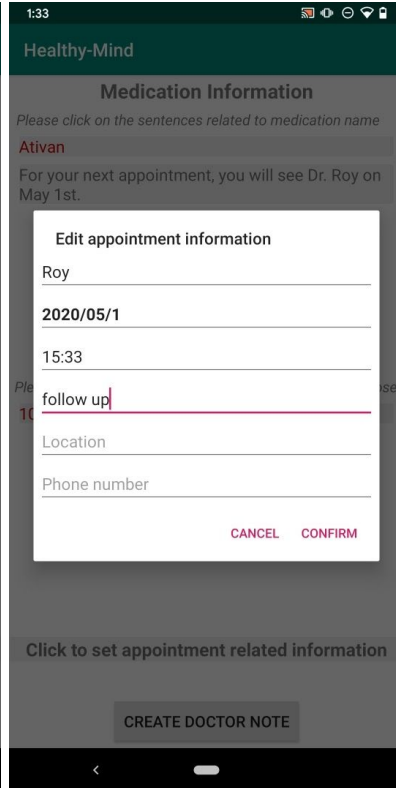Figure 12: Medication Info

Figure 13: Medication Info

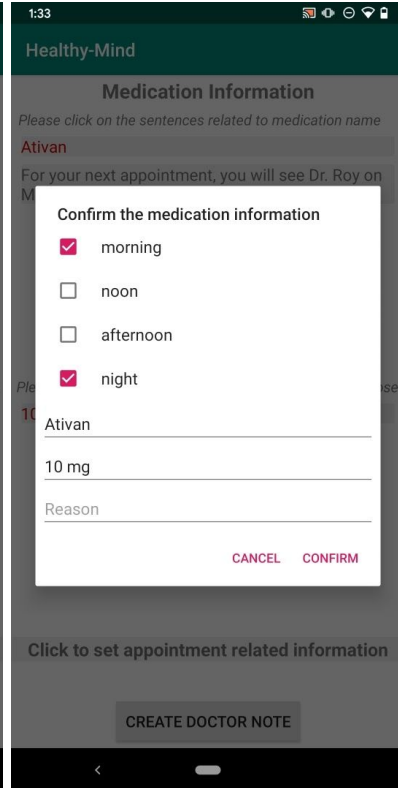Figure 14: Appointment Info

Figure 15: Medication Time
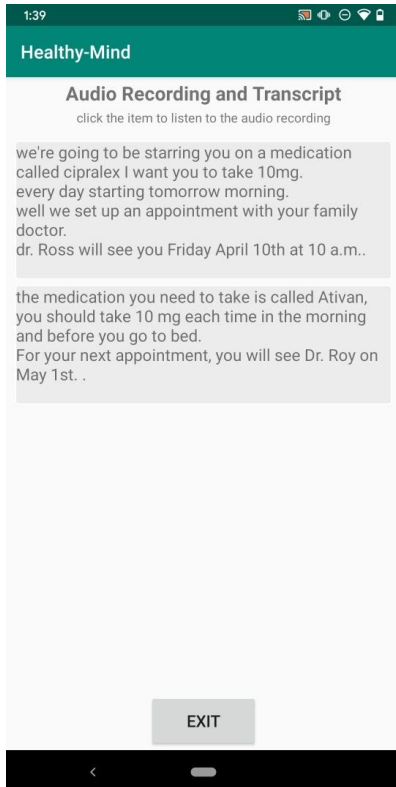
Figure 16: Transcription Only
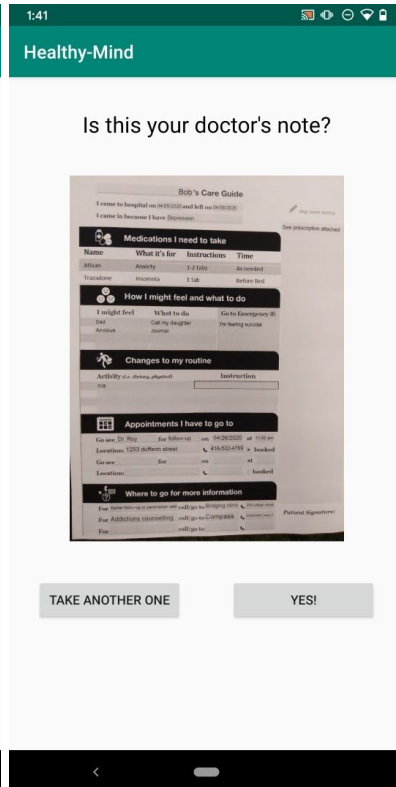
Figure 17: PODS photo
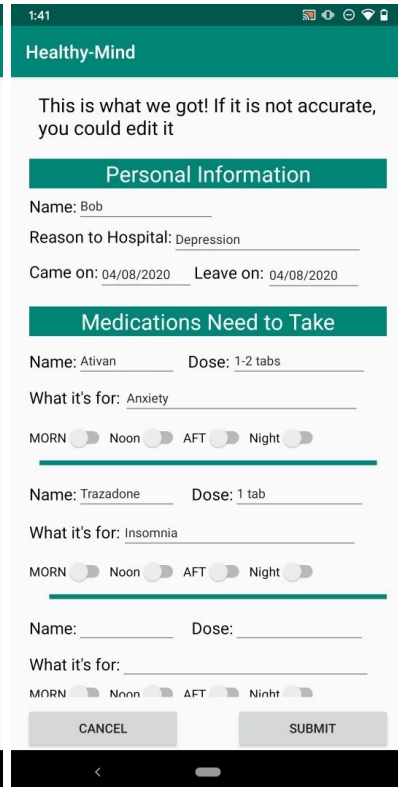
Figure 18: Keyword Extraction

Figure 19: Keyword Extraction Figure 20: Fill Form   Figure 21: Fill Form

Figure 22: Fill Form   Figure 23: Fill Form   Figure 24: Fill Form
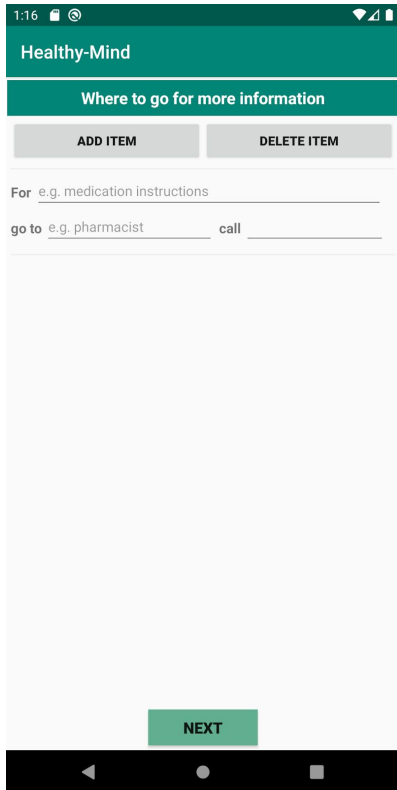
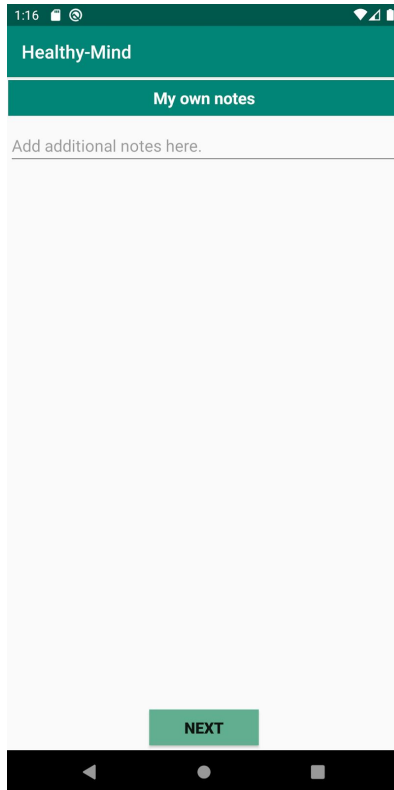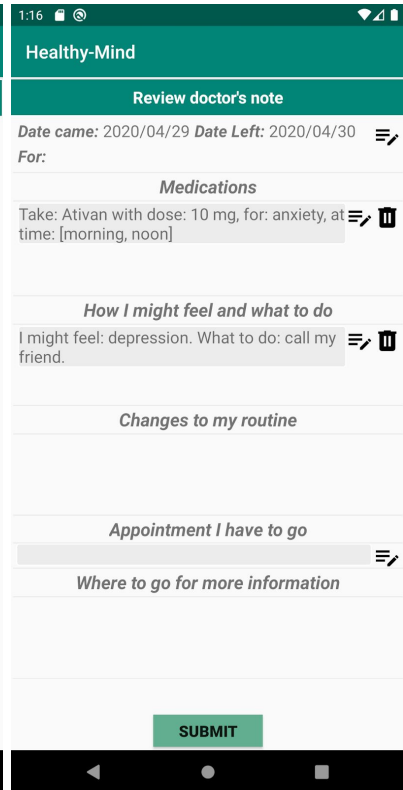Figure 25: Fill Form   Figure 26: Fill Form   Figure 27: Fill Form Summary
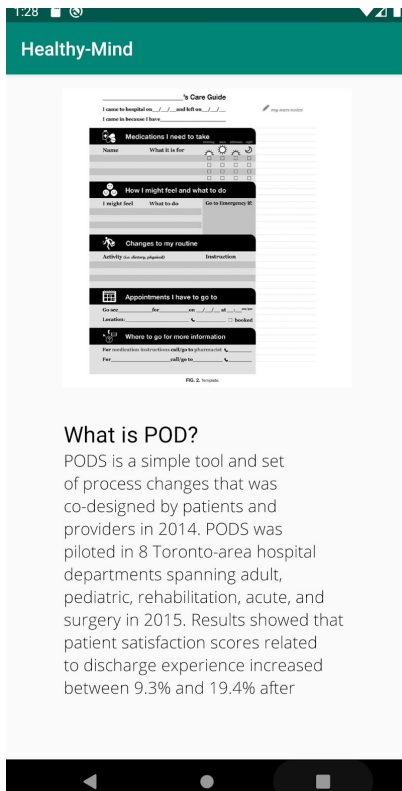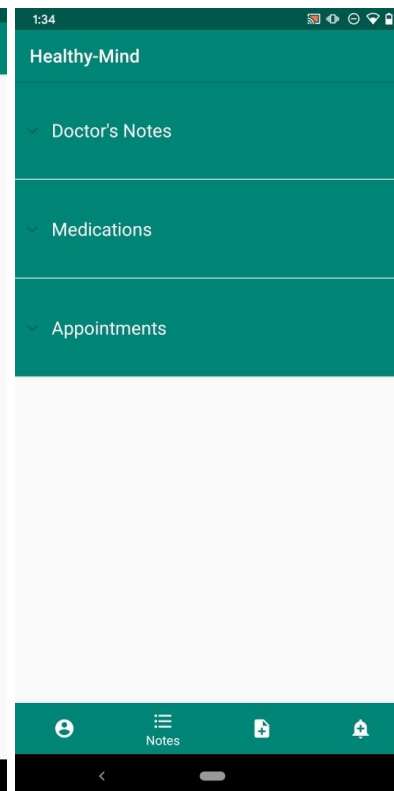

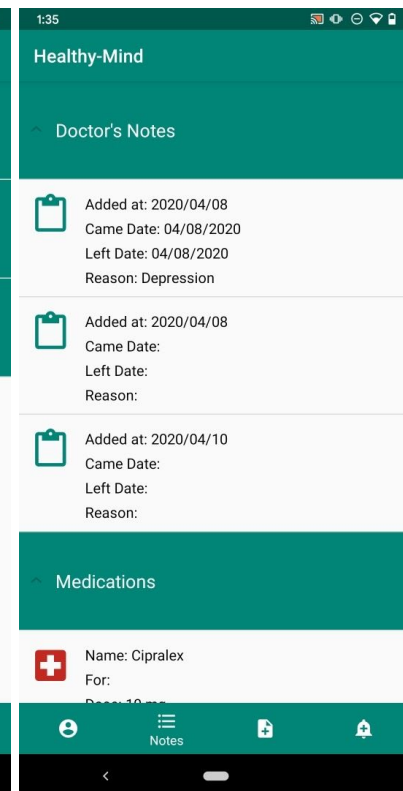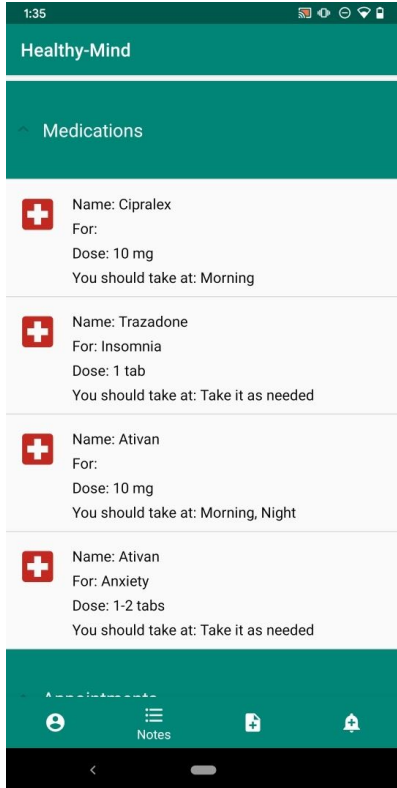Figure 28: PODS description   Figure 29: Note Summary   Figure 30: Note Summary
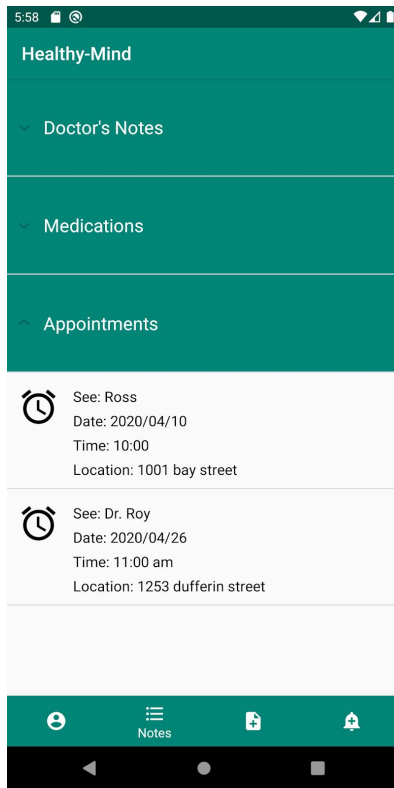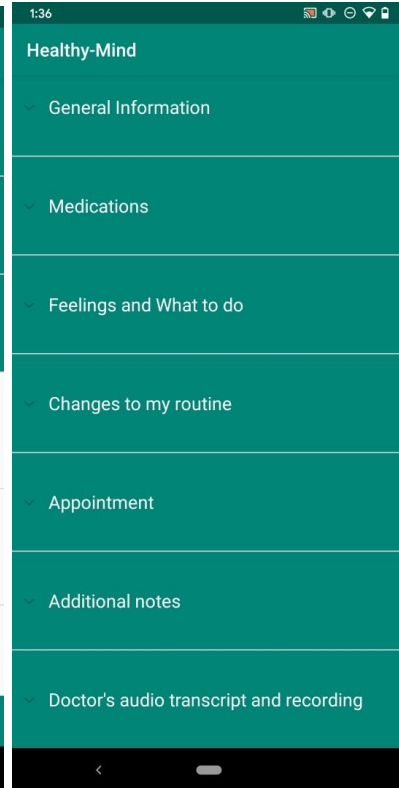
Figure 31: Medication List
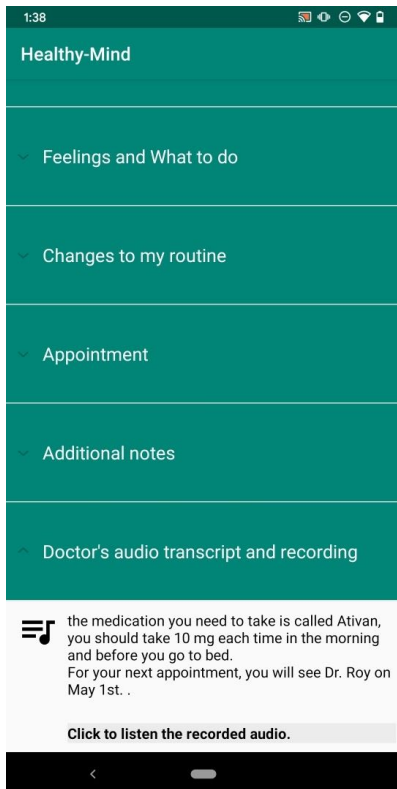

Figure 32; Appointment List

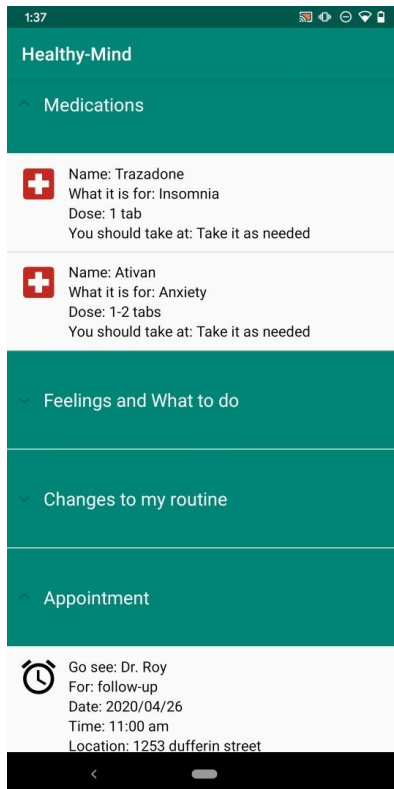Figure 33: Note Details

Figure 34: Note Details
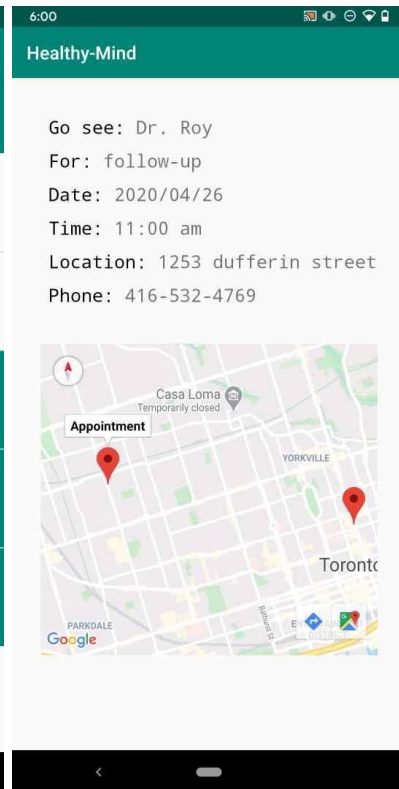

Figure 35: Note Details
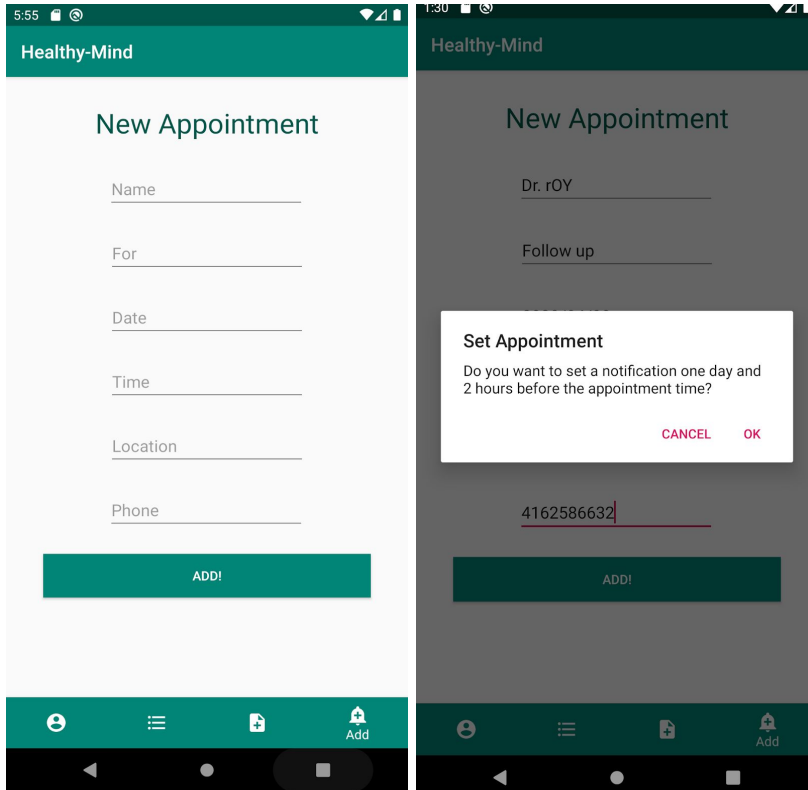

Figure 36: Appointment Map

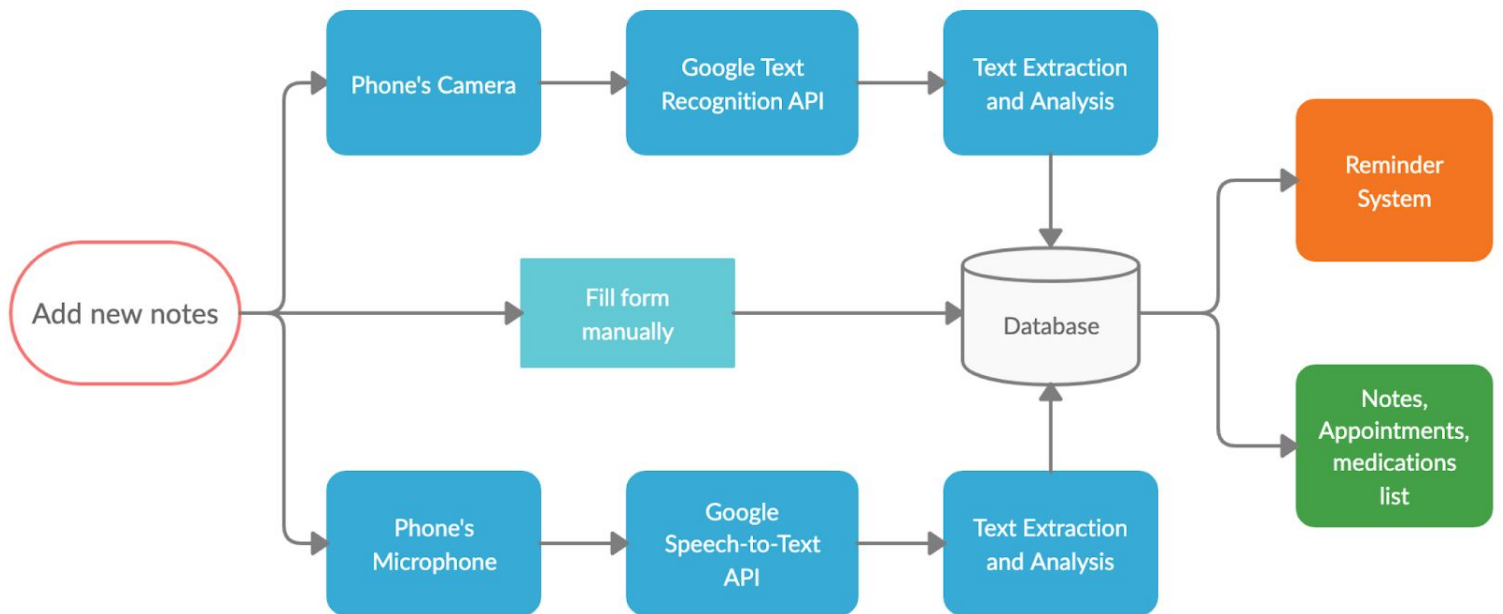Figure 37: New Appointment Figure 38: Appointment Notification

Figure 39: Block diagram

Overall Design

Please refer to Figure 39 for the block diagram which outlines the functions of the app. The main feature of this app is to allow users add new notes and there are three ways to do that, which correspond to three flows on the block diagram:

1) The upper flow is the photo input. The user can take a photo with the phone's embedded camera. Our app would then send the photo to Google's Cloud Text-Recognition API and wait for the result. The result is sent to the Text Extraction and Analysis block. The function of this block is to extract relevant info from all the text recognized by the API. Finally, the result would be shown to the user and after it is confirmed, it is stored to the Firebase Database.

2) The middle flow is the manual input. The user fills out the form, which has the similar content as the PODs. After the user confirms the result, it is stored in the database.

3) The lower flow is the audio input. After the user records the audio with the microphone, our app sends this audio file to the Google Speech-to-Text API and converts audio to text. The text is then sent to the Text Extraction and Analysis block and key info like medications and appointments are shown to the user to be confirmed.

There are also two additional sections for our app:
1) The first one is the reminder system. In detail, this block fetches medications and appointments associated with the current user and reminds this user to take medication and go to the appointment.

2) The second one is the list of doctor's notes, medications and appointments. This block fetches all the doctor's notes, medications and appointments associated with this user and displays them in an expandable list view.

Reflections & Key Learnings

Our group found this experience valuable and we learned a lot during this process. We discovered in clearly articulating a problem and need that the app is trying to address prior to starting the coding process. Unlike other groups, who expressed challenges with picking one idea from the beginning, our group had a clear app idea from the beginning of the project. Our specialist was amazed at how precisely the programmers were able to execute this vision. However, as the app progressed, the specialist realized there had been a bit of a "solution jump" and an assumption that the app functionality accurately addressed the problem intended. Pitching the app idea to patients, family, friends, classmates and colleagues would have been useful to ensure

the app was effective. It would be interesting if this was an assignment for the Specialist early on in the course.

Secondly, we learned a valuable lesson in time management and realized the benefit of starting the most difficult part first. For our project, this was the keyword extraction from the audio transcript. The main challenge to implement this function is that Android's API does not support the long audio transcription. This means it is not possible to control when the transcription process starts and ends, as it is based on the punctuation of a potential sentence. Therefore, this is not going to achieve the main functionality of our APP, since we cannot restrict the way the doctor will give instructions during a visit. Also, Google's speech to text API does not natively support Android, therefore, a large amount of time was spent on integrating the function that uses Google's speech to text API into our app. We would start this audio transcription part first and spend more on it rather than the relatively easier part like the Fill Form function.

Contribution by Each Group Member

Below we have outlined the major contributions of each group member throughout the project.

Zoe Findlay (Specialist)
1. Responsible for app idea and vision. Provided feedback, research knowledge, clinical expertise and collaborated with programmers to realize this vision.
2. Provided mock-ups for app UI and contributed app content (such as medication names, PODS example etc).
3. Conducted usability testing once app was in final stages.

Kaixuan Hu (Programmer)
1. Implemented the Fill Form function for the app including the User Interface and the backend.
2. Implemented the Audio Recording & Transcription function, including the User Interface and the backend as described above in the functionality section.
3. Contributed to database construction and testing parts of the app.

Haotian Zhao (Programmer)
1. Implemented the photo input and analysis part including the User Interface and the backend.
2. Built the basic structure of the app(including navigation flow and UI for the dashboard, adding new notes and sign in/up).
3. Worked out the dashboard activity(both frontend and backend).

4. Worked out adding new appointment and notification setup functions.
5. Built the activity to show all the doctor's notes, medications and appointments.
6. Finished functions to show the detail of each doctor's note and appointment(including the map view for each appointment).

Specialist Context

Through this app, we have created a meaningful and effective method to help the patient remember and manage the information they receive at the time of discharge. Especially important, is the app's incorporation of the PODS tool as this heightens the relevance and novelty of our app. There are no other apps on the market that digitize the PODS feature or enable the user to remember doctor's instructions via audio transcription. In the psychiatric emergency department, patients often express feeling frustrated and overwhelmed. Patients often struggle to remember the information they are given at discharge. Written materials have been shown to improve recall and understanding of instructions. (Hoek et al., 2020). Self-management tools can help the patient manage their condition ultimately leading to improved health outcomes (Whitehead & Seaton, 2016). The evidence, as well as clinical expertise strongly suggests this app could be very valuable to patients and clinicians. This value was further confirmed through a usability test conducted with a potential user.

Future Work

Currently, our app focuses on depression, anxiety and insomnia. In the future, this app could expand the breadth of mental illnesses it addresses. Additionally, it would be beneficial if it was possible for family members to access or share information to the patients' account. This may be beneficial in the instance that the patient requires their family members' assistance in managing their condition.

Lastly, in the future the keyword extraction functionality would need to be improved. We based this algorithm on recordings provided to us from doctors that work in the psychiatric emergency department, on clinical expertise and on what PODS recommends is covered in discharge education. However it is possible that doctors will say the same information in differing ways that the algorithm may not be able to account for.

Posting on the Course Website

I agree to have the following posted on the course website:

	Zoe	Kaixuan	Haotian
Video of final presentation	Yes	Yes	Yes
Report	Yes	Yes	Yes
Source code	Yes	Yes	Yes

References

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