Medication Management Application to Assist Older Adults with the Indications, Contraindications, and Drug-Drug Interactions of Prescribed Drugs

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Abstract: This research aims to develop a medication management application that is capable of keeping track of users' prescribed medication and informing them of its indications, contraindications, and drug-drug interactions. This application can be used by people of all ages but will primarily be targeted towards older adults due to the fact that they are more likely to take multiple amounts of medication and require assistance. The significance of this study is to reduce human error in medication management since this would lessen the risk of users experiencing the dangerous effects of erroneous dosages and contraindications.

Key Words: medication management; medication adherence; web crawling; web scraping; optical character recognition

1. INTRODUCTION

Medication plays a big role in the lives of older adults, but as more medicine is prescribed, the higher the risk of improper dosages and uninformed contraindications, which may lead to detrimental consequences.

According to the findings of Dobbs and Rule (1989), the aging of a human may have a strong impact on their ability to control the working memory processes. This can be correlated to the study done by Schwatz, Wang, Zeitz, and Goss (1962), wherein medication errors commonly occurred amongst 178 older adults who were chronically ill patients. They were interviewed about their everyday routine related to their prescribed medication. The experimenters asked what medications the subjects were currently taking, how often, and what the purpose of the medication was. Each patient's statement was compared to the hospital's records, and the results were scored accordingly. Errors were divided into five categories: self-medication, omission, improper dosages, inconsistent timing, and inaccurate information. It was found that 59% of the patients committed one or more errors, with omission of medication being the most common, followed by inaccurate knowledge, then self-medication, improper dosage, and lastly, inconsistent timing. From the results, physicians, nurses, and other medical workers can work on preventing these problems from further happening by making the medications and instructions more simple and easy to understand and use creative visual aids.

Medication errors could bring about unwanted drug-drug interactions (DDIs), which, according to the work of Roblek, Vaupotic, Mrhar, and Lainscak (2015), are the dangerous, sometimes fatal, consequences brought about when certain drugs are taken together. This work also stated that the frequent launching of new drugs in the market make it more difficult for health care professionals to keep track of their implications. There are several DDI screening programs and databases that have been developed in order to address this problem. These programs and databases can come in many forms such as books and web-based applications. Roblek et al. (2015) performed a systematic review on drug-drug interaction software and found that Drug-Reax from Micromedex Healthcare Series was the most commonly used DDI database. Aside from this, Day and Snowden (2016) state that MIMS is a reliable and well known source for medical product information and DDIs. These databases could then be integrated into an application focused on medication management. Labovitz, Shafner, Reyes Gil, Virmani, and Hanina (2017) performed a study which analyzed the effects of a medication management application on the adherence in patients on anticoagulation therapy. Their results show that patients who used the application had higher levels of adherence to their medication versus those who did not.

Medication management applications attempt to assist people with compliance to their medications. Following the work of Dayer et al. (2013) which assessed features of medication adherence applications across various operating systems, MyMedSchedule, MyMeds, and RxmindMe were the ones rated the highest. The feature that these applications had in common was a basic reminder for medication. The study stated that the applications that made use of medication databases were RxmindMe and MyMedSchedule, which not only saved a lot of time for the users and providers, but also bettered the application's accuracy. The two applications that had the ability to track whether or not a dosage was missed and send this information to a professional were RxmindMe and MyMeds.

Although medication management applications, DDI software, and DDI databases are quite common, there still exists no medication management application that can provide both information on the contraindications of prescribed drugs and reminders to adhere to medication simultaneously, while also allowing the users to immediately have their medication added to their list of medication by utilizing the camera of the mobile device. This research presents a mobile application for older adults that assists them in their medication management and provides indications, contraindications, and drug-drug interactions.

2. Medication Management Application

2.1 Architectural Design

The system consists of six major components: the Optical Character Recognition (OCR) system, the parser, the web crawler, the online DDI database, the local database, and the medication management system as shown in Figure 1. The OCR system converts the text of the prescription image into a text file. The parser reads the text from the text file and determines the medication name, dosage, and frequency which is passed to the web crawler. The web crawler searches for the necessary inputs online using the DDI database that returns drug information including the indications, contraindications, and drug-drug interactions of the medicine. This information can be added to the local database, allowing the user to access the information offline. This component works with the medication management system that utilizes the stored information by taking into consideration the relevant attributes of each medication for its functionalities such as scheduling and displaying information.

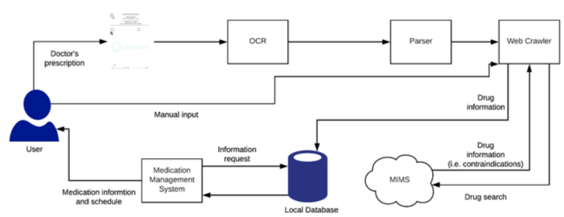

Fig. 1. Diagram of system architecture (OCR-Optical Character Recognition; MIMS – Medical Information Management System)

2.2 Medication Management System

The medication management system is what allows the user to keep track of their medication intake and schedule as well as display important medicinal information.

It also warns the user of any contraindications and interactions that may occur based on the list of medications added by the user. Before doing so, the system first utilizes the stored information in the local database by taking into consideration the relevant attributes of each medication along with the user's medical history.

2.3 System Functions

2.3.1 Adding Medication

Users are able to add their medications to the app in two different ways: Manually adding the medication or utilizing the OCR by taking a photo of their prescription. Both these methods are accessed by pressing the ”Add Meds” button in the home screen seen in Figure 2. Once the ”Add Meds” button is pressed, the user is asked how they would like to add their medicine and is given two more buttons to choose from ”Input Manually” and ”Upload Photo Prescription”.

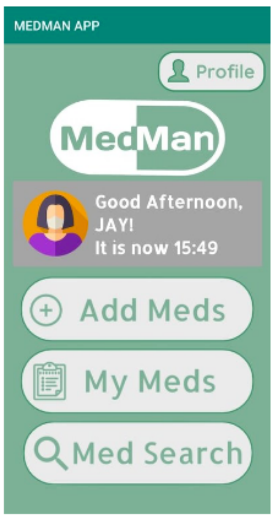

Fig. 2. Home Screen

2.3.1.1 Adding of Medication Manually

If the user chooses to manually input the medication themselves, they will be asked to provide information such as medication name, dosage, start date, end date, and frequency.

2.3.1.2 Adding Medication Using Optical Character Recognition (OCR)

Optical character recognition is done to accurately extract all the information from the users prescription image. The OCR will convert the text in the image to a string, get analyzed and processed by the parser, and get the medication name, dosage, and frequency. These inputs will be automatically placed in their respective text fields. After the user manually inputs the duration and confirms, the medication information will be searched for, using the web scraper, and get added to the list of medications.

2.3.2 Medication List

The My Meds screen contains the list of all the medications the user is taking. When the medication is clicked, it shows the generic name, dosage, duration, frequency, indications, contraindications, and interactions. If the medication has a contraindication or interaction, a warning will be displayed next to the medication name with an explanation on why it is inadvisable

2.3.3 Search Medication

The Search Medication feature allows the user to search for any medicine (that is part of MIMS) without having to add it to their list of medications. After inputting the name of the desired medication in the search bar, the web scraping tool searches for it in the online DDI database. After, the user is led to the page that contains the information of the medicine, namely its generic name, indications, contraindications, and interactions.

2.3.3 Demographic Survey

By default, the Demographic Survey of the user starts off empty, and they are free to edit it anytime they use the application. The information from the survey is stored in the user table of the local database, and is utilized by the medication management system in determining the contraindications of different medicines.

A user can edit his/her demographic such as their name, birthday, and sex. If they select female, they are then asked to put whether or not they are pregnant, as this has may have contraindications with medicine. The user is then asked to complete a checklist to check whether they have been diagnosed with the following: AIDS, asthma/COPD, blood clots, bone disease, cancer, diabetes, drug dependency, emphysema/bronchitis, epilepsy, heart problems, hepatitis, hypercholesterolemia, hypertension/high blood, kidney disease, multiple sclerosis, MRSA, pneumonia, psychiatric disorder, rheumatoid arthritis, stroke, thyroid problems, ulcer/hyperacidity. Moreover, the user is asked if they are allergic to any medications or food. If so, they are to state these allergies in the available text field separated by commas. The final step is to click the save button at the bottom of the page when they are finished so that this information will stay saved until the next time the user decides to edit it.

2.4 System Design and Prototype

The name of the application is MedMan, and it is compatible with Android mobile phones.

The Home Screen (Figure 2) contains four main buttons: Profile, Add Meds, My Meds, and Search Meds. To add a specific medication to the list, the user must select Add Meds, which brings the user to the Add Meds Screen. This screen allows the user to choose whether to input the medication manually or to scan an image prescription (Figure 3a). If Input Manually is selected, the user is required to input the medication name and dosage, start date and end date and frequency (Figure 3b) After which, the user is shown a confirmation screen before the web scraping process begins (Figure 4a). Once all the necessary information is taken from the online DDI database, a final confirmation screen is displayed (Figure 4b). If the user confirms the information, then the medication is added to the My Meds List (Figure 5). If the user chooses cancel, the user is brought back to the Add Meds Screen.

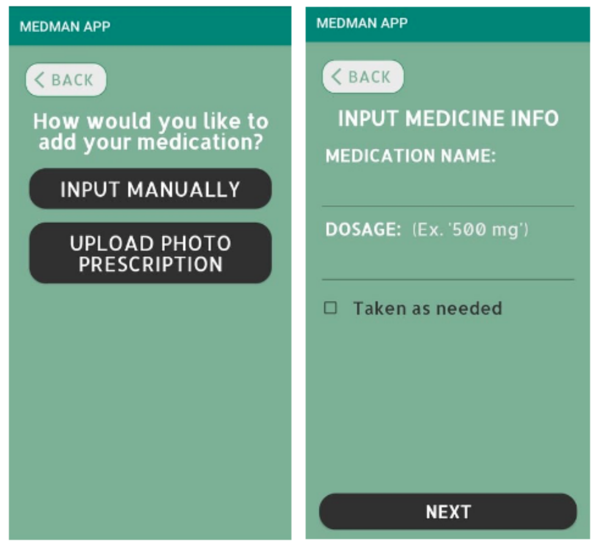

Fig. 3.(a) Add Meds Screen (b) Manual Input of Medication and Dosage

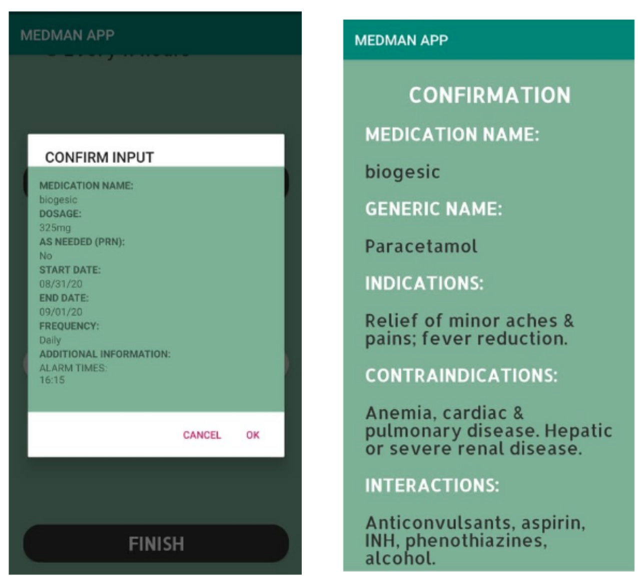

Fig. 4.(a) Confirmation of Input (b) Confirmation after Scraping

Fig. 5. My Meds List

On the other hand, if the user is in the Add Meds page and selects Upload Photo Prescription, the OCR Screen is shown with two options: choose from gallery or take a photo. If the user selects the first option, then the mobile devices photo gallery will be prompted, letting the user select an already existing image prescription. On the contrary, if the user selects the latter, then the mobile devices camera will open, allowing the user to capture an image. Once the image is selected, the OCR will transform the writings on the prescription to actual text, which will then be processed by the parser. Next, the OCR Confirmation Screen will appear, which enables the user to edit and verify the parsed information. When confirmed, the user is asked for additional details including the start date, end date, and alarm times, that is necessary for the scheduler. When the finish button is pressed, the medication is finally added to the My Meds List.

3. RESULTS AND DISCUSSION

The Medication Management application was tested in order to verify that it has met the requirements defined in the objectives, as well as to evaluate its usability.

Five users were given six tasks to do within the application. Three participants of 60 years old and above were tested in person, while one doctor and one pharmacist were shown the application through online video call. The users were required to complete each task while the interviewers took note of the time, observations, comments, and suggestions. These were then were taken into consideration for the improvement of the application.

After completing the tasks, the participants were asked to rank their answers to each of the questions from one to five, one being "Strongly Disagree" and five being "Strongly Agree" using System Usability Score (SUS) Questionnaire. The Usability Score per participant was computed first by subtracting one from the score of each of the odd numbered questions, and then subtracting the value of those in the even numbered questions from five. The sum of these new values was then multiplied by 2.5, yielding a score out of 100. This is not a percentage but rather, a clear way of visualizing the usability. User 1 yielded a Usability Score of 82.5, User 2 with 95, User 3 with 72.5, User 4 with 82.5, and finally User 5 with 82. The participants' individual usability scores averaged to 82. Based on this result, the application is perceived to have an above average level of usability.

4. CONCLUSION AND FURTHER WORK

The medication management system was implemented as an application for Android devices. It is designed to assist older adults with the adherence of medication by allowing them to input their medications and schedule when they are to be taken. Based on their chosen schedule, the application generates notifications as a reminder to take their medication at that specific time. This notification comes as a text pop-up along with sound to capture their attention. Furthermore, relevant user experience concepts were implemented into the application's design to accommodate the needs of the target audience.

The medication management application allows the user to add and search for any medication found on the chosen online DDI database. The supplementary information of each medicine, such as the indications, contraindications, and interactions, is extracted using the developed web scraping tool. In order to allow the user to view their medication details offline, the application stores all the extracted necessary information on the device's local database.

The medication management application also utilizes an open-source third-party OCR tool to accurately extract the information from a prescription image.

Aside from manual input, the user may choose to add their medication by uploading an image or taking a photo using the camera on their mobile device. The OCR tool extracts the text on the photo which is then parsed accordingly based on the selected prescription formats.

The medication management application implements the use of a web scraping tool that extracts information from an online DDI database. This tool simulates a web browser which is then navigated through the use of JavaScript functions. Once the scraper arrives at the final web page containing the specific medication information, it performs another set of JavaScript instructions to extract the appropriate information.

Future works include the enhancement of user experience features, integration of more prescription formats, improved user testing, integration to a smart pill box and multi-platform installation of the app. Integrating the mobile medication management application with a physical smart pillbox would further improve the monitoring of the user's medication adherence. Correctly engineering the smart pill box to work alongside the medication management system of the mobile application would allow it to more accurately track which medications the user is taking and warn them if they are not taking them as scheduled.

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