CS 6365 Introduction to Enterprise Computing.
Project Report
Topic: Patient Aid

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MOTIVATION AND OBJECTIVES

Healthcare is an extremely interesting and challenging domain and one with a lot of untapped potential for technological intervention to help solve problems and inconveniences. In order to develop an application that would prove to be useful and productive in this domain, we decided to interview a patient to identify key pains and problems that she would like to have fixed. The patient we spoke to was a homemaker. She mentioned that she had so many chores to do and errands to run everyday that it got hard for her to remember everything that need to be done. To keep track of important tasks, she habitually wrote things down but more often than not, she would forget to check the list. She had diabetes and high blood pressure which meant that she had to take a lot of tablets several times in a day. She also emphasized that she frequently forgot to take her morning medication due to a lot of work that had to be done at that time of the day. Her doctors constantly warned her about the consequences this would have on her health in the long run. To add to her woes, she also tended to lose her prescriptions as they increased in number after every visit to the doctor's. She also mentioned that it got hard for her to look at those prescriptions every time to be reminded of what tablets has to be taken when. She also valued her independence and believed that she should be able to take care of her health. We believe that a mobile application solution can be used to solve the problem mentioned above where the patient is benefited and the patient does not have to rely on anyone except herself .

RELATED WORK

Smart Patient

This Mobile app helps patient monitor their health by keeping track of their health indicators like Blood sugar, Blood pressure etc over time and use charts to get a snapshot of their health history. This app enables the patient to create a checklist which enables the patient to be prepared with questions throughout their care. Another feature of this application is that it also allows the patients to store text notes or voice notes of what the

doctor suggested, to refer to later, and delete them when it is no longer needed. This app also provides video tips from Dr. Oz show that delivers good health related information that are needed to maintain good health.

Patient Records Doctor ON GO

This patient data storage app has several patient management features for busy medical professionals. They can create custom templates in order to fill and store any particular type of data based on speciality. The features provided in this app are Add, update, delete and search patients. The patient history can also be viewed. The app allows the addition of multiple photos, images, voice (medical transcripts) files and video attachments to patient visits. It also allows the scan of lab-reports, x-rays etc. The app also as the feature that enables the any medical professional to schedule appointments and remind patients via SMS, email or phone call with one tap.

Tesseract is an Optical Character Recognition engine which was developed by HP between 1985 and 1995**.** Tesseract development is currently being led by Google. It can read a wide variety of image formats and convert them to text in over 60 languages. It is open source and licensed under Apache. Tesseract is highly accurate when recognizing texts from languages that are currently supported.[3]

SYSTEM IMPLEMENTATION

Swift

Swift is a successor to the C and Objective-C languages. It includes low-level primitives such as types, flow control, and operators. It also provides object-oriented features such as classes, protocols, and generics. Swift adopts safe programming patterns, is more flexible and the syntax is concise. Applications written in swift run lightning-fast because it uses the incredibly high-performing LLVM compiler were the swift code is transformed into optimized native code, tuned to get the most out of modern iPhone hardware. Swift is easier to understand -it has more rational code, which decreases the length of the code and thus the time of development.Since this programming language is new, the pool of Swift development resources are less.[1][2]

Tesseract OCR

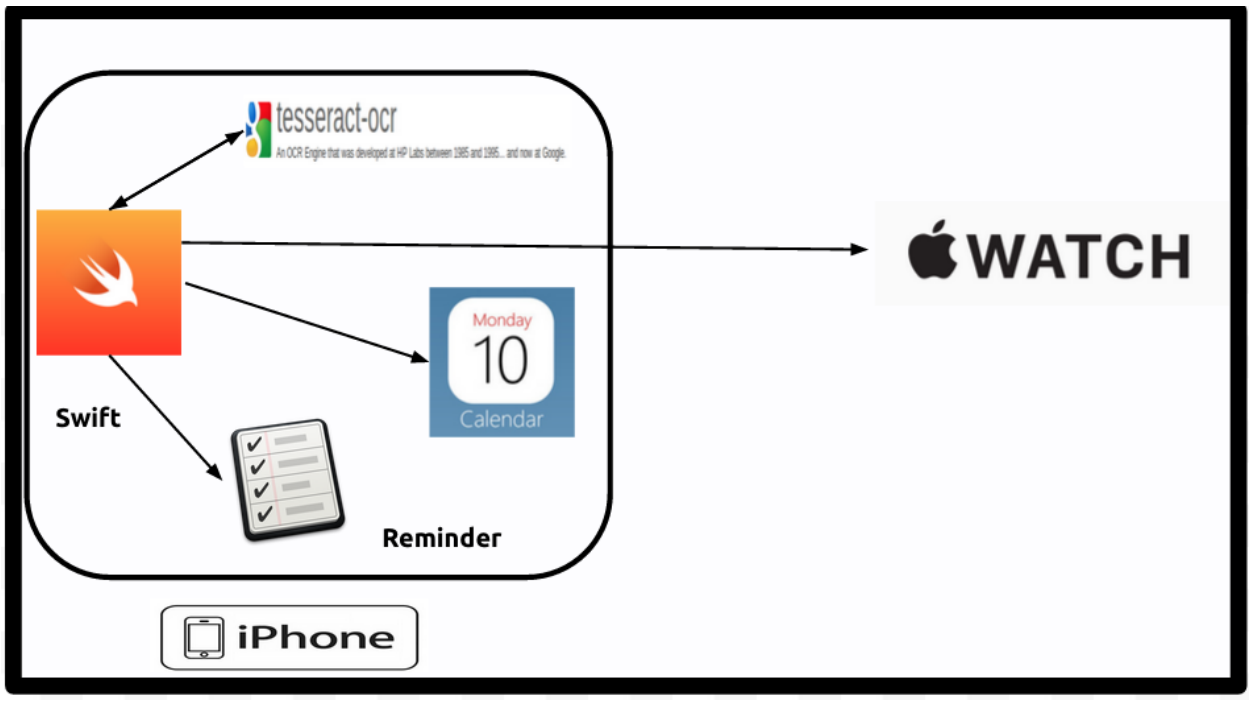
Tesseract is an open source optical character recognition engine which is highly accurate when recognizing texts from languages that are currently supported. It works in the following manner: First ,adaptive thresholding on the input image is performed .Then the image is analyzed for the presence of connected components in the binary image.After which the process to find text, lines and words begins.Next the first pass of recognition process begins along with it the tesseract attempts to recognize each word in turn .Satisfactory words are then passed to an adaptive trainer.Lessons learned from the first

pass are then employed in a second pass which then is used for words which was not recognized properly in the first pass , which finally results in producing the output text.[3]

Apple Watch

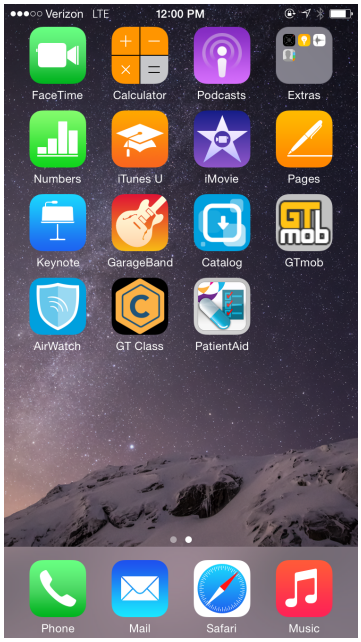
Apple Watch combines the traditional features of a watch with more advanced options enabled by modern technology, especially when used in combination with an iPhone.It is designed around simple gestures, such as zooming and panning, that already come naturally. Navigation is fluid and responsive that is , with a simple raise of the wrist we can wake the display of the watch.The user must have a watch app installed on an iPhone and have the two devices paired together. The phone will be used for the majority of the watch's functions, including services such as calling or texting.The Apple Watch communicates with the companion iPhone via Bluetooth 4.0, and it's also NFC enabled. When the app is launched on the watch, the companion iOS extension is automatically launched. They both work in synergy, with the watch app showing content to the wearer and responding to interactions, while iOS extension is doing everything else. Actually, no application code is executed on the watch: all processing is delegated to the iOS extension. [6]

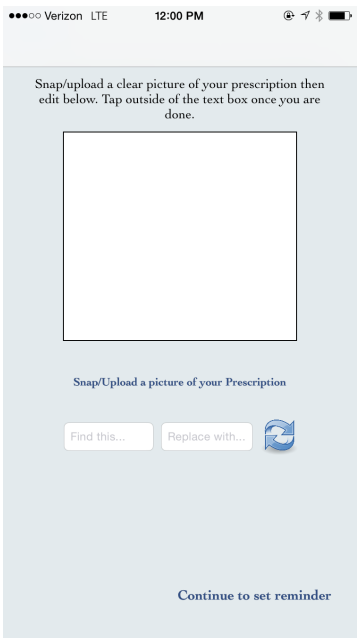
SYSTEM ARCHITECTURE

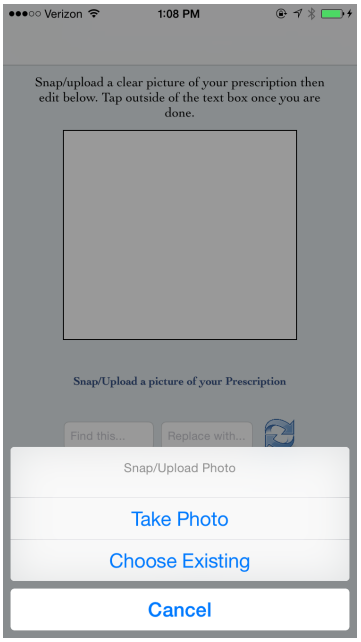


MOBILE APPLICATION FEATURES AND WALKTHROUGH

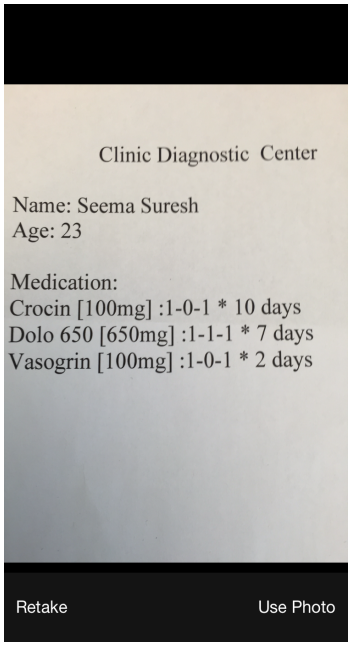
The mobile application user interface is designed to be intuitive, visually appealing and easy to use. The main reason for this is that the targeted customers for this app is largely people who are not accustomed to using complex functionalities on a mobile app such as the elderly or those suffering from long term illnesses. Once the application is launched, the opening screen provides the user with two options. One is to take a snapshot of a prescription using the device's camera and other is to let the user to upload an existing prescription from the phone's camera roll. After the prescription is uploaded, the OCR engine converts the prescription image to text. The application currently supports one kind of prescription format.





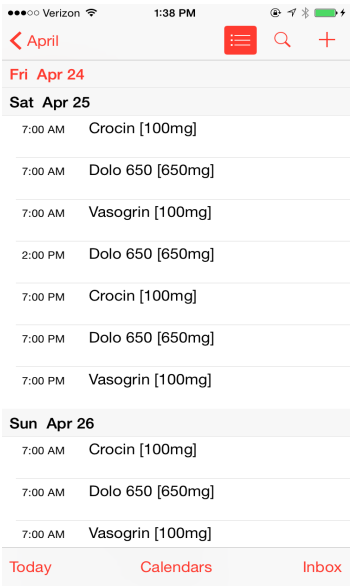


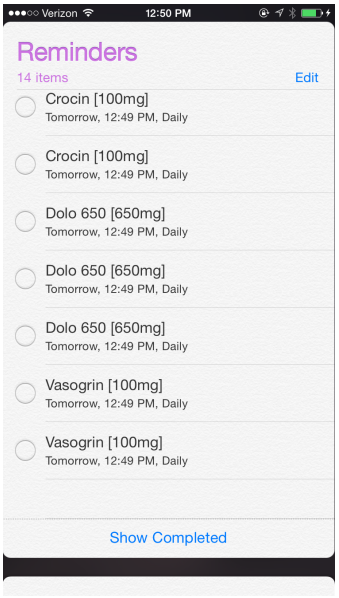
The prescription text appears on the app screen in editable text format so that the user can correct any error made during the OCR process. The user can then click the button "Continue to Set Reminders". The prescription text is parsed to obtain a list of medicines and the frequency (number of times in a day and when) and duration (number of days) of each. This button redirects the user to the next screen of the application which lists the aforementioned information in tabular format. The user is then expected to press the "Set Reminders" button to set the reminders for the medicines to be consumed appropriately.

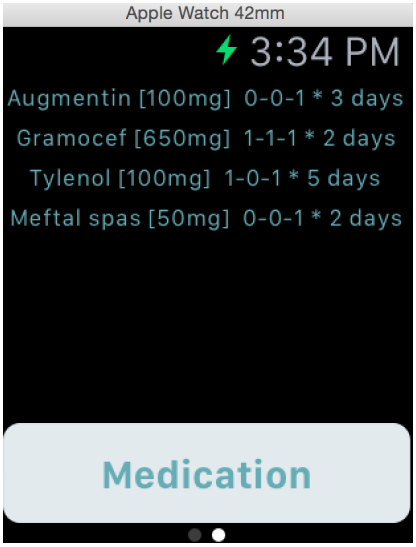


The application accesses the native Reminders application provided by Apple to set reminders. Reminders are set with the medication name and dosage as the title. Multiple reminders are set in accordance with the frequency and duration of each medicine. The “Set reminders” button also launches the Reminders app so that the user can view the reminders set by the app and make any required changes. The application also accesses the native **Calendar application** provided by Apple to set calendar events for these medicines with their names and dosages as the title and the time and recurrence set in accordance with the frequency and duration of the medication. The integration with Calendars is provided since Calendars is a more widely used service when compared to the Reminders application provided by Apple and the backing up to iCloud capability provided. Our application searches for calendars present on the phone storage as well as those backed up on iCloud to set the calendar events. This is further beneficial as now the calendar notifications are available on all Apple devices that are synced with iCloud.

The medication information is also communicated to the Apple watch using App groups shared container and NSUserDefaults. The user can view his/her current prescription directly on the watch.







Apple Watch

MAIN CONTRIBUTIONS OF THE APPLICATION'S DESIGN/ARCHITECTURE

The main contribution of this mobile application is that users who have multiple medications to take several times a day over extended durations, can be reminded at specific times of the day about medications they need to take at that particular time. This can be done by simply snapping a picture of the prescription. The app automatically sets reminders and calendar events for each medicine mentioned in the prescription (for example, thrice a day for 7 days). The user is reminded accordingly

and since the reminder title is the name and dosage of the medication, the user does not need to worry about keeping track of which medications need to be taken when. The ability to access a prescription through Apple watch is an additional convenience which users can benefit from to ensure that they do not skip their medications.

CHALLENGES AND LESSONS LEARNED THROUGH HANDS-ON EXPERIENCE DOING THIS PROJECT

This project was an exciting and challenging endeavour. We initially started out with the idea of creating an application that improves communication between doctors and patients. However, after brainstorming with Professor Pu and obtaining feedback on our proposal, we realized that improving support for patients was more key and that the features we had originally proposed were present in many mainstream healthcare softwares. We then decided to try out something that would benefit patients - particularly those that were elderly or suffering from long term illnesses and might not have caregivers to ensure that these people would not skip their medications.

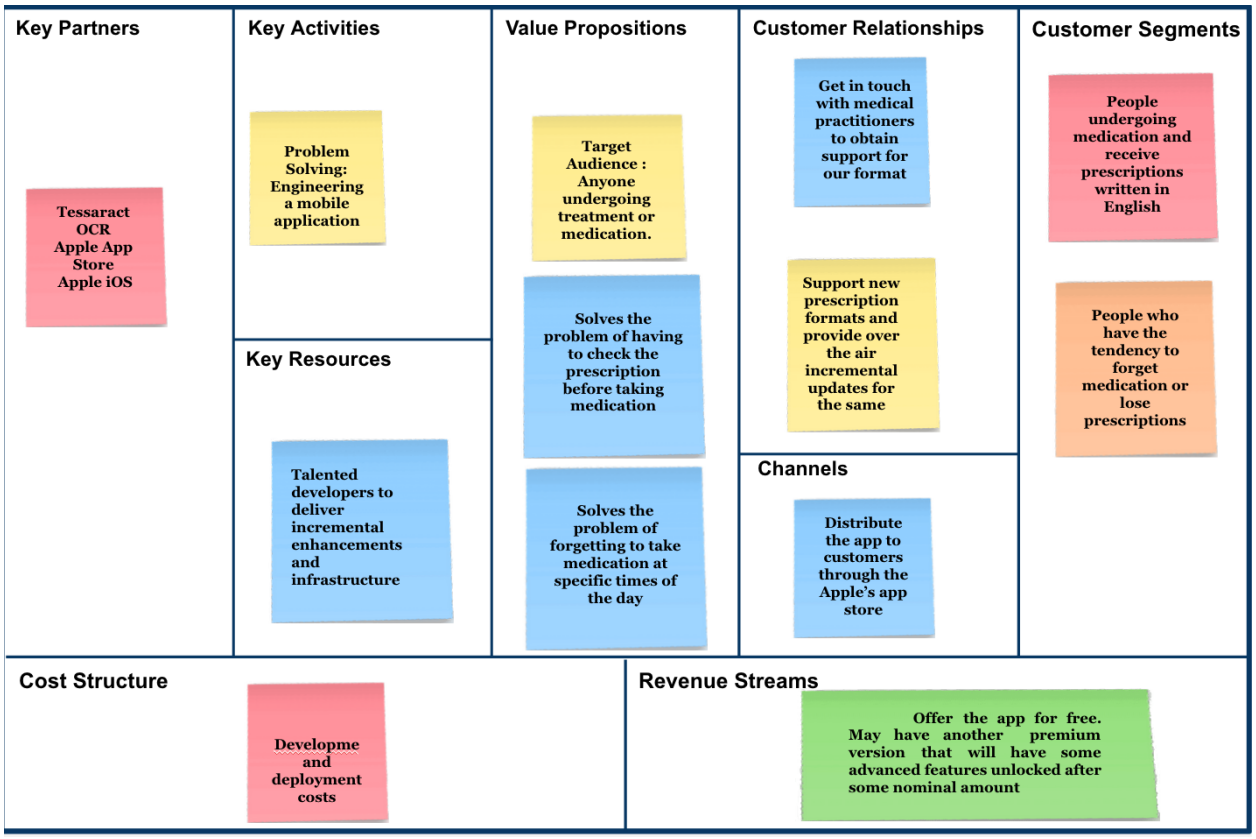
This project enabled us to dabble with several interesting (and new) technologies. The Swift programming language, introduced by Apple in WWDC 2014, is being pitched as a complete replacement for Objective C. This application has been written Swift. The image recognition was done using Tesseract OCR engine which is currently being supported by Google. The integration of Tesseract OCR with swift was a key challenge as there is currently no support for Swift. However, Tesseract has an Objective C wrapper that could be used in Swift by including an Objective C bridging header in our application. This project also gave us the opportunity to develop for the Apple watch which is scheduled to release at the end of April. There is a lot of development underway for the Apple watch and it was a great opportunity to be a part of this wave. Integration with Apple watch was challenging because of the one way communication currently supported i.e. the watch can wake up and poll the iPhone app but the phone app can't wake up the watch. This project provided us with the opportunity to experiment with App groups shared containers to communicate information between devices using NSUserDefaults.

This project taught us how to work with new technologies that lack significant support and how to adapt quickly in the face of challenges. It provided us good insight into the importance of incremental development and testing that is used in many agile projects today. It also taught us that it takes a lot of effort to convert an idea

into a final product and efficiency and perseverance is key in accomplishing targeted application features.

RELEVANT CONCEPTS AND TECHNIQUES LEARNED IN CLASS

There were several key takeaways from this class that enabled us to make this application idea a reality. The ideas of development for robustness, scalability, customer satisfaction etc. enabled us to design this application and its features keeping the targeted users and their convenience in mind. The creation of a business model canvas which included information such as value proposition, revenue streams, customer relationships etc provided us great insight into development endeavours at the enterprise level. The Professors' focus on ideating a marketable product and developing with a business model and proposition in mind for the project made it possible for us to think of our app in the same way. We also tried to incorporate design principles such as ease of use, simplicity, intuitivity etc. to make our application widely acceptable.



FUTURE WORK

There are several key enhancements that we hope to achieve to improve support for patients in the long run such as:

- More efficient integration with the Apple Watch utilizing all the available features provided by Apple once it is launched.
- Improving patient support with features such as details regarding the drugs prescribed and expected side-effects, reminders for appointments etc.
- Integrating many more prescription formats and obtaining support from medical practitioners or pharmacists.

REFERENCES

[1] Swift Tutorial viewable at https://developer.apple.com/library/ios/documentation/Swift/Conceptual/Swift_Programming_Language/GuidedTour.html

[2] Swift EKEventStore API reference at https://developer.apple.com/library/ios/documentation/EventKit/Reference/EKEventStoreClassRef/

[3] "Apple's top 80 apps for doctors, nurses, patients" viewable at http://mobihealthnews.com/19206/apples-top-80-apps-for-doctors-nurses-patients/

[4] Smith, R., "An Overview of the Tesseract OCR Engine," *Document Analysis and Recognition, 2007. ICDAR 2007. Ninth International Conference on* , vol.2, no., pp.629,633, 23-26 Sept. 2007

[5] "No longer a novelty, medical apps are increasingly valuable to clinicians and patients" by Joseph Conn viewable at http://www.modernhealthcare.com/article/20131214/MAGAZINE/312149983

[6]" Apple Watch" at https://developer.apple.com/watchkit/