International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-7, Issue-5S4, February 2019

IoT based Automated Medicine Dispenser for Online Health Community using Cloud

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Abstract — Online health communities generally provide a platform for patients and their families to learn about an illness, seek and suggest support, and connect with other peers in analogous situations. In this paper, an architecture and implementation of an automatic medicine dispenser is proposed to support and extend the online health communities. Through this solution, doctor in the online health community may suggest pills based on the health conditions of their patients as communicated by them through online platform. Each user is secured with a unique barcode while starting the communication between the doctor and the patient. The barcode may then be scanned in the nearby automatic pill dispenser that can dispatch the medicine. Cloud is used as a medium to support Storage as a Service. The proposed model eliminates the need to spend time to visit the doctor and the time to spend in pharmacy. Also, the patients are relieved from the errors that might be caused due to handwriting misinterpretation and change of medicine that exists in manual medicine dispensing system.

Keywords - Medicine, Pills, Automatic Medicine Dispensing, Pharmacy Automation

I. INTRODUCTION

Among the disruptive technologies for the future, Online Health Community (OHC) platforms play a vital role. OHCs provide a way for patients, health care related staff, clinicians, caregivers etc., to share their views and develop solutions for the problems of interest[1]. A study with WebMD.com's most active OHCs [2] showed 62.1% of patient posts could benefit from clinical expertise. The most common problem that prevails in the medical and pharmaceutical industry is the medication errors that occur through improper use of transcription writing, dispensing medicines, and administration. The alarming statistics about medication errors have lead to numerous efforts in research, development and deployment of Information and Communication Technologies (ICT) to prevent medication errors.

The process of prescribing and governing a patient's medication involves several steps including[3],

- Ordering: the clinician must select the appropriate medication, the dosage and frequency.
- Transcribing: the handwritten prescriptions must be read and understood by the pharmacist.
- Dispensing: the pharmacist must check for delivery of medicines in the correct dose considering the chemical matching, if any.
- Administration: the medication must be received by the appropriate patient at the right time and should be consumed in the right dosage.

The above process is error-prone and hence requires computerization to support OHCs too. The digital transformation of medicine is best supported by computerized provider order entry (CPOE), a term that refers to system in which clinicians directly place orders by electronic means, with the orders transferred directly to the patient or whomsoever it needs to be. Kuperman et. al.[4] states that automation along with clinical decision support systems can help prevent up to 80% of prescription errors that accounts to 40% of all errors. The administration errors stand next (i.e., errors due to failures to compliant to medication directions) and they contribute 25 – 40% of all preventable errors. Tsai et. al.[5] pointed out the necessity of CPOE based systems for senior citizens who live independently.

Long appointment wait times in hospitals always result in negative impact on patient satisfaction that directly influences healthcare experience[6]. A survey from the Medical Group Management Association (MGMA) in 2017 states that the average wait time in clinician practices was 20 minutes whereas the wait time in hospital-owned physician was 17 minutes.

The automatic medicine dispenser described in this paper is designed to prevent users to waste their wait time in hospitals[6] and to reduce transcribing and dispensing errors. It is primarily for the OHC lovers as well as the type of users who are elderly that is preventing them to spend time at hospitals and pharmacy. These kinds of users may be prescribed by doctors through OHC and can use the automatic medicine dispenser nearby to ensure error-free operation.

II. RELATED WORKS

H. Yeh et. al.[7] explained about APAMAT, A Prescription Algebra for Medication Authoring Tool. This tool includes The tools include prescription entry systems, authoring, scheduling, and pill dispenser. Authoring tool helps pharmacists to collect and integrate prescriptions given by clinicians, to verify drug-drug interactions amongst them, and to generate the corresponding scheduling instructions for dispensers.

Revised Manuscript Received on February 11, 2019.
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Large variety of medication administration assistance devices are deployed for non-professional users. All these type of devices target on elderly people who live independently and are left out with administration errors. These devices require human beings to load the medicines for individual days manually and hence needs weekly attention. This manual process frequently results in errors. Wan D[8] introduced Magic Medicine Cabinet that uses face recognition for day to day scheduling of pills. Puneet[9] discussed about the necessary of automation in current world scenario where people are not able to spend any time.

Debiao [10] discussed about the design of parallel pharmaceutical automatic dispensing (PPAD) machines that are widely used in central fill pharmaceutical units to improve the prescription dispensing speed and accuracy. The objectives of the design by Debiao are to minimize the makespan and collation delay. Many devices emerged into the market and can schedule the dispensing of medicines based on clinician's prescription and can be monitored through Internet. These kinds of devices are better suited for patients who need close professional supervision and fully integrated health care services.

The intent of our work is to automate the medicine dispenser system combined with cloud based services to simulate pharmacy works. The proposed dispenser is a stand-alone tool, capable of releasing pills to the users based on the prescriptions suggested by clinicians without the need to manually visit the clinician. The methodology is found to reduce the waiting time of patients at hospitals and pharmacies and ensures privacy and independence among the patients.

III. PROPOSED METHODOLOGY & RESULTS

Figure 1describes the proposed architecture of a prototype model of automatic medicine dispenser.

The proposed solution composed of three main components:

1. Medicine Dispenser – A dispenser that can dispense medicines to the patients, based on the prescriptions suggested by the doctor secured by individual barcodes. These dispensers are to be owned by the pharmacies and to be filled with medicines on the time of requirement (like ATM machines). Users of Online Health Communities are the target users of these machines who can get appropriate suggestions from the doctors associated with the same group.

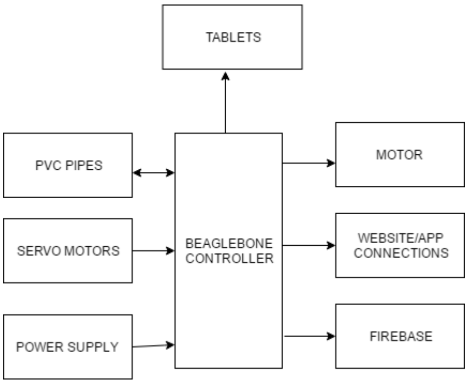

Fig 1: Architecture

2. Datastore – cloud based datastore is required to store the details of OHC users along with their history of medication and the sequence of medications they had etc., Firebase is used for prototype modelling that can be replaced with appropriate cloud infra.
3. User Interface – an android application that can be used by doctors to create prescriptions for patients registered in OHC.

A. Medicine Dispenser

Medicine dispenser is modelled using various components as stated in Figure 1. A short description about the various technical requirements is discussed below.

i BeagleBone

The BeagleBone as in Figure 2 is open-source, low-power, single-board computer produced by Texas Instruments in association with Digi-Key and Newark element14. The board is left for use by academicians to teach open source hardware and software capabilities. This small computer is used to control the operations of the dispenser based on the input from firebase.

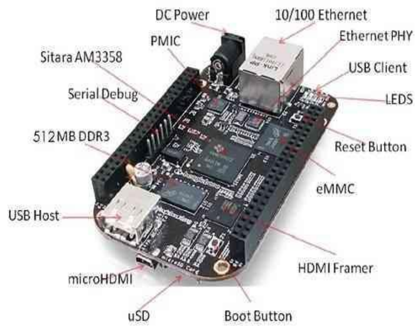

Fig 2 : BeagleBone

ii Servomotor

A servomotor as in Figure 2is either a linear or rotary actuator coupled with a sensor that allows precise control of angular or linear position, velocity and acceleration. It finds it's applications in many areas including, robotics, CNC machinery, automated manufacturing etc.,. A servo motor is used in our prototype to control the dispenser unit which in turn controls the number of pills dispensed in each category. The servo motors are connected to the beaglebone. According to the data generated by the app, the servo motors corresponding to the medicine rotate that many times. For eg., If number of pills is 2 then servo motor rotates 2 times to enable dropping of medicines.

Fig 3 : Servo Motor

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iii Pill containers

For prototype, PVC pipers are used to store pills to ensure cost efficiency. The usage of PVC in pharmaceutical industry is witnessed by the literature in different cases. In real implementation, based on the environment and nature of pills, this storage unit may be fixed.

B. Datastore

For the prototype, firebase is used as a common cloud platform to store the details of prescriptions as suggested as suggested by the community doctors.

C. User Interface

A website coupled with an app is developed for the usage of clinicians and patients. Every interacting person of the OHC are provided with unique ID. When a prescription is generated from the consulting physician, a barcode combined with the unique ID of the patient is generated and sent to the patient through his unique login. The clinician has the provision to check the status of medicine dispense along with the history of each patient.

D. Operational Procedure

Figure 4 shows the working flow of the complete system.

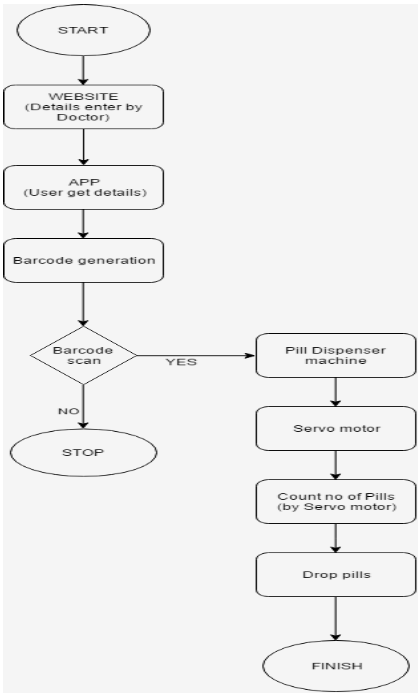

Fig 4: Flow diagram

The following points describe the procedure to be used by the OHC users.

1. Users of OHC should register themselves in the portal and will be identified with a unique ID for identification. Email id is used as a means for identification as it is unique.
2. Users can choose their doctors for discussion and consultation through the portal based on the sequence of conversations and other parameters like rating and comments by other community users.
3. Users can post their issues, which will be tagged with query ID to specific doctors through the private chat provided in the application.
4. The doctors can then view the patient's history, if they are registered with the doctor and can suggest appropriate medicines to the patients.
5. A barcode will be generated coupled with unique ID of patient and will be sent to patient's login.
6. The patient has the flexibility to see prescriptions of all suggestions and can choose according to his/her preference.
7. The patient can visit the automatic medicine dispenser nearby and can scan the barcode.
8. Based on the validity of barcode and left-out prescriptions, the dispenser will dispense the medicines that can be collected through the vent provided in the dispenser.
9. The dispenser will run sequentially for as many numbers of medicines as stated in the prescription.
10. The delivery status of prescription will then be set to be "delivered" and hence the patient cannot reuse the prescription to take out the medicines without doctor's consultation.
11. If the patient is delivered with the medicines, all the prescriptions corresponding to the query ID will be locked to ensure multiple deliveries of medicines.
12. All the data are stored using cloud as a platform to support SaaS (Storage as a Service).

A. Assumptions

Following are the assumptions that are made for the use of process.

1. Automatic medicine dispensers are to be managed by pharmacies (like ATM machines) to reduce crowd at their places.
2. Filling of medicines to be ensured based on the usage scenario at respective places.
3. Proper billing mechanism to be adopted with the dispensers (like online payment portals like, paytm etc.,) based on the result of which the dispenser can be allowed to dispense medicines.
4. The dispensers cannot hold all type of medicines available in the market. Hence, these are expected for usage of only common medicines required frequently.

IV. RESULTS AND DISCUSSIONS

Figure 5 shows a sample authentication screen for OHC users.

Fig 5: Login screen for OHC users

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Figure 6 and 7 show a sample screen of a patient with multiple doctors' suggestions. The patient has the flexibility to choose any suggestion according to his/her preference. Once the prescription is chosen, a unique barcode is generated and will be sent to the patient's login.

Fig 6: Doctor's suggestions

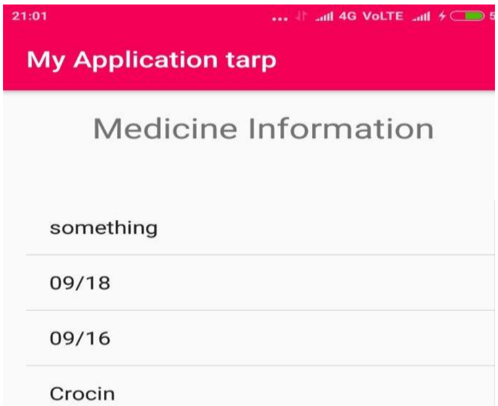

Fig 7: Suggested medicines

The application is tested with about 25 users registered in internal discussion form and the dispenser is tested for generating to a maximum of 8 different tablets. Reliability of the prototype is good and can be improved using the appropriate components on actual production.

A. Threats to Validity

1. The application was tested in a controlled environment with minimal prototype. Upon extension to real time deployment, mapping of components is a critical task to be taken care.
2. The shape of each medicine dispenser is currently set to be circle. This dimension and shape of the dispenser is a critical element to be decided on real time implementation.

V. CONCLUSION

The overhead incurred to the patients for waiting in hospitals and pharmacy can be greatly reduced using the proposed architecture. The methodology is found to be error-free in the perspective of transcribing and dispensing. Pharmacy people will be relieved off from the distribution tasks for small tasks. Since all the automated dispensers are networked through the cloud, future expansion to include multiple pharmacies becomes easier. Security can be provided by managing private cloud for each OHC groups.

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