IoT Based Pill Reminder and Monitoring System

Sultan Ahmad[1*], Mahamudul Hasan [2], Gouse Pasha Mohammed [3] Mohammad Shahabuddin [2], Tasnia Tabassum [2] and Mustafa Wasif Allvi [2]

[1*] Department of Computer Science, College of Computer Engineering and Sciences,
Prince Sattam Bin Abdulaziz University, Al-Kharj, Saudi Arabia
[2] Department of Computer Science and Engineering, East West University, Dhaka, Bangladesh
[3] Department of Computer Science, Preparatory Year Deanship,
Prince Sattam Bin Abdulaziz University, Al-Kharj, Saudi Arabia

Summary
There are many people around us who are the victims of chronic disease. Most of them suffering from dementia. Some people overlook to take care of health. Because of the lack of an expert system, people are forced to submit in frequent health related problems. By analyzing the data, an internet of things (IoT) based reminder system has been developed. It is designed to assist the patient who forgets to take medicine. The proposed system consists of an IoT enabled device and an android application. It mainly focuses on dementia patient. But it is beneficial for all. Patients will no longer have to worry about daily medication. The application will send a notification when it's time to take medicine. The mobile application is used for keeping the record in medicine details and reminding the schedule of medicine. We have used the IoT enabled Arduino device for monitoring the whole system. The device can sense whether a patient has taken medicine or not with the help of the infrared (IR) sensor. We have tried to develop a system which will help patients to manage their health care properly.

Key words:
Reminder system, IoT, Dementia, medicine scheduler, IR sensors.

1. Introduction

In modern society, most of the time people remain busy in their daily life schedule. It is true that they give more preference to their work than taking care of their health. Several diseases like diabetes, blood pressure is nowadays very common. Maintaining daily medication become very difficult for old people. Sometimes younger is faced with the same problem. There are many people in our family who need constant help may it be our elderly people, younger or others. But it is not always possible for us to remind them of their medicine's dosages every time. For this purpose, there needs to be some facility for us which monitoring patient and take care. Nowadays we are all used to living technology-based life. We can use this technology in a way that will be beneficial for us. Cell phones aren't best utilized for calling but now maybe used as an ensemble of embedded sensors that together allow new packages including human services, healthcare, social networks, environmental tracking etc. Today in medical services frameworks, the usage of cell phones is turning into an expanding number of values [1]. IoT may be helpful to monitor real-time condition and IoT can be a powerful and effective paradigm to store data collected by sensors devices to the cloud. In our project, the IoT enabled device will control the overall monitoring system. And developed an android application which help patients by reminding medicine in take time and so on.

2. Problem Statement

Patients may often fail to comply with their medication whether it was from forgetting to take the medicine, from taking medicine at the wrong time or even from taking too much medicine. Therefore, there are many systems such as reminder, alarm, and so on to remind patient. We have focus on those patients who having difficulty to take medication on time, we tried to design and to aid patients with managing their medical prescriptions, through a reminder app they will use to look at and manage their medications. The Pill Reminder will facilitate users to require the right medication on time. This system provides a real time monitoring system that allow related people to monitor the patient's activity remotely.

3. Related Work

There are various medication systems which are in use currently. They depend on various stages and ideas. There is a medicine update framework, My MediHealth [2] which has been created for children. It is made available on mobile phones such as personnel digital assistance. It is a mobile application that gives Graphical User Interface to design drug schedules and alarm system to remind the patients, about time and other details.
Zao et al. have created application - a smartphone application intended to help patients to avoid prescription organization mistakes [3]. Prasad B has proposed an Application, 'Medicine update expert'. This App has a

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limit of 15 updates. A patient can select these updates while rehashing or Non-rehashing caution designs. Between the two caution designs at a time should be selected. The duration between two caution designs should be at least one hour. A reminder shall be delivered at the schedule time. This reminder could be caution vibration or LED sign [4].

Hamida et al. have recommended a secure and efficient in-Habitation Wearable insomnia monitoring and diagnosing system (2013)[5]. The sleeping data of patient at home could be received by Remote clinical background system with the help of recent technology like an experimental estimation of communication and security measures protocols in terms of security and overhead.

According to Ray, (Home Health Hub Internet of Things 2014), health is one of the most important part of the life span. Making life easier is one of the most desired thing that humans want to achieve with the help of recent development of IoT [6]. The novel framework designed by Ray, helps to monitor the health of old people at their residence places through this H3IoT system.

Again, according to Al Majeed et al. (Home Tele Health by IoT, 2013], IoT helps in real time monitoring of health condition. The related devices can sense, transfer data and do analysis in order to perform healthcare process. In this proposed system, they are using cost effective feasible algorithm to minimize the complexity in order to process huge data. These data are being generated by imaging devices, sensing devices and Human interaction [7].

Huang et al. [2014] proposed an intelligent Pillbox system for elderly people. The purpose of this work is to provide safe and secure medication on time [8]. Moga et al. [2015] recommended an internet based control, monitoring, low cost embedded system for a smart home. This work is using distributed sensing and control system to make this system user friendly and remotely accessible [9]. It provides a very user friendly touchscreen application to perform all events.

The personal activities and independence can be well managed and improved by AT(Assistive Technology) to do better. But very few people know and access assistive Technology, because it is costly and there is lack of training, availability, and awareness. As per a survey, 2 billion people will require at least 1 assistive product by 2050. In the same time, the older people may need 2 or more assistive products. Jaun et al. have proposed “The Intelligent Pill Box”[10]. They explain how to design and implement Assistive Technology devices using open source technologies. This provides a new way to manage medication dosages. They used Arduino Mega 2560 as main controller. This assistive technology provides more option for taking the medicine. It is based on an automatic alarm system, that uses interacted interface and notice system via GSM network. A pillbox based on an MCS-51 micro-controller can send out medicine using a stepper motor at a scheduled time, but there was no provision to record the time when the patient took the medicine [11].

Sawand et al. has proposed a architectural frame work to handle life cycle and important service components of e-healthcare [12]. They used the new technologies likes IoT, WBSN (Wireless Body Sensor Network) and cloud computing to collect data, to transmit and to analyze and finally store to the cloud center for further use. Ahmad et al. proposed a solution where the fog and edge computing has been used in 5g and IoT system. Self-addictiveness and resilience in cyber-physical systems is the key concern in their research [13].

Abdallah and Fayyoumi have developed a mobile application to assist dumb and deaf person in daily life activities [14]. They are using Arabic language as medium of interaction. They used the concepts that the people with special needs communicate with normal people by choosing the sign images. Al-Haider et al. have recently proposed a “Smart Medicine Planner for Visually Impaired People”[15]. Their proposal may helpful specially for blind and elderly person to manage the daily medicine dosage. Dispensing and Alarming are two main parts of their whole system. Google Cloud is being used to store the recorded voice and recognizing in the application. Raspberry Pi3 with Bluetooth connections are being used to communicate between their Smart medicine planner and voice box.

Finally, we studied expensively the existing problems in the current methods and proposed systems. We have tried to solve them and developed our novel Pill reminder and monitoring system.

4. Proposed System

Here we introduce a smart medicine reminder system based on IoT. The proposed scheme was particularly created for the Android platform. For our system, we implement a reminder system which provides an alarm when it is time for taking medicine.

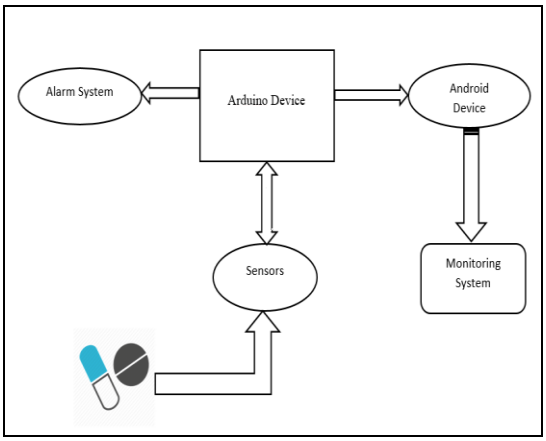

Fig. 1 Block Diagram of the Proposed System

Along with that, there is an android application where the user can set their medicine time. In the application, there will some feature that help the user to know more details about their medicine. It keeps track for the medicine which means how much medicine they have to take they can be fixed in the application. The device setup consists of an IoT enabled pill box having multiple compartments, each having a lid to open, and an IR sensor attached to it. The system of pill box includes of IR sensors for observance and reported the state of medication, that frequently checks whether the medicine is taken or not. Whenever the medication is loaded into the pillbox it'll be updated the medicine data and saved in database. The Arduino device fetching real time data and send it to the application.

5. Software and Hardware Interface

5.1 Software Interface

Arduino Software is an open source software which makes it simple to write code easily. This fuses a word processor for composing code and hence the projects composed Arduino PC code are called as sketching. Portrayals are kept with the augmentation '. ion' that are keep amid a typical spot alluded to as sketch cushion. This product can be utilized with any Arduino board.

Apache Cordova is an application for mobile devices using CSS3, HTML5, and JavaScript rather than counting on platform-specific genus Apies like those in the automaton, iOS, or Windows Phone. It permits wrapping of CSS, HTML, and JavaScript code relying upon the platform of the device.

Spring is called as java platform. It's the quality application development framework for enterprise Java. Most of the programmers round the world use this to make simply testable and reusable code. The core of the spring framework is spring container, which can produce the objects, wire and configure them along and liable for the complete life cycle until destruction. These objects are known as Beans. It's an object that's assembled, instantiated and managed by an IOC container.

Cloud database AWS (Amazon Web Service) offers a wide range of database services to fit your application requirements. These database services are fully managed and can be launched in minutes with just a few clicks. AWS provides the AWS Database Migration Service, a service which makes it easy and inexpensive to migrate our databases to AWS cloud.

5.2 Hardware Interface

In our proposed system, we have a device that generate an alarm and hold the medicine in it. For that purpose, we design a smart IoT box. For it, the require instruments are Arduino Uno, IR sensors, Buzzer, Pill Box, jumper wires.

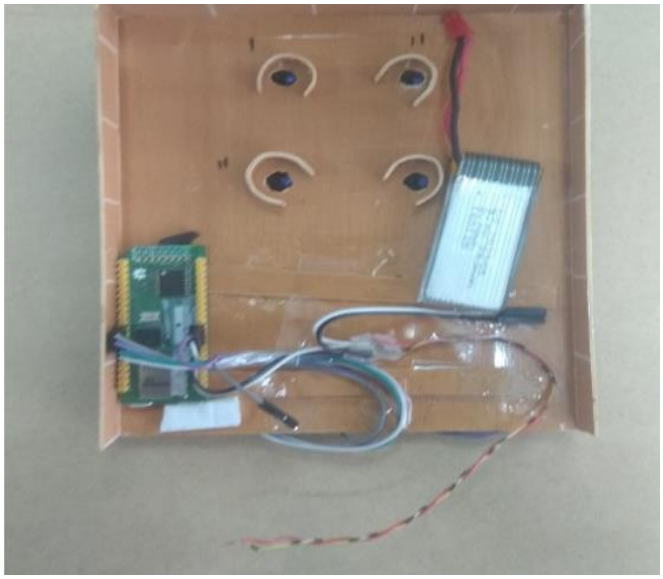

Fig. 2 Medicine Box

Arduino Uno is an expansive microcontroller which is created by Arduino.cc which is an open-source gadgets stage dependent on Atmega328. As electronic gadgets are getting to be minimal, adaptable and shabby alongside that are fit to accomplishing more capacity. Microcontrollers are broadly utilized in implanted frameworks and make gadgets work as per our necessities and prerequisites.

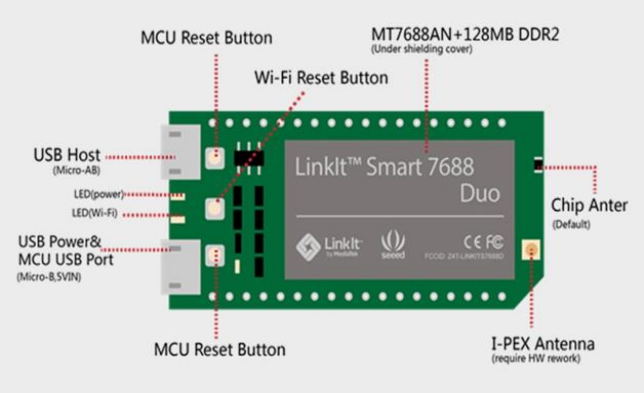

Fig. 3 Linkit Smart Duo

We utilized Arduino Uno to get the constant information in our application which help the client to comprehend that drug has taken on schedule. For our experiment we use Lin kit Smart 7688 Duo which is a version of Arduino Uno.

Jumper Wires are accustomed transmit electricity between 2 points in an exceedingly circuit in the main jumper wires are used to analyze defects among the circuit or accustomed change the circuits.

Fig. 1 Jumper Wires.

IR Sensor, IR represents Infrared Sensor. An IR sensor in an electronic instrument that is utilized to detect certain development of an item by utilizing heat created without anyone else. An IR sensor can be dynamic or aloof. A functioning IR sensor continues discharging IR beams and when it doesn't get back the quantity of beams it has reflected; it distinguishes an article. An inactive IR sensor is the one that identifies the items without radiating the IR beams by straightforwardly detecting the article from the temperature.

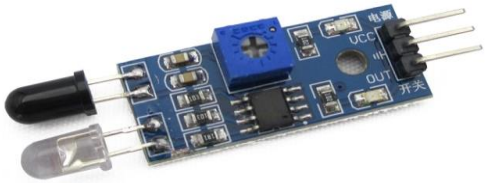

Fig. 2 IR Sensor.

6. System Architecture and Working Procedure

A. System Design

The system of pill reminder could be designed as:

- The device provides multiple ways of reminding to the patient to take medicine
- Allows to load four weeks' worth of variety of pills.
- The device allows family member or caretaker to monitor the patient's activity remotely.
- Sensors to detect the status of taken medicine.
- Gives stock alert when medicine is low.

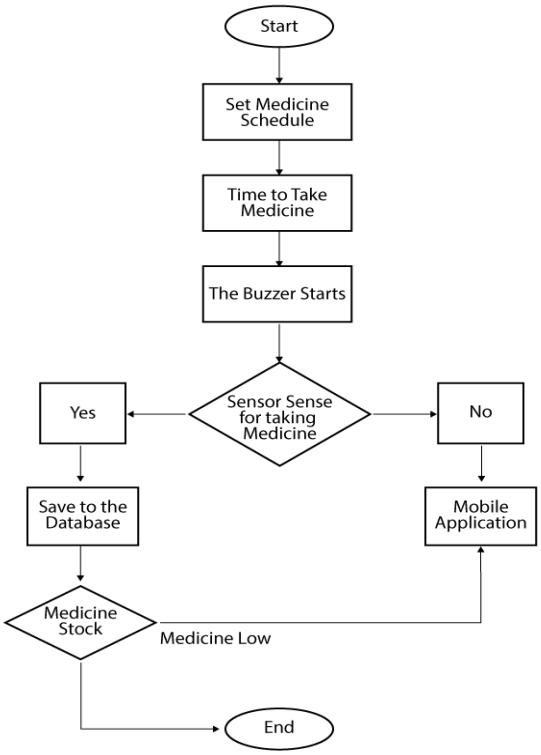

Fig. 3 Flow chart.

B. Working Procedure

The pill dispenser loaded by the patient himself or by somebody helps the patient. The Entered details of medicine are kept within the cloud database and reminders are set. The system can read the details which saved in the database and generates the reminder to the user to require medication and it transmits a notice message to the mobile application. The system provides alerts once it's time to take medication. These details are regularly updated automatically from the cloud.

1. If the patient takes the pills and opens the lid, the IR detector connected to the lid can find that the lid is opened and therefore will send the output to Arduino which is able to stop the reminder. This can be recorded that the patient has taken his medication with success.
2. In case the patient fails to require the drugs or refuses to, the lid won't open and therefore the reminder can automatically stop after a pre-set time and can be placed on snooze. If someone once more misses the drugs, the output can be sent to the mobile application and send a message to the patient reminding him that he has missed a doge.

7. Android Based Smart Phone Operation

Android is a software program platform and Linux-based operating system (OS) designed for touchscreen cellular devices. In addition, Android is open source which is freely available for utility developers. The increasing demand of Android gadgets makes it a notable platform to leverage on.

Fig. 4 Android device function.

Homepage :

This module describes different feature of the application. The user will be able to view medication timings and amount of dose that require, registered doctor list with their names, contact information, designation. Disease information with its symptoms and caution.

Set reminder Module:

Firstly, the medicine loaded into the device, then user should set the medication details using the mobile application. It includes of medicine name, medicine quantity etc. The device will remind and send notifications on time by using this information. The input includes

- Medicine name.
- Number of dosages.
- Times of the day to take.
- Reminder Days.

After getting the inputs, mobile application saves the data. Output gives medicine reminders and medicine in take records.

Notification Module:

This module is basically for notification. When the user set any reminder for their medicine. The user can activate or deactivate this as they want. When the user doesn't want to see the notification, he can turn it off or he can receive it in the device.

Stock Alert:

There is another option that is stock alert. The default color of the medicine slot is set red. When the box filled by medicine the color will turn into green. When the patient opens a lid, it will turn into red again. When there is only one medicine a notification will be sent to the mobile application. After getting the notification message user can fill the medicine again.

Report:

This module is used for collecting a report based on Patient's activity. The report indicates whether the Patient is taking the medicine on time or not. The user will get the report consists of medication time, type of medicine taken, whether the drugs was missed at any time and so on.

Along with the user can see the list of all the registered doctors with their names, contact info, phone numbers, hospital address, the provision of doctor consequently. They can see the dropdown read of the diseases and might directly navigate to the list of Doctors. This helps the patients to seek out the Doctors disease wise. The services facilitate them to understand the system properly in order that it becomes helpful and productive.

8. Experimental Result and Analysis

For our project, we divided our work into two section.

1. **Survey:** We took a survey about 100 people on different age group. In the survey we asked the several questions about the features of our application. Which features are they like most and which they don't?

2. **Observation:** We took around 10 patients of different aged and observed them according to our survey. We focus on when they mainly took their medicine while with the buzzer beeps.

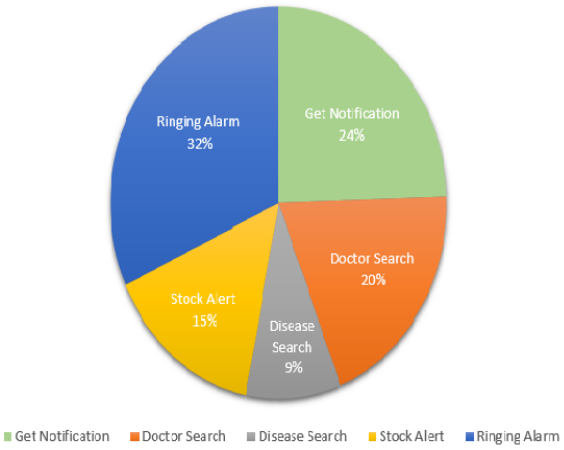

Fig. 5 Features of the application

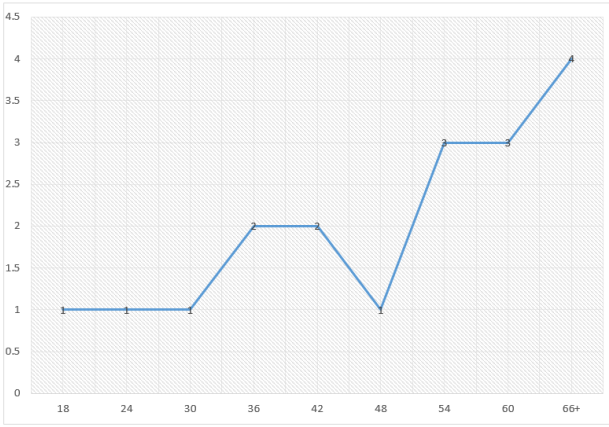

Fig 6 Number of repeat vs different age people reaction

9. Conclusion and Future Work

We have demonstrated a mobile application that generates alarm signals to remind a patient to take medication. We focus on helps patients and improving the monitoring system. The application Medicare is easily accessible. Combination of a sensing system with android application helps us to measure how well a patient can take their daily medication in real-time. The availability of sensors and other medicinal services gadgets (IoT) work better in consideration of patients. It allows real-time monitoring. Better compliance in terms of the taking of medicine can be acquired with the use of our proposed framework. This framework assures the security of the patient, prevent wrong dosages, support medication adherence. As a future work, we are wanting to improve our drug update framework by presenting extra highlights utilizing portable application and incorporate other medical

services. A data-sharing feature between patient and health care professionals would also be developed. Voice-alert notification is being considered as part of the future works; a system that will not only send notification however also read the content of the notification alert to the listening of the patient.

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References

[1] Evgeny Stankevich, Ilya Paramonov, Ivan Timofeev, 'Mobile Phone Sensors in Health Applications'.

[2] Slagle, J.M., Gordon, J.S., Harris, C.E., Davison, C.L., Culpepper, D.K.,Scott P. and Johnson, K.B., (2011) "MyMediHealth– Designing a next generation system for child-centered medication Management", Journal of Biomedical Informatics, Vol. 43, No. 5.

[3] Zao, J.K., Wang, M.Y., Peihsuan, T. and Liu, J.W.S., (2010) "Smart Phone Based Medicine In-take Scheduler, Reminder and Monitor",IEEE e-Health Networking Applications and Services (Healthcom).

[4] Prasad, B., (2013) "Social media, health care, and social networking",Gastroin test Endosc. Vol. 77.

[5] S.T.-B. Hamida, E. Ben Hamida, B. Ahmed, and A. Abu-Dayya. Towards efficient and secure in-home wearable insomnia monitoring and diagnosis system. 13th IEEE Int. Conf. Bioinforma. Bioeng.pp. 1–6; 2013.

[6] P. Ray.Home Health Hub Internet of Things (H 3 IoT): An architectural framework for monitoring health of elderly people. Sci. Eng. Manag. Res. , pp. 3–5, 2014.

[7] S. S. Al-majeed. Home Telehealth by Internet of Things (IoT). pp.609–613; 201.

[8] S. Huang, H. Chang, Y. Jhu, and G. Chen. The Intelligent Pill Box -Design and Implementation. pp. 235–236; 2014.

[9] C. List, O. F. Authors, D. Moga, N. Stroia, D. Petreus, R. Moga, and R. A. Munteanu. Work Embedded Platform for Web-based Monitoring and Control of a Smart Home no. 53, pp. 1–3; 2015.

[10] J. M. Parra, W. Valdez, A. Guevara, P. Cedillo and J. Ortíz-Segarra, "Intelligent pillbox: Automatic and programmable Assistive Technology device," 2017 13th IASTED International Conference on Biomedical Engineering (BioMed), Innsbruck, Austria, 2017, pp. 74-81, doi: 10.2316/P.2017.852-051.

[11] G H.-W. Kuo, "Research and Implementation of Intelligent MedicalBox," M.S.thesis, Department of Electrical Engineering, I-ShouUniversity, Kaohsiung, TW, 2009.

[12] A. Sawand, S. Djahel, Z. Zhang, and F. Na. Multidisciplinary Approaches to Achieving Efficient and Trustworthy eHealth MonitoringSystems. Commun. China (ICCC), 2014 IEEE/CIC Int. Conf., pp.187–192; 2014.

[13] Ahmad S., Afzal M.M. (2020), "Deployment of Fog and Edge Computingin IoT for Cyber-Physical Infrastructures in the 5G Era". In: Karru-pusamy P., Chen J., Shi Y. (eds) Sustainable Communication Networksand Application. ICSCN 2019. Lecture Notes on Data Engineering andCommunications Technologies, vol 39. Springer, Cham

[14] E. E. Abdallah and E. Fayyoumi, "Assistive Technology for Deaf People Based on Android Platform", Procedia - Procedia Comput. Sci., vol. 94, pp. 295-301, 2016.

[15] A. J. Al-Haider, S. M. Al-Sharshani, H. S. Al-Sheraim, N. Subramanian, S. Al-Maadeed and M. z. Chaari, "Smart Medicine Planner for Visually Impaired People," 2020 IEEE International Conference on Informatics, IoT, and Enabling Technologies (ICIoT), Doha, Qatar, 2020, pp. 361-366, doi: 10.1109/ICIoT48696.2020.9089536.