Technology Survey of Pillbox and Design using IoT

Mr Borish Moirangthem[1], Mrs Pritam Tambe[2], Mrs Lakshmi Panat[2], Dr P Chitra[3], Mr Bhupendra Pratap Singh[3]

[1]M.E-Embedded & IoT, SIST, Chennai
[2]Project Engineer, AAI Group, CDAC, Pune
[2]Joint Director-AAI Group, Pune
[3]ECE Department, SIST, Chennai
[3]Project Engineer, CDAC-ACTS, Pune

Abstract - *The lack of good medication adherence leads to critical consequences of the Tuberculosis infection, which will be resistant to the antibiotics. Treatment Adherence is a much necessary for taking the prescribed medicines at the designated time. Therefore, there is an intention to design a pillbox based on IoT which will help such Tuberculosis and other chronic diseases like diabetes, blood pressure, etc. patients to take their prescribed medication at right time without missing it. This paper studies the different technologies of various pillboxes available in the market. It also tells about the introduction of Internet of Things (IoT) and its role in the medical adherence. Above all these, we discuss about our propose model of pillbox that will mainly help for the Tuberculosis patients and other chronic diseases.*

***Keywords*- Adherence, Pillbox, IoT, Arduino, Technologies**

1. INTRODUCTION

Internet of things is the network connecting between the devices which contain electronics, software, sensors, actuators and connectivity which allow them to interact and exchange data without any human interaction. Internet of things with their growing interdisciplinary applications has transformed our living. The impact of Internet of things will be the most important and personal impact. The convergence of medicine and information technologies, such as the medical informatics, will be having transformation in healthcare as we know it, curbing costs, reducing inefficiencies, and saving lives.

Medication Adherence has become a big concern in the healthcare sector with the doctors, healthcare system and other healthcare stakeholders since the older patients always forget to take their prescribed medication and misuse of the drugs[2]. In this busy paced life, even the caretaker/family members forget to take care of their older patients. Even there is born of new diseases with new medicines and a timely curing therapy is needy for the patients [1]. Older patients need a long term medication for their better health.

Tuberculosis (TB) is one of the diseases that mainly suffer to the elder people. About a quarter of global total TB is estimated to be found in our country India. In 2016, India has an estimated of 28 lakhs cases and 4.5 lakhs people died due to TB. There is a big burden of TB in our country. We can cure TB with a good treatment medication and it is a long term medication. The treatment can be done using different types of drugs that are available in the markets. There is a need for a good monitoring of the medication of the TB patients so that the doctors/caretaker can know that the patient has taken the drugs at the right time with right dose. The main objective is to provide an affordable and quality healthcare to the population and achieving a zero TB deaths by the 2025.

To eliminate TB and others chronic diseases, we bring the IoT technology to provide a good treatment plans for the medications. IoT means the way of monitoring, analysing, triggering alert and taking an action with the connection of several devices. In this paper, a pillbox which will provide a good medication is proposed with sending SMS alert to the doctor/caretaker. With the GSM technology, we are able to connect to the doctor that will give a good interaction between the doctor and patient. The pillbox will help to identify whether the patient has been taking the right medicine or not.

In the section II, we describe the details of pillbox available in the market. Section III discusses about the related works and different technologies of the various medication pillboxes. In the section IV, the methodology of the propose work and last section V, we are discussing the upcoming scope of our own propose model.

2. PILLBOX AVAILABLE IN MARKET

GlowCaps and GlowPack from Vitality: Vitality's GlowCaps are cellular-connected caps that fit on regular pill bottles. The caps connect wirelessly to a base station and both the caps and the station light up when it's time to take the pill. The can play music and call the user's or caretaker's phone if they miss a dose. The cap can also automatically request a refill of the medication using AT&T connectivity. The GlowPack is an adjustable pouch that can hold blister packs, inhalers, injectable solutions, liquid medicines and topical ointments, rather than just pill

AdhereTech' smart pill bottle: This smart pill bottle can sense the amount of medication inside the bottle, which helps in preventing accidental overdose. It has its cellular connectivity built directly into the bottle rather than into a base station. AdhereTech has no plan to market directly to consumers instead it is looking to a partner with pharmaceutical companies, insurance companies and hospitals to have their bottle automatically provided with certain medications.

Abiogenix's uBox: The uBox has a locking and spinning system which is connected to a Smartphone app that includes schedules, a calendar and the ability to notify family members about missed doses. The device can lock as well, automatically unlocking at the time of dosing time, allowing it to be used in settings where there's concern about patients abusing medication.

MedMinder's Maya &John: MedMinder makes two cellular-connected seven-day pill-dispensers – one that locks (John) and one that doesn't (Maya). Each dispenser has 28 compartments (4 times a day). It needs to be plugged into a power source: all the connectivity is cellular. It has a system for sending SMS by phone, email or text message.

e-Pill's Monitored MedSmart PLUS: e-Pill is mainly focused on range of pill containers, wristwatches and alarms to improve adherence and mainly marketed at the elderly and aging in place. This dinner-plate-size sells for $800 with no monthly fee. It stores and dispenses medication, sounds an alarm when it's time to take it and can make call, email or text multiple care providers if the user misses a dose. The device also has a calling system to inform the caretaker when the dispenser needs to be refilled.

*Philips Medication Dispensing service***:** Philips is offering a large medication dispenser designed for the aging people and can be easily accessed by an adult or a child. The caregiver is called by the Philips unit when the medication needs to be refilled misses a dose or the power goes out. This device has a back-up battery. It has refillable cups that are used to load the dispenser at the allotted time. It is not a portable device so difficult for the people who travel.

3. RELATED WORKS

As per the research, there are various types of pillbox available in the market developed by different companies with different technologies to notify the patients and the doctors. Some of them are as follows:

In the paper "**Smart Pill Box",** they ways of sensing method- load cell sensing, LDR sensing and Capacitive based sensing. But according to the developer, he uses the **capacitive based sensing method**. A slot wise pillbox is used a capacitive based sensor to monitor the pills along with a GSM module to give the notifications to the doctor or the caretaker. A **microcontroller LPC2148** is used to as the main controller of the system and a **RTC (Real Time Clock)** module to set the alarm for the medication. The main principle of working is that the medicine or the tablets placed in the slot will produce a dielectric value leading to varying in frequency when it is emptying.

$C=\epsilon A/d$,
Where
C= capacitance across the sensor
ϵ= Permittivity of the dielectric medium
A= Area of conducting trace/plate
d= Distance between the plates/traces,

$f=1.44(R1+R2)\ C$,
Where
f= frequency,
C= capacitance of the sensor,
R1 & R2= resistances forming the potential divider

The method used in this paper is very accurate method of sensing the presence of pills. But it is a very complex to develop and the cost of development is very high. [1].

In the second paper"Smart **Medicine Dispenser (SMD)**", the primary way to interact the system with the patient is the **Android Application** which stores the data on the Cloud and performs synchronization upon login. The Application is connected to the Arduino via **Bluetooth** and start sending commands indicating which container and stepper motor should be rotated. The application will have an overview of login, a home page which contain a history, today and tomorrow overview for the medicine. Also there is an option to set an alarm. Each container of the SMD will controlled with its own LED. When the user want to take a pill, his phone will connect to the Android via Bluetooth and send it which container should be rotated.
It is very easy for monitoring the action of the patient but difficult for the older patient to use the application and we have to use the phone every time we open and close the box [2].

In the third paper***"A* Smart Pill Box with Remind and Consumption Confirmation Functions**" they use a **matrix barcode** printed on each medicine bag which contains all the information of the patient like ID, medicine name, medication time and other information of the bag. A **camera** is used to detect the matrix barcode and medicine bag. A **user interface** is used to provide a reminder and alarm functions. After visiting a doctor, the only thing the patient has to do is scan the matrix barcode using the camera in the box and then loads the medicine bag to the box. At the time of taking pill the alarm will remind the patient via light, sound or vibration. The box will use the barcode of the medicine bag to ensure the correctness of the medicine bag. This system does not need internet service. It doesn't need internet and can be secured the patient information. But there is a lack of interaction between the doctor and the patient.[3].

In the fourth paper "**Automatic Pill Reminder for Easy Supervision"** uses **IR sensor** to check the closing and opening of the box. The box is attached with a **RTC module** and **Arduino Uno** which process the activities and accordingly display the details of the pill and time intake on the LCD. A **GSM** is used to send the SMS to the doctor or caretaker and a buzzer is used to alarm the patient. It has an easy alarm system which will notify the time of medication to the patient. But it is difficult to detect the missing dosages of the medication [4].

4. PROPOSED METHOD

This section will present the methodology used in our proposed model. The hardware requirements that will be used in the model are as follows:

- Arduino Uno Board
- Arduino GSM Shield with SMA Connector
- LDR Sensor
- SIM Card
- Pillbox, jumper wires, Breadboard, LED

The block diagram of the model is given in the Figure 1. The LDR sensor is placed under the box along with other hardware. The LDR will monitor the event taking place inside the box and the Arduino microcontroller is used as the main controller of the system. LDR mainly works with the intensity of light in which decrease resistance with increase in intensity of light. The analog input of the LDR sensor is converted to the digital output by the Arduino microcontroller and then the digital output is sent as an SMS through GSM module. The main objective of this model is to send a confirmation SMS indicating some action has been performed by the patient on the pillbox which will be considered as pill taken. The flowchart for the model is given in Figure 3 and explains about the LDR sensing method and confirmed SMS sending through GSM module. Also we have circuit diagram shown in Figure 2.

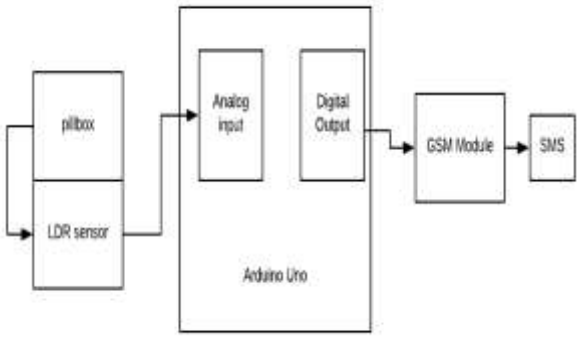

Figure 1: Block Diagram of the Pillbox

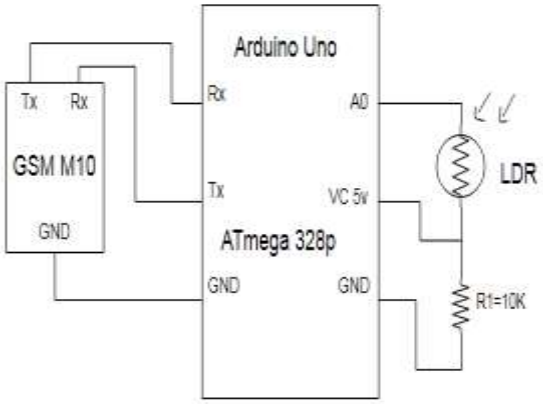

Figure 2: Circuit Diagram of the pillbox

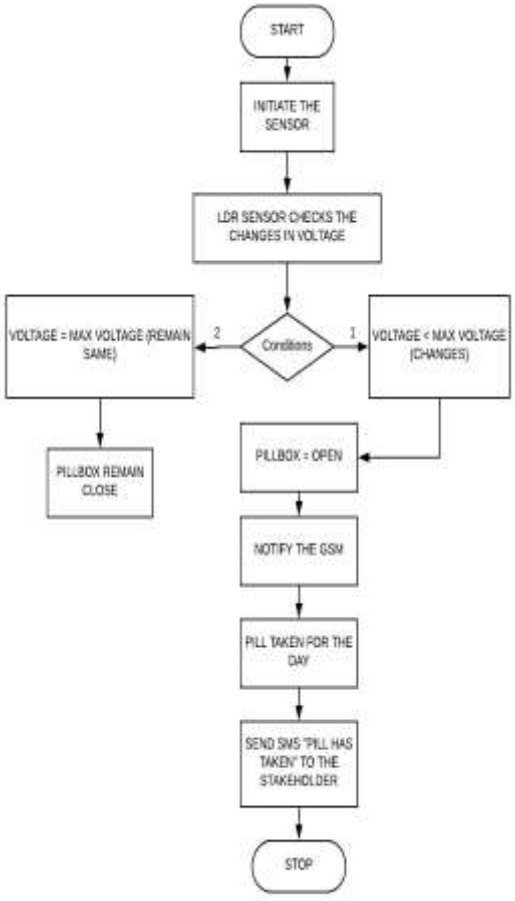

Figure 3: Flowchart of the Pillbox

5. FUTURE SCOPE

This paper will tell about how IoT will involve in solving the medical adherence using the LDR sensor which monitor the action in the box. This pillbox will help to monitor the action of patient whether he is taking the pill regularly or not. It will improve the medical adherence and will give a good interaction between the patient and the doctor.

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