

A Smart Medicine Box for Medication Management using IoT

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Abstract- The growing technologies and lifestyle, aids health sectors in modernizing world exponentially. In current decade, only fifty percentages of people are aware about their medication schedule to receive the full advantage of their prescriptions. The rest of the people are very busy with their hectic schedule which results in irregular intake of medicines. Patients with gradual loss of memory like elderly patients forget to take right medicines at right time. The treatment goes ineffective for the concerned patient, when they fail to follow the clinician prescribed medication schedule. In the past days, there had been many attempts to design “Medicine Box” which helped people in medication reminder, storing their medicine uptake details and provided suitable temperature conditions for storage. In accordance to current technologies, we propose this work, which additionally include some feature to the medicine box, such as health monitoring, emergency alert through SMS are given to their predefined guardian and automated opening and closing of the lid. Using IoT system, vital parameters are recorded, uploaded to cloud and reviewed by clinicians. This helps the clinician to gain knowledge about the patient’s growing health conditions. It avoids the complexity of patients carrying their prescription details and their medical records and hence they live independently.

Keywords – Smart Medicine Box, IoT, Cloud Storage, Emergency Alert, Health Monitoring.

I. INTRODUCTION

Now a days, Technologies requires updating with growing generations who adopts the modern lifestyle. In modern lifestyle, improper habits from dinning to bed, intake of health less food decreases the lifespan of people. The needs and necessary of countries makes the scholars to invent or discover to bypass Technologies to overcome their drawbacks. Each and every inventions or discoveries had its own drawbacks which had its effects with specific human organs. These various diseases arrived in human body due to incompatibility of food and other technological environment with human immune system. As the cost of products goes hike, there peeks an economical and financial issues in a country. Thereafter, people want to run behind busy schedule to accomplish their daily commitments. This made them to lose the conscious of taking care of their health. Health concern had been decreasing due to lack of awareness of growing high risk death factors seated in food and surroundings. Even though many new developments in medicine had been invented or discovered to step-down the death rates, people fail to follow their drug schedule. Normal people forget to take their medicine due to their hectic work condition, stress, carelessness. Also patients are with disability to remember events for a period of time, often due to brain injury or the effects of drugs or alcohol. The factors like ageing, stress or lack of sleep also cause memory loss. This makes a severe condition to be focused and help for aging patients suffering from gradual loss of memory to gain benefit of clinician prescribing drugs. Ambient Assisted Living (AAL) designs a framework that helps the older people to live independent in doing their routine activities as far as possible [3].

Medicine box, an intelligent medication dispensing device designed to help the elderly people who often forgot to take their medicine at their right time or take the wrong medicine or dosage. Medicine box can also be utilized for patients with following limitations. i.e. carelessness, absence of appropriate mindfulness about the medicines, an absence of contribution from family, etc., [3]. Along with medicine dispensing, software aided upload of patient data in server for clinician review to analyze the patient’s health condition. Here comes the health sector

concreted with IoT and IoMT. The internet of things or IoT is simply refers to the system of physical devices that collect and exchange data. It is also allow us to transfer data over a wireless network without any human intervention. IoT offers an easy way of connectivity to the network platform connecting up all these different objects and adding sensors to them adds a level of digital intelligence to device that would be otherwise dumb, enabling them to communicate real time data without involving a human being. The Internet of Things is making the fabric of the world us smarter and more responsive, merging the digital and physical universe. The Internet of Medical Things (IoMT) is an amalgamation of medical devices and applications that connects to the healthcare information. Technology using networking technologies reduces unnecessary hospital visits and burden. On healthcare system, by connecting patients to their physicians and allowing the medical data transfer over a secured networks.

The IoMT market consist of smart devices such as wearables and medical or vital monitors, strictly for health care use on body, in the home, or in the community, clinic or hospital settings and associated real-time location, telehealth and other services. To bridge the hardware and software, the Arduino software which runs on Mac, Windows and Linux is used to build low cost scientific instruments. The previous works had been made with microcontroller which employs with complex coding's [1-3]. Arduino boards are relatively inexpensive when compared to other platforms. The Arduino is based on the C platform so it is easy to learn & program. So the entire device control is provided from programmed Arduino. In case of patient's data transfer, it is made advanced by wireless mode between user and clinician. The ambiguity of paper records are thrown out by means of cloud server [4-7]. In addition to the existing works, this projects helps monitoring of patient's vital parameters to reduce the multiple times of hospital visits with clinician by patients. Along with Host Management System (HMS), the vital parameters are stored in the cloud server specially made for clinician review. Hence, this project of appropriate temperature storage box of medicine assists elder patients to live independently in taking care of their medication schedule by reminder alarm with automatic wireless transfer of their health.

The rest of the paper is partitioned into sections as follows. The architecture and working theory are explained in Section II. The section III lists out the hardware modules used for the project. The Section IV shows the results and discussion and Section V concludes the project with conclusion and future work.

II. ARCHITECTURE AND WORKING THEORY

This Architecture consists of both Hardware and software modules as shown in figure 1. The required hardware modules are built in compartmented medicine box. The box is compartmented based on storage temperature and medical adherence. According to storage temperature, the box is splitted into room temperature and cold temperature. The Peltier module is constructed to generate appropriate lower temperature for drug storage [1]. Peltier is imported into one of the compartments made for cold storage and other compartments left without Peltier for room temperature storage. According to medical adherence, box is splitted to store drugs to be taken thrice times in a day (i.e. morning, afternoon, night). For each time of a day, it is further divided into double to store drugs to be taken before and after meals. For each main compartments which made for storing drugs to be taken thrice a day is provided with switches. These compartments are opened or closed by stepper motor controlled switches by means of electrical signal arrived from Arduino microcontroller [5-6].

The power supply is provided along with buck converter to distribute power to other modules in the device [1]. The device is programmed with Arduino-Mega which is plugged with alarm and led display. The patient's vital signs namely body temperature and heart beat rate are sensed and sent via sensor probe [4]. An additional switch is built to alert the preset guardian through GSM module when it is triggered by strangers or guardians at emergency situation [3]. It is mounted at the back of the medicine box. The wireless Wi-Fi module used to upload patient's vital sign data and stored in cloud server for further analysis by clinicians sometimes later [7-10]. Along with medicine dispensing, software aided upload of patient data in webpage for clinician review to analyse the patient's health condition. Here comes the health sector concreted with IoT and IoMT.

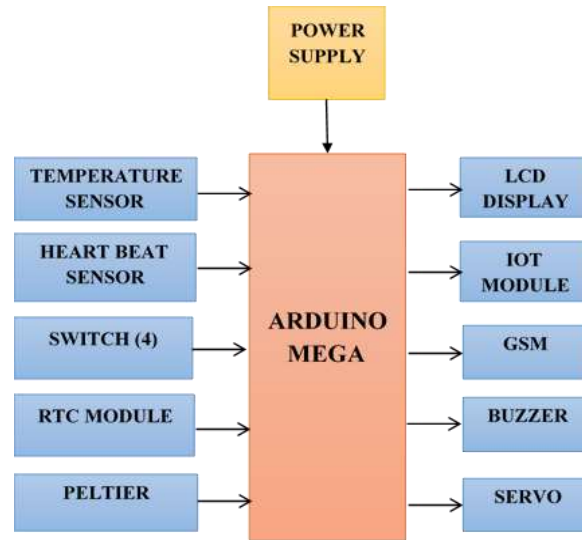


Figure 1. Block Diagram of SMB

III. HARDWARE MODULES USED

RTC MODULE: Real Time Clock module is a battery operated module that derives only less power from the power supply. Its interfacing with Arduino is provided with range about 5v. The time and date is set at this module and doesn't get reset on power shut down. The time and date runs automatically from which it is set initially. It is more accurate and updated. This module is connected with Arduino through its serial connection pins. When the user pre-set time matches the programmed reminder time, it triggers the Alarm to alert patients to take medicine at right time.

16x2 LCD: About 16 columns and 2 rows of digital electronic element to display the commands for the users is named as 16x2 LCD. It has two registers namely Command and Data. It is a display built up with liquid crystal that displays the programmed statement or command to the user. The statements programmed for user to handle the medicine box stating "MEDICINE BOX FOR TABLETS", "MEDIBOX OPENED", "MEDIBOX CLOSED", "PLACE YOUR FINGER".

WIFI MODULE: The device is more comfortable when wireless connection is built. Here, Node MCU is used which runs on ESP 8266 WIFI SOC. This microchip is based on ESP-12 module used in the integrated board. The board is integrated with GPIO, PWM, I2C and ADC. Node MCU is preferred here due its compact size, low cost and enough number of serial communication pins. Power supply about 3.3v or 5v is sufficient for this module. The patient data are transferred to cloud server in wireless manner using this module.

ARDUINO-MEGA: The Arduino mega 2560 is a microcontroller board used to bridge software and hardware modules of the device. It is the board based on AT MEGA 2560 IC with number of input and output pins about 54 digital pins and 16 Analog input/output pins. It also contains 4 UART. Every other modules are ported into the ports of Arduino and programmed with easy C++ coding.

GSM MODULE: GSM or GPRS module is used to send Short Message Service (SMS) to their relatives or guardians and doctors who are given with SIM card. It is supplied with 12v battery supply. The combination of the inputs of logic gates of switches of three compartments outputs the information about the tablet taken status of a day as "TABLET TAKEN", "TABLET NOT TAKEN". The trigger of panic switch at an emergency situation also alerts the guardian or doctors through SMS as "PATIENT NEED HELP IMMEDIATE ATTENTION".

TEMPERATURE SENSOR: LM35 sensor is used as one the patient's health sign calibrating module. It is powered by +5v which is low power deriving module. It outputs the body temperature in degree Celsius. For example, 99 degree Celsius. It outputs the Analog output voltage proportional to the body temperature. The sensitivity of the sensor ranges 10mv per degree Celsius. For example, 500mv means 50 degree Celsius. It measures the temperature from -55 degree Celsius to 150 degree Celsius.

PELTIER MODULE: The Peltier module can be used as a thermoelectric generator in medicine box. In medicine box it is operated as a cooler device. When a voltage is applied across the device the temperature difference is generated between the sides. The heat is moved from one side to another side. The exhaust fan is used with heat sink to eliminate the heat generated in the one side of the module. It uses 12V power supply.

HEART RATE SENSOR: The Heart beat sensor is designed to give digital output of the heart beat when the finger is placed in it. At the time of working, the bright light flashed from LED for each heartbeat. It works in the principle of light modulation by blood flow through finger at each pulse. Finger is placed between the arrangement of LED and phototransistor. The LED emits at one side of finger and transmits to phototransistor at the other side of finger. The change in blood pressure during pulse results in changes of flux. The detected flux by phototransistor outputs slight variation in its resistance. It uses 5V power supply.

SWITCH: It is an electrical component which interrupts the flow of electrons in a circuit. It works based on ON (open) and OFF (closed) mechanism. There are 2 important factors determines the type of switch connection, they are poles and throw. Poles of the switch refers to number of separate circuits that controlled by the switch. A single pole switch refers to controls of one separate circuit. In medicine box single pole switch is used, it just breaks or connects the connection between terminals.

BUZZER: a buzzer or beeper is an audio signaling device in medicine box it is used to provide alarm sound to the user. It uses 5V power supply.

SERVO: Servo motor is an electronic component that operates with 5V. It has a angular rotating shaft. It's angular movement functions based on customized Arduino programmed coding. This is imported into the medicine box to close and open the lid of box automatically when accessed through the fingerprint sensor. It opens and closes at 90 degree each and totally 180 deg. Its operating speed ranges about 0.1s per 60 degree.

IV. RESULTS & DISCUSSION

In this paper, a smart medicine box attached with vital parameter measuring sensors is implemented with IoT technology as shown in figure2(a). This project doesn't requires special training for medicine box handling. It is a user friendly device even elder patients can operate easily that the instructions are displayed in LCD display as shown in figure2(b). The purpose of this medicine box fully satisfies the need of elder people who has gradual degradation of memory. It reminds them by alarm to take medicine in prescribed schedule which will be programmed earlier. On taking those drugs at right dose at right time, patient grasps the benefits of treatment. The patient's health graph obtained from two sensor probes for measuring heart beat rate and body temperature in Celsius and uploaded to the website as shown in figure3(a) using cloud wireless connection. Perhaps, cloud storage assists doctors to analyze the patient's health graph and gain knowledge about the recovery or degradation of their patient's health. By these knowledge doctors easily prepare their treatment plan earlier for his/her patients. The Wi-Fi connection bridges the hardware and software modules.

The storage unit of box is partitioned based on room temperature drug storage and lower to room temperature drug storage. The lower temperature from room temperature to cold temperature is provided by the Peltier module by means of Peltier effect. Room temperature storage about 15 degree to 25 degree Celsius. For cool temperature, it ranges about 8 to 15 degree Celsius. For refrigeration, it is about 2 to 8 degree Celsius whereas freezing temperature between -10 to -25 degree Celsius. The drugs to taken at number of times is stored at various compartment and the respective drug to taken is indicated by LED light when alarm rings. The binary digit(1's and 0's) combination resulted from digital automatic open/close of lid done for the whole day sends a message to the caretaker or doctor about the moment tablet taken or not. The opening and closing of medicine box occurs only on the acquisition of signal from switch and this flow of procedure is guided by instructions displayed in LCD display. The statement of either tablet taken or tablet not taken is displayed in display box and also simultaneously uploaded in cloud server to update patient's day-to-day medication follow up activities to the doctor. To overcome a situation when medicine box requires to be accessed by other people to give drugs to patient

The number of patient records had been made uploaded manually by means of Host Management System and it is also kept confidential. The various tests had been conducted to test the sensor performance and some of the measured vital parameters at different times are uploaded in created cloud system and viewed as shown in figure3(b). Hence, the medicine box operated successfully as an assist device for elder patients and patients those busy with their career, not mindful of taking their tablets at right time with right dose.

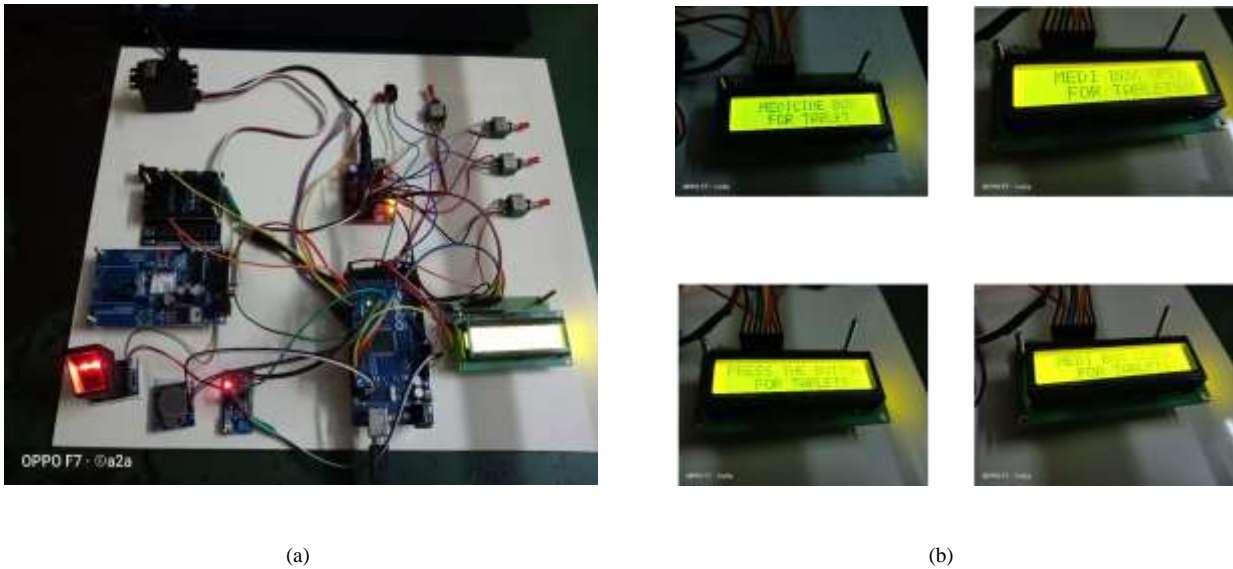


Figure 2. (a) Assembly of the medicine box in working condition (b) Various operations displayed in LCD

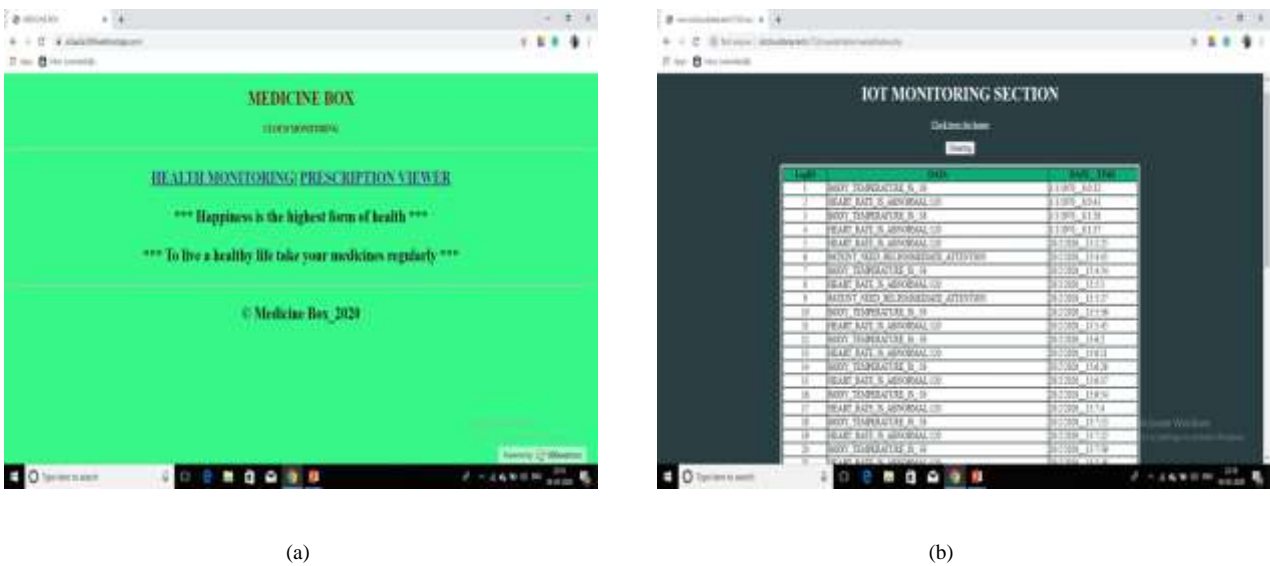


Figure 3. (a) Webpage for patient records (b) Data sheet of patient's medicine taken details and vital parameter measurements.

IV.CONCLUSION AND FUTURE WORK

Hence, IoT based smart medicine box designed with embedded system to overcome the holes of elder patient's ambient living. The Wi-Fi connected box transfer the daily activities of the respective patient's health details and their medication details added with benefit of GSM mode alert SMS. An inconvenience of record handling between patient-Doctor had overcome by the cloud system through IoT. The effectiveness of the doctor prescribed treatment become beneficial when the tablets are reminded alarm as per schedule and taken by patients. This compartmented box design comforts the people to take the drugs at right dose at right time. The setup of double division for thrice times a day helps the people to store and consume the drugs easily i.e. user friendly. The design is made with no complications in usage, so that people needs no training to handle the medicine box. The aim of ambient assisted living of a patient is achieved by less complex design and health monitoring sensors along with high security. The updating of their sensed vital signs parameters in cloud webpage assists both doctors and patients to alert the abnormal or critical readings of observed parameters of body. The less power consuming modules into the Arduino gains the merits of the construction of the box. Finally the use of panic switch engulf the

whole benefits of the medicine box for the patients by assists them at emergency situation which triggers the alert SMS to the guardians and doctors. Henceforth, the patients are safely protected through IoT by their doctors and relatives or guardians and live independently.

As a future enhancement to MEDIBOX, the number research studies are underway to provide evolution by cross over study such as offline application for patient health data storage. The compartments as per patient's requirement in some more precise and compact manner can be intelligently designed. The draining power by Peltier module for cold storage can be reduced in upcoming works to increase the battery capacities. The method of adaptive cooling for drug storage will be more efficient and beneficiary in future. Drug storage temperature prediction can be done by sensors to store medicines for longer days. The pill counter setup using IR sensor can be imported in cloud or suitable application to assist caretaker or patient to refill the medicine box. The more health sensors can be added to get patient health details more accurate. The medicine box can be provided high security with second factor authentication i.e. fingerprint recognition & voice recognition for added strong security.

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