IoT based Medicine Reminder and Dispensing Machine

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***Abstract*- Our project involves the design & development of medicine reminder and dispensing machines based on the healthcare system. Because of the pandemic situation, this innovative system is proposed because patients are given medicines by nurses and doctors to alleviate pain, boost immunity, and reduce symptoms. However, this puts our healthcare warriors at risk when they administer the medication to patients, so we planned to create a machine that could take in the medication doses for an entire week. Thus, ensuring distance from patients and nurses. The data of when the medicine is taken is been stored in an SD card for further reference by doctors. This machine can also be used in homes where elderly patients forget to take their medications on time and require a caregiver to administer each dose. Food and exercise times are beneficial to patients because certain medications must be taken at specific intervals before or after food.**

Keywords – Automatic Medicine Dispenser[AMD], Comma Separated Value[CSV] file, pill box.

I. INTRODUCTION

Nowadays health-related problems are the major issues in a real-life of a human. Good health is needed for every social being. Health is the first priority in life. Medication is one of the major problems in the health care sector. Each and every patient needs medication on time with high accuracy by maintaining the timings to take them if it is either pills or tablets. We are aware of the current situation, how Covid-19 is affecting entire human life and healthcare warriors are serving the patients even putting their lives in danger. So as a part of that, we studied in detail about the whole system where we can give better system to society by using our technical knowledge and skills. Finally came to know that designing and implementing of Medicine dispensing machine would be an advantage in such a way that patients are no need to remember the medicines and doses to be taken and also it reduces some work of nurses. The health care warriors will be having PPE kits, still, there is a chance of getting infected by the patients. This is because they give medicines and drugs to the patients in close contact to study and monitor the effects. In the present situation, a fully functional embedded system is not available in the market. So, this system is designed for this project.

Old aged patients, especially above fifty-year persons need more medication because more of them have multiple chronic diseases. If they miss even one dose could be a cause for health fluctuations. In a busy lifestyle, it's difficult to remember everything even for caretakers. Insurance companies can also provide this type of system to patients so that work will be easy. This portable system can remind the medicines at regular intervals like morning, afternoon, and night including before or after food.

II. EXISTING SYSTEM

In the present scenario, most of the time people forget to take their medicines prescribed by the doctor. To overcome this, we have medicine reminder but it just plays an alarm tone remembering them to take medicine but there is no proper dispensing machine. And also, the computerized system can't be able to remind in local languages, which creates a lot of confusion among people about which medicine to be taken from the available doses. The presently available system can't remind for more than once. And also, currently, available medicine reminders are costlier, have unreliable difficulty in setting dose timings, and are also not user-friendly. Arduino Mega-based machine in which an android application is used to set alarm, alert message, and dispense machine. Apache Cordova is an app created based on CSS3, HTML, and JavaScript which can be easily run-on mac and android iOS. AWS cloud is web storage used here to load and store data. It displays crucial information about medicine stock also [9]. In the paper [10] the machine is built based on Arduino mega and Wi-Fi shield. It can be operated using the mobile app in which data in the form of alarm time is set to dispense medicine. The medicine is dispensed in the form of an opening of a rack. Wi-

Fi shield is used to send data to the cloud so can be accessed when and where required.

III. Related Work

Juan Marcelo Parra et.al in their paper "Intelligent Pillbox: Automatic and Programmable Assistive Technology Device" [1], uses Arduino WeMos microcontroller. RTC is used to measure timestamps. The login credentials are given by user name and password. Data is constantly been sent and retrieved from the database. Arduino Uno is used for processing and computations. The major advantage of this project is it notifies if the medicine is getting over a buzzer is used to notify the user. One system can be used for many people by maintaining separate rows in an excel sheet. Wissam Antoun et.al in their paper "Smart Medicine Dispenser (SMD) [2]", creates an android application to monitor and set dose time. A good user interface is created to communicate with the user and database along with passwords and user id. The application stores data in the cloud. Before the medicine is dispensed the phone gets connected automatically via Bluetooth. The data from the local database is synced into the MySQL server. An alert message is sent if the medicine is taken. M Saravanan et.al in their paper "MEDIBOX – IoT Enabled Patient Assisting Device" [3], it's a portable device that can be used as a multipurpose kit so, medication will be done at proper timings. This device uses MQTT and Wi-Fi transport protocol. Data will be sent to the cloud through Wi-Fi. The medicine is taken data stores in an SD card and will be sent as notification in the mobile web app. The health sensor is attached with Node MCU. It contains a Peltier device, cooling fans with a sink. Temperature and humidity will be measured.

Bhagya Shree S R et.al in their paper "automated medication dispensing system" [4], medicates automatically to help old aged people to inform medications as per the doctor prescription. The medicine should be preloaded by doctors and nurses during doze time. 8051 microcontroller is used for processing and computation. LCD, buzzer and LED are used as an indicator. RTC is used to compare real-time data and time stamps given by the doctor. But this machine does not dispense the medicine but the user should open the corresponding box manually. If the medicine is not taken then the caretaker gets the message about the missing doze using the GSM module. Murtadha Aldeer et.al in their paper "Medication Adherence Monitoring Using Modern Technology" [5], deals with modern medication adherence technologies like sensors, RFID, and their benefits technically. It is just a prototype that is used with a box and compartment in the box. The medicine is kept in the corresponding compartments. Arduino is used as a controller; GSM is used for medicine notification. The low-cost model used an IR sensor to detect whether the medicine is taken or not. Users get notified by LCD, led blinking, and also buzzer sound. RTC is used to monitor given timestamp and RTC time data. But this machine does not dispense medicine to the user instead the user should pick the medicine from the corresponding racks. Jyothis Philip et.al in their paper "Automatic Medicine Dispenser using IoT" [7], uses the RTC model to maintain time, and also relay and motor are used to dispenses. Separate motors are used for both pill dispensers and syrup dispensers. Firebase Database is like storage in the webpage. Data from Arduino IDE was sent to the cloud using Node MCU. The software part is very well designed but the hardware part is just prototyping. In this prototype an app named "Medicare" is designed in which alarm is set, data can be fed, and doze time and date can also be set. The other advantage of this machine is it also dispenses syrup (the opening time of syrup is equal to the quantity of syrup that needs to be dispensed, like opening 0.18s for 2ml, like 0.42s for 5ml).

Sowmya Kini et.al in their paper "A Review on Dispenser Mechanisms of Medicine Dispenser" [8], uses a system that stores data in the cloud and provides synchronization while login. The pill is stored in a pill storage unit and a pill chamber is provided to dispenses the tablets. Well-designed plastic canisters, trough cup, pathway, flippers, and magnetic lid to dispense. RTC module is used to check time data and time stamps. The connection between the machine and the tool is through Bluetooth. Wi-Fi module is used to upload and download data from the cloud. A Stepper motor is used for opening and closing the lid. Tahaseen Hasrath et.al in their paper "Automatic Medicine Dispenser" [11], uses Node MCU to process the data, and relays are used. Blynk app is used to set alarm tone and time is set by using it. It is designed in such a way that each medicine is assigned with a different signal based on the signal generated by Node MCU corresponding medicine is dispensed. Kunal Agrawal et.al in their paper "Design and Functioning of Automated Medicine Dispensing Module" [12], segregates pills based on their size which is very notable. According to shapes like oval, height, and cube, and dimensions like height and widths are taken into consideration. The controller used here is raspberry pi for dispensing medicine and object detection sensors are used to count medicine rack coming out of the dispenser. The machine has three parts in it namely slider spring, height adjuster, and the body.

D MohanaPriya et.al in their paper "A Real-Time Support System to Impart Medicine Using Smart Dispenser" [13], uses Arduino mega as a controller, and hx711 humidity sensor is added peripherals to the dispenser. RTC module is used with an external crystal oscillator, Bluetooth module is interfaced to provide necessary communication between dispenser and pc or mobile. Lcd is used for displaying information, the buzzer is used to play an alarm tone with blinking led. Diaa Salama Abdul Minaam et.al in their paper "Smart drugs: Improving healthcare using Smart Pill Box for Medicine Reminder and Monitoring System" [14], uses Arduino nano as a controller and ESP package to establish a server in Smart medicine reminder. The pill dispensing mechanism consists of Pill storage, Pill hatch, Pill chamber, and Pill pipe which uses Arduino-controlled servos for dispensing medicine. Through the mobile application, if the user sends the order to dispense, it will check with the available drugs and dispenses medicine by indicating through led and buzzer. Ranjitha et.al in their paper "Smart Medicine Reminder with Smartwatch Using Arduino Nano" [15], uses Arduino Uno connected to a GSM

module that enables pillboxes and smartwatches to function. A buzzer in the pillbox alerts the user when it is time to take medicine. In this paper, the machine uses a reed relay for an indication when a user opens the box. In a smartwatch, the time and medicine name can be displayed on the OLED display. If a medicine is to be taken from a particular-coloured compartment, the smartwatch will flash an RGB led of that colour as a signal that it's time to take it.

IV. Problem Statement

In the present world, not all children will be always available to take care of their parents regarding medication. Many especially elders don't remember to take their medication. Hence, we need a proper system to overcome such problems. Some of the systems are available to remind them but there is no proper fully functional embedded dispensing machine except the medicine reminder which plays the alarm tone when the dose has to be taken. People living in local areas can only understand their local languages which are not possible in those computerized systems. For any embedded system power backup is very much essential which is the drawback in the present system when there is a power outage. There are chances that gel-type capsules stick inside the chambers, so medicines will be wasted. The presently available system can't remind for more than once. The shape of the medicine dispenser is currently said to be a circle; hence dimensions and shapes become the critical element for implementation in real-time. There are many more complexities in this current system like cost, portability, and difficulty in setting dose timings.

V. Methodology

Figure 1 shows the exact methodology involved in working of Medicine Reminder and Dispensing machine. The working of the system is as mentioned below. The user/ doctors set the dose timing to which the medicine should be dispensed by using the rotary encoder. The rotary encoder acts as a push-button so the option like time and doze can be selected and through the rotating knob, time can be set easily. The input from the rotary encoder is processed and saved as a "Comma-Separated Values (CSV)" file in the SD card that is placed in the SD card module through Serial Peripheral Interface (SPI) communication protocol. Arduino mega reads the CSV file stored in the SD card with the help of the SD card module and time data in the CSV file is constantly matched with the real-time.

- The actual time is provided by extremely accurate I2C real-time clock DS3231 RTC Module, Arduino mega compare the CSV time data and the actual time if both times matches necessary actions are taken i.e., medicine will be dispensed onto the human hand.
- As both times matches dispenser alerts the user/patient through LCD which displays the dose to be taken and by blinking LED and by a voice note by using Mp3 Module.
- Mp3 module reads the files like MPEG-1 Audio and MPEG-2 Audio encoded data which is nothing but an audio file. The audio voice notes like "time to morning medicine" or "place take doze 1" or a buzzing tone are recorded which can be in the local languages as well so that every common people can recognize the tone and react accordingly and this data (human response towards medicine) stored in the SD card which later can be accessed easily.

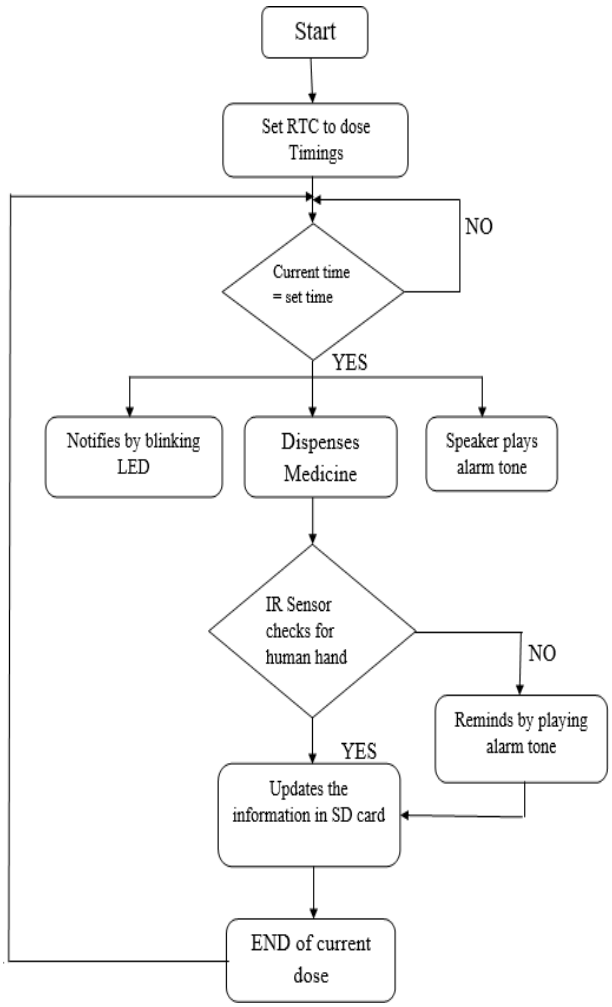

Figure 1: Flow chart

- The advantage of the Mp3 module with interfacing SD card module is any voice note of any language can be recorded and stored then plays when the medicine is taken time approaches.
- The dispenser is fitted with an IR sensor near the dispensing section (rack), medicine is dispensed only if the user holds the hand near to IR sensor. It is like a confirmation that medicine is taken by the user.
- When medicine is not taken in the first intimation there will be another intimation just after 10 minutes to first intimation using the Mp3 module. Even after alerting if the medicine is not taken the medicine box of that

particular doze is cleared and guardian/ caretakers are informed through message notification.

- Based on the user actions like medicine dispensed or medicine is cleared the results are stored in the SD card which can be checked as and when required.

VI. Block Diagram

Figure 2 shows the block diagram of the Medicine Reminder and Dispensing machine. Each block is explained below.

A. Pillbox:

A square or circle-shaped small pillbox is used as a medicine container. All shapes of medicines can be pre-loaded by doctors or users. But liquid containers should be taken care of to avoid spilling.

B. Arduino Mega 2560:

Arduino Mega 2560 is a microcontroller board that has Atmega2560. This controller is used for this project because it has essential ports, is inexpensive, open-source in both software and hardware. Only 7-12 volts are needed to power up the board. Easily programmed with "C" language. Arduino gives the best community support and I/O functions are not complex compared to other hardware which is available in the market.

C. RTC Module:

RTC is a real-time clock module that remembers times and dates which are having a battery setup to maintain a real-time clock even in the absence of external power. Here, for the accuracy purpose, the DS3231 RTC module is used because the external temperature doesn't affect the crystal oscillator. 2.2V-5.5V power is required. The time format is like HH:MM: SS and the date format are like YY-MM-DD. It will capture the date and time tag when the medicine is taken. Accuracy ranges from ±2ppm from 0°C to +40°C, it counts seconds, minutes, hours, days, dates, months, and years, including leap year compensation, which is valid up to 2100 and looks negligible. Error with time comparison is 1 sec in 100 years.

D. Rotary Encoder:

A rotary encoder that performs conversion of electromechanical motion to digital or analog output signals. It supports push, holds, release, and rotational movements by producing different types of sawtooth waves. Here 24 PPR, 24 detents, a vertical rotary encoder is used to select parameters in the display device.

E. Servo Motor:

SG-90 is a lightweight servo with maximum output power. The rotational angle is up to 180 degrees controlled by the PWM signal. It's having a rotational speed of 110 RPM(4-8V) and torque of 2.50 Kg/cm. Here servo motor is used for holding as well as releasing the medicine from the cartridge.

F. IR Sensor:

IR sensor which measures and detects infrared radiation. The operating voltage is 3-5V. They detect 38 kHz IR signal and support up to 20cm range. IR is invisible to the human eye whose wavelength is higher than visible light. Here active and passive and passive infrared sensors are used to generate as well as to detect IR radiation. In this project, the IR sensor will sense the user hand to capture the time and date stamp will trigger the RTC New Text file.

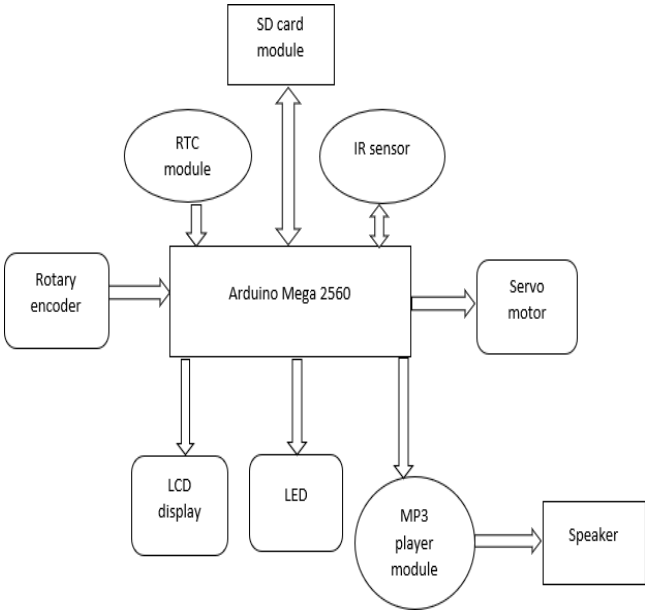

Figure 2: Block Diagram of Proposed Work

G. MP3 Player Module:

It is also called a DF player with an attached battery, speaker, and push button to control volume and all. Audio files can be played from a micro-SD card that supports FAT16 and FAT32 file systems. It can store MP3 files and process audio systems by reading files and turning them back into music as an output. Here human voice is played as an acknowledgment when the medicine is taken.

H. Buzzer:

Small buzzer of 12mm round-shaped speaker that operates around the audible frequency 2 kHz range but it needs a DF player to process the audio. Just 5V is needed to process audio as an output.

I. Micro SD Card and Adaptor:

SD cards can't store the information directly. So, with this adapter and SD card, reading/writing the files will be easier. It supports a Micro-SD card of(<=2GB), micro-SDHC card of(<=32GB), and power supply of 5V. Here .csv file will be stored in an SD card that contains a time and date stamp when the user has taken the medicine. The stored information is further analysed.

J. Speaker:

The speaker provides different audio tones to remind the patients about the time of medication. Also, it gives certain notifications about pills/capsules and calls the patients in regional languages.

VII. IMPLEMENTATION

The pure success of an embedded system project depends both on its software and hardware. Projects include effective coding and optimized hardware to develop an application-specific system. These software skills include modular design, testing, and verification of each component. Real-time embedded systems can be on a smaller scale but they should be effective.

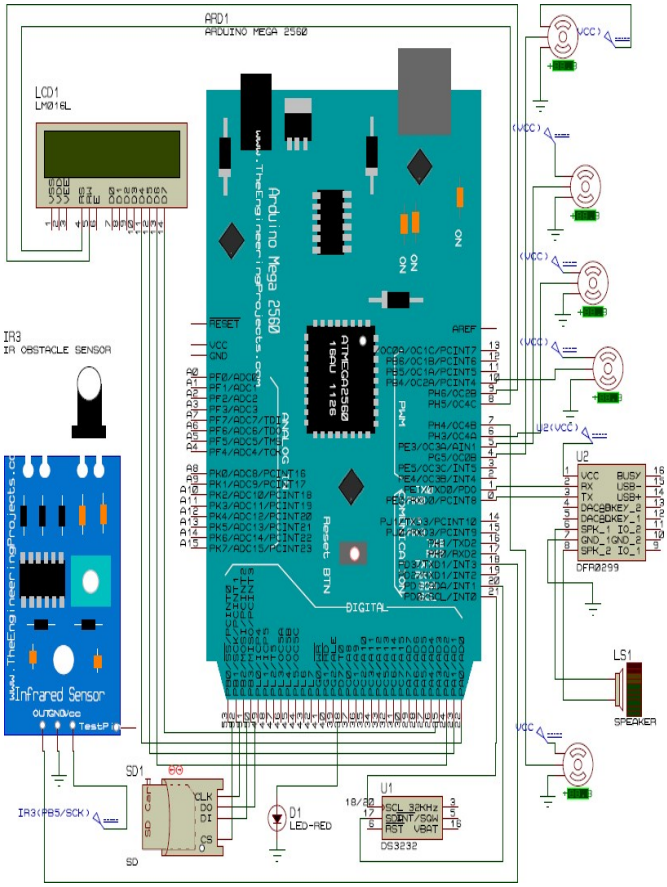

Figure 3: Schematic

In the Software approach visualization of the working, a model can be done using proteus professional design suite software. So that there will be minimal damage to components in the future. Programming is the major part of every firmware-based project. Mainly Arduino IDE is used here for coding and debugging.

In the hardware approach, each component is first tested and analysed. After the verification and countermeasures, step by step each component will be interfaced according to the designed manner. Power configuration and setup play a major role in interfacing.

The schematic is implemented by using proteus professional design suite software. Every component needs to be dragged in the workspace and then components interconnections will be done. This visual schematic makes the system simpler to analyse.

VIII. RESULTS

- The bought components like Arduino Mega, DS3231 RTC Module, Rotary Encoder, Servo Motor, IR Sensor, Mp3 player module, LCD, Micro SD card, LED, · wires are tested and verified for its working separately using Arduino application and display devices like LCD and LED.
- IR sensors sense the IR rays which are bouncing back due to the presence of obstacles. Led is programmed in such a way that it gets ON when it senses obstacles.
- IR sensor doesn't sense the IR rays because the ray doesn't bounce back due to the absence of obstacles. Led is programmed in such a way that it gets OFF when it doesn't sense obstacles.

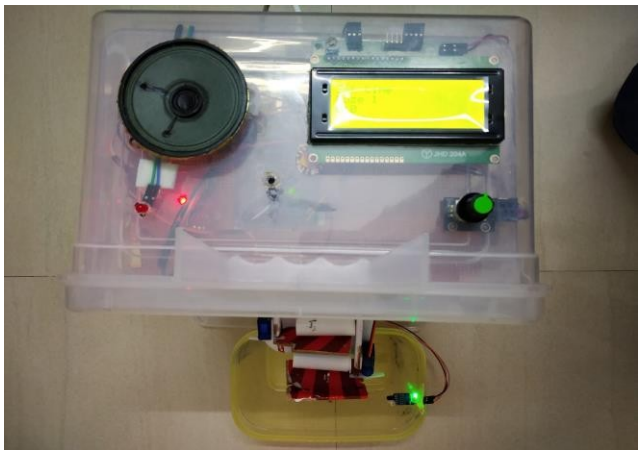

Figure 4: Top View

- Interfacing of LCD which is used display the essential information. It is also used to convey the message or any instructions to the users.

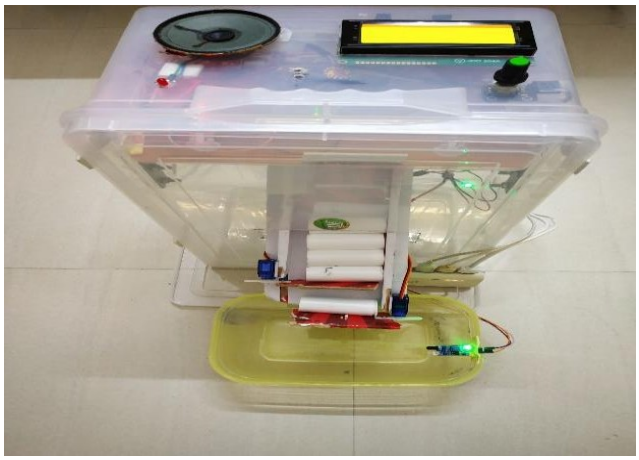

Figure 5: Front view

- The circuit design of the project is done using the website circuit.io so that it helps to do the best and most efficient practical design while keeping all the given constraints in mind.
- The schematic of the projects is done by using an embedded software named "Proteus" and tried to simulate in that but few components like mp3 module, Sd card module just acts as a schematic, so we are not able to complete fully functional simulation so moved to implement it with hardware.
- To make it more efficient PCB designing has been done where all the required components are soldered onto the PCB and necessary components are mounted on the surface as shown in Fig 4.
- Medicine rack has been arranged in such a way that medicine will be dispensed easily as shown in Fig 5. Medicine boxes are arranged in the rack accordingly based on the doses and loaded from the rear end as shown in Fig 6.
- The response of the user towards the dispensed medicine has been recorded, time and date stamps are saved and updated in a .csv file on the SD card.

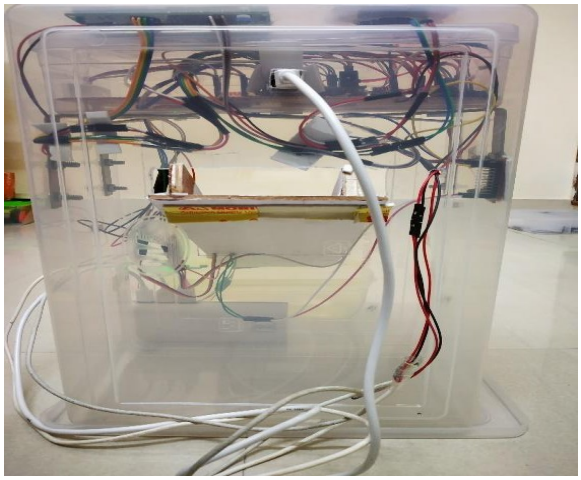

Figure 6: Rear view

IX. CONCLUSIONS

Nowadays people are having so many schedules, so it's very difficult to remember each medication time, moreover who forgets easily. So, this designed medicine reminder and dispensing machine properly assists the patients. It reminds the patient to take the medicine on time and also it provides a good storage condition by maintaining the temperature.

This efficient intelligent product can be installed in Covid care centres besides patients' beds to give better medication assistance by reminding and dispensing medicine. So that no need to wait near the pharmacy to get the medicine every time. On the other hand, it will reduce the number of healthcare warriors like doctors and nurses who are infected when short-distance contact while giving medicines to patients. This is an error-free model and is ready to use for the actual purpose.

Every user wants performance with efficiency and also should consume less power with the best service in the market at lower cost by considering portability and safety. The system is designed in such a way that considers the above things in mind with different features like led notifications, audio models with a visible display unit.

The system can be deployed with IoT cloud for real-time application and remote observation's which can be done by doctors like medication taken to date and time. Every patient's record will be saved more easily and seems to be effective who are having multiple diseases and prevents overdose if they forget easily. Health checking with real-time monitoring sensors can be added as a future perspective and suitable cooling techniques can be introduced at a lower power.

Comparisons	Automatic medicine remainder and dispenser	Smart Medicine Dispenser [2]	Automatic Medicine Dispenser [7]
Controller	Arduino Mega 2560	Arduino Uno	Arduino Uno
Notification	Two time	One time	One time
Dispensing capacity of medicine at once	More than one	single	single
SMS alert	not available	available	available
Syrup dispensing	possible	Not possible	possible

Figure 7: Comparison table

Figure 7 depicts the comparison of various features such as Controller used, Notification count, Dispensing capacity of medicine at once, SMS alert availability, Syrup dispensing of our system with various other systems.

REFERENCES

[1] Juan Marcelo Parra, Wilsom Valdez, Anderea Guevara, Priscila Cedillo, Jose Ortiz-Segarra, "Intelligent Pillbox: Automatic and Programmable Assistive Technology Device", Proceedings of the IASTED International Conference Biomedical Engineering (BioMed 2017), February 20-21, 2017 Innsbruck, Austria.

[2] Wissam Antoun, Ali Abdo and Suleiman Al-Yaman Abdallah Kassem, Mustapha Hamad and Chady El-Moucary, "Smart Medicine Dispenser (SMD)", 208 IEEE 4th Middle East Conference on Biomedical Engineering (MECBME), 978-1-5386-1462-4, 20-23, 19 March 2019.

[3] M Saravanan, Achsah Mary Marks, "MEDIBOX IoT Enabled Patient Assisting Device", School of Electronics Engineering VIT University Chennai, India, 978-1-5090-4130-5, 213-218, 2016.

[4] Mrs. Bhagya Shree S R, Mr. Chandra Shekar P, Mr. Arjun A, Mr. Manoj G R, Mr. Nithin A, Mr. Ravitheja S Raj, "Automated Medication Dispensing System", IEEE Digital explore IEEE, ISBN: 978-1-4799-3975-6, September 2014.

[5] Murtadha Aldeer, Richard P. Martin WINLAB, Rutgers, "Medication Adherence Monitoring Using Modern Technology", The State University of New Jersey, North Brunswick, NJ 08902, US, October 2017.

[6] Animesh Kumar Sahu, Rohit Roy, A. Jabeena, N.Sardar Basha, "Automatic Pill Reminder for Easy Supervision", ICISS- 2017 (IEEE Conference) School of Electronics Engineering VIT University Vellore, India, ISBN:978-1-5386-1959-9, 98-102, 2017.

[7] Jyothis Philip, Feba Mary Abraham, Ken Kurian Giboy, B J Feslina, Teena Rajan, "Automatic Medicine Dispenser using IOT", International Journal of Engineering Research & Technology, ISSN: 2278-0181, Vol. 9 Issue 08, 342-349, August-2020.

[8] Sowmya Kini, Sagar S Acharya, Shreeraj Hegde, Ashwitha Sathish Kumar, "A Review on Dispenser Mechanisms of Medicine Dispenser", International Journal of Engineering Research & Technology, ISSN: 2278-0181, Vol. 10 Issue 03, 305-309, March-2021.

[9] Sultan Ahmad1, Mahamudul Hasan, Gouse Pasha Mohammed, Mohammad Shahabuddin, Tasnia Tabassum, Mustafa Wasif Allvi, "IoT Based Pill Reminder and Monitoring System", IJCSNS International

Journal of Computer Science and Network Security, VOL.20 No.7, 152-158, July 2020.

[10] Abdulrahman Alkandari, Sarah Alshamery, Samer Moein, Nayfah Mohsen Almutairi, "Smart Medicine Drawers Using IOS Application and Arduino Board", International Journal on Perceptive and Cognitive Computing (IJPCC), Vol 5, Issue 2, 59-65, 2019.

[11] Tahaseen Hasrath, P.Sowmika, N.Rajendra, R.Nishma, U.Gowthami, "Automatic Medicine Dispenser", Journal of Emerging Technologies and Innovative Research (JETIR), ISSN-2349-5162, Volume 8, Issue 6,e317-e323, June 2021.

[12] Kunal Agrawal, Jil Jain, Vrutant Shah, Gargi Chauhan, Piyush Surani, "Design and Functioning of Automated Medicine Dispensing Module", International Journal of Engineering and Advanced Technology, ISSN: 2249 – 8958, Volume-10, Issue-4, 120-123, April 2021.

[13] D MohanaPriya, Deepika V, ShanmughaPriya M, Sivasankari@Yogeswari C, "A Real Time Support System to Impart Medicine Using Smart Dispenser", IEEE ICSCAN, ISBN: 978-1-7281-6202-7, 2020.

[14] Diaa Salama Abdul Minaam, Mohamed Abd-ELfattah, "Smart drugs: Improving healthcare using Smart Pill Box for Medicine Reminder and Monitoring System", Future Computing and Informatics Journal 3, 443-456, 2018.

[15] Ranjitha, Shefali Shetty, Srilaxmi Upadhyaya, Teena Lobo, Prof. Santhosh S Nayak, "Smart Medicine Reminder with Smart Watch Using Arduino Nano", International Journal of Research and Scientific Innovation (IJRSI), ISSN 2321–2705, Volume VI, Issue IV, 84-86, April 2019.