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IoT-Based Smart Medicine Dispenser

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Abstract: ***Correct on-time medication is very important to recover from the health problem. This paper aims to develop a smart medicine dispenser system. Taking medicines for elderly, deaf, and blind people is difficult without any attendant around. The designed system helps to remind them to take their medicines and delivers the medicine according to the prescription. The system has three medicine delivery parts one for the morning, one for the afternoon, and one for the night. The pills are put in the boxes according to the prescription and delivered automatically based on the input from a real-time clock (RTC) at appropriate timings. The system uses a microcontroller to control various operations. It senses the inputsignal from RTC and gives a control signal to the servo motor to actuate dispensing the box containing pills. The provision is made to give an alarm to the patient through voice message and LCD displays to remind the patient to take medicine. A mobile app is developed using the Cayenne mobile app developer so that the caretaker will get a live notification at his or her workplace. This ensures the caretaker that the patient has takenthe medicine. The system has the facility to store medicine for seven days. The scheduling and modification can be done through the mobile app according to the prescription. The prototype has been developed and tested. The system is workingsatisfactorily.***

Keywords: NodeMCU, Arduino, Cayenne Mobile App, RTC.

I. INTRODUCTION

People generally tend to forget their prescribed medicines because of various reasons. Sometimes it is very essential thatsomeone has to remind them regularly to take their medicineson time. It is very likely that elderly people forget to take theirmedicine on time. It is very essential for any patient to take medicines in the prescribed quantity at the prescribed times for fast recovery. Being Nuclear families, no one would be free to take care of elderly people throughout the day. It is very difficult for a middle-class family to appoint a caretaker to look after the elderly or even people with a physical disability. In this project, a medicine dispensing unit is developed to remind the patients and also deliver the medicineaccording to the prescription. The unit is useful for a patient who is left alone at home without any caretaker. The system reminds the patient to take their medicine through voicemessage and also displays the messages on the LCD. Once the medicine is taken patient has to press the button and the message will be delivered to the caretaker who is at their workplace. The message is sent through Cayenne mobile app,which is an IoT platform to deliver messages to mobiles. Many medicine storage units and dispensing units are available in the market. Some of these units have the facility only to store the medicines and many of the units are required to be operated manually. The system also uses the state-of- the-art technology IoT, through which the device can be monitored and controlled from a remote place.

II. LITERATURE SURVEY

The authors suggested a medicine vending machine [1-2] which will be useful for people living in remote areas and also for people traveling. The work done by Mukund in 2012 suggested a system that is functioning for medicine and tabloids of any proportion. The model is programmable for 31 days for 21 different pills. The pill dispenser has the efficiency to send the audio notification. It is also programmable which is used to adjust the number of times and medicines as per the prescribed dosage [3]. The work done by Varun Vaid in 2014 recommended the model of methodologies to establish a vending machine related to the medicine dispensing mechanism. Vending machines can be built relatively anywhere and any user can use them [4]. According to the work done by S Gayathri developed a method to access and monitor the patient's health using wearable sensors in the remote area. The system comprises temperature, heartbeat sensor, and acceleration sensor. The data is collected and analyzed using a microcontroller. All the patient's health information is sent to the doctor's mobile via SMS by using the GSM modern technique [5]. The work done by Chi-Sheng Shih in 2016 suggested the model and implementation of a smart medicine dispenser, where the dispenser is fully automated apart from setting up the operation and renewal of doses from the pill boxes. The model provides interface and communication among the components [6]. The work done by Sarika Oundhkar in 2017 recommended the awareness of technology in machinery especially with the medicine vending machines present all over the world, further also illustrated in the automation process associated with the vending machine with higher efficiency, thus lowering the dependence of the manpower [7].

Microcontroller-based smart medicine dispenser is proposed by the authors [8] with an electromagnetic principle and servo motors. A microcontroller-based smart medicine dispenser has been proposed by authors with an android application [9].

It is evident from the literature review, that the available units are general medicine vending machines. Some are costly to use for personal use. Hence there is a need for a small simplepersonal medicine dispensing system.

III. PROPOSED METHOD

A. *Hardware*

In this project, IoT based smart medicine dispenser is designed and a prototype is implemented and tested. The block diagram of the system is shown in Fig1. Microcontroller is the heart of the system which is used as themain controller. The Arduino Uno is used as the microcontroller in this work. An RTC module is connected toinitiate the alarm in real-time. The speaker unit delivers the audio message to the patient, LCD display is also used to display the alarm message. In the proposed system along with the pills, a provision is made to remind about the intake of liquid medicine and also an inhaler. This is indicated on three LED's fixed at appropriate places on the system. Three dispensing channels are used to dispense the medicines for three sessions, one in the morning, the second one in the afternoon, and the third one at night. To dispense the medicine automatically three servo motors are used. The servo motors get their actuating signals from the microcontroller to deliver the box containing the pills at appropriate timings. once the patient takes the medicine, he or she has to press the appropriate buttons to indicate that the medicine has been taken, then the message will be sent to thecaretaker mobile to notify that the medicine has been taken.

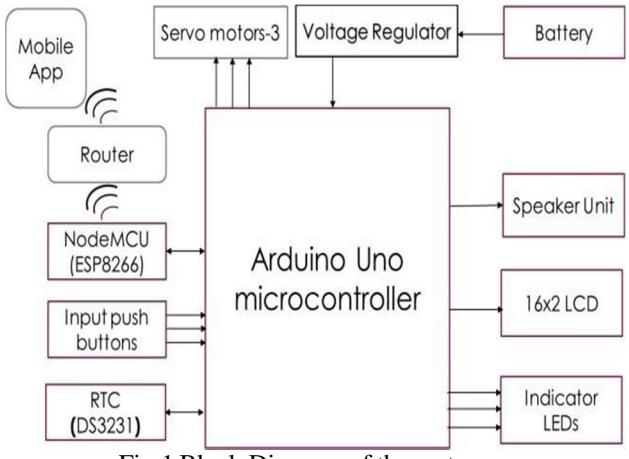

Fig.1 Block Diagram of the system.

B. *Software*

The software has been developed to read the signal from RTCand send the alarm messages to the speaker and also todisplay on the LCD, the software has been developed on an AMD Ryzen 5 4000 series processor. Tools used to develop the microcontroller programming is ARDUINO IDE andmobile app is developed on CAYENNE mobile app.

Arduino IDE is an open-source platform that is used for writing the code and programming the modules for the microcontroller (Arduino Uno R3) and WIFI module(NodeMcu). There are mainly two programs running on the device, one is the main program for the microcontroller and another one is for setting up the NodeMCU WIFI module. Various libraries have been used like "RTC.h" for setting up the RTC, "Wire.h" which allows communicating with I2C or two wired interfaced devices through SDA and SCL pins,

"LiquidCrystal.h" is used for communicating with LCD module, "Servo.h" for controlling the servo motors. These libraries consist of inbuilt functions for each module. The "Void setup ()" function has been used for defining the variables and initializing the variables and setting up the pin modes for input and output. "Void loop ()" function consists of if else operation for the particular module to work.

The Cayenne cloud processes and stores user and sensor data from the device(thing), while the online dashboard provides a graphical environment for working with IoT and Embeddedprojects, as well as monitoring and managing the Devices. The Cayenne app is used to set up and manage IoT devices on Android, and Apple as well as a Web App. In this project,it is used for sending the data from the device to the mobile app as a notification of the dosing status. The flowchart of thesystem is shown in Fig.2.

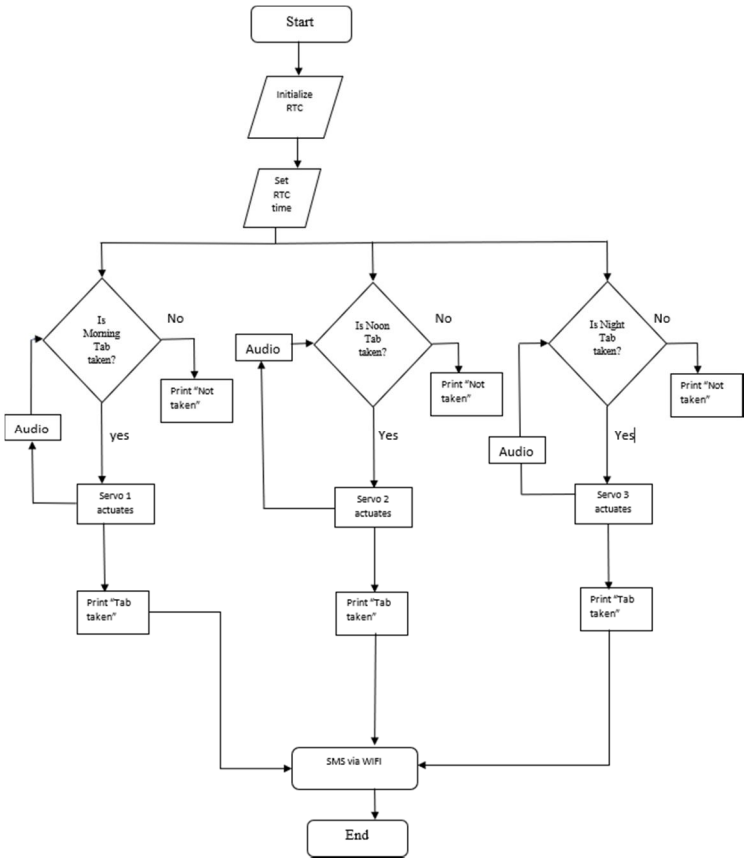

Fig.2 Flow chart of the system.

IV. RESULTS AND DISCUSSIONS

The prototype of the IoT based smart medicine dispenser hasbeen designed implemented and tested. For testing, purpose expired crocin and dolo medicines are used, which are put insmall plastic containers. The dosage assumed is two tablets taken three times a day. In the prototype provision is made tostore the medicine for seven days. The system is tested by assuming that the medicine needs to be given three times perday. The morning, afternoon and night medicine dispensing has been tested by giving two minutes delay. In the beginningan audio message "PLEASE TAKE YOUR MEDICINE" is delivered as an alarm patient has to press the button, to remind him or her that it is time to take the medicine. The same message is also displayed on the LCD, once the medicine is dispensed "THANK YOU Y" message will be displayed on the LCD and same message is also updated on the mobile app. After taking the medicine patient has to pressthe button, if the button is not pressed it is assumed that the medicine is not taken "THANK YOU N" message will be displayed on the LCD and also updated in the mobile app.

Table.1 Status and different alarm messages

Status	Audio message	Message displayed on LCD	Mobile app status
Before taking medicine/Alarm message	"PLEASE TAKE YOUR MEDICINE"	"PLEASE TAKE YOUR MEDICINE"	LED symbol is OFF.
After taking medicine and pressing the button	"THANK YOU"	"THANK YOU Y"	LED symbol is ON.
If the medicine is not taken and the push button is not pressed	-	"THANK YOU N"	LED symbol is OFF.

Various alarm messages and LED status are listed in Table1.The medicine can be changed according to the prescription using the mobile app. The dosage can be set on the mobile app and is shown in Fig.3, the page setup of the mobile app allows one to enter the medicine names as well as time and dosage shown in Fig.4.

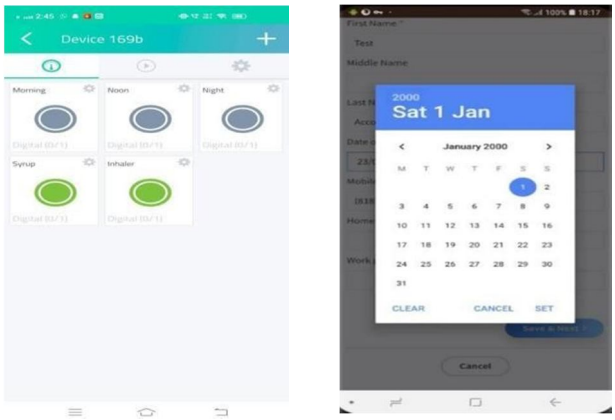

Fig.3 Dosage status on the mobile app

Table.2 Features Comparision of Various Pill DispensingDevices.

No.	Features	IOT Based Smart Pill Dispenser	Phillips	MedMinder	PivotCell
01.	Price	$50/Device	$60/month	$60/month	$160/device
02.	Programmability	Yes	No	Yes	Yes
03.	Dosages Per Day	14	6	28	28
04.	Reminder	Yes	Yes	Yes	Yes
05.	Smartphone Control	Yes	No	Yes	No
06.	Battery	7 days	7 days	None	None
07.	Refilling	Manual	Manual	Manual	Manual

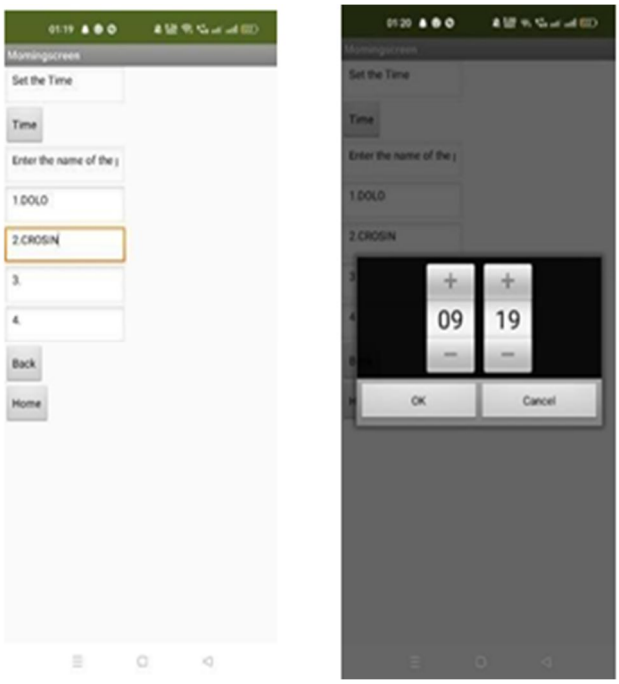

Fig.4 Entering the name of the medicine and set up the time for the dosage.

Provision is made to save the name of the medicines taken, date time, and whether the pill is taken or not in the database of the mobile app. This data may be later used by the doctor to analyze and understand the effect of medication taken for a particular period. The format of the database in excel is shown in Table.2.

Table.3 Database format.

	A	B	C	D
1	Date	Time	Pill name	Status
2	17-06-2022	21:32	CALPOL	Pill is taken
3	17-06-2022	22:33	Azithromycin	Pill is taken
4	18-06-2022	09:10	Oxy spray	Nose spray is taken
5	18-06-2022	12:37	CALPOL	Pill is taken
6	18-06-2022	22:33	Azithromycin	Pill is taken
7	19-06-2022	13:41	CALPOL	Pill is taken
8	19-06-2022	21:44	Azithromycin	Pill is taken
9	25-06-2022	21:45	Augmentine	Pill is taken
10	25-06-2022	22:46	Sinarest	Pill is taken
11	26-06-2022	21:47	Diclomol	Not taken
12	27-06-2022	11:48	Augmentine	Pill is taken
13	27-06-2022	21:49	Sinarest	Pill is taken
14	28-06-2022	21:49	Diclomol	pill is taken

The list of the medicine that should be taken can also be displayed on the LCD as shown in Fig.5.

Fig.5 Medicine list display.

The photograph of the front panel of the medical dispensingunit as shown in Fig.6, and the dispensing unit as shown in Fig.7. unauthorized people from manipulating the dispensing units.more dispensing pipes can be included to separate the medicines to be taken before food and after food, and provisions can be made to air-tight containers and temperature-controlled pipes if medicines are to be maintained at particular temperatures.

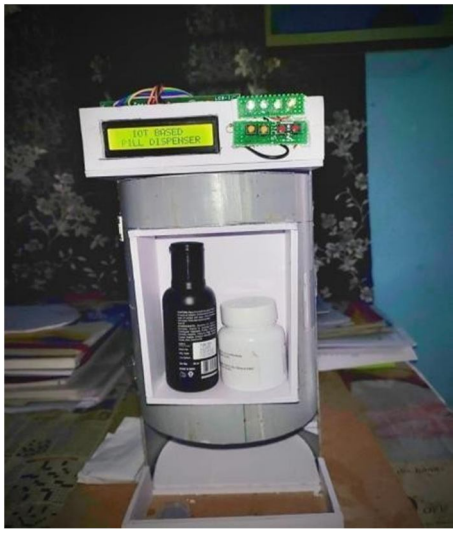

Fig.6 Front panel view of the medicine dispensing unit.

Fig.7 The internal arrangement of the medicine dispensingunit.

V. CONCLUSION AND FUTURE SCOPE

The prototype of the medicine dispensing system has been developed and tested. Provision is made to deliver medicinesthree times a day. Scheduling can be done using the Cayennemobile app and medicines to be taken for seven days can be stored. The system is working efficiently and is user-friendly. The system can be even used by aged people without the helpof any assistance. Ultimately this user interface can be used on all Operating Systems and Platforms. The system developed is user-friendly, convenient, and easy to understand and use, even for aged patients. The system is flexible and also provides options to add future advancements.
The system performance can be improved by adding more features and also biometrics can be included to prevent

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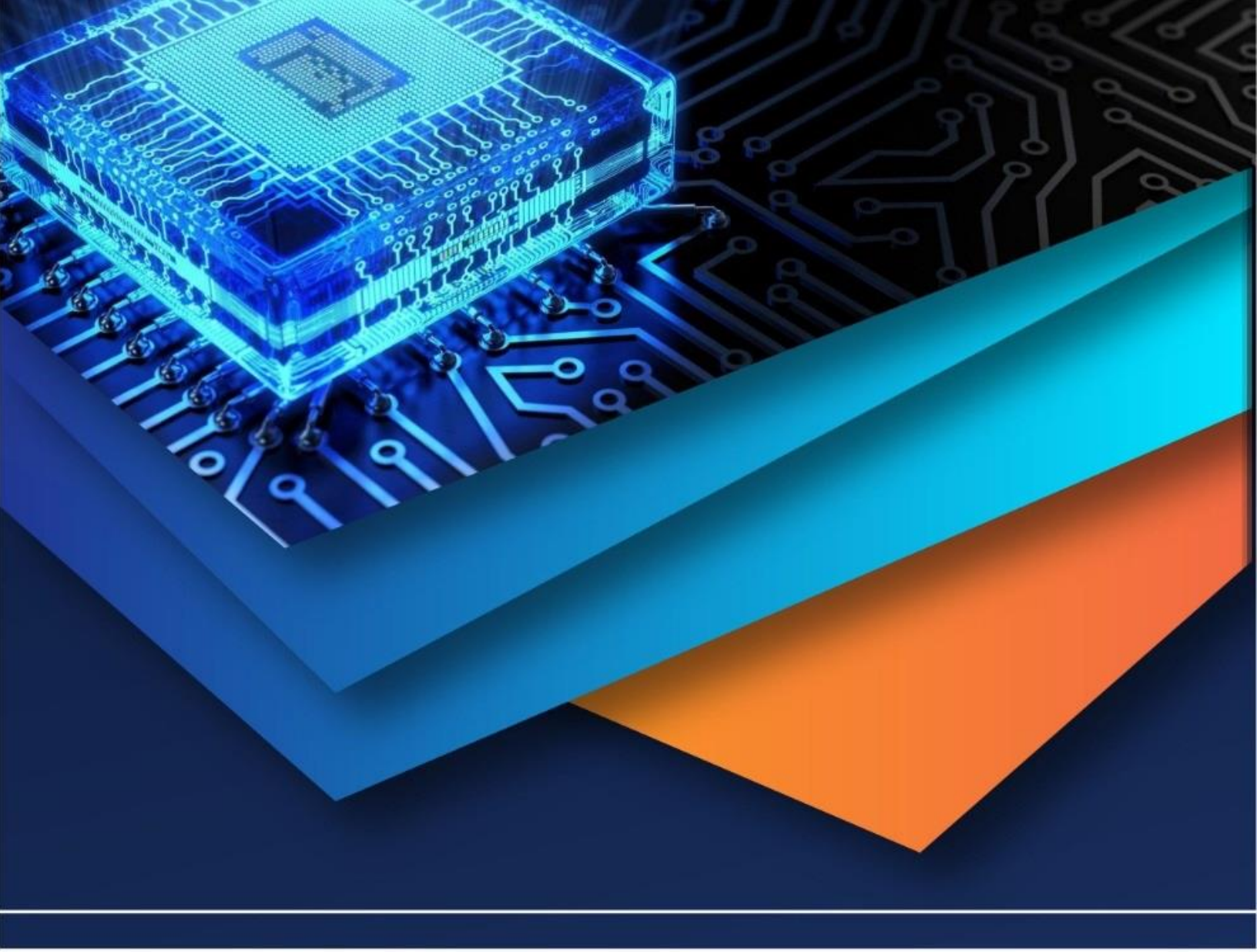

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