Medibox-Iot Enabled Med Alert Device

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Abstract- *Technology has proven to be critical driver for effective modern medicine. The drive towards improving diagnosis, improving patient care and improving patient outcomes continues to push forward and the Internet of Things (IoT) is now accelerating things even further. The Internet of Medical Things (IoMT) enables machine to machine interaction and real-time intervention solutions that have the potential to radically transform healthcare by improving affordability and reliability in the near time future. In this paper, one such attempt is made to design a multipurpose portable intelligent device named Medibox which helps the caretakers to monitor the babies or patients. This box is a proficient system equipped with a web application which helps the health professionals or caregivers a tool to check and program the medibox. The details of continuous monitoring with specific time interval are saved on a secure cloud that can be used for further analysis. Also, a mobile application is implemented to establish a connection with the web-application to show the emergency notifications.*

Keywords- Internet of Medical Things; Continuous monitoring, Cloud storage, Appointment fixing, Email Notification.

I. INTRODUCTION

Sensors are used in everyday objects such as touch-sensitive elevator buttons and lamps which dim or brighten by touching the base. Sensors have innumerable applications in almost all the fields. These applications include manufacturing, machinery, airplanes and aerospace, cars, medicine, robotics and many other aspects of our day-to-day life. Technological progress allows more and more sensors to be manufactured on a microscopic scale as micro sensors using MEMS technology. In most cases, a micro sensor reaches a significantly higher speed and sensitivity compared with macroscopic approaches. There exist many different sensors in the world. Some of the few sensors which are used to measure the physical properties are temperature sensor, proximity sensor, accelerometer, IR sensor, pressure sensor, light sensor, ultrasonic sensor, smoke, gas and alcohol sensor. Touch sensor, heart beat sensor, color sensor, humidity sensor, tilt sensor, flow and level sensor.

IoT is making strong inroads in the medical industry with the introduction of relevant sensors and devices. IoMT is a collection of medical devices connected to healthcare IT systems for different applications. The growth of IoMT has particularly impacted healthcare for the aged and disabled people, but not just limited to them. The advancement in the field of IoTsimplified the daily routine of every people. Some of the applications of IoT includes smart home which has become the revolutionary ladder of success in the residential spaces nowadays, the next application of IoT is Wearable devices which are installed with sensors and softwares that collects data and information about the users and later the data is pre-processed to extract essential insights about the users. In the fast-paced world, even ordinary persons need support with their daily activities. These Wearable devices are broadly used in fitness, health and entertainment industries.

Connected healthcare is the most upcoming trend in today's world. The concept of connected healthcare system and smart medical devices bears enormous potential not just for companies, but also for the well-being of people in general. Research shows IoT in healthcare will be massive in coming years. IoT in healthcare is aimed at empowering people to live healthier life by wearing connected devices. The collected data will help in personalized analysis of an individual's health and provide tailor made strategies to combat illness. One such important activity is to help them to take their medications on a daily basis without missing any dose and to report in case of emergency. The presently available devices for medication adherence have some drawbacks and are restricted to basic functionality like serving only a single purpose of reminder system.

The complexity and cost associated with more elaborate system lead to the development of a new portable device in this paper named as "MED ALERT" system- an intelligent medicine reminding device. It helps the working parents of the babies to monitor their babies health condition from their working place and to take prior actions in case of emergency. This smart medicine box helps us in reminding us of the medicine that we should take at that particular time. The history of continuous monitoring is uploaded to the cloud for further medical reference. This med alert system is also

capable enough to alert its user and caretakers about their appointment with the doctor.

Ambient Assisted Living(AAL) encompasses technical systems to support the people in their daily needs to allow an independent and safe lifestyle as long as possible. Hence in this paper, we have designed a healthcare system that, through the use of IoT- enabled sensors and relevant hardware, assists individuals in taking their prescribed medicines on time avoiding future consequences.

The paper is organized as follows. Section II introduces several closely related research projects. Section III presents the overview of the proposed design. Section IV introduces the MED ALERT device working methodology which includes real time data generation and actuation steps and cloud based analysis. Section V depicts the results and conclusion.

II. RELATED WORK

Various electronic pillboxes have been developed both in industry and academia during the past three decades. These medication adherence devices can be categorized into four groups as pill holders, alarm-based pill holders, pill monitoring devices and mobile phone based solutions.Our design is a combination of pill monitoring and mobile phone based solution which will monitors the patient condition. There are several pill dispensers available in the market which consists of built in alarm to notify the users but it does not contains the online database for storing the details which can be used for future reference, some pill dispensers may not contain remote access functionality.

To state a few:

An electronic pill dispenser realized using pic microcontroller with keyboard and an LCD that lets the user schedule his/her pills and generate an audio alarm to alert the patient. Also, an SMS is sent to the caregiver phone number in case the pill wasn't taken.

- A pill dispenser was created using a combination of infrared sensors and Arduino microcontroller with alarm system to help the patients take their pills at the correct time. The alarm system was implemented using a popup notification on smartphone.
- Another pill dispenser that is created using Arduino microcontroller that is dispenses only one pill at a time to prevent overdose. Then it notifies the user via SMS that the pill is ready to be taken. Also it was connected to an android application that is used by the caretaker to edit the dates and times of the pills to be dispensed.
- An electronic pill box which is equipped with a camera and contains a medicine bag which contains a matrix bar code which is used to interact with the pill box in order to perform pill reminder and confirmation functions.

The proposed Med Alert system takes the idea of smart pill box to the next level as it has some functionalities that are not included in any other smart pillbox. In which the temperature and heartbeat of the people who wears the Med alert transmitter will be continuously monitored. An account is provided to the parents/patients/care givers to monitor the status of the temperature and heartbeat of the concerned patient. Online database is the great feature that helped the design of our project. These databases can also reflect in the mobile app through smartphones. The Med Alert system also monitors the status of the load cell continuously and provides an alarm to remind the medication, if the medicines are not taken at emergency situation where the temperature and heart beat rises than the normal the smart MED ALERT system fixes an appointment with the nearby hospital and the notification of which is sent to the parents/caregivers through mail.

III. PROPOSED MED ALERT SYSTEM

The main objective of our proposed system is to create a user-friendly design that the patients can use as a reminder to take their medicines on time if their body conditions hiked than normal body condition. This system can also be incorporated to babies to monitor the babies and if their conditions got worsen it reminds the caregivers/patients to provide them with the medicines. So that the parents at work can carry with their work without worrying about their babies in home. The device incorporates three main parts; transmitter, medi box circuitry and receiver circuit.
The block diagram is as follows

Transmitter System:

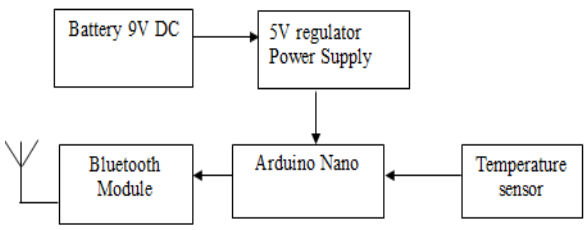

Fig1. Transmitter System

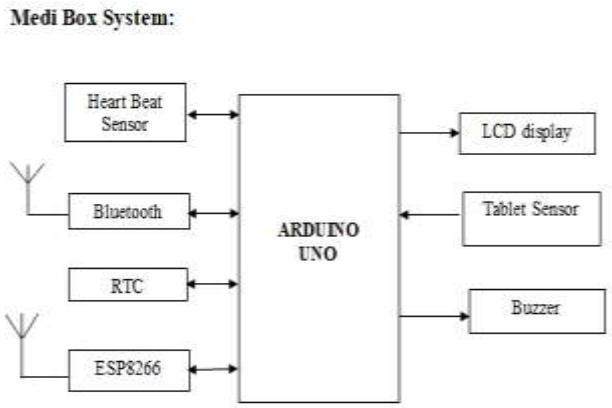

Fig 2. Medibox system

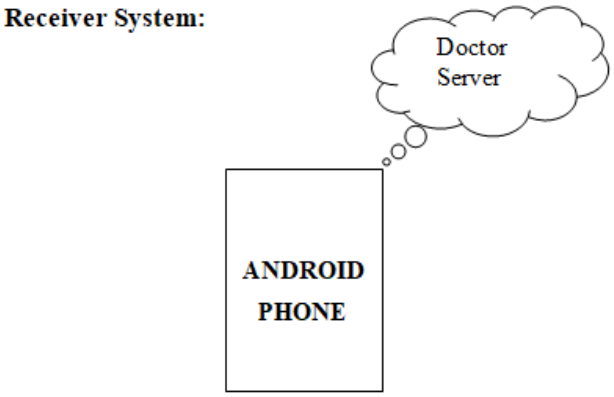

Fig 3.Receiver system

The circuitry incorporates multiple sensors incorporated with their respective hardware modules. The power supply is intended to produce the required power supply to the medibox circuitry. The transmitter circuitry is driven by a 9V battery supply. Now we will describe the components used in our system with its salient features

.

Arduino Uno: The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. Each of the 14 digital pins on the Uno can be used as an input or output using pinMode(), digitalWrite() and digitalRead() functions. These pins operate at 5 volts. Some pins are also have specialized functions.

Arduino Nano: The Arduino Nano is a small and complete breadboard-friendly board based on the ATmega168. The Nano board consists of 14 digital input/output pins and 16 KB of flash memory for storing code and consists of 1 KB of SRAM and 512 bytes of EEPROM.

NodeMCU: NodeMCU has a firmware that runs of ESP8266 Wi-Fi System on Chip (SoC) and includes a hardware based on ESP-12 module. The development board contains GPIO, PWM, I2CC, l-Wire and ADC all in the same board. NodeMCU is used as a controller because it contains more number of serial communication pins compared to Arduino board and also due to its compact size, inbuilt Wi-Fi and low cost. Unlike Arduino some modules in the circuitry need a 3.3V and others 5V supply. As NodeMCU incorporates both 3.3V and 5V pin there is no need for external regulating circuitry for these modules

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Bluetooth Module: Bluetooth employs wireless communication thereby replacing traditional cable connections which makes the device portable and it employs serial communication to communicate between the devices. We employed HC-05 module which communicates with the controller through USART. The Bluetooth operates in 2.45GHz frequency band. An HC-05 module provides switching between master and slave mode thereby it communicates with both Nano board and UNO board.

Temperature Sensor: Temperature sensor measures the changes in temperature corresponds to change in its physical properties. There exists many kind of temperature sensors like Temperature Sensor ICs (like LM35), Thermistors, Thermocouples, Resistive Temperature Devices etc. We employed Temperature sensor IC (LM35) in our project to detect the body temperature of the baby. The LM35 measures the temperature more accurately than a thermistor. It also possesses low self-heating and operates at a temperature range of -55°C to 150°C. The output voltage varies by 10mV in response to every °C rise/fall in ambient temperature.

RTC:RTC is an integrated circuit that keeps track of the time. RTC is preferred because of low power consumption and its highest accuracy. The device also has an I2C serial communication pins. RTC maintains the time in the Med Alert System. Time is the major parameter for the design so an accurate module is very essential. Hence we employed a DS1307 RTC.

Heart Beat Sensor: Heart beat sensor(PC-3147) is used to count the number of times the heart beat per minute of the patient who wearing the heart beat sensor in their finger. The heart beat sensor is based on the principle of photo-plethysmography. The heart beat sensor counts the number of pulses for ten seconds and then multiplies it with 6 to get pulse count for 60 seconds thereby it saves time.

Buzzer: Buzzer is an integrated structure of electronic transducers and DC power supply. Buzzer works with a power supply voltage of 5V. In our project it serves as an alarm for taking the medications on emergency situation. It reminds the

caregivers to provide the medicine upon hike of patients body temperature and heartbeat.

LCD: A 16x2 LCD is used for display notifications. LCD contains an interface IC to get the commands and data from MCU and process them to display meaningful information on LCD screen. LCD operates at 5V and it can display both alphabets and numbers. This LCD is capable of displaying 16 columns and 2 Rows. The LCD serves the current state of the patient body condition and also displays the load in mg present in the load cell. Thus LCD improves the system design of our project.

Load Cell:A load cell is a transducer which is used to create an electrical signal whose magnitude is directly proportional to the force being measured. The strain gauge load cell (HX711) is a precision 24-bit analog to digital converter designed for weigh scales and industrial control applications. In our project, the load cell measures the load present on it and the weight in mg is displayed continuously on lcd display.

Fig 1 represents the transmitter system which consists of 9V battery to power up the transmitter and a 5 V regulator power supply to distribute the even power to Arduino Nano board, Bluetooth module and to the temperature sensor.

Fig 2 represents the medibox system which consists of heart rate sensor, load cell (tablet sensor), RTC, Bluetooth module, buzzer, power supply unit, Node MCU and LCD display and Arduino board.

Fig 3 represents the receiver system where all the data's captured using various sensors are stored in a secured cloud and the details of the patient are reflected in the smart phone through a mobile app called medikit.

IV. METHODOLOGYOF MED ALERT SYSTEM

The MED ALERT system is designed as a compact and portable device that facilitates connectivity to a secure cloud via Node MCU. Arduino microcontroller is used for monitoring the baby/patient health. During continuous monitoring, if there is a severe increase in body temperature the alarm sound is start and incase of skipped pill, the caretaker/parents will get alerted instantly via mail.

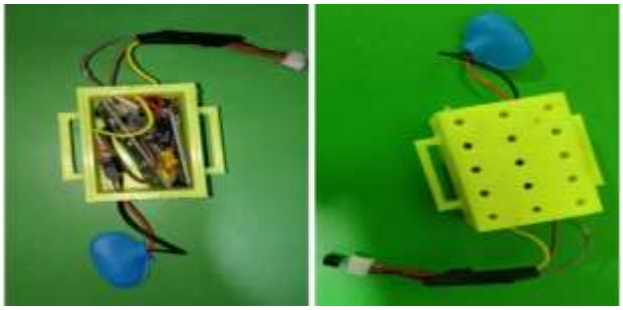

Fig 4. Transmitter system

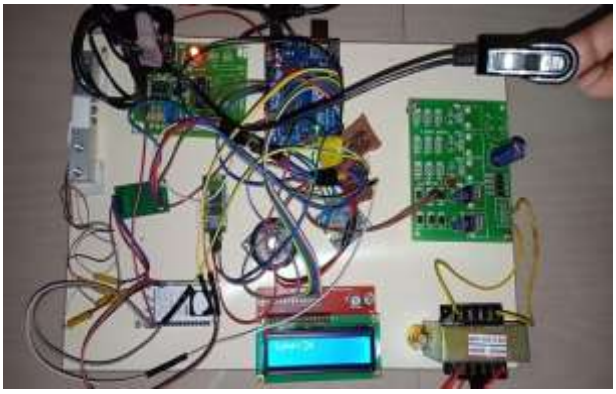

Fig 5. Medibox and Receiver system

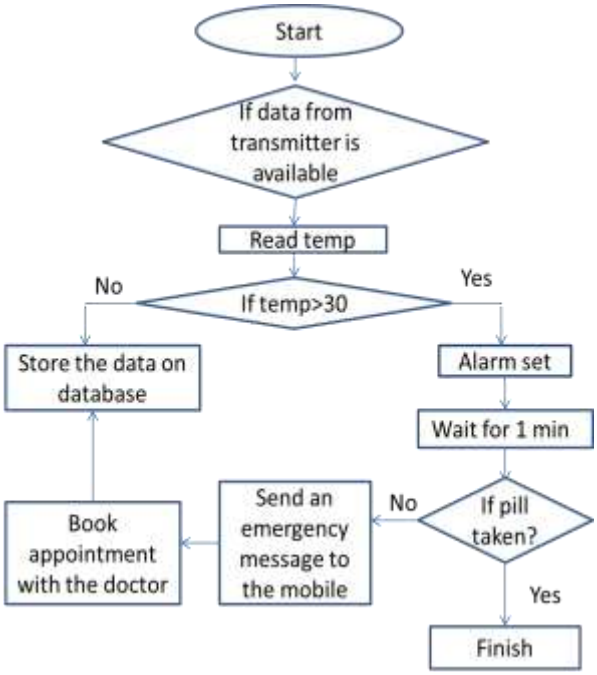

Fig 6. Flowchart of the MED ALERT System

The flowchart of our proposed system is shown in Fig.6. Upon providing the proper power supply to all the components of the system, when data from transmitter is available the temperature sensor senses the body temperature which will be sent to the receiver via Bluetooth. This temperature value will be displayed in the LCD. When the temperature is greater than our threshold value i.e.30 then an alarm will be turned on for 1

minute. Within 1 minute if the pill is taken then it returns back to its initial state and continue to carry out its monitoring. When tablets are not taken within 1 minute then an emergency message will be sent to the parents mobile and an appointment with the doctor will be fixed. The details of heartbeat and temperature will be stored in the database for all temperature and heart beat measurements.

A. Database Management

The pill alarms and continuously monitored data are stored first locally using SQLite database for the benefit of doctors. The data stored on the cloud is sent to the mobile application which acts as a gateway for sending it via the internet. The mobile application can be used by the caretakers and also family members. This application shows the baby/patient details with appointment details.

S.NO	STATUS	TEMP	HEART RATE	DATE	TIME
62	noproblem	24.49	1	2019-02-20	11:59:00
63	noproblem	24.49	1	2019-02-20	12:00:20
64	noproblem	25.46	1	2019-02-20	12:00:49
65	emergency	50	92	2019-02-20	12:03:57
66	noproblem	21.27	1	2019-02-20	12:04:34
67	noproblem	19.34	1	2019-02-20	12:05:59
68	emergency	50	94	2019-02-20	12:06:56
69	noproblem	21.27	1	2019-02-20	12:08:12
70	emergency	50	93	2019-02-20	12:08:57
71	noproblem	23.20	1	2019-02-20	12:12:08
72	noproblem	23.20	1	2019-02-20	12:12:36
73	noproblem	25.14	39	2019-02-21	04:43:17
74	noproblem	25.14	96	2019-02-21	04:43:49
75	noproblem	24.81	240	2019-02-21	04:45:10
76	noproblem	25.14	174	2019-02-21	04:45:41
77	noproblem	29.33	237	2019-02-21	04:47:02
78	noproblem	31.26	189	2019-02-21	04:47:33
79	noproblem	31.2	249	2019-02-21	04:48:53
80	noproblem	31.58	153	2019-02-21	04:49:23
81	noproblem	33.19	285	2019-02-21	04:50:47
82	emergency	3126	177	2019-02-21	04:51:19
83	noproblem	29.97	183	2019-02-21	04:52:40
84	noproblem	32.55	240	2019-02-21	04:54:39
85	emergency	31.58	36	2019-02-21	04:57:15
86	emergency	34.16	327	2019-02-21	04:58:15
87	emergency	31.58	363	2019-02-21	05:00:16
88	noproblem	24.81	0	2019-02-21	06:37:50
89	noproblem	24.81	81	2019-02-21	06:38:19
90	noproblem	24.81	174	2019-02-21	06:39:37
91	noproblem	24.81	48	2019-02-21	06:41:08

Fig 7. Database of sensed data

B. Android Application Overview

The whole system relies on android application to provide the user interface. The application starts with a login screen. After the user login with the essential details, the application is ready to notify in case of emergency. The details which are included in the application are the baby/patient name, age, email id and nearby hospital.

Fig 8. Appearance of Mobile Application

C. Advantages and Applications

The advantages of our med alert system are (1).Med alert system is used to overcome the remarkable problem where the patients forget to take the proper medicines (2). It is used for patient to take the right medication at the right time according to the doctor's prescription. (3). Ubiquitous Communication/Connectivity (4).Pervasive computing and Ambient Intelligence. (5) While checking blood pressure and temperature if the condition is abnormal it immediately indicates the patient to take the tablet. (6) It is very easy to use and moreover the circuit is very less complex.

The application of med alert system includes (1).This medicine box can be used by the users who are under medication. (2).It can be used in hospitals where we can see on in charge takes care of whole ward. With the help of this all the patients can be easily monitored and medicine can be given at the right time. (3). The user can view the details through mobile or PC from the server and collect database whenever it is needed.

V. RESULTS AND CONCLUSION

We have meticulously carried out a different set of experiments on the MED ALERT system by measuring the temperature and heart rate and how efficiently it alerts using the app at exact timings.

Fig 9. Initial status of LCD

Fig 10. LCD displaying weight

Fig 9 shows the initial LCD display when the kit is powered on and Fig 10 shows the time with loaded tablet compartment.If the tablet is taken from the load cell the value will get reduced and if there is no tablet in the compartment then negative value will be displayed on the LCD.

Fig 11.Temperature displayed

Fig 12.Heart Rate dispalyed

Fig 11 shows the temperature of the person/baby who wears the transmitter. The temperature value may ranges between 18 to 32. Fig 12 shows the heart rate of the baby/person who wears the sensor clip in their hand. The heart beat rate may varies from 60 to 100 beats per minute.

Fig 13. When tablet is taken

Fig 14. Message sent to email

Fig 13 indicates that the tablet is taken from the tablet compartment and Fig 14 shows that the message has been sent to the parents about the appointment with the doctor through the mail and mobile app notifications.

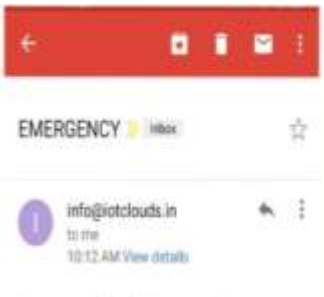

Fig 15. Mail notification Fig 16. Mobile notification

Fig 15 and Fig 16 shows the email and mobile app notifications which has been sent to the parents about the appointment of the baby /patient with the nearest hospital.

Finally we have seen that the designed MED ALERT system can be used by the users for their different needs.

VI. CONCLUSION

This system has focused on the problems faced by home alone and senior citizens adherence to their prescribed medication and emergency situations. It not only aids the elderly who live independently but also the caretakers of the babies by reminding right amount of medicine at the right time and in case of emergency it sends a message to the parents of the home alone and books an appointment with the doctor in the surrounding. The smart medicine box using IoT platform has been experimentally proven to work satisfactorily. The other advantage of this box is that it is very easy to use and the complexity is less. This ensures that the home alone is monitored properly.

VII. FUTURE SCOPE

As a future enhancement to the MED ALERT system, few more health monitoring sensors can be added. The design can be optimized to accommodate more pills. Automatically collecting the users hand gestures during medication intake will provide detailed information.

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