IoT based Smart Medicine Reminder kit

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Abstract

Patients across the globe have varying requirements and schedules for the intake of their medicines. This usually results in patients missing their dosage or taking their medicines at the wrong time. The IoT based smart medicine kit reminds patients to take the dose and keeps track of their schedule. Additionally, the kit consists of health data capturing sensors such as glucose sensor, pulse oximeter sensor and temperature sensor. We can operate the Smart Medicine Reminder Kit from a mobile application. We feed the time as to when the patient should consume the medicine. The user gets notified through mobile notification, LED glow and a Buzzer alarm embedded in the smart medicine reminder kit alerts when a patient is supposed to take medicine. Predefined users other than the patient can also get notified about the status of the medicine intake and medicine quantity through mobile application. The load sensor senses and notifies a nearby pharmacist. Such a system would be beneficial when there is a Pandemic like COVID-19 or an epidemic like Ebola, as the patient would get minimum physical assistance. We can use the device in hospitals and nursing homes on a large scale.

1. Introduction

IoT takes connectivity to the next level by connecting numerous devices to the web, working with man to machine and machine to machine interactions. IoT ecosystems are not limited to a particular field but have business applications in home automation, healthcare, factory line automation, medical, retail, vehicle automation and more.

IoT technology lets us produce real-time solutions in a global environment. Mainly, it provides us wireless solutions that can be utilised in indoor and outdoor conditions to monitor the environment and track objects distantly.

Perhaps the most appealing application for IoT in Healthcare, giving us a chance to various clinical applications, such as remote health monitoring, work-out plans, illness care and elderly care. The diverse implementations of the frameworks and products related to the Internet of Things (IoT) are transforming the medical services field. Patients and suppliers both stay to benefit from IoT. A few employments of medical services in IoT are portable (mobile) health applications of wearable gadgets that grant patients access to their health information.

In [2], A.P.Sankar et al. surveyed 45 people (including 17 clinicians). This survey revealed that more than thirty-three per cent of patients assumed that it is better to skip the dosage than take medicine later than the prescribed dosage time. Many clinicians disagreed with this assumption. This opinion makes the need for a Smart Medicine reminder kit stronger on a daily basis. Missed or delayed dosage of medicines and sorting of the medicines are regarded as our problem statement here. Many aged and people with complex medicine schedule face difficulty in managing their intake. Using the Smart Medicine Kit to solve this problem will help manage medicines and dose intake.

The Smart Medicine reminder kit that we propose reminds the medicine intake with a notification on the mobile phone and LED and Buzzer in the IoT Device. The kit reminds the patient and assures that dosage has been taken by notifying concerned personnel related to the patient and even notifies when the patient misses the reminder. It can also be used to collect data of the patient to analyse his health, concerned with the time of medicine intake by premeditating the consequences of missing a particular dosage. In paper, [5], has used an IoT based intelligent box to monitor health. Temperature sensor, Pulse Oximeter sensor and

glucose sensor are included in this box to monitor health along with providing medicine reminder. Paper [12], and [16] has briefed about how a smart medicine reminder device can be beneficial to blind people. A wearable can also be included in the device to make the system useful for deaf patients.

Additionally, a system like this would be beneficial during Pandemics and Epidemics. The proposed system would be handy for remote monitoring and timely medicine intake for COVID-19 diseased home-quarantined patients as there would be none to assist them physically.

2. Related Work

In paper[1] by Alen John Thomas et al. have efficiently used Raspberry pi, and Magnetic Reed switches operated by Stepper motors. They have made their model such that the medicine box is opened when the reminder occurs. A user may or may not come to take medicine. Exposing medicines to air might contaminate them or may lead to misuse by children unintentionally.

In paper [10] written by Abdul Minaam et al., they have used modules like pill dispensing, pill refilling, et cetera. The module for pill refilling is complex and could use more power to dispense a pill. Instead, we can include an LED screen to display the number of pills to be taken from the medicine box along with its name and save the data to mobile application through Bluetooth/WiFi module.

ARM 7 is used in the paper [3] written by Karishma K et al. and in the paper [6] by mrunali et al. In our model, we are using an Arduino, which can be interfaced with many more components and also be used to store and record data in the cloud.

DR. P. H. Zope et al. in paper [4] and papers[7], [13], [18], [22] have made a system with an LCD interface to display the data like time,compartment and medicine name which are related to the medicine intake. Additionally, this model can be made more usable by utilising a mobile notification for medicine intake reminder using a mobile application. Whereas, model in paper [8] has used an SD card for data input to the medicine kit, we use a mobile application.

In a similar use case by Cornell University students [11], the device provides an edge in avoiding the confusion of mixing up medicines by maintaining separate compartments but creates a problem of finding a ceiling for the number of compartments to provide as it varies from patient to patient.

Paper [9] written by Goncalo et al. talks about how even the smallest sensor data can be used in healthcare systems to enhance it.

In [20], authors propose a Non-invasive glucose sensing IoT system that makes use of an Opto-physiological glucose sensor, which uses a photo-diode and accelerometer to measure blood glucose levels. This sensor can be embedded in the medicine reminder kit to collect glucose levels without pricking the user's finger.

Kumar et al. in [24] stated a non-invasive method for glucose sensing that uses smart contact lenses that take the tears in a person's eye and measure the glucose levels.

IEEE has introduced IEEE 11073 standard, which caters to health and fitness devices. For example, in [21], medication dispensers, activity monitors, glucose level monitors, et cetera have been used to collect medical data that can be analysed later for providing health-related suggestions to the user.

In [14], the authors Jayesh Patil and Sameer Khairmode built the system such that pill intake time for particular patients is initially set in the system and can be changed by the patient to his requirement and the alarm buzzes at that specific time. An LCD screen is added to show the timing and make the system user friendly. After consuming the medicine, the system will update the pill number. Also, to check the pill count, if the quantity of box pills goes low, the order for a particular pill is sent by the system automatically to the medical store via SMS.

Authors of paper [23] aid us in understanding and reassuring us how Mobile health systems from an IoT perspective can be feasible in terms of data acquisition and security. They also suggest that mobile health devices will reduce the cost of healthcare and "can benefit patients in quick diagnosis, remote monitoring and home rehabilitation".

3. Proposed Model

The prescribed medicine dosage time is required to be set by the user through his mobile application, at which the device should remind the user for medicine intake. The user will get a notification at that time on his mobile notifying him to consume medicine. Apart from the user, any concerned/predefined user can also see if the medicine was consumed or not (See figure 1). At the time of the medicine intake, an LED will blink, and a Buzzer embedded in our IoT Device will ring along with a display of the number of pills to take in the LCD. When the user takes medicine, he can press a button to stop the Light and the Buzzer. Alternatively, we propose to embed weight and light sensors on the device to acknowledge the intake by confirming the difference in weight of the compartment when the medicine is taken and as the light sensor is exposed when the box is

opened.

3.1. Block Diagram of the Proposed System

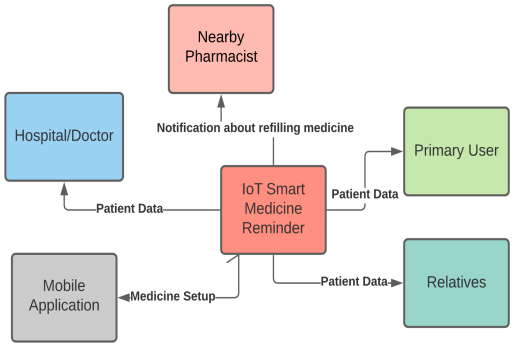

Figure 1. Block Diagram of the proposed system

The data collected from the smart medicine reminder kit, preferably using a mobile application as cited in papers [15] and [17] can be used for tracking the time at which the medicine is being taken, patient monitoring, analysing data from time to time to send reports of improvement or trends of ill-health by comparing with existing data sets. In this case to complete the system, IoT and Cloud can be integrated as cited in [19] and [25] (See figure 2).

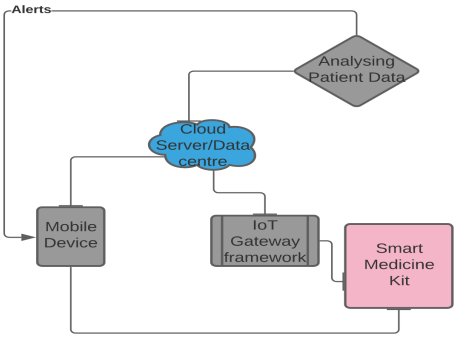

Figure 2. Flow of Patient/User data

3.2. IoT system Involvement

The IoT Devices' LED glows, and Buzzer rings for a certain amount of time, or we can set a button to control it. The IoT device also sends a notification to our mobile device when it is time for medicine intake(See figure 3).

3.3. Mobile Device Involvement

After the medicine intake time is set, the phone reminds the user to take medicine with a notification. The led glows on the corresponding compartment, and buzzer alarms on the IoT device when it is time for medicine intake. We also

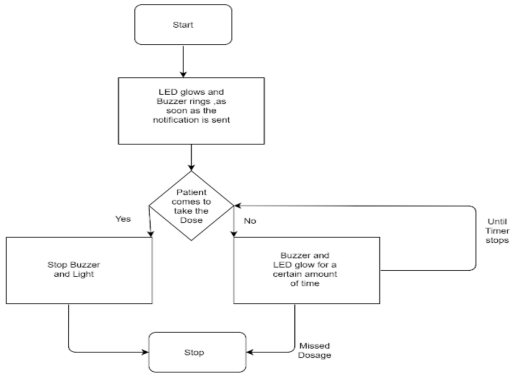

Figure 3. Workflow of our IoT Device Involved

record and keep a log of data stored in the mobile application for future use(See figure 4).

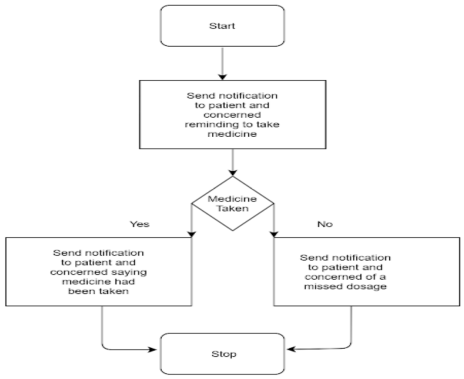

Figure 4. WorkFlow of our Mobile Device

4. Implementation

A set of hardware components is required to implement the proposed model. These are few essential components:(See figure 5):

- Arduino Uno Board
- LEDs
- Buzzer
- RTC DS3231 module
- Wifi ESP8266 Module
- Weight Sensor
- Light Sensor LDR
- Temperature Sensor LM35
- Glucose sensors
- Pulse Oximeter sensors

4.1. Hardware tools Required

1. Arduino Uno uses an 8-bit microcontroller ATmega328P, and it has a 32KB flash memory. Arduino Uno board makes interfacing easier as it can be connected to all other components. It also has an internal EEPROM that stores real-time data in it, and we do not lose the data stored in EPROM when the Arduino loses power. A set of instructions can be sent to the microcontroller by programming in Arduino Uno IDE.

2. The LCD screen is connected to Arduino Uno through some control pins, address and data bus. It displays what setting the system has been set to through the buttons. It displays time by communicating with RTC via Arduino Uno.

3. RTC module has I2C interfacing with Arduino Uno, and it keeps a time counter in real-time.

4. Led Blinks and the Buzzer rings as the reminder for time to take medicine.

5. Temperature sensor LM35, Pulse Oximeter Sensor and glucose sensor are used to collect patient data when he visits the medicine reminder kit. This data is sent to the cloud for further processing or analysing.

6. The weight sensor is to compute the difference in weight of the medicine compartment before and after the intake, enabling us to know the status of the intake and the logs of the box detail. It can also send notifications for refilling to a pharmacist when the weight goes below a threshold value.

7. Light Sensor is to know when and which compartments have been opened. It can be used to notify the user if a compartment is not close properly.

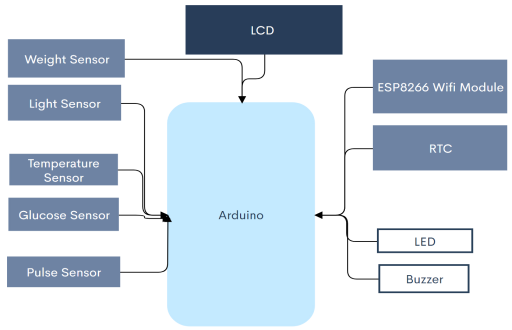

Figure 5. Block Diagram Of the sensors connected to Arduino

5. Experimental Results

We have simulated a basic version of the smart medicine reminder kit using Proteus Pro 7.

5.1. Software tools Required

We have written code in Arduino IDE for simulating a basic model. We use Proteus Professional 8, a software application utilised essentially for electronic circuit designs, to build the schematics for assembling printed circuit boards. We have written code in Arduino IDE for simulating a basic model.Arduino IDE is used to write and upload the code to the board.

5.2. Working of the Simulated system

Real-world connections can also be made in the same manner. The same code can be loaded, and the systems' behaviour will be the same. The simulated version is not very smart compared to the proposed model as it does include real-time sensing and processing of data. The circuit of the simulated system is given in figure 6.

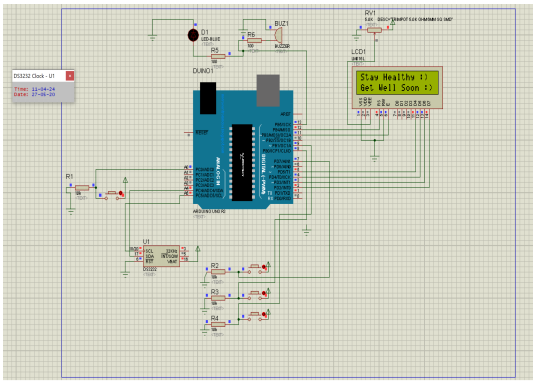

Figure 6. simulation Circuit

5.3. Flow chart of the Simulated Circuit

The flow chart depicts the workflow of the simulated circuit. The LCD screen keeps showing different screens until there is an input from the button. The time is set in the code, and when it is the time of medicine intake, the led blinks and buzzer rings until the stop button is pushed(See figure 7).

5.4. Basic Prototype of the smart medicine reminder kit

We are using Pulse Oximeter and temperature sensor, and their data is being transmitted to Thingspeak(cloud) via ESP8266 WiFi Module. This data can also be exported to hospitals and doctors. It can also be used for research and further analysis. On the other hand, the Bluetooth module is used to serve as a reminder from the app. For the prototype, we manually controlled the operation of LED and

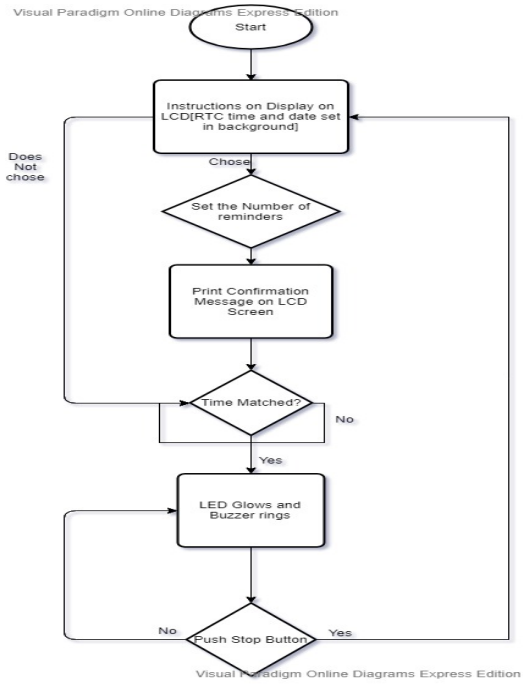

Figure 7. Flowchart of simulated circuit

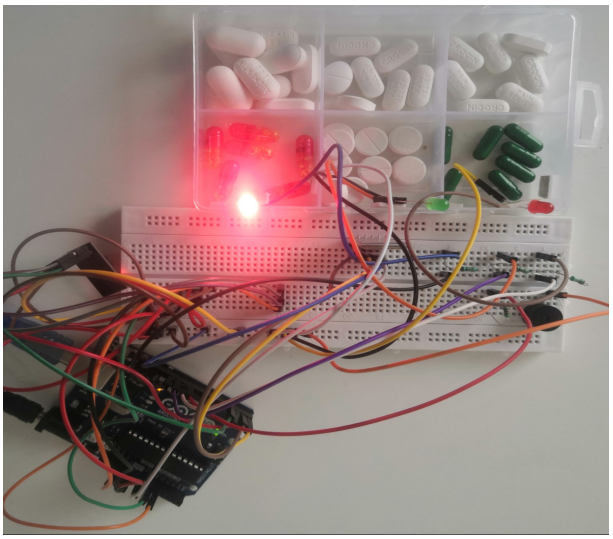

Figure 8. Basic Prototype of the Smart medicine reminder kit

buzzer due to the absence of the RTC DS3231 timer module. LED glows in the compartment of which the medicine is to be taken. The glow of LED in compartment one can be observed(Figure 8), indicating that the medicine in compartment one should be taken. Buzzer also rings as long as one of the lights is on, which acts as an additional reminder.

6. Conclusion

An IoT based Smart Medicine Reminder kit will be helpful for older people, people with a long prescription list, people who are unable to read the medicine description and can be used for tracking dose and not missing a dosage. Further, the multi-user feature can be useful for old age homes and hospitals by increasing the number of compartments. It will keep the patients' close ones informed about medicine intake, which is a necessary aspect of this model. Further, our model has new features of using a weight and a light sensor in the IoT device for notifying about refill and box open/close status. We aim to monitor and analyse the collected data at the data centre to come up with useful insights that may be helpful for doctors, patients and concerned relatives. The IoT-based smart medicine reminder kit will address the widely persisting issue of missed dosage by regular and occasional medicine consumers and provides several additional features to utilise the obtained information from the Smart Medicine Reminder kit.

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