MEDICATION REMINDER AND MONITORING SYSTEM USING IOT

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Abstract
The idea of digital world where the different types of sensors and local processing connected to share information is used in many industries nowadays. There are various products which are developed based on these ideas. Healthcare industry is one where lot of improvements is taking place. The proposed system consists of an IOT enabled medicine box which gives timely messages for the patients about their medication time.
It alerts the patients to take medicines at the proper time. The medicine details can be recorded in the mobile application by the patient himself or by the caretaker of the patient. The system helps to preserve track of medicine intake, stock of medicine and so on.
Index Terms: Internet Of Things, Medical reminder systems

I. INTRODUCTION

Modern life style and busy life leads to many problems and people may forget many important things. If they are suffering from any serious disease or illness then it is necessary to take medicines at right time prescribed by the doctor. If the patient is at home then the family members or care takers of the patient may remind patient to take the medicine at proper time. But every time it is difficult for the family members to tell the patients about the medication. For this purpose there should be some facility for the patient which will remind them about their medication time.

The software developed is an IOT enabled system which provides timely alerts and messages to users to notify them of the medicine intake. It has two modes: "in takers" mode and the "caretaker" mode. The system will function differently for the patient and the household member or caretaker. The scheme will generate reports regarding the medicine intakes, time of intake and will record the complete account of the medical details (including the wrong medicine intake, missed days and so on) at a pre-defined interval in "caretaker" mode whereas in "in takers" mode, it will remind /alert the person to take medicines for the day at the right time.

II. PRODUCT PERSPECTIVE

The major functionalities of the system are:
In "caretaker" mode, user can save the details about the medicine to take, timings and dosage instructions
The shelf alerting the user about medicine timing.
System sending out intelligent signals to respective caretakers.
Providing Cloud-based access to the caretakers where they can customize the holder.

USERS:
Three types of users who interact with the system are as follows:
Admin:
The person who developed the system and taking care of each activity of the System. He is responsible for any changes in the system behavior.
Patient:
Patient is the person who needs medical care. The IOT enabled system will generate an alert signal and notification so that the patient can take required medicine at the proper time.

Assistive Person/caretaker:
Caretaker is the custodian of the patient who has access to enter the details about the medicine, dosage and timings of intake. He even has the access to track the medication intake, stock of medicine and so on.

HARDWARE INTERFACES
Arduino Uno R3
It is a microcontroller board with 14 digital input or output pins (6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, USB connection, power jack, ICSP header, and a reset button. It has everything needed to support the microcontroller and we can connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

Memory
There are three types of memory systems.

- SRAM: This is called as Static Random Access Memory where the sketch creates and implemented when it runs. It is a volatile memory and 2 KB SRAM is available in microcontroller board.
- EEPROM : Long-term information can be stotred in this memory space. 1 KB of EEPROM is available on arduino boards. It is a non-volatile memory.
- Flash memory: This is a non-volatile memory storing Arduino sketch. 32 KB of space is available, of which 0.5 KB used by the boot – loader.

ESP8266 WiFi wireless Transceiver
ESP8266 is a WiFi module for adding WiFi functionality to an existing microcontroller project via a Universal Asynchronous Receiver/Transmitter serial connection.
Microcontroller can access the WiFi network by using the TCP/IP protocol stack. All WiFi networking functions are offloaded from another application processor and an application can behosted using this transceiver. This transceiver can be pre-programmed and we can hook this up to Arduino device. ESP8266 module requires 3.3V power.

Ultrasonic Sensor
   An ultrasonic sensor transmits ultrasonic waves into the air and detects reflected waves from an object. There are many applications for ultrasonic sensors, such as in intrusion alarm systems, automatic door openers and backup sensors for automobiles.
   This sensor is used to calculate the distance from objects. An LED can be used with the sensor, as nearer the object is brighter the LED.

Breadboard
   A breadboard is used to construct and test circuits quickly before finalizing any circuit design. The breadboard has many holes into which circuit components like ICs and resistors can be inserted. The breadboard has strips of metal which run underneath the board and connect the holes on the top of the board. The top and bottom rows of holes are connected horizontally while the remaining holes are connected vertically.

LCD Display
   Liquid Crystal Display is an image displaying technology used in many electronic devices.

Jumper Wires
   Jumper wires are used to transmit electricity between two points in a circuit. The wires either used to updating the circuits or to analyze defects within a circuit.

SOFTWARE INTERFACES
Arduino Software (IDE)
   This has a text editor for writing code and the programs written using Arduino Software are called as sketches. Sketches are stored with the extension '.ino'. which are stored in a standard place called sketchbook. Once the sketch is written, that can be uploaded to the arduino board. The Arduino IDE will display a message if the upload is successful or it will display an error.

Angular2
   Angular 2 is an open source JavaScript framework to build web applications in JavaScript and HTML. Angular 2 is faster and easier than Angular. It supports the latest version of browsers and also supports old browsers including IE9+ and Android 4.1+. It is a cross-platform framework. Angular 2 is mainly

focused on mobile apps. Code structure is more simplified than the previous version of Angular. **Advantages:** If an application is heavy, then Angular 2 keeps it fully UI (User Interface) responsive. It uses the server side rendering for fast views on mobile. It works well with ECMA Script and other languages that compile with JavaScript. It uses dependency injection to maintain applications without writing lengthy codes. The applications here have a component-based approach.

Apache Cordova

Cordova is a framework for developing mobile applications using HTML, CSS and JS.

Ionic

Hybrid mobile apps can be developed using a complte open-source SDK called Ionic. This is developed on the top of Cordova and AngularJS and it provides tools and services for developing hybrid mobile applications using technologies like HTML5 and CSS. Applications can be developed with these technologies and then distributed among app stores to be installed on devices.

Spring

Robust Java applications can be developed using a open source Java platform called Spring Framework. It is the standard application development framework for enterprise Java. Most of the programmers around the world use this to create easily testable and reusable code.

The core of the Spring framework is spring container which will create the objects, wire and configure them together and responsible for the complete life cycle till destruction. These objects are called as Beans. It is an object that is assembled, instantiated and managed by a IOC container.

MonetDB

MonetDB is a open source databse management system. It is a column oriented database system designed to give high performance on complex queries and against big databases.

III. SYSTEM DESIGN

Pill Box Design

An IOT enabled pill box provided with a set of compartments. It is designed in such a way that normal users can use it easily for their medication purpose. The control system of pill box comprises of sensors for monitoring and reporting the state of the environment and its associated control software, which regularly checks whether the medicine is taken or not. Whenever the medicine is loaded into the pill box it will be updated and the data will be stored in the database. Pill Box contains Arduino Uno R3 which is an open-source electronics platform. Arduino boards are able to read inputs and turn it into an output, for example turning LED on etc. User can control the board by sending a set of instructions to the microcontroller on the board. The user should register for this device using the device ID before using this device. No two users can register for the same device. The user should maintain a username and password authentication using the device ID.

The user should register with the application and the IOT device to start using the system. The user should be given the access to set a medicine reminder and other functionalities. After logging to the system he will get the details of the compartments and availability of the medicine. There will be alarm in the pill box which alerts the patient to take the medicine. It even indicates which medicine to take. The caretaker of the patient will also get the reminder using the mobile application.

Whenever the medicine is loaded in any of the compartments of the pillbox, the caretakers of the patient can record the accompanying details in the mobile application.
1. The name of the medicine
2. Amount (Quantity of intake)
3. Schedule
4. Exact Time to remind
5. Interval details
6. Compartment Number

The Entered details will be stored in the cloud and reminders will be set.
The details about each of the above activities will be stored in the local database. Whenever

net connection is available the details will be pushed to cloud database.

- The system will read the details from the database and generates the reminder to the user to take medicine and it also transmits a notice message to the mobile application. It will show a display message consisting of medical data and time stamp.
- The caretaker will get an alert whenever the medicine stock reaches a predefined minimum level. The system will read the details from the database and generates the reminder to the user indicating available medicine stock in the pill box. It will present a display message consisting of medical info and available inventory.

Caretaker

- The caretaker is responsible for filling up the medicines into the pillbox. Whenever the caretaker gets a stock alert message, he can occupy the box with medicines. There are many compartments in the box; different types of medicines can be filled in different compartments.
- The system provides alerts when it's time to take medication. These details are regularly updated automatically from the cloud. When there is a change in the dosage of medicine caretaker can update it through the mobile application. If the medicines were taken or not, alert messages will be transmitted to the caretaker and also the details will be stored in the database.

Mobile Application

Mobile Application consists of User Interfaces for-

User Registration

User can register in the application by providing necessary information. It includes caretaker's name, contact number, email id, age, username, password etc.

The registration form is validated with following validations.

- The username should consist of at least 5-10 characters.
- The password should consist of minimum 6 characters.
- Age should be an integer value.
- Contact number should have Max 10 digits.
- Once the details are entered, validation should be done if same username and email already exists. If exists, then an appropriate message should be displayed to the user.

Device Registration

A new user can register with the device by providing a valid details.

User Login

After successful registration,user can log in by providing a username and password. After successful registration in the app, login will be the default screen.

Medication Registration

Once the medicine loaded into the device, simultaneously user should upload the medication details using the mobile application. It consists of medicine name, medicine quantity, etc.

By using this information device will alert and send notifications on time.

User can save the following medical information.

1. Medicine Name
2. Total quantity of medicines.
3. Reminder time.
4. Image of the medicine.
5. Username.
6. Number of medicine that has to be taken.
7. Compartment Number in which the medicines are kept.
8. Reminder Days.
   - Every day
   - Specific days of the week
   - Days Interval

Homepage

This module describes medication timings and amount of dosage that need to be considered. It also indicates the stock availability in various slots.

Medication Alert

User can also set the medication alert to take the

medicine using the mobile application. Default color of the slot is Yellow and when it is time for medication it will turn Green. If sufficient quantities of tablets are not available in the compartment, then it will turn to Red.

Stock Alert
User has the option for setting a stock alert when the quantity reaches a particular predefined minimum level. A notification message will be sent to the mobile application. After receiving the notification caretaker can refill the medicine. The user will get the medicine type, quantity of medicine left in the stock as the stock alert.

Report
This module is used for bringing forth a report based on Patient's performance. The report indicates whether the Patient is taking the medicine on time or not. The user can get a The report consists of medication time, type of medicine taken, whether the medicine was missed at any time and so on.

Admin
- The Admin is the individual, responsible for designing, carrying out, and evaluating all functionalities.
- Admin responsible for maintenance of the application. He is also responsible for making alterations to the application. He is likewise responsible for providing customer service and he will demand a response from the customers and try to improve the performance of the application. He can generate reports on application utilization, the number of users using the application etc.

The system shall allow the admin to add users given the accompanying information:

- Username
- Password
- E-mail Address
- Age
- Contact Number
- DeviceId etc.

The system shall allow the admin to update user information of following fields:

- Name
- Password
- E-mail Address
- Age
- Contact Number
- Device Id etc.

IV. CONCLUSION

This system assures the safety of the patients and also prevents wrong dosages. It reduces the effort in remembering medicine and patients will get the schedule of the medicine containing medicine name, timings and so on.

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