

Survey on Smart and Safe Medication Box for Medication System with Timely Reminders

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Abstract- *Since the population of the world is ageing rapidly, how to provide appropriate healthcare to the elderly and disabled people becomes an important issue and draws high attention from medical, academic and industrial fields of the society. This smart and safe medication box based on IoT, aims to offer assistance about medicine taking with the support of smart devices as medicine cabinet and android applications. This medication box is targeted on users who regularly take drugs or vitamin supplements or nurses who take care of the older or patients. The medicine box is programmable that allows nurses or users to specify the pill quantity to take and the serve time for each day. The smart medicine box contains six separate sub-boxes which helps to organize six different pills, provides timely remainders for the patient or caretaker in an android application like hand-held devices like smartphone. This smart medication box contains bio-sensor for monitoring of temperature and heartbeat and also maintains temperature by means of adaptive cooling method. Overdosage and improper intake of medicines may lead to serious issues in health of elderly people to avoid mis-usage of medicines a simple authentication process either by the care taker or the patient himself is performed. The proposed medication is much safer and secure as it clearly intimates about time, dosage, stock of medicine and sorts out different pills in correct sub boxes during the next fill by caretaker.*

Indexed Terms- *smart medication box, Internet of Things (IoT), timely remainders, secure, Arduino, bio-sensors, smartphone.*

I. INTRODUCTION

The Internet of Things (IoT) is an integrated information network of future Internet where physical and virtual “things” with identities, physical attributes and intelligent interfaces are seamlessly connected. It

connects a large number of information and communication systems, in which people interact with information and communication technologies in support of business processes. According to Cisco Internet Business Solutions Group (IBSG), the Internet of things is regarded as the first real evolution of the Internet, and will lead to many applications with revolutionary potential for improvement of people’s way of life, work and entertainment.

Wireless broadband is seen as a prerequisite of IoT development, and it allows a wide range of different types of objects to benefit a lot from network connection. Radio-frequency identification (RFID) is often a method used to achieve unique identification of things, with objects equipped with radio tags that can be identified and inventoried by computers. Now many IoT projects are on the way of improving distribution of the world’s resources, closing the gap between rich and poor, and helping people understand the planet so they can be more proactive.

There can be a lot of individuals out there who need constant help, may it be our elderly people, family members, the ones who have special needs. Elders are more affected by the timing of taking a certain drug than others, in order to prevent any dysfunction or illness timing is a must. But as with aging comes poor eye sight and poor memory, what if the patient has a dementia like Alzheimer. Some people may forget to take the medicines at the correct time and can forget the medicines which they have to take.

- Elders Problems

A. Alzheimer

Alzheimer’s is the most widely recognized type of dementia, a general term for memory misfortune and other intellectual capacities sufficiently genuine to meddle with day-by-day life. Alzheimer’s illness represents 60 to 80 percent of dementia cases.

Alzheimer's isn't an ordinary piece of maturing. The best-known hazard factor is expanding age, and the dominant part of individuals with Alzheimer's are 65 and more seasoned. In any case, Alzheimer's isn't only an illness of seniority. Around 200,000 Americans younger than 65 have more youth-full beginning Alzheimer's infection (otherwise called early-beginning Alzheimer's) [15].

B. Missed dose

The build 'missed dose' is integral to numerous appraisals of medication adherence. Nonetheless, few examinations have explored how patients or clinicians conceptualize missed dosages or the degree of the concordance or harshness amongst clinicians and patients. Generally speaking, patients revealed a stricter meaning of missed measurements than did clinicians. Fifty-five percent of patients suspected that a pill-taking postponement of 6 h past the endorsed dosing time constituted a missed measurement, by correlation, just a single doctor concurred with this evaluation. More than 33% of patients believed that the best possible reaction to a missed dosage is skipped it through and through, yet just around 12% of clinicians concurred.

In order to eliminate the factors of always needed observation like nurses or taking a risk of a missed dose, we had to find an easy, portable and efficient solution. Medication boxes already exist but most of them are either has limited use, doesn't fit for elder ages or even has a big size that makes it not suitable to take it with you anywhere. In order to make a really useful intelligent medication box it had to be easily integrated with the recent sweeping smart technologies. While at the same time it had to be fit for the elders and their limited knowledge and experience to implement the ease of use. Size and portability was also an important fact that we had to keep in mind.

For it to be called smart, its connected through a wireless network, which enables it to be connected to the internet for future applications and integration, also its distinguished by the wide range of the Wi-Fi instead of a Bluetooth or any other field communication, and erase the need for any wires or wired connection which enables portability in the first place. Through that same network is connected to the mobile phone, which with you can set the timing

interval for the dose and also notifies you by many ways when the dose time comes. Also, we added a timer with a LED to make a type of physical warning, so that it leaves you no choice but to remember the medicine time and take it.

The aim of this study is to build an intelligent medication box for Medicine Reminder and Monitoring System. When the pill time has been set, the medication box will remind clients or patients to take pills utilizing sound and light. The warning of pills should be taken will be shown by an android application which is held by the patient. Contrasted and the conventional medication box that requires clients or attendants to stack the crate each day or consistently. This model can aid in help elders to take their medication.

II. BACKGROUND

Population Ageing Based on the report from the United Nations in Ageing and Development 2009, the average annual growth rates of population aged 60 or over, 80 or over are very high [1]. Figure 1. Average annual growth rate of total population, aged 60 or over and aged 80 or over.

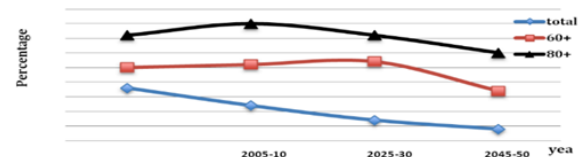


Figure 1. Average annual growth rate of total population, aged 60 or over and aged 80 or over

Figure 1 illustrates that the older population is growing faster than the total population of the world practically, the oldest-old one is growing even faster. In 2009, an estimated 737 million persons were aged 60 years or over, with this growth rate, by 2050, the world will get to the situation where one out of every five persons will be aged 60 or over [1]. Therefore, there is an increasingly desperate need for something that can improve life quality for those elderly people. For example, smart devices that are invented to detect vital signs of a person, or to send emergency messages to a healthcare professional when urgent help is needed, or to diagnose and determine the causes of certain

diseases after ingested into patients' bodies. The Internet of things can definitely meet this requirement.

III. METHODOLOGY

As pills have taken such an important role in everyday life there has been the past years an increase in the number of medical neglect cases related to incorrect medication given to patients. Any minor ignorance such as forgetting to take medicines or taking medicines at wrong time may cause potential fatal problems. The elderly people and people who are suffering from chronic diseases need to intake tablets regularly on timely basis. Care takers with their busy daily routine may forget the instructions and time about pills which are prescribed for patient. Also care takers who are dealing increased number of patients may feel hectic to sort the medicine list for corresponding patients at proper time. It is also difficult for the doctors or pharmacists to know the up-to-date information—whether it is time to fulfill prescriptions or take other urgent actions. Therefore, this smart medicine system for the elderly and impaired users enables to manage their self-care and keep medical intake working.

The smart medication box proposed in this work have specialized features including six sub boxes which helps to organize six different pills, provides timely reminders for the patient or caretaker in an android application like hand-held devices like smartphone. This intelligent medication box contains bio-sensor for monitoring of temperature and heartbeat. The proposed medication is much safer as it clearly intimates about time, dosage, stock of medicine and sorts out different pills in correct sub boxes during the next fill by caretaker.

IoT enabled medication box framework is composed of various compartments. The overall view in architecture is described below. The Microcontroller collects the patient's information using the bio sensor namely temperature sensor and heart beat sensor. Power supply as DC is transmitted to smoothening capacitor which modulates DC fluctuations from the rectifier then same DC current without fluctuations is given to the regulators. The voltages available allow these regulators to be used in logic systems, instrumentation, Wi-Fi modules module, bio sensors

(temperature and heartbeat sensor) and other solid-state electronic equipment's. The proposed medication box consists of sensors for collecting and reporting state of the patient through its related software control which continuously checks whether the medicine is taken on time or not. Usually supporting database hold the information about the capsules when they are initially loaded into the kit.

A. BLOCK DIAGRAM

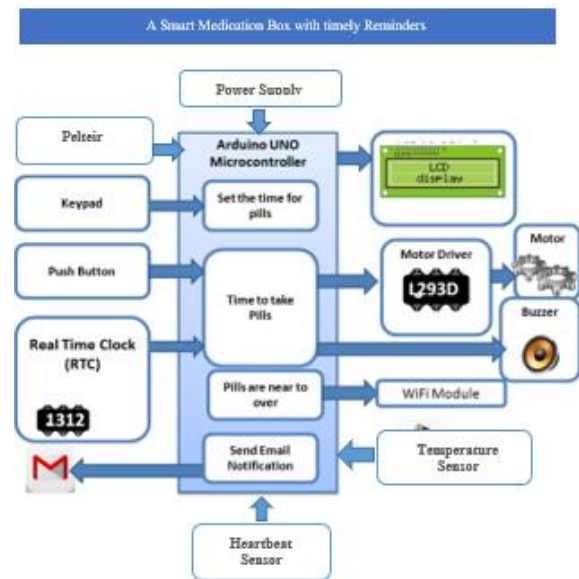


Figure 2: Architecture Diagram

B. COMPONENTS

- 1) RTC Module: Real Time Clock module is primary module in the medicine box to achieve the vital aim of the project. It is a simple module doesn't requires much voltage to operate i.e. it requires only about 5 volt. The function of setting the real time and date is done using this module. It doesn't get reset at the shutdown of the device. Also, the feature of reminding the patients by the alarm occurs at matching of real time and date with the preset medication time and date. This leads the patient to take right medicine at right time.
- 2) Bio sensors: The device is made up of a transducer and a biological element that may be an enzyme, an antibody or a nucleic acid. The bioelement interacts with the analyte being tested and the biological response is converted into an electrical signal by the transducer. Depending on their particular application, biosensors are also known

as immunosensors, optrodes, resonant mirrors, chemical canaries, biochips, glucometers and biocomputers.

Parts of a biosensor, every biosensor comprises:

- A biological component that acts as the sensor
- An electronic component that detects and transmits the signal.

So, a Biosensor is a combination of a biological sensing element and a transducer, which converts the data into electrical signals. Additionally, there will be an electronic circuit which consists of a Signal Conditioning Unit, a Processor or Microcontroller and a Display Unit.

The following is a simplified block diagram showing the important components of a Biosensor.

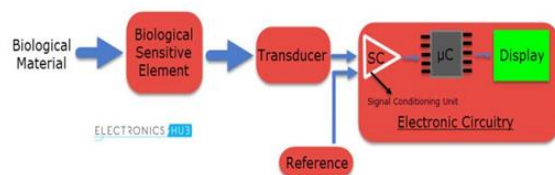


Figure 3: Block Diagram for Components of Biosensors

2.1 Temperature Sensor: The one of the patient's vital parameters as temperature is calibrated using LM35 sensor. It is a 5v operating module outputs in degree Celsius unit (i.e., for example, 101 degrees Celsius) whose analog output voltage is directly related to body temperature. This sensor has the capacity of measuring from -55 degree Celsius to 150 degree Celsius along with the sensitivity of about 10mv per degree Celsius i.e. 750mv meaning that 75 degree Celsius.

2.2 Heart Rate Sensor: The other vital parameter of patient's body as heart beat rate is calibrated using heart rate sensor. It is a 5v operating module having LED and Phototransistor arrangements on either side of the modules. Its output results by changing flux and changing resistance observed at phototransistor at the time of pulse check. The finger is put into the space between the arrangements to check pulse rate. The change in blood pressure causes variation in flux at

phototransistor. Further it results in variation in resistance which is directly proportional to the output of units of beats per minute.

- 3) **Arduino Uno:** Arduino may be a single-board microcontroller meant to form the appliance more accessible which are interactive objects and its surroundings. The hardware features an open-source hardware board designed around an 8-bit Atmel AVR microcontroller or a 32-bit Atmel ARM. This board consists of digital pins and analog pins and it can be interfaced with various expansion boards and circuits. It has 14 digital input/output pins during which 6 are often used as PWM outputs. This contains all the required support needed for microcontrollers.

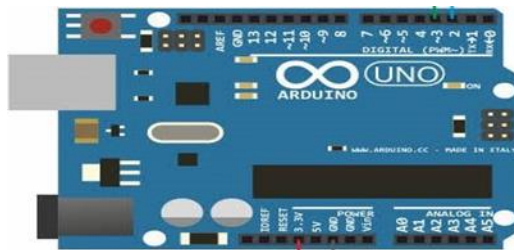


Figure 4: Arduino Uno

- 4) **GSM:** A GPRS or a GSM module is generally used as a communication between a microcontroller and GSM network as shown in fig 5. The SIM900A is a GSM / GPRS module which is generally used in mobile phones. This module is generally used for developing IoT based projects and also embedded applications. GSM module is a dual band engine. It operates on different frequencies like 850MHz, 1900MHz, 900MHz and 1800 MHz.



Figure 5: GSM module

- 5) **Wi-Fi Module:** The ESP8266 WiFi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is

capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi - ability as a WiFi Shield offers (and that's just out of the box)! The ESP8266 module is an extremely cost-effective board with a huge, and ever growing, community.



Figure 6: Wi-Fi Module ESP8266

- 6) Peltier Module: The peltier effect is the principle of this module which outputs the cold effect as a result of temperature differences between two sides when voltage transports from side to other side of module. It is a thermoelectric generator module operating at 12v supply along with exhaust fan and heat sink to get rid of heat generated as a result of cooling process.
- 7) Buzzer: Piezoelectric signals, or piezo ringers, as they are at times called, were developed by Japanese makers and fitted into a wide cluster of items amid the 1970se1980s. This headway primarily came to fruition on account of helpful endeavours. In 1951, they set up the Barium Titanate Appli-cation Research Committee, which enabled the organizations and achieves a few piezoelectric developments and creations. Piezoelectric materials are either normally accessible or syn-thetic. Piezoceramic is class of synthetic material, which postures piezoelectric impact and is broadly used to make a plate, the core of piezo bell. At the point when subjected to an exchanging electric field they extend or pack, as per the recurrence of the flag in this way creating sound.



Figure 7: A Buzzer

- 8) Switch: The device to begin/end the operation, an electrical component called switch is used. It cut off the electron flow to call off/make the connection. When the connection starts, the device gets ON and the device gets OFF when connection cut off. In medicine box, the binary digits '0s' and '1s' resulting from 3 or 4 single pole switches and emergency switch sends patients data through GSM to allotted guardian and doctors and simultaneously upload to the cloud storage.
- 9) Fingerprint Sensor: To secure the medicine box, here we had included the fingerprint sensor. Only authorized user can access the medicine box through their set fingerprint earlier to prevent misuse of drugs by unauthorized people as well as child security. The minutiae of fingerprints also called templates are stored in the database are involved in 1:N matching for verification to open the box when the optical scanner scans the current fingerprint pattern. It is interfaced through arduino with help of TTL logical level (UART) and scans with speed of about 0.5s and verification speed about 0.3s.

IV. FLOW OF SYSTEM

The flowchart represent the logic of the medication box when operating. Fig. shows the flowchart for implantation the smart medication box.

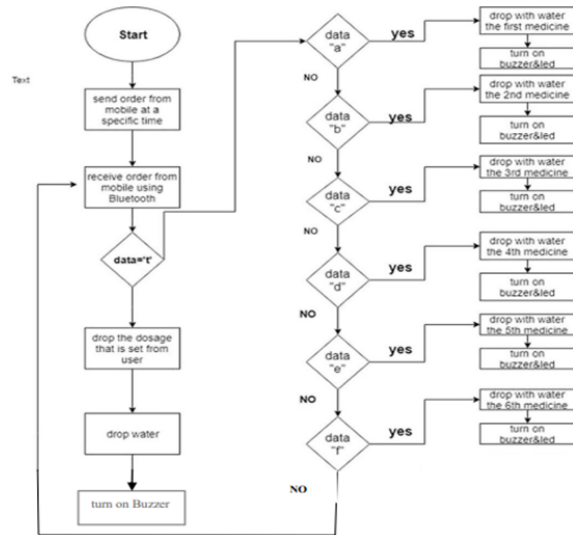


Figure 8: Flow chart

A simple block diagram was created to use as a template when designing the different parts (both physical and software) of the pillbox, this diagram can be seen in figure above. Arduino board will be the “brain” of the medication box, managing each one of the different areas and will be powered directly with the adapter. The notification block will be in charge of emitting sound and light signals for the patient to know a pill has to be taken and wireless signals to the caregivers. In a separate block the pill compartments and the pill dispensing mechanism will be also managed apart by the Arduino. Finally an external charger will be in command of charge the battery directly through the Arduino.

V. IMPLEMENTATION

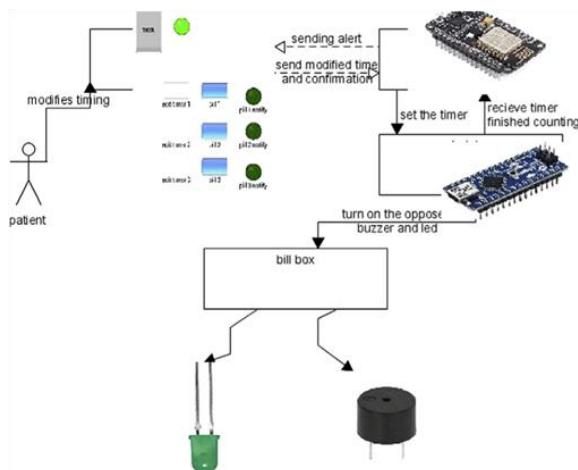


Figure 9: Implementation of Proposed System

PILL REFILLING AND DISPENSING MODULE

In the Pill refilling and dispensing module, the attender can refill the pill box as required. The refilling can be done from the top surface of the medication kit. Supportive pill box management software and database helps in refilling the medication box. A prompt will be given to insert a specific capsule and after inserting a button is pressed which completes the process of filling that particular compartment. After pressing the button next prompt will be given which insists the attender to refill the next pill continuously all the six different pills get refilled. Next pill dispensing is performed when the Arduino sends the signal, the pill which needs to be dispensed will fall in the tray. The pill dispensing module is responsible for selecting the correct compartment for dispensing from the pill storage. At a particular time only, single pill will be dispensed and for the next pill another signal will be sent from the Arduino. More than one pill will not be dispensed at a time which may cause fatal error. The Arduino controller monitors the pill loading and pill releasing. The smart medication box framework undergoes three stages every time when the pill falls in the tray i.e. pill loading, pill releasing and default stage after releasing the pill in the tray.

- **Timer:** The internal timer of the Arduino is controlled by the Timer One. The smallest scale of time in seconds is counted to set periodical timing for each dose by the timer. Initialize function is called to initiate the timer and Interrupt service routine is provided by controller.
- **Pill Chamber:** A cylinder with a circular hole at the centre is present in pill chamber which holds the medicines vertically. Only one pill can be hold in the cylindrical passage, the pill from the storage area will move out to the tray based on the timer notifications through this passage.
- **Android Application:** Medicine schedule is set and updated in the android application.
- **Motor Controller:** Motor controller is a control device which controls all the six motors to start and stop. It boosts the circuit while starting and de-boosts the circuit while stopping. Stepper motor selected may vary in design. The motor controller collects the input from the micro controller and transmits enough power to the stepper motor.

- LED: The Light emitting diode display will be a simple red light is nothing but the Light emitting diode. Power on and flashing with the beeps for alerting the patient during emergency situations.

VI. ADVANTAGES OF PROPOSED SYSTEM

- Better adherence to prescription taking: If the senior has a busy day, they could quickly get distracted and forget their medications. The pill dispenser will alert them either visually or audibly and ensure that the dosages are taken on time. And if you or they also have your dispenser's mobile app, that will also track your medications and remind you or them.
- Prevents errors: Seniors have a very high chance of skipping doses or taking the wrong meds. A pill dispenser makes it easy to remember, since they do not have to read doctor notes. They only need to pick their meds from the compartment once the gadget beeps. Smart pill dispensers also have back up batteries that ensure they work during travel or a blackout.
- Easier organization: These prescription managers have compartments that can fit a multitude of drugs at a go. When the doses are all used up, the gadget's lid will pop open to allow access to the compartments.
- Easy to use: The smart pill dispenser also eliminates the use of labels, which is excellent for the aging eye. There's no small print to deal with. Instead, there is a large LED display, which is super easy to set up.

VII. RESULTS AND DISCUSSION

A medication box is proposed and actualized. It illuminates the elders to take medication. It productively controls the season of senior citizens to take medication. It additionally diminishes the proportion that patient misses and defers taking medication. The remote user interface joins with the software programming so that the parental figures can help the patient. Which adds more functionality by applying more usability through networking locally or using the internet if it is available. The outline design is too appropriate for the medication bundles. Later on, we trust that the vitality sparing and compact can be

considered. In this way, missing and deferring taking solution can be totally eliminated.

Intelligent medication box is very useful for old age home environment with a patient managed by a single caretaker. Since care taker is not able to remember all the medicines and dosages of the patient. Patient and care taker are authenticated initially, pill refilling and feeding necessary information such as name, quantity, duration till the medicine should be used are done by the care taker. Based on RTC alerts the pills will move from the storage space to patient's tray. Proper dosage gets differentiated by milligrams measurement unit. From six different medicines based the motor controller alert any one pill will fall in the tray and the next pill for the second alert from motor controller and it goes on as user required.

CONCLUSION

The intelligent Medication box will be good choice for old age people and old age home. It can handle capsules of any size. The information feeding and capsule filling are done for a month duration. Six different medicines can be fed and dispensed, the number of medicines can also increase according to the patient requirement. Maximum three times the box will alert the patients, the number alerts can also be increased since the system is dynamic. The system is developed to explore possible combinations between real world issues and the visual technologies that we are increasingly depending on. This is an effort made to promote the utility of the Internet of things into our daily life, which is believed will dramatically improve people's life quality crop production in the longer run and increases the profit.

FUTURE WORK

In the future, the application can be to linked to med karts, if the tablets are empty, it directly sends a prescription message to the med kart in which they can help with delivering the prescribed tablets to our door step. Scanning of prescription to load the app can be done using image processing technology.

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