Smart Medication & Monitoring System for Secure Health using IoT

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Abstract - In modern society, busy life has made people forget many things in day to day life. The elderly people and the people victims of chronicle diseases who need to take the medicines timely without missing are suffering from dementia, which is forgetting things in their daily routine. Considering this situation study has been done in this. Paper reviewing the technologies of home health care which are currently used for improving this situation by reminding the scheduled of medicine, remote monitoring and update new medicine Consumption data of patients, which can be done by prescriber through IOT.

Key Words: Smart medicine box, old age patients, permanent diseases, setting up time table, bright light, notification, sound, sensing capability

1. Introduction

In day-to-day life most of the people need to take medicines which was not there in past couple of years and the reason behind this is diseases are increasing in large amount. So sooner or later many people come in contact with these diseases. Some diseases are temporary diseases while many are permanent life threatening diseases. Life threatening diseases gets mixes with the human body in such a way that they can't leave the body ever and they increases in rapid time[4]. Life span of humans became less because of such diseases and to overcome or to live a better life we need to take medicines regularly and also in large amount. We need to be in advice of Doctor who tells us to take desired pills in desired way so that patients face problems like forgetting pills to take at right time and also when Doctor changes the prescription of medicine patients have to remember the new schedule of medicine [7]. This problem of forgetting to take pills at right time, taking wrong medicines and accidentally taking of expired medicine causes health issues of patient and this leads to suffer from unhealthy life.

Our project is to make PIC Microcontroller based Smart medicine box which uses Real time clock. The new awaited feature in our project is our system is sensible that patient has taken medicine or not and thus the patient can't postpone the time on which he needs to take pills. It is compulsory for the patient to take pills from the box at the right time otherwise our systems continues to make large sound until the medicine is taken out from the box. This notification feature adds life years to the patient and thus this thing is not available in any device which is the necessity for present days.

2. Literature Survey

In this section, a combination between electronic and mechanical pill boxes or dispensers is presented. It's been included certain traditional pills organizers, which represents a first step in these developments and allowed us to obtain ideas about design useful patterns in development of this solution. In is presented a pill dispenser which has different prescribed administration schedules. It includes a plurality of pill storage compartments, each of them capable of holding more than one pill. This device has a pill detector and generates a signal to alert patients to take the prescribed medicine.

There are twelve storage compartments, arranged in a ring about a vertically rotating wheel. However, this solution has a limitation Due to this pill dispenser can only hold doses for 24-hours [9]. A current design presented in Cheyenne, shows a device that allows the storing and dispensing of pills and various supplements. In this section, a combination between electronic and mechanical pill boxes or dispensers is presented. It's been included certain traditional pills organizers, which represents a first step in these developments and allowed us to obtain ideas about design useful patterns in development of this solution.

In is presented a pill dispenser which has different prescribed administration schedules. It includes a plurality of pill storage compartments, each of them capable of holding more than one pill. This device has a pill detector and generates a signal to alert patients to take the prescribed medicine. There are twelve storage compartments, arranged in a ring about a vertically rotating wheel [2]. However, this solution has a limitation due to this pill dispenser can only hold doses for 24- hours. A current design presented in Cheyenne shows a device that allows the storing and dispensing of pills and various supplements (i.e., food, drug, supplements, liquids, powders or pills).This device works such as an alarm clock and may work with blister packed pills or alternatively uses an encapsulated compartment to hold and dispense loose pills[6].

Also, it can be connected by wireless to external environments (cellphones, computers). However, this device does not allow the management of several dosages and different Kind of pills. Another solution is the e-pill. It has in its stock various alternatives to organize and dispense pills, can be mentioned especially two i) A device dedicated to dispense pills composed by 2 medication trays, and 3 day-dosage discs. It has a circumference shape and it has turning compartments for each dosage time. The dosages are dispensed when an alarm is activated, this device does not use referential diseases, just use dosages per days, and is also not programmable for any schedule. ii) It is a reminder medication product focused on patients, caregivers or medical health professionals.

This device locks automatically and includes 2 keys. For patients trying to get medications before it is time there is tamper resistant. This device considers supply pills in one week, four times per day [8]. Also it has alarm and text message reminders disadvantages perceived are to close device by interaction of keeper and is not Independent.

As far as we know, more than it has been described before, there are many solutions which offers advantages as dispensing or alerting system however they do not provide an automatic reminder system, different alert forms or a study in IOT field, besides devices are economically difficult to access. In this work, it is proposed a solution that solves these problems [1].

3. Device Contribution

Improving lifestyle not only in elderly sick people also in general sick people is a main goal of this development; our device involves reliability and usability with a friendly technology. In the case of elderly people as in Marceline et al. It is well known with the years, the gradual degradation of faculties can affect the ability to cope with machine technology that is nowadays common in public spaces, like telephone cards and ticket machines (which requires physical and mental agility) or automatic tellers (where codes are needed to be memorized and alternatives must be selected rapidly)[3]. It is important to understand that these devices could become more an obstacle than an aid. This conclusion obtained through a study using two generations of men and women giving us a way to focus our priorities in development of a pillbox, considering parameters to interact correctly with elderly users mainly[5].

Achieving an appropriate reminder system combined with a new type of programming dosages inside a device may be a possible solution to currently. Interface that nowadays are everywhere to interact in a better way with a keeper or doctor who are tied most of the time to keep track from their patients, who can use easily technology interfaces. Give them partially release from that responsibility and focus only in load dosage in device[9]. While the interaction between patient and object. Won't be deep, is necessary to give a solution which doesn't complicate prospective interaction patient -pillbox, even though interact between them through technology is an important contribution which this work looks for. As Figure shows, a block diagram which summarizes the contribution of this paper. Here, it is an interaction between keeper and doctor (1) with the pillbox (4) through an interface (3) and a microcontroller. The device (4) sends notifications (5) to patient (6) and keeper (1). When a patient (6) takes the pill, there is an interaction between the pillbox (4) and a sensor (7).Finally, about that interactions are send.

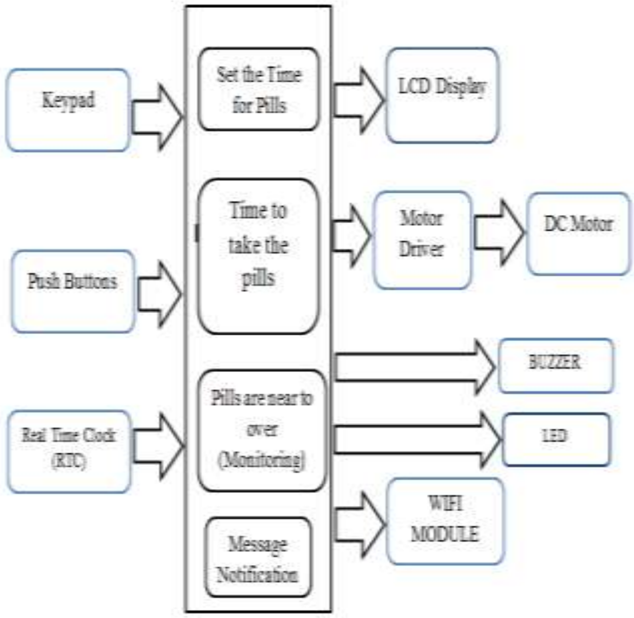

Fig-1: Block Diagram of System

4. Component

The elements have been selected due free hardware and software, and another, looks for functionalities that we pretend to give to the device. With these preambles, selected materials are listed below:

4.1. PIC 16F877A

The PIC controller compared to other controllers is with low cost. The clock speed of the controllers is high with the rate of 20MHz. 8Kx14 words of FLASH program memory, 368X8 bytes of data memory (RAM), 256x8 bytes of EEPROM data memory and this is enough for the temperature control application. At the maximum clock rate, a PIC executes most of its instructions in 0.2 micro seconds or 5 instructions per microseconds. It has high speed in executing instruction. The efficiency and accuracy is very high. The instruction set consists of 35 instructions. For executing a program it requires only small steps. Power on reset and brown out protection ensure that the chip operates only when the supply voltage is within sections. A watch timer resets the PIC, if the chip malfunctions and deviates from its normal position. Any one of the core clock options can be supported including a low cost RC oscillator and a high accuracy crystal oscillator. These versatile timers can be characterized by inputs; control outputs and provide internal timing for program executions. The PIC microcontroller has a number of inbuilt modules such as analog to digital converter, universal asynchronous transmitter and receiver that increases versatility of microcontroller. The PIC IC (Integrated Chip) is having wide operating voltage range from 2.5 to 6V, using power saving devices with a less power loss. The PIC start plus development system includes PIC start plus development programmer and machine perception laboratory. The PIC start plus programmer gives the product developer the ability to program user software into any of the supported microcontrollers. The PIC start plus software running under MP LAB provides full interactive control over the programmer[8].

4.2. 16X 2 LCD Modules

16×2 LCD is named so because; it has 16 Columns and 2 Rows. There are a lot of combinations available like, 8×1, 8×2, 10×2, 16×1, etc. but the most used one is the 16×2 LCD. So, it will have (16×2=32) 32 characters in total and each character will be made of 5×8 Pixel Dots. Operating Voltage is 4.7V to 5.3VCurrent consumption is 1mA without backlight Alphanumeric LCD display module, meaning can display alphabets and numbers Consists of two rows and each row can print 16 characters. Each character is built by a 5×8 pixel box Can work on both 8-bit and 4-bit mode It can also display any custom generated characters Available in Green and Blue Backlight.

4.3. ESP 8266

ESP8266 offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor. When ESP8266 hosts the application, and when it is the only application processor in the device, it is able to boot up directly from an external flash. It has integrated cache to improve the performance of the system in such applications, and to minimize the memory requirements.802.11 b/g/n/d/e/i/k/r support; Wi-Fi Direct (P2P) support,P2P Discovery, P2P Group Owner mode, P2P Power Management. Infrastructure BSS Station mode / P2P mode / soft AP mode support, Hardware accelerators for CCMP (CBC-MAC, counter mode), TKIP (MIC, RC4), WAPI (SMS4), WEP (RC4), CRC;WPA/WPA2 PSK, and WPS driver; Additional 802.11i security features such as pre-authentication, and TSN; Open Interface for various upper layer authentication schemes over EAP such as TLS, PEAP, LEAP, SIM, AKA, or customer specific;802.11n support (2.4GHz / 5GHz);Supports MIMO 1 1 and 2 1, STBC, A-MPDU and A-MSDU aggregation and 0.4s guard interval; WMM power save U-APSD; multiple queue management to fully utilize traffic prioritization defined by 802.11e standard; UMA compliant and certified;802.1h/RFC1042 frame encapsulation; Scattered DMA for optimal CPU off load on Zero Copy data transfer operations clock/power gating combined with 802.11-compliant power management dynamically adapted to current connection condition providing minimal power consumption; Adaptive rate fallback algorithm sets the optimum transmission rate and TX power based on actual SNR and packet loss information; Automatic retransmission and response on MAC to avoid packet discarding on slow host environment; Seamless roaming support; Configurable packet traffic arbitration (PTA) with dedicated slave processor based design provides flexible and exact timing Bluetooth co-existence support for a wide range of Bluetooth Chip vendors. Dual and single antenna Bluetooth co-existence support with optional simultaneous receive (Wi-Fi/Bluetooth) capability.

4.4. Node MCU

The Node MCU devkit is a development board with the ESP8266 mounted on it. It also has a USB to Serial convertor chip on board. This removes the need of the FTDI USB to Serial Converter. Also, it has a voltage converter on board for converting the 5V supplied by the USB port to 3.3V input required by the ESP8266. So all you have to do is plug the USB cable from the computer right into the micro USB slot of the Node MCU dev. board, and you can start with your ESP8266 programming / prototyping. The Node MCU provides easier way to program the ESP8266 module.

4.5. DS1307 (64 x 8, Serial, I2C Real-Time Clock)

The DS1307 serial real-time clock (RTC) is a low-power, full binary-coded decimal (BCD) clock/calendar plus 56 bytes of NV SRAM. Address and data are transferred serially through an I2C, bidirectional bus. The clock/calendar provides seconds, minutes, hours, day, date, month, and year information. The end of the month date is automatically adjusted for months with fewer than 31 days, including corrections for leap year. The clock operates in either the 24-hour or 12-hour format with AM/PM indicator[2]. The DS1307 has a built-in power-sense circuit that detects power failures and automatically switches to the backup supply. Timekeeping operation continues while the part operates from the backup supply.

4.6. DC Motor

DC Motors convert electrical energy (voltage or power source) to mechanical energy (produce rotational motion). They run on direct current. The Dc motor works on the principle of Lorentz force which states that when a wire carrying current is placed in a region having magnetic field, than the wire experiences a force. This Lorentz force provides a torque to the coil to rotate.

4.7. Infrared LED

Diode LED emitting infrared waves, this component has high reliability and high radiant intensity, its peak wavelength is p=3.7e-5in and 1.00e-7in lead spacing. Its applications are in free air transmission system or infrared applied system.

5. Testing Methodology

In order to verify the functionality of the device, a methodology developed for Paunovic, 2012 has been selected. It explained four phases for testing a device. Phases need to be executed sequentially, and then the transition to the next stage is only possible with positive report from previous stage. The advantage of this testing approach is providing a structured plan for finding and fixing errors and obtaining precise results

5.1. Hardware Testing

The first step of testing a device it is to examine the correctness of the device's hardware. It means to verify the printed circuit board, links, components on the PCBs, etc. On this case most of the components are PCBs, so it is important to check the correct state of each one[3]. In order to make that revision a Fluke multimeter has been used to measure the resistance of the lines and also to measure continuity of the layers.

5.2. Functionality Testing

In this phase we test the correct function of the components. Here we assembly those ones that have sub systems for example the display and its shield or the DC motor and its driver. We prove each component in conjunction with its software.

5.3. Stress Testing

The third phase of the test aims to verify the stability of the system when the environmental and other conditions differ from nominal, defamed by device specification [7]. This phase involves testing beyond normal operation, often deliberate causing failure of the device, in the interest or consideration of the testing result.

5.4 Robustness Testing

The final phase of device testing is to examine working in the conditions beyond nominal conditions, by improper use of the device, and the consequences of those situations. Robustness testing is defined as the degree to which a system or component can function properly in extreme conditions [8]. These two phases has been skipped, because the main goal of this study it's to prove the final functionality of the device.

5.5 Testing: "Medication System"

The system is composed by different modules that are controlled by PIC Microcontrollers. There are different types of communication of each module. It could be one way or two ways. Therefore the PIC Microcontrollers send commands to the modules but also receive data from them.

6. Conclusion

Older people play an important role in the society. They are part of the priority group of healthcare. Therefore, creating new devices using the emerging technology in order to improve their lives quality is necessary. The creation of alternatives of medication devices looks promising and necessary due to that today only 1 of each 10 people in need have access to such system due to high costs and a lack of awareness, availability, personal trainee, policy and financing . The introduction of such devices in IOT could lead us to a future where important information of patients would be available anytime and anywhere, in order to make a correct treatment and to prevent calamities. 80 Based on open source solutions, a new alternative to remind medicine dosages was raised. Arduino Mega, as main controller works totally right and gives many other opportunities to develop. The objective of creating a device that allows the organization of several medication schedules, automatic opening system and an effective notification system was reached. As is mentioned in future works section, design and functionality will change not only with perceptions in developers of this prototype, is necessary to investigate a fellow implicated in this problem. IoT is an important aim pretended in this device, finding a way to keep pillbox connected to Internet and it will help surely to manage in better form the treatments in patients, mainly in elderly patients. Scientific validation method used is dedicated to validate electronic equipment and applications, for the future works this method will change and it let us evaluate response between elder patient and keepers with pillbox and this one with the biggest network is Internet.

7. Future Scope

While this paper has demonstrated the potential of the assistive technology, from a specific and effective pillbox device, many opportunities for extending the study of this paper is remain.

7.1. Infrared System

As pointed on section 5, there will be an additional study of the actual modules, one of them is the IR system. The IR 333-A transmitter and PD 333-3B\HO\L2 receptor are used but they have a lot of problems on its operating distance and receiver angle. Therefore the study more precise IR system is needed.

7.2. Touch Screen CTE 50

Another module marked as inconclusive is the TFT LCD Touch Screen. In this process the touch function is not available, but the goal is to use this interface to configure the medication scheme. Methodology testing when the mal elements are selected, the phases; stress testing and robustness testing, will be completed.

7.3. Security

After the design is selected, a lock system will be added. The device will be used only by; doctors, keepers, and patients without significant disorders. They would only program the device with a personal password.

7.4. Raspberry PI

All this proofs has been done using the Arduino Mega Controller. For future works maybe a more powerful controller will be needed. Raspberry PI model 3B has been selected because it has a better processor, RAM, additional ports and interfaces, SD card slot, and also; 802.11n Wireless LAN, Bluetooth 4.1,BLE (standards used on IOT) are included.

7.5. Thermometer

A thermometer would be included in order to analyze the internal temperature of the device for the correct conservation of the pills. An alarm would be activating if the temperature exceed the previous set limit.

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REFERENCES

[1] Juan Marcelo Parra 1, Wilson Valdez \ Andrea Guevara\ Priscila Cedillo2, Jose Ortiz-Segarra, “INTELLIGENT PILLBOX: AUTOMATIC AND PROGRAMMABLE ASSISTIVE TECHNOLOGY DEVICE,” Proceedings of the IASTED International Conference Biomedical Engineering (BioMed 2017) February 20 - 21, 2017 Innsbruck, Austria.

[2] F. J. Lagrange and F. Jacq, "Developing an innovative oral unit dose robot dispenser: Patient care performance and industrial perspectives," Le Pharm. Hasp. Clin., vol. 49, no. 1, pp. 43-S6, 2014.

[3] F. Marcellini, H. Mollenkopf, L. Spazzafumo, and I.Ruoppila, "Acceptance and use of technological solutions by the elderly in the outdoor environment: Findings from a European survey," Z. Gerontal. Geriatr., vol. 33, no. 3, pp. 169-177, 2000

[4] P. Casanova-Sotolongo, P. Casanova-Carrillo, and C. Casanova-Carrillo, "Deterioro cognitivo en la tercera edad," Rev. Cuba. Med. Gen. Integr., vol. 20, no. 5-6,pp. 0-0, 2004.

[5] Aakash Sunil Salgia*, K. Ganesan and Ashwin aghunath, “Smart Pill Box”, Indian Journal of Science and Technology, Vol 8(S2), 189–194, January 2015.

[6] Sanjay Bhati, Harshid Soni “Smart Medicine Reminder Box”, IJSTE - International Journal of Science Technology & Engineering | Volume 3 | Issue 10 | April 2017.

[7] S.-C. Huang, H.-Y. Chang,Y.-C. Jhu and G.-Y. Chen, “The intelligent pill box-design and implementation,” in proceedings of the IEEE International Conference on Consumer Electronics, May 26-28, Taiwan.

[8] Health Information Technology. Improved Diagnostics & Patient Outcomes 2014 [cited 2015 May 22]. Available from: http://www.healthit.gov/providers-professionals/ improved-diagnostics-patient-outcomes.

[9]T.L. Hayes, J.M. Hunt, A. Adami and J.A. Kaye, “An electronic pillbox for continuous monitoring of medication adherence,” in proceesings of the 28th IEEE EMBS Annual International Conference, Aug. 30-Sept. 3, 2006.

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