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MEDIC-The Smart Medicine Dispenser

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Abstract*: *Aged had to be medicated on time, MEDIC is a specially designed smart medication dispenser is for the persons taking medications without having a close supervision or guidance from a medical professional, user will not be exposed to an error prone task of administering misdosage of medicine at the wrong time. The components of MEDIC are microcontroller, an OLED display, stepper motor drivers with stepper motors, alarm system, a multiple tablet container to store different types of tablets and dispenser for medicine storage and dispensing and a cooling compartment for vaccine storage. The overall procedural operation helps the caretaker to feed the prescription and the time to dispense multiple types of tablets into the container. The Alarm System is incorporated to provide two types of indications one by LED light indication and the other by providing a buzzer sound. The user is required to consume the pills and press the reset button to bring back the container position near the funnel and there is an alarm to check for the tablets in the pill container and to inform the caretaker to fill the dispensing container with pills. These two alarms are also alerted through a message alert to the users through their cellphone.

Index Terms: MEDIC, OLED display, LED, Stepper motor

I. INTRODUCTION

Caring of the aged is of an important and serious concern in the developing nation. Family members are responsible for the care and management of the old. In the present situation of the society it is impossible and yet difficult for family members to be available and assist the elderly population all the time. As they would prefer to be independent and their desire for independence is quite natural. Although, the aged fail and are unable to remember to the intake of medicines on time. MEDIC-The smart medicine dispenser is such a device prototyped to help the elderly to consume medicines in time and efficiently also. Since the expenses of in-home medical care and practice rises, the availability of such device in every home is difficult and it has become more difficult among individuals to opt for a dispenser that effectively monitors their health. [1] The project aims at the design and construction of an Assistive technology that helps in assisting the user especially elderly for medicine intake time to time without any misdosage and skipped dosage.

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This can be achieved by designing a controller system that will store and dispense tablets as per the prescription given by the doctor, using sensor and actuators such as temperature sensor, stepper motors, Mechanical dispensing parts these actions can be programmed accordingly by interfacing an RTC module to microcontroller resulting which right dosage of medicine are dispensed at right time and parallelly message alert is sent as an indication for the consumption.

I. RELATED WORKS

There are several types of pill dispensers available in the market that are produced by different companies which consists of in-built alarm systems to notify the users without having online database to save the users and pills, or having remote access functionality.

- An electronic tablet dispenser realized using microcontroller, LCD and a Keyboard that lets the user schedule the pills manually on a container. It dispenses the tablets and gives an audio to alert the patient. Also, a message is sent to the caretaker's mobile number in case if the pill wasn't taken [2].

- A pill dispenser was constructed using a combination of IR sensors and microcontroller with an alarm system to help the patients to take their pills at the proper time. The alarm system was interfaced using a screen notification on smartphone [3].

- Another tablet dispenser that is constructed using Arduino controller that dispenses one unit of tablet at a time to prevent overdose. Then it gives a notification to the user via message alert informing that the tablet is ready to be consumed. Also, it is connected to an android app that is used by the caretaker to edit the date and time of the pills to be dispensed [4].

II. METHODOLOGY

MEDIC is an assistive system which has various advantages over the existing system, those being the cooling system, storage compartments with freezing temperatures, easy to load pill trays, multiple user interface, multiple prescription enabled loading and text to speech output for visually impaired people.

The system that takes the idea of automated dispenser to the next level as it has some functions that are not seen in any other automated dispensers. An account is

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provided for each patient and no one else can access it except the patient and the caregiver, these credentials are provided to him/her and can be input to the controller to load the prescription of medicine using the keypad.

This section describes the methodology of the proposed prototype. The block diagram which is shown in figure 1 consists of the design of MEDIC and its I/O peripherals. A system that is be responsible of controlling the whole dispensing action, alarm action and message alerts is designed. The smart medicine dispenser must be able to isolate and dispense a single pill from a dispenser, regardless of size and shape of the tablet.

III. BLOCK DIAGRAM

MEDIC has various advantages over the existing system, those being the cooling system, storage compartments with freezing temperatures, easy to load pill trays, multiple user interface, multiple prescription enabled loading and text to speech output for visually impaired people.

To dispense the pills, the phone will auto connect to the Arduino controller via Bluetooth and starts sending commands which indicate the container and motor that should be rotated to dispense a particular pill from the container. The device will store multiple types of pills, just in case if the patient is consuming more than one medication. The device has to send patients a message and indicate the correct time of intake of medicines as well alarm that the dispensed medicines is ready for consumption. The device will communicate and manage externally through a mobile application.

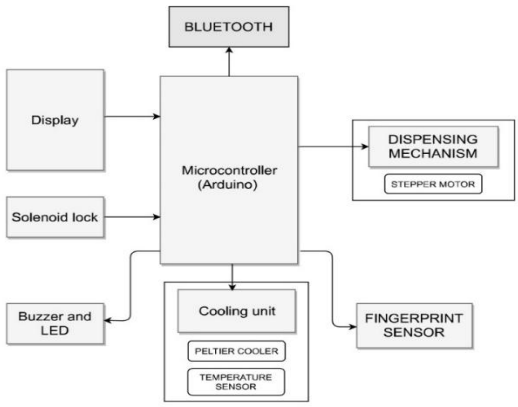

Fig. 1: Block Diagram of MEDIC

MEDIC used various hardware components, the characteristics specifications and working of each of these are discussed in this section. These devices are categorized as INPUT and OUTPUT devices and are interfaced with Arduino microcontroller. It is a simple electronic remainder and dispenser system comprising of the following components:

A.Arduino Uno

It controls the whole dispensing action of the smart medicine dispenser, the control of the stepper motors, Bluetooth communication between the controller and the android app, fingerprint sensor interface, temperature sensor interface, relay module interface and control and button switch interface. Arduino microcontroller is easy to program and easy circuit construction compared to other microcontrollers available.

B.Thermoelectric Cooling Module

Thermoelectric cooling shown in figure 2 uses the effect known as Peltier effect to generate a heat between their junction, which are made up of two types of materials. A Peltier cooler/heater, is a solid-state device which transfers heat from one side of the surface to the other with consumption of electricity, this is dependent upon the direction of the flow of current. Such an instrument is called a Peltier device or TEC. It can be used either for heating or for cooling, although in practice the main application is cooling. It can also be used as a temperature controller that either heats or cools.

C. Fingerprint Sensor Module

Fingerprint reader is a scanner used to identify a person's fingerprint for security purposes. After a sample image of fingerprint is taken, access to a cooling unit system is granted if the fingerprint of the user matches to the stored input database

Fig. 2: Peltier cooling module [7]

IV. HARDWARE IMPLEMENTATION

This section describes a modular prototype, with expandable container units. Each container is controlled separately with its own stepper motor and can keep up to 7 servings (a serving can consist of multiple pills of the same type). Stepper motors are used to rotate the cylinders; the motors are controlled by an Arduino Uno, using PWM signals that make the servo rotate for a bit then stop. When the user has to consume medicine, the smartphone will connect to the Arduino via Bluetooth interface, and sends a command so as to tell which container should be rotated and the tablet has to be dispensed.

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The Arduino will then verify if the command is valid by checking if the command string starts with a "c", the character that comes after the "c" is the container number which will be used to trigger the desired container. The following are the various interfaces with Arduino in order to function the dispensing mechanism in MEDIC.

A.Push Button Switch Interface

The interface between arduino and four switches are used to control two stepper motors for their rotation motion in both clockwise and anticlockwise direction. These button switches are connected to the digital i/o pins of arduino and their states (high/low) are read by the arduino, checked for the condition and rotation function for steppers are executed.

B.Fingerprint Sensor Interface

The fingerprint sensor can store up to 240 fingerprint images and can be processed for checking the biometric of the user for the opening and closing access of the cooler door(cold storage of medicine).Initially the fingerprint of the user has to be enrolled into the sensor and then the same can be used to check every time when a finger is placed on the sensor scanner and is checked for the match to activate the relay through the digital pin D9 and the solenoid lock will unlock to access the door. The fingerprint sensor works on 5V and it is connected to Rx and Tx pins of arduino for transmission and reception of image data.

C.Temperature Sensor Interface

The temperature sensor is used to measure the internal temperature of the cooling unit and checked for the storage atmosphere of the medicine storage, the absolute storage temperature for medicine being 2-9 degree Celsius for vaccines and 10-12 degree Celsius for other medicines, this has to measured and maintained for an efficient cooling action of the unit. The DHT 35 temperature sensor gives both digital and analog values and through the program we have to convert these analog values into its equivalent temperature measurements.

D.Relay and Solenoid Interface

The locking mechanism of the solenoid is controlled through the arduino microcontroller. The solenoid lock is working at a high voltage of up to 12V, since arduino cannot supply this voltage an external supply is given for the functioning of solenoid through the relay module.

V. WORKING AND RESULTS

A.Pill Storage and Dispensing mechanism

As shown in figure 3 a 3D printed wheel and a cap is used for storage and dispensing each unit of pill. Regardless of the radius and shape of the pill it can be stored inside the wheel slots with a storage capacity of 14 pills and this wheel is covered with a wheel cap which has two slots/openings for input and output of pills, such type of multiple dispensing units can be replicated for the storage and dispensing of multiple types of pills.

B.Cooling unit for medicine storage

Figure 4 shows the cooling unit which is nothing but a container for the storage of medicines and vaccines with a nominal temperature from 2-5 degrees Celsius, its door is fit with a locking mechanism and interfaced with a fingerprint sensor such that only authorized person can access the unit. The cooling unit comprises of a peltier module which helps the reduction of temperature inside the box making it suitable for medicinal storage.

Fig. 3: Dispensing Mechanism

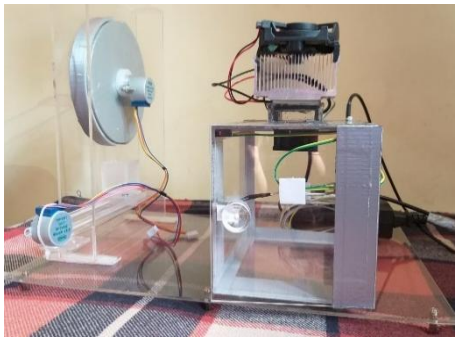

Fig. 4: Cooling Unit

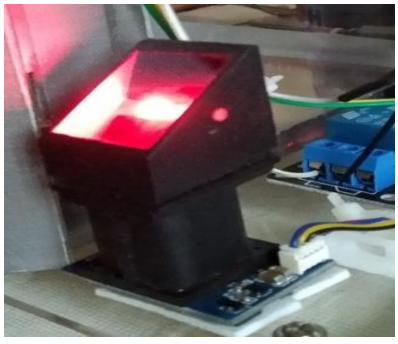

Fig. 5: Fingerprint scanner

C.Temperature and Humidity Display

Figure 6 shows the display interface which shows the temperature readings from DHT 11 sensor indicating the internal cooling temperature of the storage unit.

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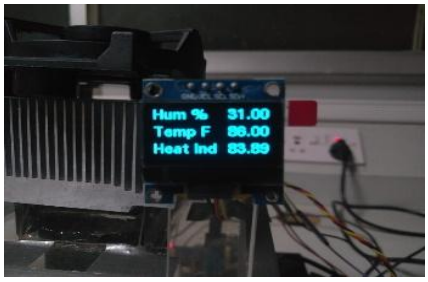

Fig. 6: Display

VI. APPLICATIONS

This device works as a reminder system for patients to take their medication at the right time. Prevents the errors of misdosage and doctor prescriptions. It has a separate compartment for the storage of vaccine. It has an inbuilt cooling system for the storage of the medicine. Easy to use as we can input all the medicine names and also upload the doctor's prescription into the device. The proposed system is beneficial for patients who have one or more chronic disease. Patients who need to take multiple medications or have complex medical regimens. Patients may have been hospitalizing already for missed and overdose medication. People who are visually impaired or visually challenged can use this device. Elderly with poor memory have a major problem in recognizing the medicinal dosages. This device can be used in a house where more than one person is suffering from chronic disease and store their database according to their prescriptions and medicines.

VII. CONCLUSION

This paper summarizes the major benefits of MEDIC. Elderly patients, especially the ones with chronic disease and has to intake medicines periodically. Since it will greatly increase their medicine adherence which will ensure a better treatment effectiveness or even save their lives. Insurance companies will benefit from MEDIC since it will help the customers to live a healthier lifestyle and push away from deadly accidents caused by forgetting to consume their medicines with the right dosage and in case of skipped pill, the Caretaker will get alerted almost instantly via SMS. The overall procedural operation helps the caretaker to feed the prescription and the time to dispense multiple types of tablets into the container. The Alarm System is incorporated to provide two types of indications one by LED light indication and the other by providing a buzzer sound. Finally, the user interface which is simple and easy to use by everyone including the elderly population. The design allows the user to add more containers or more pills per serving.

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