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Preprogrammed Pill Dispenser for Elderly Care in COVID-19 Pandemic

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ABSTRACT: Sometimes there is a necessity to be self-isolated during pandemic attack. In such scenario, the patients would probably forget to take right medicine at the right time. In times of COVID-19 pandemic, where we need to follow self-quarantine, there is a need to develop a pill dispenser with a preprogrammed feature, which will be used by the elderly or infected people. The proposed pre-programmed medicine dispenser is designed with alerting module using alarm and camera unit. The continuous monitoring can be provided. The patients are able to take medicine without close professional supervision. It prevents the problem of un-timing, over dosage etc. The overall operation is to facilitate the user to set the timings to dispense multiple pills at required timings. The Alarm system is designed to provide two types of indications – one by lighting an LED and the other by providing a beep sound. After taking the medicine from the dispensing tray the alarm can be reset. The second alarm is to indicate the optimal availability of the pills in the container to warn the user to refill the dispenser with the required quantity of pills. The camera is interfaced with the dispenser which is enable us to view whether the patient has taken medicine. It can be sent to mail using Wi-Fi module attached. The primary motive of this dispensing unit is to be cost effective and also reliable. The software code is compatible and it can be upgraded.

Keywords: Automatic medication dispenser, cost efficient, elderly care, microcontroller, pills, warning alarm

Abbreviations: LED, light emitting device; LCD, liquid crystal display; GSM, global system for mobile communication; RTC, real time clock; IDE, integrated development environment; Wi-Fi, wireless-fidelity.

I. INTRODUCTION

In the season of pandemic attacks like COVID-19 or SARS, the aged people are the most suspected victims. To provide care for them is of a serious concern in the developing countries like India. Their family members are responsible for the care management. Currently elderly people prefer to be independent and they restrict themselves from other people in the family rather they like peer group friendship. If a person fell sick it may be end up in severe consequences where no family members will be nearby them to take care. In some elderly care homes, they have caretakers who will be taking care of them. Sometimes despite their best effort, the aged people fail to remember to take their medication on time. The proposed preprogrammed pill dispenser (PPD) is one such approach which is designed to help them to take their medicines at regular interval of time. As the in-home medical care cost in a developing country is much higher, which leads the individual to think for a cost effective solution. The proposed medicine dispenser serves the purpose. Many smart pill dispenser are available and many have designed. But their purpose are only delivering the pills at regular intervals of time. The proposed model comes with monitoring unit, where the care giver can continuously monitor the regular intake of pills. The proposed model aims to make things easier for such patients by providing an automated medication dispenser which provide the right dosage every time and also has a reminder for the patient. The tracking of patient movements, their medicine intake is carefully monitored using this model. The rest of the paper is designed as section II includes literature survey, section III includes methodology, section IV includes working and section V includes future scope and conclusion.

II. LITERATURE SURVEY

Authors have proposed advanced pill dispenser, in which only authenticated person alone is allowed to get access to it. It is done by using RFID module. The system is designed using, ChipKit Max32. It is designed for single medicine only [1].

Also proposed the dispenser unit which has database information about the medicine and provides human interface GUI. But it doesn't make sure about the genuineness in taking medicines. The system doesn't provide any tracking methods [2].

Pak & Park [3] provide the scalable feature of medicine dispensing tray unit. The status of the medication and system configuration is sent to the monitoring server, which is for remote management. In the case of any deviation occurring that status is immediately sent without any delay. The deviations can be of shortage of medication, memory overload, software error, or nonadherence. All these operations are performed automatically without the intervention of patients, through the agent program installed in the dispenser. The movement of patients are not able to track with this scheme.

Minaam & Abd-Elfattah [4], provides the design and creation of a pillbox prototype which can able to solve the medicine deficiency in the remote area. The developed prototype is able to sort out the pills and also have some advanced features, which can be used in hospitals or retirement homes. The initiation of taking tablets is done by android applications. Rantanen *et al.,* [5], undergone a study where robots are engaged in providing health care.

Ahadani *et al.,* [6], have introduced the design and fabrication of a low cost scalable prototype of robotic medicine dispenser for the use of pharmacists. Penna *et al.,* [7], designed a machine which is based on computerized enabled storage system. It is designed to hold some basic and emergency medicines. The people can use this system without approaching any pharmacy in case of any emergency. The developed kit can be installed in the remote areas like long highways, desert areas, remote tribal areas and rural areas.

Mugisha *et al.,* [8] aimed at developing low-cost, portable and easy-to-use pill dispenser that addresses the infrastructural and economic challenges of low-income families, especially in developing countries. Tsai *et al.,* [9] presents the architecture and implementation of an automatic medication dispenser for users who take medications without close professional supervision. The tablet recognition is done using support vector machine classifier. This idea can also be incorporated in further enhancement. In which if a bowl contains many tablets also it will recognize and sort it out. The patients are taken care only with human intervention. Now with advancement in technology, the programmed kit is designed to help the old people. That too during the time of pandemic like COVID-19, many people lives are in threat for infection. Hence this proposed model will serve the purpose.

III. METHODOLOGY

The block diagram of the proposed work is given in figure 1.

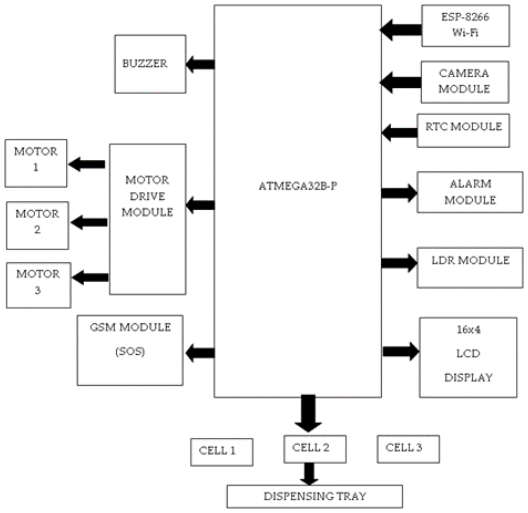

Fig. 1. Block diagram of proposed model

In the proposed model, the patient or the nurse or the health care provider sets the dosage of the medicines and the time when the patient has to take the medicines. This is carried out via the keypad and LCD. The LCD in the pill dispenser displays how the patient has to set the alarm and the dosage which the patient enters via the keypad. The time and the dosage entered via the keypad is stored in the Atmega-328P used in the pill dispenser. A RTC is used to keep the time running even if the power goes off in the pill dispenser. The RTC has a battery which allows it to increment the time even if the power goes off in the pill dispenser. The Atmega-328P is programmed in such a way that it reads the time from the RTC and compares it to the alarm time entered by the user, and the moment the alarm time and RTC time match the alarm goes off and the pills are dispensed. The pills are dispensed by solenoids. The solenoids push the pills the same number of times as the dosage entered by the user. The pills are arranged in a stack manner in a tube which has opening at the base for the pill to be pushed out and the solenoid to push the pills. In order to make sure the patients are taking medicine, the work includes a camera module. The images/ video are sent to mail using Wi-Fi module.

A. Hardware Components

The hardware components includes the following,

- Atmega-328P
- 12v relay
- Solenoid 5v
- 16x2 alphanumeric LCD
- 4x3 keypad matrix
- RTC DC1307
- Buzzer
- ESP 8266 Wi-Fi module
- Camera module

ATMEGA-328p. It is a product from Microchip. It has been used for its high performance and low power features. The controller used belongs to ATMEGA family with series number 328p. It is an 8-bit microcontroller based on AVR RISC architecture. It has 28 pins. It supports SPI, UART and I2C communication interface. It has on chip ADC with 6 channels with 10 bit resolution. The controller has timer module with capture and compare modules [10].

Relay. A relay is an electrically operated switch. The purpose of the switch is to turn on or off the appliances connected to its end. The relay also do the same. It is a current and voltage controlled device. By allowing the current to flow or not and can be controlled with low voltages, like the 5V provided by the Arduino pins.

The interface diagram of relay with Atmega-328P is given is figure 2.

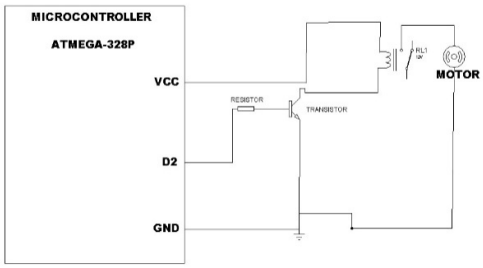

Fig. 2. Interface relay with controller.

Solenoid. A solenoid is formed by making a long piece of wire to a shape of coil. A uniform magnetic

field is created, when the electric current passes through it. This created magnetic field will generate a linear motion with the help of a metal core. This simple device can be used as an electromagnet, as an inductor or as a miniature wireless receiving antenna in a circuit. The interface diagram of solenoid with Atmega-328P is given is figure 3.

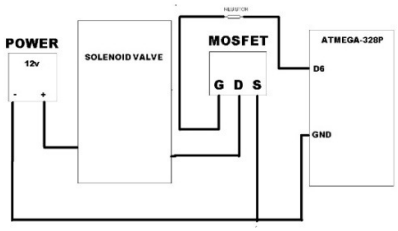

Fig. 3. Interface solenoid with controller.

Alphanumeric LCD display. The liquid crystal display is used as an output device which displays the medicine description, timing details etc. It is controlled using LCD library and interfaced with the controller using a driver IC. The interface diagram of display with Atmega-328P is given is figure 4.

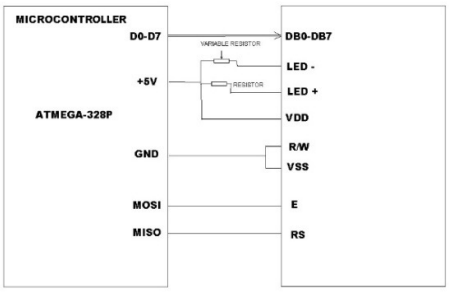

Fig. 4. Interface LCD with controller.

4 x 3 Keypad. The keypads are used to entry the time details, dose level. In other ways to provide authentication, it is used provide password. It is the combination of push button switched arranged in the form of matrix. Several variants are available, it can 2x2, 4x4, 4x3, 4x5 respectively.

So there are rows and columns of switches. 4 rows and 3 columns are connected to the pins of the controller, When a particular key is pressed the corresponding value is read by the controller and it can be written a software code. The interface diagram of keypad with Atmega-328P is given is figure 5.

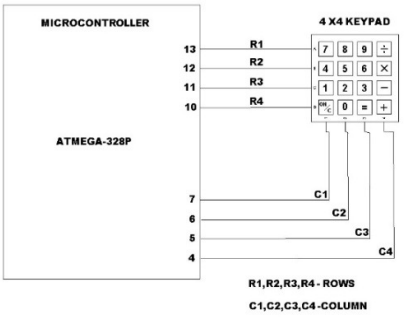

Fig. 5. Interface Keypad with controller.

RTC. It is a computer clock available in IC form which keeps track of the current time. It is available is computer servers and embedded systems, which needs to keep accurate time. The interface diagram of RTC module with Atmega-328P is given is figure 6.

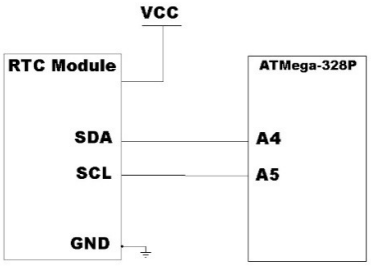

Fig. 6. Interface RTC module with controller.

Buzzer It is an audio signaling device. Depends on design it may be mechanical, electromechanical, or piezoelectric (piezo for short). The application of buzzers includes alarm devices, timers, and confirmation of user input such as a mouse click or keystroke. The interface diagram of buzzer with Atmega-328P is given is figure 7.

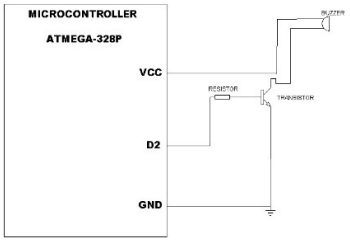

Fig. 7. Interface Buzzer with controller.

CAMERA. The camera module is interfaced with controller which enables to track the motion of the patient. It also enables to make sure that patient takes the tablet regularly. The interface diagram of camera module with Atmega-328P is given is figure 8.

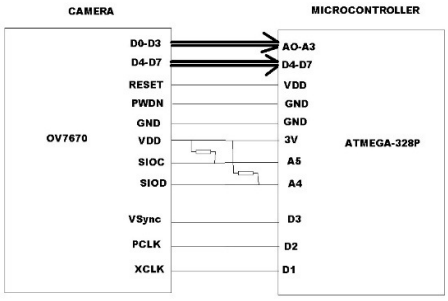

Fig. 8. Interface camera module with controller.

ESP-8266. The Wi-Fi module enable to send mail to the concerned care giver about the patient details. The interface diagram of Wi-Fi module with Atmega-328P is given is figure 9.

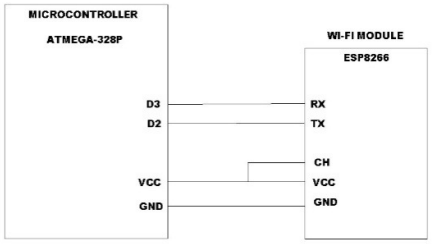

Fig. 9. Interface Wi-Fi module with controller.

IV. WORKING

In order to dispense the pills, the patient or user need to use the keypad to enter the dosage and the time. The patient can set the dosage and time for each medicine separately (we are using three different types of medicine). The time is set in RTC first. The life of is for 10 years so it can run without stopping for many years. The time is already set on the RTC so that the patient do not have to worry even if the switch or power goes off. The dosage and time can be set by the person. Once the dosage and time is set the values get stored in the microcontroller. Each medicine can have its own time. The microcontroller used (Atmega-328P) displays the time on the LCD. This time is being read from the RTC.

When the time from the RTC matches the time entered by the user the alarm is rung and the pills are dispensed. Solenoids are used to dispense the pills. When the time in the RTC matches the time entered by the user the solenoid pushed the pills as per the dosage entered by the user. The pills are kept in a vertical stacked position in a tube and space is present at the base of the tube for the pills to get dispensed. Solenoid pushes the pills one by one which get then collected in a container. The hardware set up is shown in figure 10.

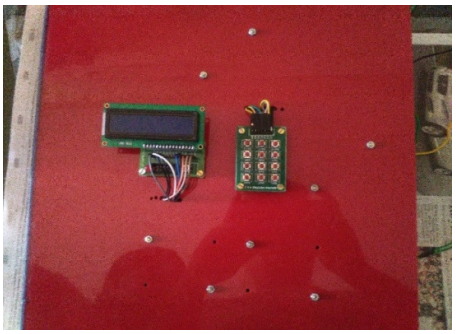

Fig. 10. Hardware working model front view

A. Cost Comparison: The proposed method is compared with cost with fully automatic. Though fully automatic mode has many advantage but it has some limitations in terms of cost. The cost factor plays a major role for middle income citizens. Not everyone are capable to buy fully automatic pill dispenser. The comparative study is presented in Table 1.

Table 1: Comparative study between various pill dispensers.

Parameters	8051 based Pill dispenser	ARM based pill dispenser	Proposed preprogrammed pill dispenser
Cost	low	high	medium
Program update	complex	complex	simple
Efficiency	low	moderate	high
Life	low	moderate	moderate
Maintenance	low	high	moderate

V. CONCLUSION

During pandemic attack like COVID-19, self-isolation is the best option. In such condition, this device will help the elderly people to take care of themselves by properly taking medications. Hence this device is cost effective and helpful. It has the feature of programming where each time any updating can be done using the software.

VI. FUTURE SCOPE

As a future scope, the pill dispenser and made automated. A robotic arm and motors can be fixed in the kit, so that the medicine will be given directly to the elder people where they are. Further machine learning algorithms can be modelled for identification of pill in faster manner and update in cloud. The machine can act as humanoid robot and advising them to take pills regularly.

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Conflict of Interest: The authors show no conflict of interest.

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