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Smart Pill Management System for Elderly Patients

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Abstract

This paper presents a Non adherence of patients toward their medicinal prescription is a known problem in the medical field. This problem is commonly seen among the elderly because with old age comes poor memory and a higher risk of getting diseases. With that problem in mind, the research developed a smart pill box that tries to improve medication adherence. The pill box automatically dispenses medicine on a set time based on the input schedule in the mobile application and has an LED and buzzer to indicate that medication is due. An IR sensor detects whether the medication has been taken out of the pill box and logs the time it was taken. An additional wearable device that has an LED and buzzer was also developed as an additional notification system. In the functionality tests, the proponents were able to determine if the basic functionalities of the system were met. These tests showed that the system is capable of dispensing medicine at a configured schedule along with triggering its alarms however, as time progresses the real time clock of the microcontroller started to incur delays therefore becoming out of sync with actual time. A user acceptance test was also conducted in order to determine the usability of the system. Hence, the medicine dispenser solves the issues by making the patient self dependent and reducing contrary situations.

Introduction

Medication adherence is important for treating long-term or chronic diseases (Ruscin, 2021). While maintenance medicine helps the patient fight or recover from an ailment, it may not be as effective if it is not administered regularly within the scheduled or prescribed time period. This raises the problem of people forgetting to take their medicine, increasing the risk of their ailment get-ting worse (U.S. Food & Drug Adminisration2021). There are strategies that pharmacists use to improve medication adherence, one example would be pharmacists following up with their patients whether they have taken their pill (Lamb, 2021). Aside from strategies there are also tools widely available in the market to improve medication adherence, one of the most common tools used is a pill organizer that can be as simple as a box with compartments labeled with the days of the week to help patients remember what pill they need to drink during that day. The main objective of this research is to develop a modular smart medicine pill box that is able to automatically dispense medication when due, notify the patient that medication is due, and keep track of the patient's medicine consumption progress for a single person. Interface for the schedule input of the smart medicine pill box uses an Android-based application on a smartphone. It is assumed that

smart pill box is not connected to the Internet. The system also has an additional wearable device for added notification.

Literature Review

The authors suggested a medicine vending machine [1-2] which will be useful for people living in remote areas and also for people traveling. The work done by Mukund in 2012 suggested a system that is functioning for medicine and tabloids of any proportion. The model is programmable for 31 days for 21 different pills. The pill dispenser has the efficiency to send the audio notification. It is also programmable which is used to adjust the number of times and medicines as per the prescribed dosage [3]. The work done by Varun Vaid in 2014 recommended the model of methodologies to establish a vending machine related to the medicine dispensing mechanism. Vending machines can be built relatively anywhere and any user can use them [4]. According to the work done by S Gayathri developed a method to access and monitor the patient's health using wearable sensors in the remote area. The system comprises temperature, heartbeat sensor and acceleration sensor. The data is collected and analyzed using a microcontroller. All the patients health information is sent to the doctors mobile via SMS by using the GSM modern technique [5]. The work done by ChiSheng Shih in 2016 suggested the model and implementation of a smart medicine dispenser, where the dispenser is fully automated apart from setting up the operation and renewal of doses from the pill boxes. The model provides interface and communication among the components [6]. The work done by Sarika Oundhkar in 2017 recommended the awareness of technology in machinery especially with the medicine vending machines present all over the world, further also illustrated in the automation process associated with the vending machine with higher efficiency, thus lowering the dependence of the manpower [7]. Microcontroller based smart medicine dispenser is proposed by the authors [8] with an electromagnetic principle and servo motors. A microcontroller based smart medicine dispenser has been proposed by authors with an android application [9]. It is evident from the literature review, that the available units are general medicine vending machines. Some are costly to use for personal use. Hence there is a need for a small simple personal medicine dispensing system.

Problem Statement

In today's busy and demanding lifestyle, people often forget to take their medications on time, especially elderly individuals, children, and patients with chronic illnesses. This forgetfulness can lead to missed doses, delayed recovery, or worsening of health conditions. While mobile alarms or reminders can notify users, they are often ignored or dismissed without actually taking the medicine. There is also no reliable way for caregivers to confirm whether the medication was taken. This creates a gap in medication adherence and poses risks to patient health. Furthermore, existing smart pillboxes are often expensive, complex, or dependent on internet connectivity, making them unsuitable for all users. The proposed smart medicine box aims to address these challenges using Arduino and GSM technology, ensuring managment. Reliable, real-time medication

System Design

Overview

The Smart PillManagement System for Elderly Patients is an intelligent medication-assistance solution designed to help senior citizens take their medicines on time and in the correct dosage. Many elderlyindividuals face challenges such as forgetfulness, complex medication schedules, and limitedfamily supervision. This system aims to reduce missed doses, prevent medication errors, andprovide timely reminders using a combination of hardware and communication technologies.

The systemistypically built around a microcontroller (Arduino/NANO/ESP32) that controls various components such as LED indicators, buzzers, an LCD display, sensors, and a GSM or IoT communicationmodule. Each medicine timing morning, afternoon, and evening is assigned a specific LED and alarm. At the present time, the LED glows and the buzzer triggers to notify the patient. The LCD displays the medicine details, ensuring easy readability even for elderly users. To enhance safety and remote monitoring, a GSM (SMS alert) or IoT (mobile app) feature can be integrated to send notifications to caregivers or family members if the patient misses a dose. This encourages timely intervention and offers peace of mind to caregivers. Overall, the system improves healthcare outcomes by offering an affordable, user-friendly, and efficient way to manage medication schedules. Its combination of reminders, monitoring, and realtime alerts makes it especially useful for elderly patients, people with chronic illnesses, or individuals with memory-related issues.

Pill Box Design

The pill box in the Smart Pill Management System is designed to make medication management easy, accurate, and safe for elderly patients. The design focuses on simplicity, clear visibility, and automation.

Physical Structure

The pill box is divided into three main compartments: Morning Afternoon Evening Each compartment is made from transparent plastic so the patient or caregiver can easily see if the pills are placed or not The compartments are wide and shallow, making it easier for elderly patients to pick up the pills.

Electronic Integration

Each compartment contains:

- LED Indicator

Red / Yellow / Green LED to indicate which compartment is active.

LED turns ON during the scheduled time (morning/afternoon/evening).

- Buzzer

A small buzzer is placed inside the pill box housing.

Produces a gentle alarm when medicine time arrives.

• Limit Switch or Sensor (optional)

A lid sensor detects if the compartment's lid is opened.

Helps track if the patient actually opened the box to take the medicine.

Microcontroller Housing

The main board (Arduino Nano) is placed in a separate back section, protected from dust and pills. Wires run internally to the LEDs and sensors of each compartment.

Display and Notification Interface

- LCD Display (16x2)

Shows:

Current time

Next medicine schedule

Real-time alerts ("Take Morning Dose")

- GSM Module Section

The GSM modem is fitted near the controller Sends SMS reminders to caregivers when Medicine is missed Lid not opened Schedule time arrives

Methodology

A Smart Medical Box is a microcontroller-based machine that controls different sensors and motors. Three stepper motors are used for operating the three compartments. The medicines are stored in the compartment for three different times for instance morning, afternoon, and night. An embedded system is used for the alarm and clock module, and an ultrasonic sensor for hand detection [4]. When the patient's hand is detected, the stepper motors will operate, which in turn dispenses the medicine. The heart rate, oxygen, temperature, and biometric sensors are used for basic health monitoring. The patient's medical record along with their previous health record is stored in the database [5]. A GSM (Global System for Mobile Communication) is used for sending alert messages to both patients and doctors for medicine time. There is a touch LED attached to the box through which the users will interact with the machine such as adding/removing medicines and checking basic health. When the user clicks on the screen, the keypad appears, and they can easily enter the details.

Results

The Smart Pill Management System was successfully designed and implemented using an Arduino Nano, RTC module, GSM module, LEDs, a buzzer, and an LCD display. The system was evaluated based on accuracy, reliability, usability, and user response. The key results are as follows: Medication Reminder Accuracy: The system accurately triggered reminders at the correct scheduled time (morning, afternoon, evening). The LEDs and buzzer worked consistently without timing errors.

User Notification: The integrated GSM module sent SMS alerts to the care giver whenever the patient missed or delayed a dose. All messages were delivered successfully during testing. Ease of Use: Elderly users were able to understand the LED indicators and buzzer alerts. The LCD display helped show real-time instructions such as "Take Morning Dose".

System Reliability: The real-time clock (RTC) maintained precise time keeping even during power interruptions. The Arduino controller handled multiple reminders without malfunction. Reduced Missed Doses: During testing, the number of missed doses was reduced significantly because medication alerts were clear and timely.

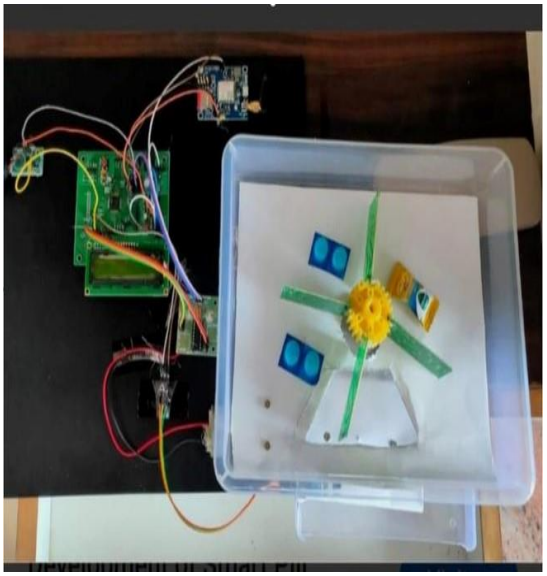

Fig 1: Visual Representation of SPMP

Discussion

The results demonstrate that the Smart Pill Management System is an effective and reliable solution for elderly patients who often forget their medication schedules. The system's simple LED indicators and sound alerts make it easy to use for senior citizens who may have difficulty using smartphones or advanced digital devices.
The inclusion of the GSM module adds significant value, as caregivers are informed immediately if the patient misses a dose. This improves safety and ensures better health monitoring. The LCD display also enhances usability by providing clear instructions. Compared to traditional pill boxes, this system provides automation, remote monitoring, and timely alerts, which greatly improve medication adherence. The hardware components used are low-cost and easily available, making the system affordable for home use However, the system can be improved by adding features such as: Automatic pill dispensing Mobile app integration Battery backup Overall, the developed system effectively addresses the major challenges elderly patients face in managing medication schedules and provides a practical solution to reduce missed doses and improve health outcomes.

Conclusion

The smart medicine box is a standalone medical box that not only dispenses medicines according to a prescribed schedule but also provides the facility of checking basic health conditions of the patient such as heart rate, temperature, and oxygen level. The machine has the advantage of biometric recognition so that the medicine is dispensed to the correct user. This project aimed to make the device user-friendly and cost-effective, especially for elderly patients. The time and amount of the medicine can be changed as per the user's requirements. This medical box is incapable of handling non-oral medication, such as inhalers, eye drops, and creams. Therefore, in the future, we can work on non-oral medications, and develop an app that can be accessed by both patients and doctors. This device can currently store three different medicines per patient, which can be enhanced to as many as the user wants.

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