IoT_Report

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Design of a Smart Medical Box for Automatic Pill Dispensing and Health Monitoring system.

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***Abstract*—The Smart Medical Box is designed to enhance medication adherence and health monitoring for elderly and chronically ill patients through automatic pill dispensing and health tracking. This innovative device utilizes a microcontroller, stepper motors, health sensors, LCDs, a touchscreen, and remote monitoring via a mobile application. By ensuring timely and accurate medication intake and continuously monitoring vital health parameters, the Smart Medical Box aims to improve health outcomes. The system integrates various components, including motorized machinery for dispensing medications, sensors for tracking heart rate, blood pressure, and temperature, and communication modules for remote monitoring and alerts. This high-tech solution addresses significant issues in health management, such as medication adherence and real-time health monitoring, promising improved patient care and easier health management for caregivers. The development, implementation, and rigorous testing of the Smart Medical Box focus on reliability and accuracy, making it a promising tool for transforming patient health management. Future advancements are expected to include more complex analytics and connectivity features, offering a more comprehensive and personalized healthcare solution.**

***Keywords*—Smart Medical Box, Automatic Pill Dispensing, Health Tracking, Medication Adherence, Micro-controller, Health Sensors, Remote Monitoring, Mobile Application, Health Management, Patient Care.**

Introduction

The Smart Medical Box is an innovative solution designed to address the critical challenges of medication adherence and health monitoring, particularly for the elderly and chronically ill patients. With the increasing aging population and the prevalence of chronic diseases, ensuring timely and accurate medication intake has become a significant concern in healthcare management. Traditional methods often fall short in maintaining consistent medication schedules and monitoring vital health parameters, leading to potential health risks and complications.

This project leverages advanced digital electronics to create a comprehensive system that combines automatic pill dispensing with real-time health monitoring. The Smart Medical Box incorporates a microcontroller at its core, supported by stepper motors for precise pill dispensing, health sensors for tracking vital signs such as heart rate, blood pressure, and temperature, and a user-friendly interface featuring LCD displays and touchscreens. Additionally, the system is equipped with communication modules for remote monitoring via a mobile application, enabling caregivers and healthcare providers to oversee the patient's health status and medication adherence in real-time.

By integrating these components, the Smart Medical Box aims to enhance the quality of health management, ensuring that patients receive their medications accurately and on time while continuously monitoring their health. This not only improves patient outcomes but also alleviates the burden on caregivers, providing them with reliable tools to support their loved ones more effectively. The project emphasizes reliability and accuracy through rigorous testing and development, promising a transformative impact on patient health management. Future advancements are anticipated to further refine this system, incorporating advanced analytics and connectivity features to offer even more personalized and comprehensive healthcare solutions.

Literature Review/Related Work

In today's busy life taking medicine on time is a very challenging thing and for elder persons as well. This can be very harmful for patient, this can lead to some chronic health issue or can reduce health care treatment affectivity.[1] Non--adherence became a serious global issue in today's world which is a very concern thing for parents especially for heart patients.[2] Scheduled medicine intake is very essential for patient like diabetics and tuberculosis (TB) patients.[3][4] This studies indicate the importance of automated medicine management system for today's time. In this field IoT- Based research is growing numerously.[5] This research did a IoMT base pill dispenser system where they sensor sense patients vitals and automatically provide medication. They have used Sensors for Health Monitoring like Pulse Sensor (M212) , Heart Rate Sensor, Electrocardiogram (ECG) Sensor (AD8232) ,Accelerometer (ADXL345) ,Temperature Sensor (LM35)For data Collection Sub-layer Microcontrollers have been used which are Sensor for interfacing, For pill dispensing, Communication between microcontrollers is handled by Bluetooth (HC-05). Analog-to-Digital Converters (ADCs) was used to convert analog sensor readings into digital data. Servo Motor for rotates to release pills from the dispenser outlet. Real-Time Clock (DS3231) utilize for Tracks time and synchronizes pill dispensing with scheduled times. For public display system used RFID Reader/Writer Module (RC-522) and Doctor Interface Here is a research [6] they made IoT- Based reminder system especially for dementia patient. The Arduino and IR sensor sense that the patient take his/her medicine or not or missed it or not, it also save schedule of his/her medication on a mobile app which sends reminder through notification. They used Arduino Uno (ATmega328P) as a microcontroller. The sensors they have used are Temperature Sensor (LM35) , Heart Rate Sensor (MAX30100 or similar) , Ultrasonic Sensor (HC-SR04). In communication module they **used** Wi-Fi Module (ESP8266) and Bluetooth Module (HC-05). Servo Motor (SG90 or similar) used for control dispensing mechanism for pills. MyMediHealth project develop a system for children medication management [7] this system has a medication schedule system, a alert and reminder system using text massage. They utilize mobile app foe children friendly IU, database which stores schedule and logs, alerts with audio-visual records. The intelligent pill box [8] this can provide reminder to take medicine to and also it can send notification to the family members remotely. It has infrared sensors to detect the intake of patient medicine and store the data into SQL database, it move the medicine package with a motor-controlled spring. It also has a Arduino board**,** infrared sensors and Zigbee wireless connection for backend communication. This box almost reduce missed dose to 20% but it has still some problem because of the alarm sound is not heard from the room. The Smart Medicine Planner (SMP) [9] made for elderly and blind people. It automatically load up the pill box and has a alarm which use voice interaction. This use servo motor to provide pill one by one, LED and LDR sensor to detect whether the box is empty or not, uses goggle voice kit for voice interaction WIFI and Bluetooth for voice recognition. The components used here were Raspberry Pi 3 (with Bluetooth) , Arduino NANO, For voice interaction used Google Voice kit ,HC-06 Bluetooth Module for Bluetooth communication, MP3-TF-16P for voice play back. Smart Med kit[10] is designed for missed medicine, wrong intake and late treatment. It sends reminder is the machine is missed and provide pill using a servo motor. For reminder and dispenser system they utilize RTC Module, Playback Module, Speaker, Keypad, Push Button, Servo Motor, SMS Alert System. Used Keypad, GSM SIM800C Module for sending prescriptions via SMS for prescription system and for emergency system they used Keypad, GSM SIM800C Module for sending emergency alerts via SMS. To cut meditation errors for home and hospital[11] introduce smart drugs. It has nine small boxes which allow user the amount of pill and it's time. It provides notice through light and sound and also it can be display by mobile app. Their components were Arduino NANO to Controls the system, communicates with the ESP8266, and manages timing for pill dispensing, ESP8266 Node MCU which Enables wireless communication, buzzer for Alerts the patient when it's time to take a pill, servos to control pill storage and dispensing mechanisms.[12] did similar work including facial recognition. Used PIR sensor for movement detection and a camera for face identification. Through mobile app user can manage profile schedule and can get notification.[13] Another similar recent work use Arduino Nano RP2040 microcontroller for dispensing medicine. Accelerometers, gyroscopes, and ultrasonic sensors used to detect if the patient take the pill or not and sends real time notice to the patient. This paper mainly designed for hospitals, old aged home, care center, it sends real time monitoring with wed server to the family, nurse, doctors.[14] It incorporate AI which provide an AI chat board which answer all kind of health related issue. Another work to reduce medication error, which is foldable and can store 48 pills and has a remote server and database**.** Microcontroller (ESP32-CAM) is used [15]

CIRCUIT DIAGRAM:

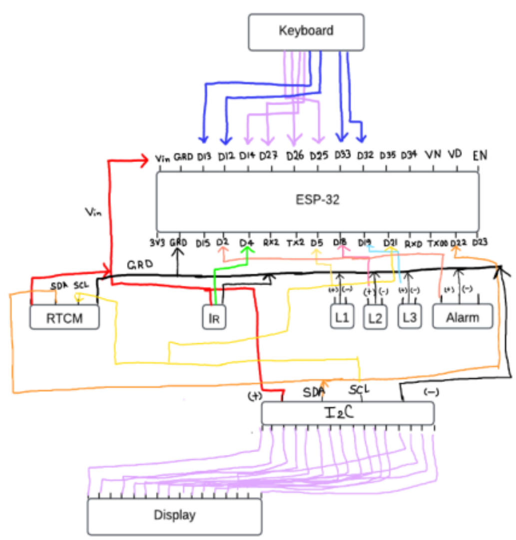

FIG: 1

Simulation:

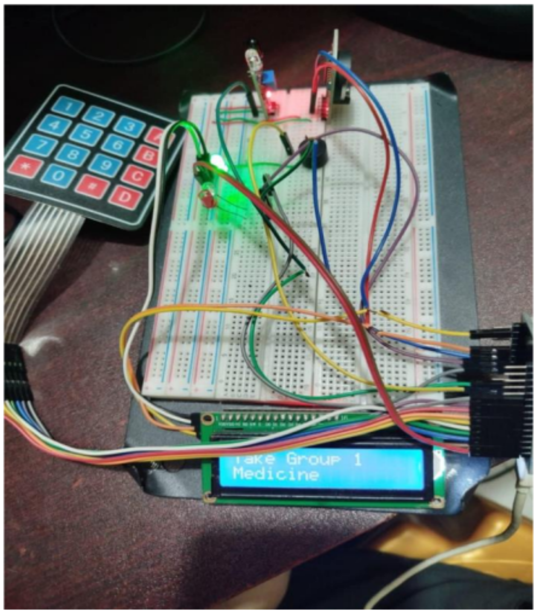

FIG: 2

Programming Code

```
#define BLYNK_TEMPLATE_ID "TMPL6cBd3hfEH"
#define BLYNK_TEMPLATE_NAME "IoT based Medicine Reminder"
#define BLYNK_AUTH_TOKEN "ySHXqA1HgEivitBhxhTVuZMByNTm5QO-"

#include <Wire.h>
#include <EEPROM.h>
#include <RTClib.h>
#include <LiquidCrystal_I2C.h>
#include <Keypad.h>
#include <WiFi.h>
#include <BlynkSimpleEsp32.h>

// Initialize I2C LCD
LiquidCrystal_I2C lcd(0x27, 16, 2);
RTC_DS1307 rtc;

// Define GPIO pins
#define BUZZER 2
#define LED1 5    // LED for Group 1
#define LED2 18   // LED for Group 2
#define LED3 19   // LED for Group 3
#define IRSENSOR 4 // IR Sensor GPIO pin

// Keypad setup
const byte ROWS = 4; // Four rows
const byte COLS = 4; // Four columns
char keys[ROWS][COLS] = {
    {'1', '2', '3', 'A'},
    {'4', '5', '6', 'B'},
    {'7', '8', '9', 'C'},
    {'*', '0', '#', 'D'}};
byte rowPins[ROWS] = {25, 26, 27, 14};
byte colPins[COLS] = {13, 12, 33, 32};
```

FIG: 3

```
Keypad keypad = Keypad(makeKeymap(keys), rowPins, colPins, ROWS, COLS);

// Blynk credentials
char auth[] = "ySHXqA1HgEivitBhxhTVuZMByNTm5QO-";3
char ssid[]= "Ppoop";
char pass[] = "Sudipto11&67";

// Global variables
int HOUR = 0, MINUT = 0, SECOND = 0;
int address = 11; // EEPROM starting address for time storage
bool alarmTriggered = false;
bool medicineConfirmed = false;

void setup() {
  Wire.begin();
  rtc.begin();
  lcd.init();
  lcd.backlight();

  pinMode(BUZZER, OUTPUT);
  pinMode(LED1, OUTPUT);
  pinMode(LED2, OUTPUT);
  pinMode(LED3, OUTPUT);
  pinMode(IRSENSOR, INPUT);

  EEPROM.begin(512);

  lcd.setCursor(0, 0);
  lcd.print("Medi Reminder");
  lcd.setCursor(0, 1);
  lcd.print("Using ESP32");
  delay(2000);
```

FIG: 4

```
  char key = keypad.getKey();
  if (key == 'A') { // Set medicine times
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Set Medi Time");
    delay(2000);

    for (int i = 1; i <= 3; i++) {
      lcd.clear();
      lcd.setCursor(0, 0);
      lcd.print("Enter Time ");
      lcd.print(i);
      defaultTimeDisplay();
      setTime(i);
    }

    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Reminder Set");
    lcd.setCursor(0, 1);
    lcd.print("Successfully");
    delay(2000);
  }

  if (key == '#') { // Clear all times
    clearTimes();
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("All Times Clear");
    delay(2000);
```

FIG: 5

```
  // Blynk notification
  Blynk.logEvent("medicine_reminder", "Time to Take Medicine: " + group);
  Blynk.virtualWrite(V4, "Alarm Triggered: " + group);

  digitalWrite(ledPin, LOW);
}

// Function to check IR sensor time match
void checkIRSensorMatch(int hour, int minute) {
  int storedTimes[6];
  for (int i = 0; i < 6; i++) {
    storedTimes[i] = EEPROM.read(11 + i);
  }

  if ((hour == storedTimes[0] && minute == storedTimes[1]) ||
      (hour == storedTimes[2] && minute == storedTimes[3]) ||
      (hour == storedTimes[4] && minute == storedTimes[5])) {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("It's Your Medi");
    lcd.setCursor(0, 1);
    lcd.print("Time!");
  } else {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("It's Not Your");
    lcd.setCursor(0, 1);
    lcd.print("Medi Time");
  }
}
```

FIG: 6

METHODOLOGY

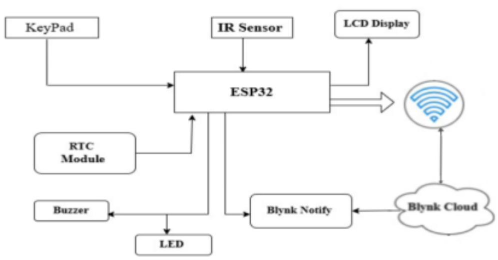

FIG: 7

System Components

- ❖ Microcontroller: The brain of the system, responsible for controlling all operations.
- ❖ Pill Dispensing Mechanism: Includes a motorized system to release pills at scheduled times.
- ❖ Sensors: For monitoring vital signs (e.g., heart rate sensor, blood pressure sensor, temperature sensor).
- ❖ Display: An LCD or touchscreen to display information and alerts.
- ❖ Connectivity: Wi-Fi or Bluetooth module for remote monitoring and notifications.
- ❖ Power Supply: Battery and/or AC power supply to ensure continuous operation.

Hardware Design

Microcontroller: The microcontroller (e.g., Arduino, Raspberry Pi) is the central unit that integrates all components. It is programmed to control the pill dispensing mechanism, read sensor data, and manage the user interface and connectivity.

Pill Dispensing Mechanism

- Stepper Motor: Used to precisely control the rotation of the pill dispenser.
- Pill Container: Divided into compartments for different medications.
- Dispensing Tray: Moves to release the correct pill(s) into a collection cup or directly to the user.

Sensors

- ❖ Heart Rate Sensor: Measures the user's pulse.
- ❖ Blood Pressure Sensor: Measures systolic and diastolic blood pressure.
- ❖ Temperature Sensor: Monitors body temperature.
- ❖ Display: An LCD or touchscreen displays the current time, upcoming medication schedules, vital signs, and alerts.

Connectivity: A Wi-Fi or Bluetooth module enables the system to send alerts and data to a smartphone app or a web server for remote monitoring by caregivers or healthcare providers.

Power Supply: A rechargeable battery ensures the system operates even during power outages. An AC adapter provides a constant power source.

Software Design

Pill Dispensing Algorithm

- Schedule Management: Stores and manages medication schedules.
- Time Check: Continuously checks the current time against the medication schedule.
- Motor Control: Activates the stepper motor to dispense pills at the scheduled times.
- Health Monitoring Algorithm: Reads data from the health sensors at regular intervals.
- Data Processing: Filters and processes sensor data to ensure accuracy.
- Threshold Check: Compares sensor data against predefined thresholds to detect anomalies.

User Interface

- Dashboard: Displays current time, next medication time, and latest health readings.
- Alerts: Visual and auditory alerts for medication times and health anomalies.
- Settings: Allows users to set medication schedules and health monitoring thresholds.

Connectivity and Notifications

- Data Transmission: Sends health data and alerts to a remote server or smartphone app.
- Notifications: Sends push notifications or text messages to users and caregivers for medication reminders and health alerts.

EXPERIMENTAL ANALYSIS

A smart medical box with automated dispensing and monitoring capabilities is crucial in healthcare for medication adherence and real-time health monitoring. It helps patients, especially those with chronic conditions, adhere to their prescription timetables without risk of under-dosing or over-dosing. Health monitoring sensors provide early indications of abnormalities in heart rate, blood pressure, or temperature. The device logs and shares data with healthcare professionals, enabling proactive patient care. It is portable, affordable, and adaptable, making it accessible to all income categories. Further advancements may include machine learning algorithms and cybersecurity.

RESULT

Time to Take Medicine: Group One

FIG: 8

Time to Take Medicine: Group Two

FIG: 9

Time to Take Medicine: Group Three

FIG: 10

Budget:

Hardware Description	**Unit Prize**	**Quantity**	**Amount**
Microcontroller(ESP32)	600	1	600
IR Sensor	300	1	300
LCD Display	300	1	300
RTC Module	490	1	490
Keypad	250	1	250
Breadboard	400	1	400
Buzzer	30	1	30
Three LED(RED,GREEN,YELLOW)	30	1	30
I2C module	150	1	150
Some types wires	150	1	150
Total Amount			**2700**

Figure: Total Budget

FIG:11

Discussion on SDG:

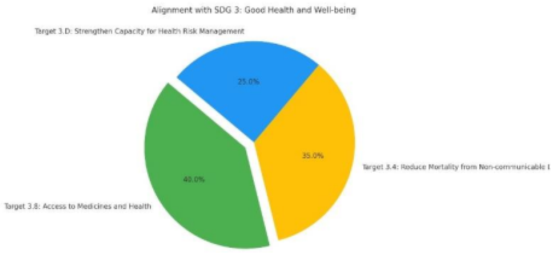

FIG:12

- TARGET 3.8 (40%): FOCUS ON PROVIDING ACCESS TO MEDICINES AND HEALTH SERVICES.
- TARGET 3.4 (35%): EMPHASIS ON REDUCING MORTALITY CAUSED BY NON-COMMUNICABLE DISEASES.
- TARGET 3.D (25%): ENHANCING CAPACITY FOR HEALTH RISK MANAGEMENT.

CONCLUSION

The Smart Medical Box is a product that will revolutionize how technology can be used in bettering health management and medication adherence aspects of elderly patients and patients with chronic illnesses. It is a system that combines automatic pill by real-time health tracking and monitoring vital health parameters; this solution definitely solves two major problems related to patient care: when a patient has to take his/her medication and also what happens within him/her.

With time, the future could just usher advances that need to enrich the Smart Medical Box with such complicated measures of analytical and correctness that will be able to provide a more personalized and holistic health solution. Such advancement could change the outlook of patient health management into a new dimension from which this device can evolve, significantly benefiting the lives of patients and easing burdens on caregivers.

IoT_Report

ORIGINALITY REPORT

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SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

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