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Smart Healthcare Monitoring System

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Abstract

Nowadays, extreme priority is focused on health, due to the out- break of Corona virus, to ensure precautions before any illness. In many circumstances, people tend to forget the importance of health and fail to monitor the health parameters, such as temperature, heart rate, and so on, due to work and busy schedules. Therefore, a smart healthcare system has been proposed in this research, wherein five sensors such as MAX30100 sensor, DS18B20 sensor, DHT11 sensor, MQ9, and MQ135 sensor which sense the patient and patient's room conditions, are used. The obtained values are displayed in the web server, through which the patient's condition is communicated to the hospital staff, where they can detect and evaluate the current health status of the patient. This approach will enhance the current healthcare system, by potentially saving many lives. Furthermore, medication should also be taken at the right time to improve the state of health which is too difficult for old patients and those who give less preference to health than work. Hence, a pill reminder system which uses IR sensor and a buzzer to remind the patients regarding the proper intake of medication is also designed.

Keywords: Internet of Things, Pill remainder system, Thingspeak.

1. Introduction

A growing trend in computing is the "Internet of Things" (IoT). It refers to the concept of connecting physical devices, appliances, and other objects to the internet and allows them to communicate and exchange data. IoT devices share the sensor data by connecting the collected data to an IoT gateway or another end device. It extends the power of internet beyond

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smart phones and computers. Due to all the advancements in IoT, nowadays the world has changed a lot and soon the world would be called as a smart world. Smart door access control system, smart cities, smart parking solutions, smart traffic management, etc. are some of the applications of IoT. It also has applications in agriculture, business sectors, healthcare, and logistics. The major advantages of IoT include effective utilization of resources with reduced manual labour and time. Also, the analysis of data can be done in a better way.

2. Literature Survey

Md.MilonIslam et al. [1] presented a health care system which tracks the heart rate and body temperature of patient, as well as the room humidity, CO and CO2 gas level of patient's room through sensors. The data obtained are transmitted through Wi-Fi module by which the clinical group of workers can collect data from the server. In this system the sensor values are updated for every 15seconds which allows the patients being tracked in real time. For all sensor output cases, this system achieves a success rate of approximately 95%. Some other important measures for determining a patient's condition, such as diabetes level and respiration monitoring, were taken into account.

Prajoona Valsalan et al. [2] proposed a healthcare system in which two sensor values are taken into account to decide the patient's health. The two sensors were body temperature sensor and pulse rate sensor. The output values from sensors are shown in an LCD so that the values are visible even to the patient. Based on the data values, the patient's health state is categorized into: Healthy, Unwell, Hypothermia and Fever. However, only two sensor values were taken into account to decide the patient's health.

Roopa Jayasingh et al. [3] suggested a health care system that focuses primarily on medical safety for patients with high blood pressure. The pulse rate of a human determines whether pressure is high or low. So, NodeMCU which has only one analog input, is taken into account. The sensor senses the pulse rate of the patient which is taken as input to the Node MCU. The value obtained is saved in cloud (Thingspeak) so that doctor can examine the patient from any location at any time. Since NodeMCU has only one analogue input, only one health parameter is used to determine the patient's condition.

The healthcare system for coma patients who need healthcare services 24/7, was proposed by Tamilselvi [4]. This system uses eye blink sensor and body movement sensor to

monitor the eye and body movement of the coma patient. An alert will be sent to predefined smartphone number if any movement or discrepancy occurs. The outputs are displayed in graphs and not in numerical values which is inconvenient for practical use. Sultan Ahmad proposed a reminder system [5] in which an alarm will be generated by an application when it's time to take medicine. This pill reminder system focuses on elderly patients and those who gives less preference to their body health. The data-sharing feature between patient and health care professionals was not developed.

3. Proposed Model

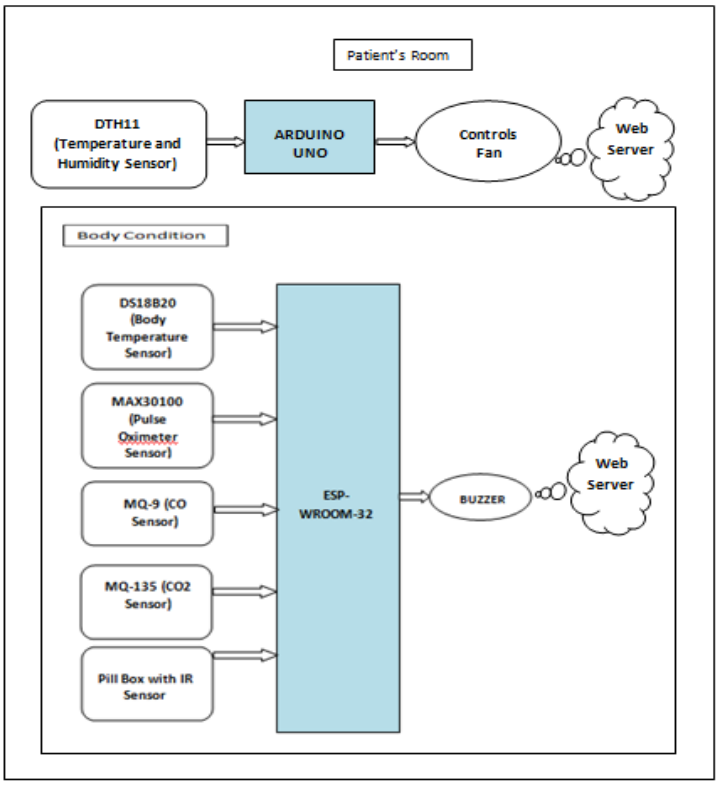

Figure 1. Proposed model of Smart Health Monitoring system

Fig.1 shows the proposed system of Smart Health Monitoring system in which the patient's health is monitored using pulse oximeter sensor (MAX30100), body temperature sensor (DS18B20), CO sensor (MQ-9) and CO2 sensor (MQ-135). The output of sensors are sent to ESP32 and the processed data is sent to the webserver. IR sensor and buzzer are interfaced with ESP32 for pill reminder system. The ESP-WROOM-32 board comes with Wi-Fi module which makes it suitable for IoT projects.

The ESP-WROOM-32 board is a low-power, low-cost on-chip microcontroller with built-in Wi-Fi and dual-mode Bluetooth. It also has antenna switches, an RF balun, a power amplifier, a low-noise receiver amplifier, filters, and power management modules built in. It is the ESP8266 microcontroller's successor. It is made up of 38 pins. The board can be programmed using the Arduino IDE and a type B USB cable. It has two cores. It is interfaced with pulse oximeter sensor (MAX30100), where the red light is made to pass through a finger; the oxygenated blood absorbs more red light than deoxygenated blood; the remaining light is absorbed by the photodetector and gives the SpO2 results. Time gap between the low light and high light is taken as pulse rate.

MQ-9 (CO sensor) and MQ-135 (CO2 sensor) monitor the condition of the room where the patient is staying. MQ-9 detects the high and low temperature and detects CO at low temperature (heated by 1.5V). If the measured value of CO is greater than 9ppm and CO2 value greater than l000 ppm, it displays that room condition is not suitable (abnormal).

DS18B20 (Body temperature sensor) can be easily interfaced with ESP32 through 1 Wire communication. The data pin connected to the ESP32 with a pull up resistor keeps the line in high state when the bus is not in use. If the body temperature ranges above 99°F or below 95°F, it displays that the patient is not in the normal condition.

IR sensors are also interfaced that works on the principle of reflected light waves. It sends the IR light, and the distance between sensor and object is calculated by measuring the light reflected from the object. If the distance between the sensor and the box (pill reminder box) is greater than 2.5cm, then it displays that the medicine is taken. If not, it displays that the medicine is not taken.

DHT11 (temperature and humidity sensor) and buzzer are interfaced with Arduino. DHT11 is used to control the home appliances like ceiling fan based on room temperature and humidity. As temperature increases beyond the threshold value (26°C), fan will be turned ON, otherwise the fan will be turned OFF. The Arduino Uno is an open-source microcontroller board based on the ATmega328P. The board has 14 digital and analogue I/O pins that can be used to interface with other circuits. This board can also be programmed using the Arduino IDE via a type B cable.

The Arduino IDE is an open-source programming environment used to write and compile code for the Arduino module. DHT11 detects water vapour by measuring the electrical resistance between two electrodes. As the relative humidity decreases, the resistance between the electrodes increases, and vice versa. The thermistor built into the DHT11 measures the temperature.

All the sensors are interfaced with an Arduino board and ESP32. ESP32 collects the data from all the 5 sensors except DHT11 and compares with the pre-defined threshold value as mentioned above. The values of the sensors will be accessed through the webserver.

HTML code for webserver is created and loaded into ESP32. By using the IP address (which is created by using SSID and password), the results can be viewed in the webpage. Buzzer which is interfaced with Arduino beeps according to the time which is set to alert the patient for the intake of medicines. IR sensor which is attached to the medicine box monitors the intake of medicines. Thus, the pill reminder system is integrated with health monitoring system of the patient.

4. Results and Discussion

Pulse oximeter sensor (MAX30100), MQ-9 (CO sensor), MQ-135 (CO2 sensor) and IR sensor have been interfaced with ESP32 and the entire data is transferred to the concerned people/doctor via the webserver. DHT11 has been interfaced with Arduino to monitor the room temperature and control the home appliance (fan). The pill reminder system designed uses a buzzer to prompt the patient to take his medicines.

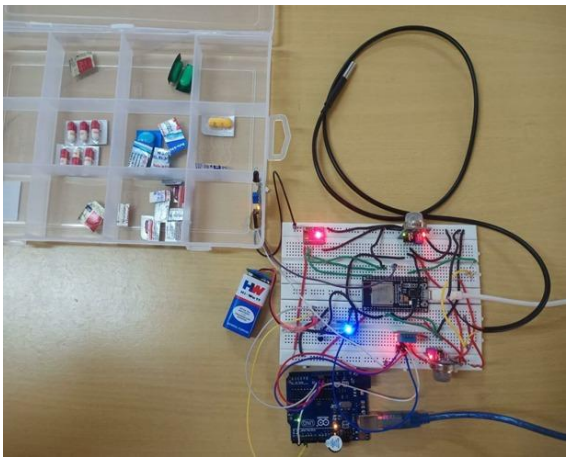

Figure 2. Hardware Setup of Smart Healthcare Monitoring System

MQ9, MQ135, MAX30100, and DS18B20 sensors have been interfaced with ESP32, and DHTl1 sensor has been interfaced with Arduino UNO, which is depicted in Fig.2. LED (instead of fan) glows because the temperature is greater than the threshold value.

The hardware setup for pill remainder system is depicted in Fig.3. An IR sensor and a buzzer are used to aid the patient in the proper intake of medication.

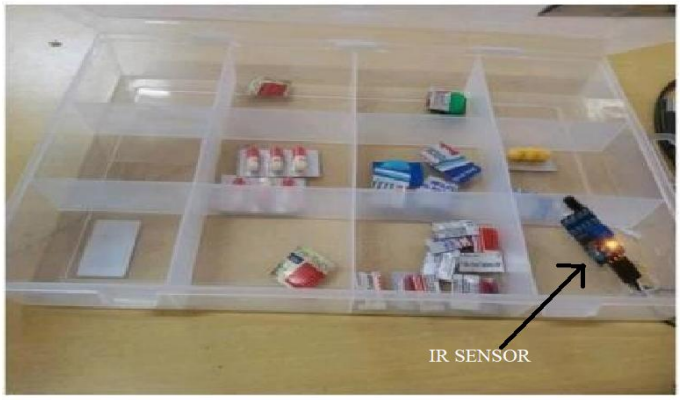

Figure 3. Hardware Setup of Pill Reminder System

The value obtained in the serial monitor of Arduino and the display shown in the webserver is depicted in Fig.4a and Fig.4b. It displays the value of heart rate, oxygen level, carbon di-oxide and carbon monoxide present in the environment and also the body temperature of the patient and the room temperature. The same information is displayed in mobile app, and so the patient and caretaker can check the patient's health condition using the mobile.

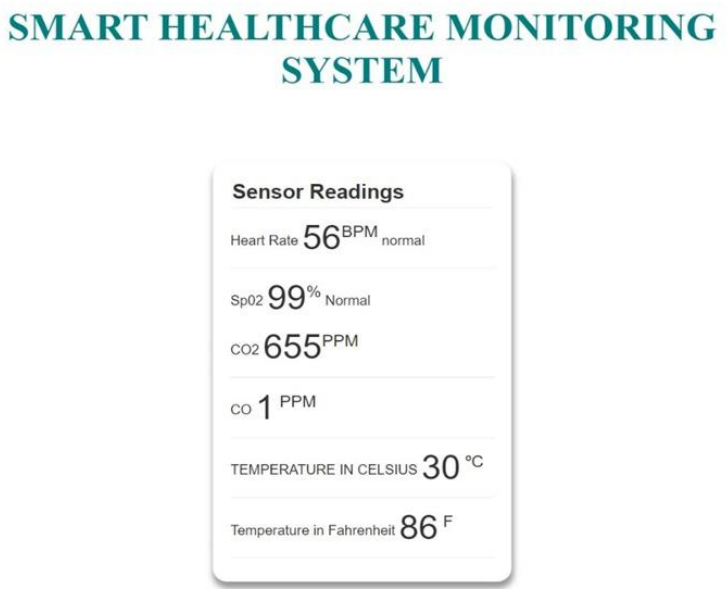

Figure 4a. Values obtained through the sensor in the Web server

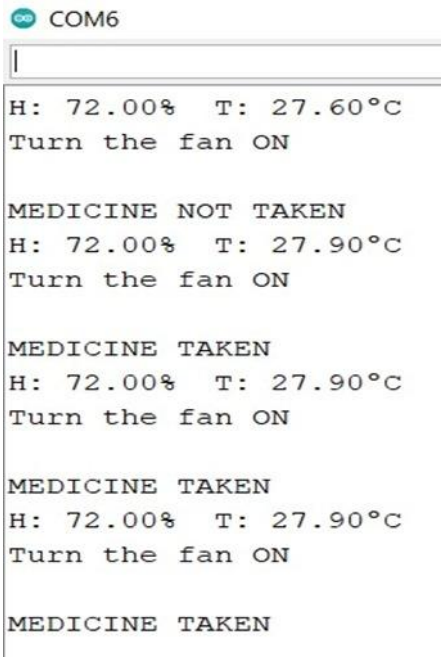

Figure 4b. Output obtained through sensors in the Serial Monitor of Arduino UNO

Aged patients have a common problem of forgetfulness to take medicines at the right times. This may increase the severity of the disease. In order to avoid this problem, a pill reminder system is incrporated to this where the medicines are kept inside the box, and if the

box is not opened at a particular time, an alarm alerts the patient and the information about the intake of medicine is also updated in the web server. The output for this setup is shown in Fig.5

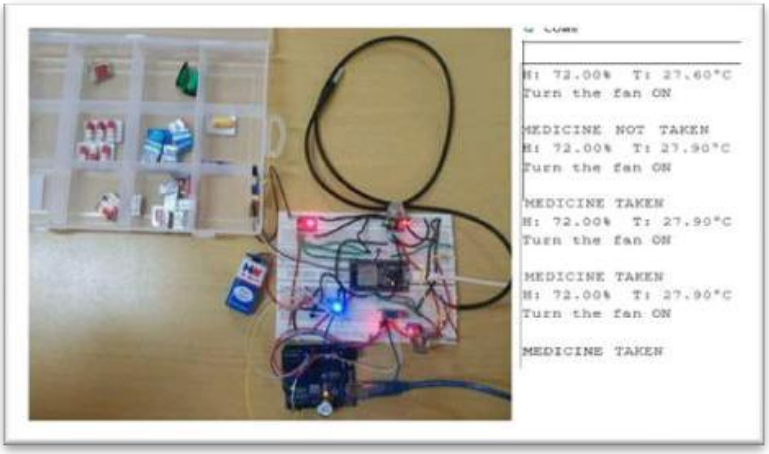

Figure 5. Pill reminder box after the intake of medicine and the message sent to the webserver

5. Conclusion and Future Work

Providing continuous monitoring of patient's health, patient's room and reminder for the intake of medicines is the main objective of the proposed system. Therefore, a smart healthcare system is designed using MAX30100 (pulse oximeter sensor) and DS18B20 (body temperature sensor) to monitor the patient conditions, and MQ-9 (CO sensor) and MQ- 135 (CO_2 sensor), and DHT11 (humidity and room temperature sensor) to monitor the patient's room conditions. Based on the patient's room temperature value, operation of home appliance like fan has been done without a manual need. A pill reminder system has been designed using an infrared sensor which helps to find whether the patient has taken medicine or not. A buzzer is also added to remind the patient to take his/her medication at proper regular intervals. The work has been implemented by designing this system setup in a compact size. A video call with doctor to examine the patient using the sensor output values can also be made possible.

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