IoT Based Smart Patient Monitoring System with Emphasis on COVID and Associated Respiratory Diseases Diagnosis

Priyanka B Pophalkar [1], Vasif Ahmed [2]

[1]*Student, Department of Electronics and Telecommunication Engineering, Babasaheb Naik College of Engineering, Pusad, India.*

[2]*Professor, Department of Electronics and Telecommunication Engineering, Babasaheb Naik College of Engineering, Pusad, India.*

Corresponding Author: priyankapophalkar@gmail.com

Abstract: - Now-a-days, though vaccination is available, a growing number of patients of covid in a developing countries like India forces to look for new solutions for the continuous monitoring of health check-up. It has become a necessity to visit hospitals frequently for doctor's consultation, which has become financially, related and a time consuming process. To overcome this situation, we propose a design to monitor the patient's health conditions such as body temperature, pulse rate, respiration rate and send the message to guardian using IoT platform. In the recent development of internet of things (IoT) makes all objects interconnected and been recognized as the next technical revolution. Patient monitoring is one of the IoT application to monitor the patient health status. Internet of things makes medical equipment's more efficient by allowing real time monitoring of health. Using IoT doctor can continuously monitor the patient's on his smart phone and also the patient history will be stored on the web server and doctor can access the information whenever needed from anywhere.

Key Words: —*IoT, Arduino, Wi-Fi module, Pulse oximeter sensor, Temperature sensor.*

I. INTRODUCTION

The three main vital signs of covid-19, which are routinely monitored by medical professionals and health care providers includes: body temperature, pulse rate, respiration rate. The covid- 19 is a disease in which no one can allow to come in contact with patient so; this system is useful to monitor the patient distantly by using IoT platform. The Internet of Things, commonly referred to as IoT, is the latest rising star in the information and communications technology (ICT) industry and embodies the vision of connecting virtually anythi ng with everything. Internet of Things (IoT) connects many objects to the Internet. The concept of IoT (Internet of Things) allows smart objects to connect to the internet and communicate with each other or with a user become increasingly popular in today's world. The remote monitoring of patients has become a highly active area of research in recent years. Application areas that utilize the concept of IoT can be broadened to healthcare or remote monitoring areas. The proposed IoT application use electronic healthcare sensors that sense and measure users' biomedical signals and send information to analog input channels.

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In this project, we have designed the IoT Based Smart Patient Monitoring System using ESP8266 & Arduino. The IoT platform used in this project is ThingSpeak. ThingSpeak is an open-source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. This IoT device could read the pulse rate, respiration rate and measure the surrounding temperature. It continuously monitors the pulse rate, respiration rate and surrounding temperature and updates them to an IoT platform.

The Arduino Sketch running over the device implements the various functionalities of the project like reading sensor data, converting them into strings, passing them to the IoT platform, and displaying measured pulse rate and temperature on character LCD. The IoT server used here is Thingspeak. The data can be monitored from any part of the world by logging into the Thingspeak channel.

II. LITERATURE REVIEW

The concept of IoT is becoming increasingly popular now a days. The web access functionality embedded in IoT concept to enhanced user interface functions for devices based on it are catching attention of many researchers .Some of the prominent research work in this area is described below:

Afef Mdhaffar, Tarak Chaari, Kaouthar Larbi, Mohamed Jmaiel and Bernd Freisleben has explained low power WAN network to perform analysis of monitored data in health caring system. They have established WAN network for communication upto the range of 33m2 at around 12 m altitude. Also they have demonstrated that power consumed by LoRaWAN network is ten times less than the GPRS/3G/4G.The IOT architecture has been given for step wise working for understanding of IOT .The main purpose of LoRaWAN is the energy consumption. The power consumption in idle mode for LoRaWAN is 2.8mA while in GPRS is 20mA.Hardware cost in LoRaWAN is 10doller while in GPRS is 50 dollar. Maximum data rate in LoRaWAN is 50kbps (uplink), 50 kbps downlink while in GPRS is 86.5 kbps(uplink ,14kbps(downlink).These results gives the overall efficiency of LoRaWAN in the demonstration of IOT for health monitoring system. [5]

Takatani, S. and J. Ling, 13, 3, 347. Proposed an article which reviews the optical techniques applied to the determination of intravascular hemoglobin oxygen saturation as well as the noninvasive estimation of arterial and tissue saturation. Although in skeletal muscles and brain tissues myoglobin and cytochrome analyses have been demonstrated (F.F. Jobis et al., 1977; K. Kariman et al., 1983), their effects upon absorption and reflection spectra of tissues are small. Thus, this review is focused only upon measurement of hemoglobin saturation.

Mendelson, Y, et al Medical Instrum., 22(4), p. 167 was developed design and construction of a new optical reflectance sensor suitable for noninvasive monitoring of arterial hemoglobin oxygen saturation with a pulse oximeter is described. The reflectance sensor was interfaced to a Datascope ACCUSAT pulse oximeter that was specially adapted for this study to perform as a reflectance oximeter. We evaluated the reflectance sensor in a group of 10 healthy adult volunteers. SpO2 obtained from the forehead with the reflectance pulse oximeter and SpO2 obtained from a finger sensor that was connected to a standard ACCUSAT transmittance pulse oximeter were compared simultaneously to arterial blood samples analyzed by an IL 282 CO-Oximeter. The equation for the best fitted linear regression line between the reflectance SpO2 and HbO2 values obtained from the reference IL 282 CO-Oximeter in the range between 62 and 100% was: SpO2 (%) = 4.78 +/- 0.96 (IL); n = 110. The regression analysis revealed a high degree of correlation (r = 0.98) and a relatively small standard error of the estimate (SEE = 1.82%). The mean and standard deviations for the difference between the reflectance SpO2 and IL 282 measurements was 1.38 and 1.85%, respectively. This study demonstrates the ability to acquire accurate SpO2 from the forehead using a reflectance sensor and a pulse oximeter.

The paper proposed by Sukriti Goyal, Nikhil Sharma, Ila Koushik, Bharat Bhushan, Abhijeet Kumar gave a brief introduction of Internet of Things and edge computing is discussed which consists of general concepts of IoT and its components, basic introduction of edge computing, and structure of edge computing. After that, fundamental concepts of cloud computing, edge computing and IoT are introduced by comparing their features with each other and a structure of IoT based on edge computing is also illustrated with a slight introduction of the architecture of both the edge computing and IoT. Moreover, the advantages of using the technology of edge computing to assist the technology of IoT are provided as well as the efficiency of integrating these two technologies together is demonstrated. Then, the issues like security and privacy, advanced communication etc. related to combination of IoT and edge computing system are discussed.

Finally, the conclusion of the paper is presented. So, basically, in this paper, an extensive survey is conducted to analyze how the usage of edge computing progresses the performance of systems of IoT. The performance of edge computing is studied by comparing delay of network, occupation of bandwidth, power utilization, and many other characteristics.

III. SYSTEM OVERVIEW

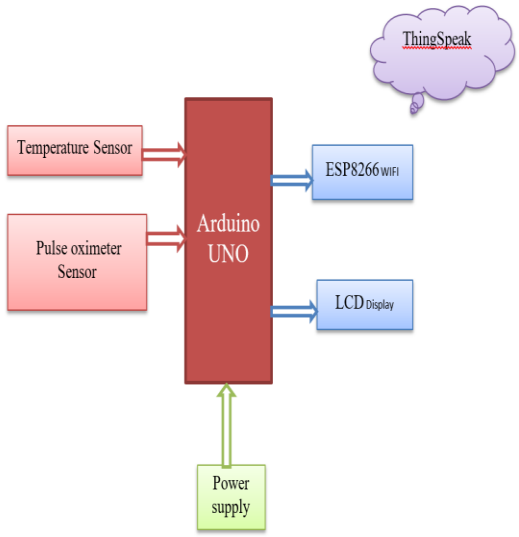

Fig.1. Block Diagram

This is a simple block diagram that explains the *IoT Based Patient Health Monitoring System using ESP8266 & Arduino*. Pulse Sensor and LM35 Temperature Sensors measure BPM & Environmental Temperature respectively. The Arduino processes the code and displays it to 16*2 LCD Display. *ESP8266 Wi-Fi module* connects to Wi-Fi and sends the data to IoT device server. The IoT server used here is Thingspeak. Finally, the data can be monitored from any part of the world by logging into the Thingspeak channel.

IV. HARDWARE ASPECTS

A. Arduino Uno

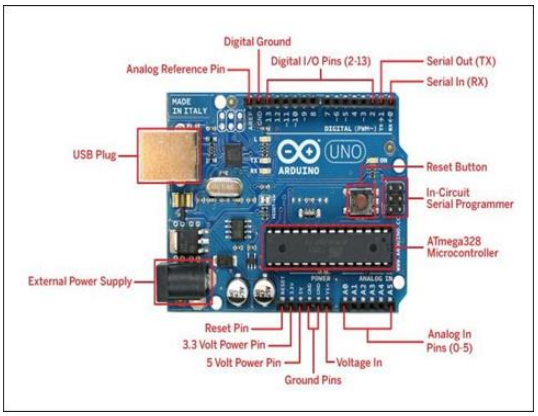

Fig 2. Arduino Uno Module

As shown in Fig2. Arduino is an open-source hardware kit with 8-bit Atmega AVR pre-programmed on-board microcontroller kit, with boot loader that uploads programs into microcontroller memory. It has 2KB of SRAM and 1KB of EEPROM. Input and Output pins: There are 14 digital I/O pins with serial transfer and external interrupts in which 6 pin can also be used as PWM pins. There are 6 analog I/O pins.

B. MAX30105 Heart Rate-Spo2

The SparkFun MAX30105 Particle Sensor is a flexible, powerful sensor enabling sensing of distance, heart rate, particle detection and even the blinking of an eye. The MAX30105 has been equipped with three LEDs as well as a very sensitive photon detector. The idea is to pulse the different LEDs, then detect what shines back. Based on the reflected signature it's possible to detect different types of particles or materials (such as oxygenated blood or smoke from a fire).

The MAX30105 utilizes a red LED, a green LED, and an IR (Infrared) LED for presence sensing, heart-beat plotting and heart-rate monitoring among its multitude of uses, including Pulse Oximetry. The MAX30105 is designed to operate at 5V and can communicate with both 3.3V and 5V microcontrollers. We've also written an Arduino library for the MAX30105 Breakout which takes care of all of the I^2C communication, bit shifting, register writing and sample reading. The sensor is an integrated pulse oximetry and heart-rate monitor sensor solution. It combines two LED's, a photo detector, optimized optics, and low-noise analog signal processing to detect pulse and heart-rate signals. It operates from 1.8V and 3.3V power supplies and can be powered down through software with negligible standby current, permitting the power supply to remain connected at all times.

Features:

- Built-in Red, IR, and Green LEDs
- 5V operation (3.3V is allowed, but green LED is not guaranteed to operate)
- Onboard 1.8V regulation and I2C interface circuitry
- Sensitivity configurable down to 7.81pA
- 3200Hz maximum sample rate
- Built-in 32 sample FIFO (First In, First Out)
- Applications include presence detection, distance sensing (18" max), pulse oximetry, blood oxygen saturation level (SpO2), smoke and particle detection

C. LM35 Temperature Sensor:

The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly-proportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 device does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to 150°C temperature range.

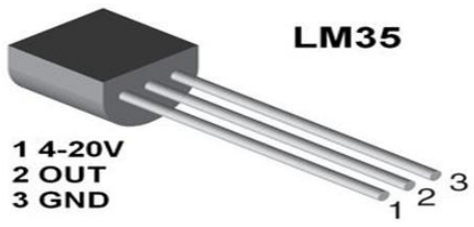

Fig.3. Pin diagram

Features:

- Calibrated Directly in Celsius (Centigrade)

- Linear + 10-mV/°C Scale Factor
- 0.5°C Ensured Accuracy (at 25°C)
- Rated for Full −55°C to 150°C Range
- Suitable for Remote Applications
- Low-Cost Due to Wafer-Level Trimming
- Operates From 4 V to 30 V
- Less Than 60-µA Current Drain
- Low Self-Heating, 0.08°C in Still Air
- Non-Linearity Only ±¼°C Typical
- Low-Impedance Output, 0.1 Ω for 1-mA Load
- Applications
- Power Supplies
- Battery Management
- HVAC

D. Esp8266:

The ESP8266 is a very user-friendly and low-cost device to provide internet connectivity to your projects. The module can work both as an Access point (can create hotspot) and as a station (can connect to Wi-Fi), hence it can easily fetch data and upload it to the internet making the Internet of Things as easy as possible. It can also fetch data from the internet using API's hence your project could access any information that is available on the internet, thus making it smarter. Another exciting feature of this module is that it can be programmed using the Arduino IDE which makes it a lot more user friendly.

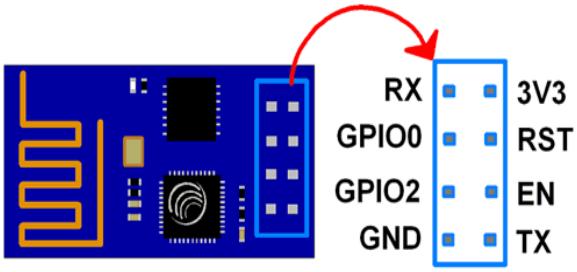

Fig.4. Pin diagram of esp8266

E. 16×2 LCD Module Pin Out Diagram

The JHD162A LCD module has 16 pins and can be operated in 4-bit mode or 8-bit mode. Here we are using the lcd module in 4-bit mode. Before going in to the details of the project, let's have a look at the JHD162A LCD module. The schematic of a JHD162A LCD pin diagram is given below. The name and functions of each pin of the 16×2 LCD module is given below in Fig5.

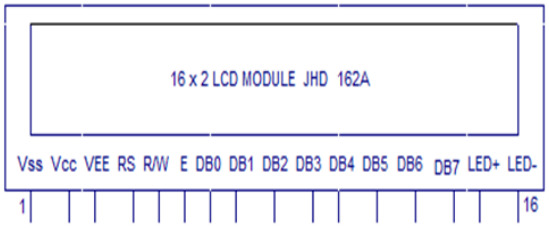

Fig.5. 16×2 LCD Module Pin Out Diagram

- Pin1 (Vss): Ground Pin of the LCD Module.
- Pin2 (Vcc): Power To LCD Module (+5v Supply Is Given To This Pin)
- Pin3 (Vee): Contrast Adjustment Pin. This Is Done By Connecting The Ends of A 10k Potentiometer To +5v And Ground And Then Connecting The Slider Pin To The Vee Pin. The Voltage At The Vee Pin Defines The Contrast. The Normal Setting Is Between 0.4 And 0.9v.
- Pin4 (Rs): Register Select Pin. The Jhd162a Has Two Registers Namely Command Register And Data Register. Logic High at Rs Pin Selects Data Register And Logic Low At Rs Pin Selects Command Register. If We Make The Rs Pin High And Feed An Input To The Data Lines (Db0 To Db7), This Input Will Be Treated As Data To Display On Lcd Screen. If We Make The Rs Pin Low And Feed An Input To The Data Lines, Then This Will Be Treated As A Command (A Command To Be Written To Lcd Controller – Like Positioning Cursor Or Clear Screen Or Scroll).
- Pin5(R/W): Read/Write Modes. This Pin Is Used For Selecting Between Read And Write Modes. Logic High At This Pin Activates Read Mode And Logic Low At This Pin Activates Write Mode.
- Pin6 (E): This Pin Is Meant For Enabling The Lcd Module. A High To Low Signal At This Pin Will Enable The Module.
- Pin7 (Db0) To Pin14 (Db7): These Are Data Pins. The Commands And Data Are Fed To The Lcd Module Though These Pins.
- Pin15 (Led+): Anode Of The Back Light Led. When Operated On 5v, A 560 Ohm Resistor Should Be Connected In Series To This Pin. In Arduino Based Projects The Back Light Led Can Be Powered From The 3.3v Source On The Arduino Board.
- Pin16 (Led-): Cathode Of The Back Light Led.

V. INTERNET OF THINGS (IOT)

Internet of Things (IoT), also called internet of everything. The network is form by physical object or "things" which are implanted with electronics, software, sensors. Things or the objects, which are connecting through IoT have ability to connect with the things for data exchange with the operator or any other connected devices. IoT is an International's Global Standard Initiative. The Internet of Things allows the connected things or objects to be Identified and controlled remotely across the network infrastructure. It helps in creating opportunities for more direct integration between the physical world and computer based system.

- Use the Thinkspeak platform to send data to the cloud from any Internet-enabled device.
- You can then configure actions and alerts based on your real-time data and unlock the value of your data through visual tools.
- Use the Think speak offers a platform for developers that enable them to easily capture sensors data and turn it into useful information.

VI. APPLICATION

Practical application of the system is superfine in rural area as there would be no need for the patients to get their continuous follow-ups.

VII. CONCLUSION

In the above-mentioned system, we have proposed the patient monitoring system which is IoT based. It is user friendly and bridges gap between doctor and patients. The system is simple and power efficient. It is portable and easy to use.

In this paper, we found the importance and fruitful benefits of implementation of IoT in remote health monitoring systems. The compact sensors with IoT will make a huge impact on every patient's life, that even though they are away from home and physician, this helps them to reduce the fear of danger. The sensory data can be acquired in home or work environments. Also, the challenges in sensing, analytics and prediction of the disease are also highlighted and those can be addressed to provide a seamless integration into the medical field.

VIII. FUTURE DEVELOPMENT

We can add a GPS module in IOT patient monitoring using the Arduino Uno and the WiFi module project. This GPS module will find out the position or the location of the patient using the longitude and latitude received. Then it will send this location to the cloud that is the IOT using the Wi-Fi module. Then doctors can find out the position of the patient in case they have to take some preventive action.

REFERENCES

[1]. Ebrahim Al Alkeem1, Dina Shehada1, Chan Yeob Yeun1,M. Jamal Zemerly ,Jiankun Hu "New secure healthcare system using cloud of things", Springer Science+Business Media New York 2017.

[2]. Afef Mdhaffar, Tarak Chaari , Kaouthar Larbi, Mohamed Jmaiel and Bernd Freisleben "IoT-based Health Monitoring via LoRaWAN", IEEE EUROCON 2017.

[3]. Mohammad M. Masud, Mohamed Adel Serhani, and Alramzana Nujum Navaz "Resource-Aware Mobile- Based Health Monitoring", 2168-2194 (c) 2015 IEEE.

[4]. Takatani, S. and J. Ling, 1994, Optical oximetry sensors for whole blood and tissue, IEEE Eng. in Med. And Biol., 13, 3, 347.

[5]. Mendelson, Y, et al, 1988, Design and evaluation of a new reflectance pulse oximeter sensor, Medical Instrum., 22(4), p. 167.

[6]. Kumar, Abhijeet et al., "Internet of Life (IOL)." (2015).

[7]. Brian Benchoff. "An SDK for the ESP8266 Wi-Fi chip". Hackaday.

[8]. Vowstar. "Node MCU Devkit". Github. Node MCU Team. Retrieved 2 April 2015.

[9]. Zeroday. "A lua based firmware for wifi-soc esp8266". Github. Retrieved 2 April 2015.

[10]. Manan Mehta "ESP 8266: A Breakthrough in Wireless Sensor Networks and Internet of Things", MAX30105 Breakout - Heart Rate, Oximeter, Smoke Sensor PIM438 datasheet.