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A Review on Design and Development of IoT Based Pulse Oximeter

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ABSTRACT:

Measuring the heart rate, oxygen saturation level and blood pressure plays a vital role in human body. In many critical condition measuring these parameters a very important when a patient is in critical condition so pulse oximeter is really necessary. Early pulse oximeter could only measure saturation level of oxygen. Later pulse oximeter evolved to measure pulse rate along with heart rate with temperature inbuilt control. Red and infrared sensors are used in pulse oximeter to detect heart beat and saturation level of the oxygen. In this paper pulse and saturation of oxygen can be calculated using different types methods that are easy and accurate to calculate. Alert system will alert the patients when there is drop of any level of the spo2 and heart rate.

KEYWORDS: Spo2, Heart rate, Pulse rate.

I. INTRODUCTION

Pulse oximetry is a medical device that is usually clipped in fingertip used to measure the heart rate and saturation level of oxygen inside the blood. Pulse oximeter uses red and infrared sensors [1-2]. The light emitted by these sensors are absorbed through skin and later they get absorbed through blood [3]. Then amount of light absorbed by our oxygenated and deoxygenated hemoglobin present in blood is calculated in the machine to detect the saturation of oxygen and pulse rate of humans [4-5]. There will be OLED display which is used to display the result of pulse rate and oxygen saturation level calculated [6]. Earlier pulse oximeter developed used red and green filters to find the oxygen saturation level which was not accurate [7]. Later the original pulse oximeter was developed which calculated accurate value of o2 saturation. Today pulse oximeter available will calculate both the heart rate and saturation level of oxygen that are very accurate [8-10]. According to change in environment it will also effect the working function of body like increase in heart rate so temperature is inbuilt in this device to accurate the working efficiency of the device [11-14].

Blood pressure can be added to available device to make the device even accurate and helpful [15]. If there is any increase above the normal value in any of the parameters like heart rate, pulse rate alert will be activated [16-18]. Using message alert system and GPS they can be used to detect the location of the humans and condition of them. Alert system is sent to the relatives of that humans and in case of any emergencies message is sent to nearby hospital to save life of the humans [19]. OLED display can be used to see the output of the device that are calculated by it [20-25].

II. RELATED WORK

[22]. Dhanurdhar Murali, Deepthi R Rao, Swathi R Rao and Prof. Ananda M “Pulse Oximetry and IOT based cardiac monitoring integrated alert system” published at IEEE 2018.

Nowadays one of the cause for death is due to heart related disease, so the cardiac values are need to be continuously monitored. Heart rate and SpO₂ count are measured using sensor. Heart rate and oxygen saturation levels are detected using pulse oximeter with leds and photodetectors. Measured data will be digitalized using converters and then it is stored in cloud. If there is any variation in cardiac value an alert is sent automatically. Patient's location will be tracked using GPS.

[23] Mustafa A Al-Sheikh and Ibrahim A Ameen “Design of health care monitoring system using IOT technology and cloud computing” published in 3rd International Conference on Sustainable Engineering Techniques (ICSET 2020)

This paper explains the design of the portable, wearable, real time health monitoring system using IOT. Heart rate, ECG Signal, body temperature and SpO₂ of the patients are monitored using sensors. Main feature of this

system is to send measured parameters to doctor's smart phone. MAX30102 heart rate sensor, signal-lead ECG sensor AD8232, LM35 analog temperature sensor are connected to Node MCU and Arduino UNO microcontrollers. After collecting data this will be sent to blynk server. This mobile application provides an affordable health monitoring system for the patients.

[24] Mian Muj Tabaa Ali, Shyqyri Haxha, Munna M. Alam, Chike Nwibor and Mohamad Sakel “Design of internet of things (IOT) and android based low cost health monitoring embedded system wearable sensor for measuring spo₂, heart rate and body temperature simultaneously” published online: 07 December 2019

This paper explains health monitoring system which measures SpO₂ count, body temperature and heart rate. Led driver circuit is used to enhance the accuracy of pulse oximeter. This wearable wireless sensor is affordable. This paper deals with developing a system which has accurate pulse oximeter sensor, heart rate sensor, temperature sensor integrated with Arduino to measure SpO₂, pulse rate and body temperature. Data collected from this device is transferred to mobile or internet at low cost. Results of this paper are compared with the commercially available ChoiceM Med pulse oximeter and 2% of maximum deviation is observed which can be accepted.

[25] R. R. Adiputra, S. Hadiyoso and Y. Sun Hariyani “Internet of things : low cost and wearable spo₂ device for health monitoring” published in International Journal of Electrical and Computer Engineering (IJECE)

This paper describes the implementation of wearable, high mobility SpO₂ and heart rate monitoring system. This device consists of heart rate and SpO₂ sensors which are connected to Node MCU microcontroller which provides gateway to the internet. Data measured using these sensors will be stored in database. User needs to register in website, which displays heart rate and oxygen saturation (SpO₂) results. These data can be observed in both patient and doctor side and this is used to measure the progress of the patient and also used to provide right treatment. In this system it is found that there is a difference of +_2.8bpm for heart rate and +_1.5% for spo₂

[26] Giovanni Bucci, Fabrizio Ciancetta, Edordo Fiorucci, Andrea Fioravanti, Alberto

Prudenzi “The pulse oximetry IoT system based on powerline technology” published at IEEE 2019.

This paper says about IOT based powerline technology. This implementation uses IoT based powerline communication. This system uses star network topology. In this system all the slave system are interconnected to master system through a network. The heart of this pulse oximetry is spectrophotometry. The red and infrared sensor are used in which these rays penetrate through our skin and reaches our vein in which they will take count of oxygenated and deoxygenated haemoglobin.

The Master Control System is simply a collection of graphical development environment, which recovers all the information given by the slave systems. This software is organized in the form of account where it shows all information of pulse oximeter along with time and graphical representation of data (acquired from PSS), information regarding to people being examined. All the data will be stored in database server. The data can be accessed through internet using web server. The communication rules uses handshaking property. For each request, the clients responds with an acknowledgement. The powerline slave System receives and dispatches the data through this network. The data cannot be accessible to doctors or patients. Security in this system is good.

[27] Thai M. Do, Nam P. Nguyen and Vo Van Toi “Development of pulse oximeter for E-Health Applications” published in 7th International conference on the development of Biomedical Engineering in Vietnam in 2020

This paper tells about home based tele-healthcare services for measuring saturated oxygen and heart rate based on the client-server architecture. Client receives the oxygen count and heart rate through pulse oximeter (hardware components) which is stored in the server side which can be accessible to all doctor where they will have their own account encrypted with password. They can access this information through Wi-Fi communication. Configuration for users are done using Bluetooth.

This project is especially designed for monitoring the hypoxia patients those who suffers from lower amount oxygen level inside the blood. If there is any variation in the oxygen it can be monitored by the specified family doctor through the server side of internet. Whenever there is emergencies the doctor may be not available which may lead to complications to patients. The error showing in counting the saturation level of oxygen in range from 100% to 73% is less than 1 percent. When range is about 73 to 50% is 2 percent.

[28] P.Szakacs – Simon, S.A.Moraru and L. Periniu “Pulse Oximeter Based Monitoring System for People at Risk”

During the hospital nature, patient record habitually formed with costly resources. The intension of the project is to provide both hardware and program solution in user friendly manner, the easiest solution is when the instruments automatically makes the measurements and stores the results into the cloud and informs the patients at final level or prewarning level. The pulse oximetry system carry-out statistical calculations based on the Beer-Lambert Law to calculate the ratio of blood that is saturated with oxygen.

[29] T M Kadarina and R Priambodo 2018 IOP Conference, Ser.Mater.Sci.Eng.453 012028 “Monitoring Heart rate and spo2 using Things board IOT platform for mother and child preventive healthcare”

This paper describes the implementation of heart rate and oxygen saturation (spo2) monitoring

system using Internet of Thing (IOT). In IOT system it enables preventive care and encourage automation to reduce the risk of human mistakes. These project is mainly concentrated on the safety of women and child preventive healthcare.

As a part of implementation of the system there is a portable device that serves to retrieve psychological data of mother and child from several sensor and send them to the database, some of the psychological data are heart rate, SPO2, fetal heart rate, ECG, photoplethysmogram (PPG). In these paper they were implemented heart rate and SPO2 level.

[30] Prajoona Valsalan, Tariq Ahmed Barham Baomar, Ali Hussain Omar Baabod “IOT based health monitoring system” published in Journal of Critical Reviews 2020

The economy of china has been disturbed due to COVID-19 so healthcare has gained more importance. So Health Monitoring System using IOT has a solution for it. The main aim of this project is to implement patient health monitoring system that tracks patient health issues and takes the help of internet to inform their family and friends. The microcontroller are attached to the sensor to track the position of the patient. These values which are tracked by the microcontroller are been displayed to LCD screen. When certain epidemic is spread it is impossible to reach the doctor in particular time. So to avoid this, if health monitoring system is given to patients they can be monitored from their own places. This system monitors heart rate, humidity and temperature. These values is sent via wireless communication which are also displayed on LCD.

[31] Adan Torralba Ayance, Hector Santiago Ramirez, Jose Miguel Rocha Perez and Carlos Gerardo Trevino Palacios “Wireless heart rate and oxygen saturation monitor” published in AIP Conference Proceedings on 2019

This paper tells about how to measure the heart rate and absorbance of oxygen using wireless communication unit. Here heart rate is detected using peak detection algorithm and the correlation function method. In this method pulse rate can be calculated by measuring threshold value when it reaches its peak value it obtains the ac cycle maximum value and when it reaches zero then the new threshold value is calculated. Between the pulses that has been calculated the counter will acquire their period and finally pulse rate can be calculated. By using the value they can also calculate saturation of oxygen level.

Once these values are calculated the result is sent to the wireless microcontroller. This system requires microcontroller to be connected to wireless network and mobiles since input is not present in microcontroller. Through Wi-Fi connection are established to phone and the microcontroller and they can communicate it easily. The obtained result will show difference less than 2%.

[32] Eka Adi Prasetyo Joko Prawiro, Chun-I Yeh, Nai-Kuan Chou, Ming-Wie Lee and Yuan-Hsiang Lin “Integrated wearable system for monitoring heart rate and step during Physical activity” published in Hindawi Publishing Corporation on 2016

This paper tells about the wearable device that consists of sensors, circuits and microcontroller. This is very light weight and can easily be worn. Wearable device is also very comfortable to wear while doing the exercise. This wearable device also consist of memory chip, MCU, ADC etc. Here device is connected to phone which can be monitored through our phone. Mobile displays all the parameters of heart rate and oxygen level. While doing exercise it keep tracks of all cycle of exercise, if there is any increase above the normal value the server will detect the drop rate and the alert message will be sent to phone. This systems accurascy rate is about 98.96%.

[33] M T Tamam, A J Taufiq and A Kusumawati “Design a system of measuring of heart rate, oxygen saturation in blood and body temperature with non-invasive method” published at 1st International Conference on Engineering and Applies Technology (ICEAT) at IOP publication in 2017.

This paper is designed to calculate the temperature, oxygen absorbance and pulse rate of patient. Here temperature sensors and pulse sensors are used and they are connected to arduino Uno. The values that are detected here are stored in cloud server and they are analyzed. The values of the heartbeat, oxygen absorbance in blood and the temperature can be seen through the led display. If there is any drop in any other values cannot be monitored here like blood pressure and the pulse rate cannot be detected here. Error detecting while calculating spo2 is 0.89% while in heart rate 3.906%.

[34] Shivleela Patil, Dr. SanjayPardeshi “Health monitoring system using IoT” published in IRJET 2018 This paper mainly talks about parameters like temperature , ECG and heart rate in which these are connected to arduino Uno in which they monitor the values. This paper also uses amplifier circuit to increase the strength of the signals as they are all weak. When device is connected to internet it will be connected to cloud server in which the data that are calculated are sent through. Here cloud server and the arduino communicate with each other and send and receives the data and are saved in cloud platform. This system is very cost effective which will not be easily available. This paper does not tells us about calculation of blood pressure and it does not have any alert system.

[35]. Ali I.Siam, Atef Abou Elazam, Nirmeen A El-Bahnaswy, Ghada El Banby, Fathi E. Abd El-Samie “Smart health monitoring system based on IOT and cloud computing” published in 1st International Conference on Electronic Engineering, Menoufia University, Egypt

Small changes in some variable in physical body such as oxygen congestion, temperature, BP and heart rate results in disease. The differences in these parameters are need to be measured to determine whether the certain disease is present or not. Using IOT and wireless sensors patient’s data can be delivered to the doctor. This plays a major role in helping doctors to take necessary action to send medical help. The patient’s data is processed and stored in cloud. Several benefits in storing data in cloud area availability, reliability and convenience. This paper provides secure solution for health records that are stored in cloud. Sensors are used to measure heart rate, spo2 and body temperature. Microcontroller is used for filtering, encode and decryption of health variables to the cloud. This paper AES algorithm which is used to secure patient data before storing it in cloud. Node MCU microcontroller is used for connectivity over Wi-Fi to cloud. This system can also send alert mails to patient’s relatives and friends.

[36].Shubham Banka, Isha Madan and S.S.Saranya -“ Smart healthcare Monitoring using IOT” published in International Journal of Applied Engineering Research ISSN 2018

In this paper the IOT is used to provide smooth medical facilities to the patients and facilitates doctors and hospital as well. This system would be confidential to the family members and their doctors about the current status of patients and medical records. This paper they used raspberry pi in which they acts as a controller to demonstrate a remote health monitoring system. The information of a patient’s status is saved to the cloud and it will be showed to the authorized user through online. It will also send the alert message to the patient’s family members and also doctors at the time of emergency.

III. PROPOSED SYSTEM

The objective of this system is to record the various sensor information and display it to the users in a simple user-friendly manner. The recorded information which can be accessed through the app and web dashboard will indicate whether the reading is within the normal limits. It will also notify the user and the contacts regarding the medication requirements such as dosage, intake time etc. In this section, the components in the architecture will be elaborated.

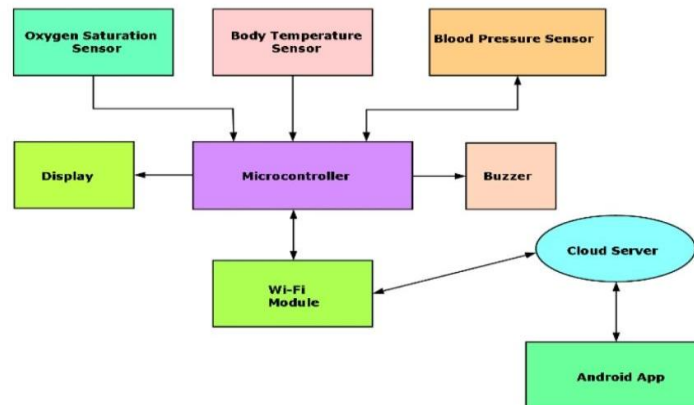


Fig: System architecture

The proposed system comprises of sensors that monitor different health parameters, namely pulse rate, blood pressure, Heart Rate, body temperature and oxygen saturation (SpO₂). The components used are described as below.

1) Blood Pressure Sensor: BPS-BTA is a non-invasive sensor developed to measure human blood pressure. It is capable of measuring systolic, diastolic and mean arterial pressure using the oscillometer technique. Monitoring blood pressure is important because as it goes higher, there is more strain on the arteries thereby making it weaker. Due to these reasons, the chances of a stroke, heart attack, dementia is possible [37-41].

2) Pulse oximetry Sensor and body Temperature sensor: Pulse Oximeter is used in the proposed design to measure the temperature and oxygen saturation. Pulse oximeter is a non-invasive test which employs a probe that can be secured to a finger or earlobe. It measures the oxygen saturation level in blood. Normal oxygen saturation levels are between 95 and 100 percent. Low oxygen saturation levels below 90 percent can cause cells to be strained and damaged. Pulse oximeter is used to monitor the health conditions of a patient with problems that affect blood oxygen levels such as anemia, heart attack, heart failure etc. [42-45].

3) WIFI Module: Wi-Fi Module is an economical Wi-Fi microchip. Its integration with TCP/IP protocol stack allows microcontroller to access Wi-Fi. This is integrated onto the microcontroller board in order to transmit the data to cloud [46-48].

IV RESULT

The sensors details are displayed on the LCD display locally, and On the android Or iOS through internet of things. The sensors details can be stored in CSV format.

V CONCLUSION

IOT along with some sensors is used to implement health monitoring system which is able to measure heart rate, SpO2 and body temperature. The paper tells us about powerline communication used and tele health care services used to implement heart rate and spo2 count. These device only calculates the heart rate and oxygen level saturation and does not consider other parameter. Blood pressure sensor can be added to detect blood pressure in blood and also alert system can be used to send alert message to patients family. This system can implement heart rate, saturation level of oxygen and also sends an automatically send patients health information alert along with patient's location to the doctor. So this system helps the patients to get a right treatment at the earliest stage.

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