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Wearable Sensors for Remote Monitoring in Smart Public Hospital.

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Abstract

In hospital there are more activities that are performed by medical staff and doctors which put less time to attend patients regularly. Patients sometimes need urgent treatment which is unaware by nurses and doctors. In current day technology and intelligent systems play important role in hospital to improve lives of patients. This paper we developed wearable system that uses sensors such as temperature and pulse rate to sense condition of patient. Microcontroller together with Wi-Fi module send information to cloud (Thingspeak) able nurses and doctors to monitor patient's activities. Data is continuously monitored all the time, this can help to medical staff to safe time going to each patient to that measurements and more time to attend patients who require urgent assistance. Also device allows patient to move freely in and outside patient room.

Keywords: Arduino; Thingspeak; Internet of Things (IoT);

1. Introduction

With low cost payment in public hospital, more people are admitted and this causes more over work on medical staff and doctors. One patient can be attended one or twice per day and this can increase vital illness of patient which requires regular monitoring. Today with increasing technology and intelligent systems, the condition of patient can be monitored remotely helping nurses and doctors to give more attention to critically ill patients. Internet has become one of the important parts of our daily's life, with new trend of internet called "Internet of Things". IoT (Internet of Things) is creating invisible network with objects that can sense and store information over private and public internet protocol. This paper focus on implementing and developing wearable sensor device that is used in smart hospital to monitor the patient's health and vital signs like temperature and pulse rate in periodic interval without the visit of doctor to patient room. Wearable system is flexible helping patient to move around. The sensors send data to internet via Arduino micro board and WI-FI module. Cloud computing (Thingspeak) assist nurses and doctors to capture information, also monitor patient remotely.

2. Related work

In hospitals has been rapidly integrating technology in monitoring and treatment of patients which designed to improve the quality of life of patients. Related work has been done by other researchers which have

limitations to access information on database and also in real time monitoring, this requires medical staff to be close to patient to access information. The proposed technique using Internet of Things assists more devices to be connected to internet simultaneously at real time. Wearable device helps nurses and doctors to monitor patient conditions by using remote computer that is connected to internet without going to each patient ward to collect data.

3. Proposed work

The block diagram of proposed device is shown in below figure. The sensors temperature and pulse sensor are connected to Arduino micro board. Arduino collect data from sensors and send data to internet via Wi-Fi module. Information of patient can be accessed on cloud (Thingspeak) by doctors at any time. Internet of Things is done using secured Thingspeak, which is open source cloud service. Real time monitoring data is transferred from Arduino microcontroller to Thingspeak cloud.

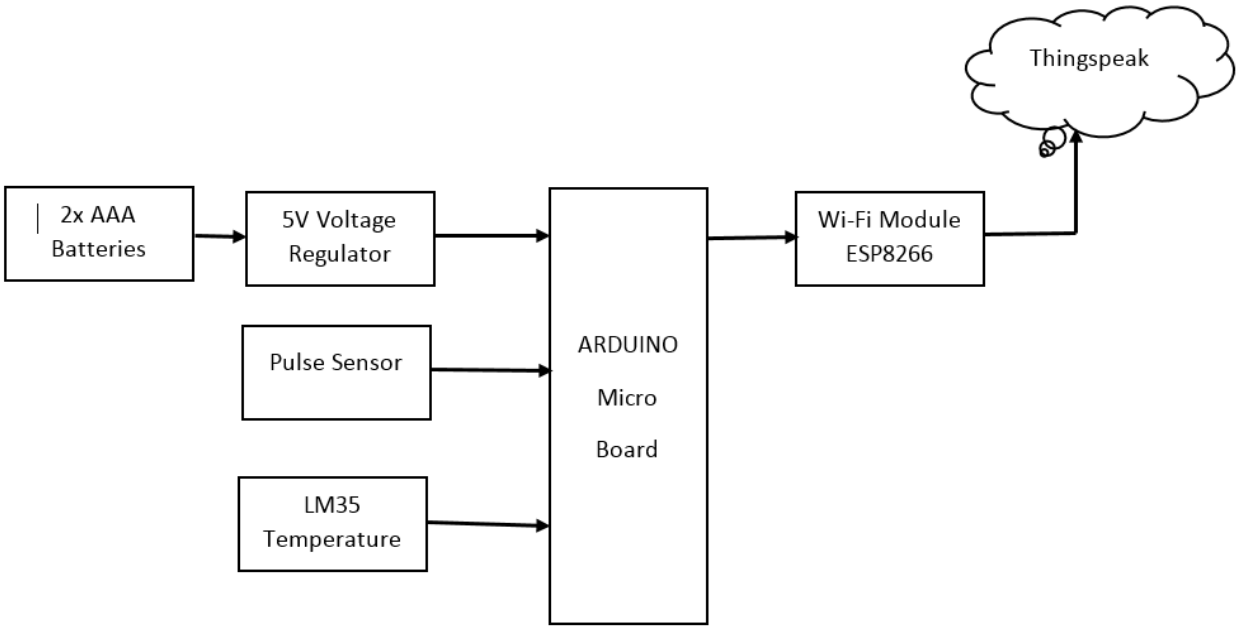

Figure 1. System Architecture for proposed wearable device.

4. Hardware description.

4.1 Arduino Micro.

Arduino Micro is a microcontroller board based on the ATmega32u4. It has 20 digital input/output pins, a 16MHz crystal oscillator. Can be simply connected to computer with micro USB cable or battery to power it up. Arduino Micro can be programmed with the Arduino software IDE (Integrated Development Environment) which is used to write and upload computer code to physical board.

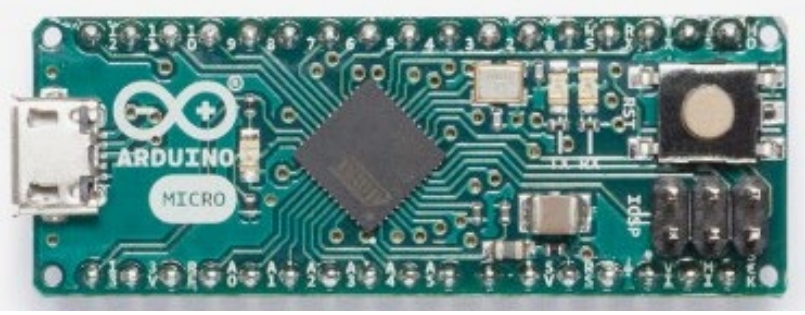

Figure 2. Arduino Micro Board

4.2 Temperature Sensor.

LM35 is a precession integrated circuit temperature sensor, with output voltage varies based on the temperature around it. The LM35 sensor does not require any external calibration to provide typical accuracies at room temperature and it can be used to measure temperature anywhere between -55°C to 150°C. LM35 can be easily be interfaced with any microcontroller that has analogue to digital converter function and development platform like Arduino micro board.

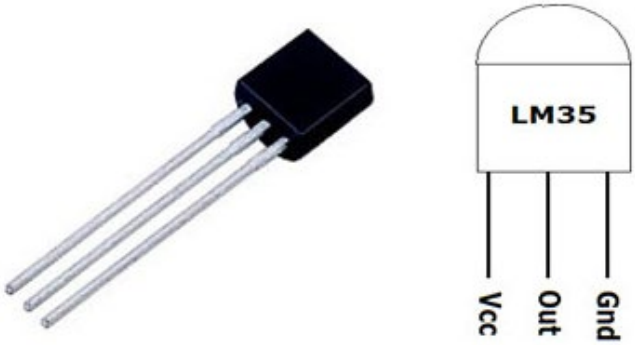

Figure 3. LM35 pins layout

4.3 Pulse Rate Sensor.

The pulse sensor is a plug-and-play heart rate sensor, with light emitter diode helps in measuring pulse rate. The light reflects will change based on volume of blood inside the capillary blood vessels. Digital output from pulse sensor in connected to microcontroller directly to measure the Beat Per Minute (BPM) rate. A normal resting heart rate can be anything between 60 and 100 beat per minute.

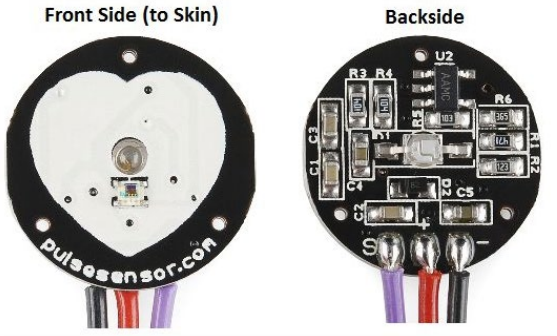

Figure 4. Pulse Sensor

4.4 WI-FI Module (ESP8266).

ESP8266 is a low-cost serial-to-WIFI module that has ability to communicate with any microcontroller. ESP8266 need input voltage of 3.3V and can be damaged if input voltage is more than 3.6V. Data process from Arduino micro is sent to the cloud server through ESP8266 module.

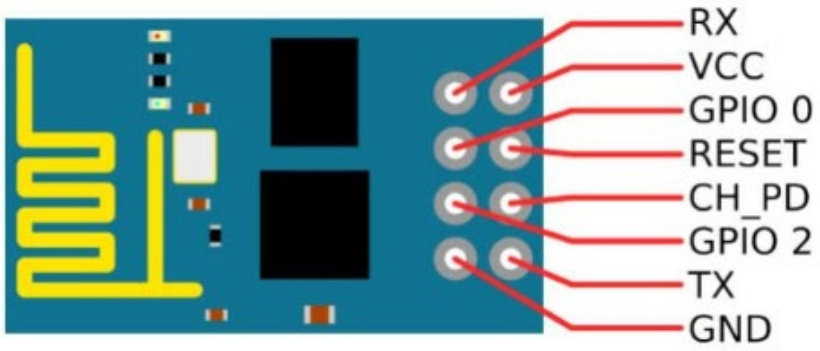

Figure 5. ESP8266 pins layout

5. Software description

5.1 Embedded C Program.

The Embedded C is a language extension of C programming, which was developed in order to address the common issue between C extensions for different embedded systems. Arduino is commonly using C programming language.

5.2 Thingspeak (Public Cloud)

Thingspeak is an Internet of Things platform that enable user to collect, analyses and visualize data from sensors that collected through microcontroller.

6. implementation and results

The overall device system is shown in figure 6 and 7, two sensors which are temperature and pulse sensor are connected to port A0 and A1 of Arduino micro. ESP8266 is used as gateway to communicate and take data from sensors, transmit them to Thingspeak cloud.

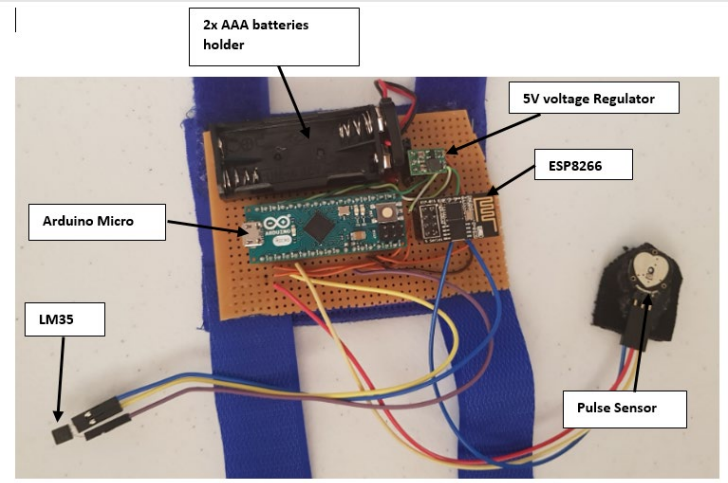

Figure 6. Wearable device circuit setup.

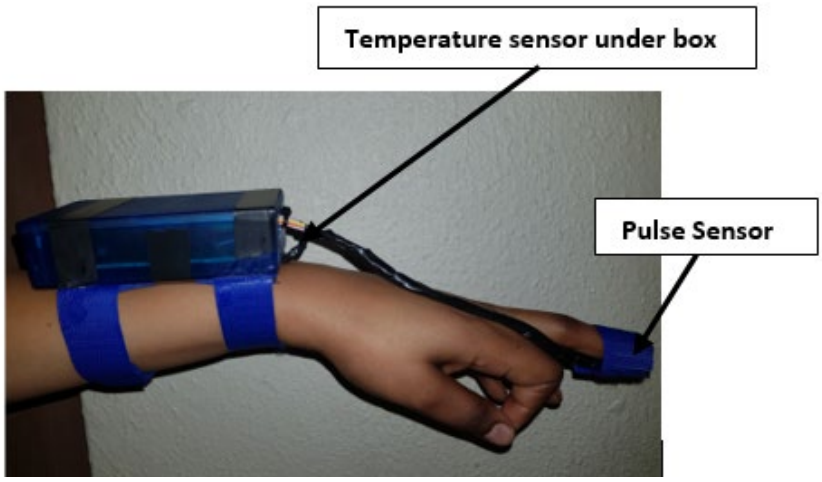

Figure 7. Completed wearable device.

Temperature sensor sense the body temperature of patient as shown in figure 8 and the values are plotted and viewed on monitoring desktop based on measurement with to time and date.

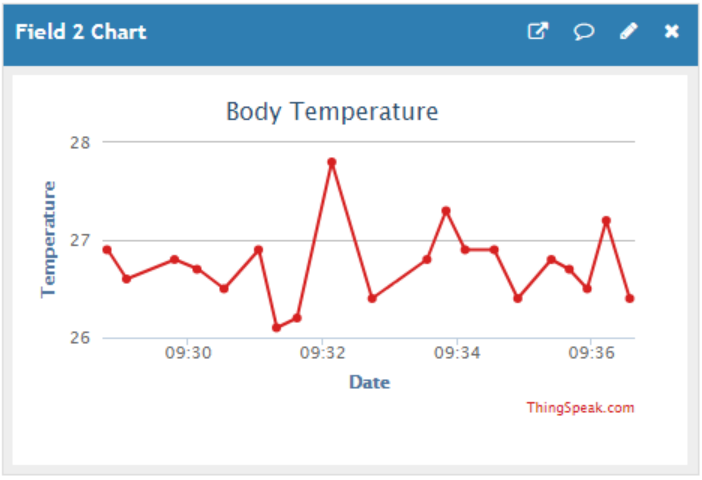

Figure 8. Temperature measurements

The pulse rate sensor measures the value based on pressure of blood flow. Normal range of heart rate is from 60 BPM to 110 BPM, doctor can easily monitor patient heart present condition remotely. As shown in figure 9 experimental measurement is approximately 60BPM.

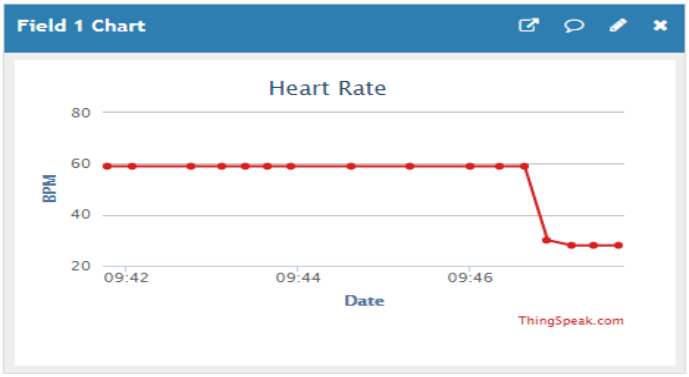

Figure 9. Pulse rate measurements

Freeboard dashboard is part of Thingspeak that have more options to choose better widget type. Figure 9 show both measurements of temperature and pulse rate from Freeboard Dashboard.

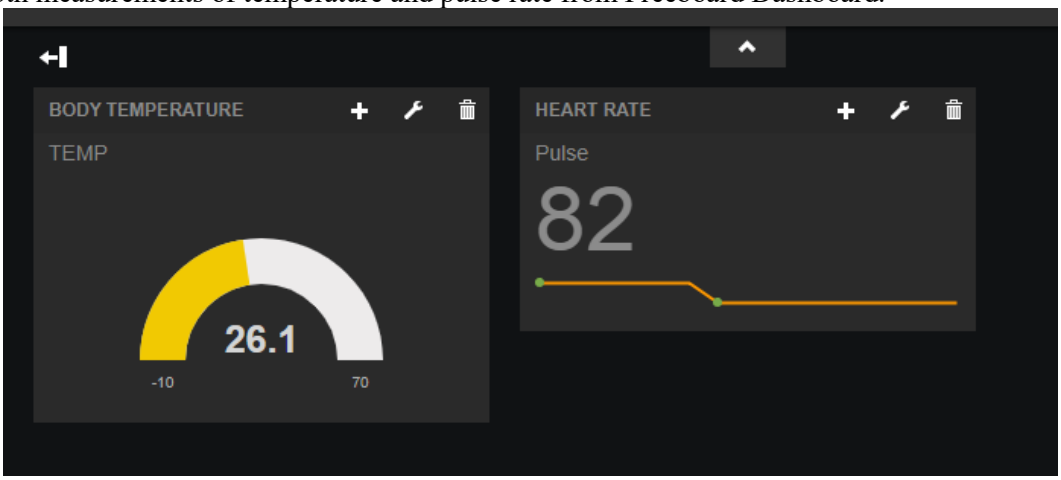

Figure 10. Both measurements on Freeboard dashboard.

Conclusion and future enhancement

The proposed wearable device helps to improve conditions of patients in hospital and safe more time for medical staff as they can easily access the patient's information anywhere with the help of internet. In the future the wearable device can be extended by adding more features that can alert doctors of any emergencies occurs on patient. Our work is extended to include challenges in complex machine learning algorithms that provide prediction solution of patients. Wearable sensors and ambient sensors will provide better solution by enabling patients to freely move around facilities. We conclude that the proposed system will not only help patients in healthcare facilities but reduce overwork of medical staff and monitor real-time condition of patients.

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Biographies

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Wesley Doorsamy received the B.Sc, M.Sc. and Ph.d. Degrees in Electrical Engineering, and a Postgraduate Diploma in Higher Education from the University of the Witwatersrand in Johannesburg, South Africa in 2008, 2013, 2015 and 2017, respectively. He is currently a senior lecturer at the University of Johannesburg and is an active member of both the Institute of Electrical and Electronics Engineers (IEEE) and South African Institute of Electrical Engineers. In 2017, he was awarded the affiliate membership with the African Academy of Sciences (AAS). His research interests are signal processing, machine learning and pattern recognition, applied probability and statistics

Babu Sena Paul received his B.Tech and M.Tech degree in Radio physics and Electronics from the University of Calcutta, India. He was with Philips India Ltd from 1999-2000. He received his Ph.D. degree from the Department of Electronics and Communication Engineering, Indian Institute of Technology. He has attended and published over sixty research papers in international and national conferences, symposiums and peer reviewed journals. He has successfully supervised several postgraduate students and post-doctoral research fellows. He joined the University of Johannesburg in 2010. He has served as the Head of the Department at the Department of Electrical and Electronic Engineering Technology, University of Johannesburg from 2015 to March 2018. He is the currently serving as the Director to the Institute for Intelligent Systems, University of Johannesburg.