Remote Heart Rate Monitor System using NodeMcu Microcontroller and easy pulse sensor v1.1

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Remote Heart Rate Monitor System using NodeMcu Microcontroller and easy pulse sensor v1.1

Salam khalaf Abdullah[1]
[1]Institute of Technology-Baghdad, Middle Technical University, Baghdad, Iraq
E-mail: hassan19851988@yahoo.com (Alhassan H Ismail)

Abstract. For high precision and low cost, the heart rate monitor system by using NodeMcu was invented which can be used in several applications such as patient treatment and monitoring in places away from the center of cities for the initial diagnosis purpose, elderly health care or sport training. in this paper a new system for detecting and remote monitoring cardio-vascular pulse wave was invented which depends on the NodeMcu board which is built-in a Wi-Fi module with an easy pulse sensor. In this proposed system the easy pulse sensor which has been used for detecting of heart rate and send it to NodeMcu board which transmits such data to the intended destination using the internet. The basic work of heartbeat Sensor used in this design depends on the principle of photo plethysmography to obtain vital information of the heartbeat from the skin surface. the calculation of heart beat was done using two methods, first by tracking the peaks in the PPG waveform while the second way by calculate the frequency of the digital output wave form which is simultaneous to the heart rate pulse. The preliminary result show that the new system is more reliable and lower cost compare with other system based on IOT Microcontroller and gives good and optimum results.

Keywords: NodeMcu, easy pulse sensor, OLED displayer.

1. Introduction

The aim of this project was to help solve the problems of diagnosis of heart attacks to able treat early and provide service to a hospitals and health care centers in poor countries because of low cost Compared to high-cost commercial heart monitors who cannot be provided to all of the hospitals referred to specific budget of these countries. Even if we consider the patients who living in the remote areas of the city will find it very difficult to move to the city center for the purpose of preliminary inspection and diagnosis Coinciding with the increasing numbers of patients with heart disease and heart attacks, remote Heart rate monitoring is indispensable to obtain the needful information Which allows the detection of emergencies and to assess the risk of Heart failure. Some designers have shown heart rate monitor designs and implements internet of things technology (IOT) by using Arduino Uno with a Wi-Fi chip esp8266. The flow mechanism of this process for monitoring the patient heart was shown in figure1.

In this paper enforcement of heart beat monitoring system using (IOT) internet of things which depends on the NodeMcu board and Easy pulse sensor version 1.1 has been done. The heart beat signals were collected from finger using Easy pulse sensor V1.1 module which was amplified in order to transform them to an Observable scale. The NodeMcu board which is based on the Esp8266 Wi-Fi module will then connect the network to router that will provides the code and will transmit the data of the sensor online that can be reached from anywhere over internet. The OLED displayer that connected will also display the heart beat in BPM. It is known that the Arduino board do not possess built-in support for wireless networks. Therefore, when using the Arduino board to connect via the wireless network, a WI-FI chip Esp8266 must be added to connect to the wireless module. In This paper an open-source development board was used to build a heartbeat monitor remote system. One of the main and important features of this board is a built-in support for Wi-Fi connectivity which makes Internet of Things applications much easier.

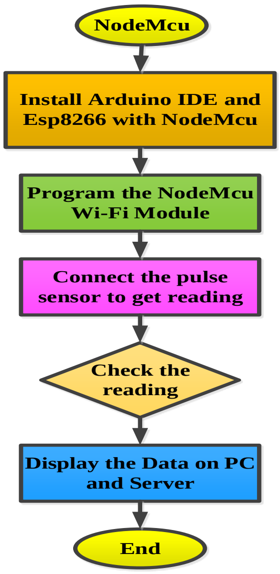

Figure 1. Flow chart of remote heart rate monitoring system

This paper is arranged as: in the beginning give summarized information about the NodeMcu board and its specification then give significance information about install Arduino IDE and Esp8266 with NodeMcu then a pulse sensor V1.1 is described in detail. finally show the simulation results to achieves how to setup the internet of things (IOT), find a way to connect the system to the internet. In practical terms, the best methods to connect through the Internet is by using the wireless networks.

2. NodeMcu board

The NodeMcu which is shown in figure2 is a built-in development board contains the Esp8266 Wi-Fi chip [Esp8266 is a microcontroller possesses Wi-Fi built-in]. it is known as (SoC) system on chip and It includes all the basic elements of computers which CPU, RAM, operating system and WIFI chip. The NodeMcu is explicit advantage over the Arduino or PIC making it connected to the Internet by Wi-Fi easily. Furthermore, the ESP8266 board which is shown in figure 3 has exclusive pins although the chip itself possesses a lot of ports. The NodeMcu fix this issue by featuring 10 GPIO pins each capable of using PWM, I2C and 1-wire interface. Node MCU has 4MB of storage and 128 Kb of Memory. It has multiple GPIO (General Purpose Input Output) pins for device connectivity. It has only one Analogue pin for Analogue input.

The NodeMcu board has miscellaneous properties such as:

1. Programmable Wi-Fi module.
2. We can use the Lua programming language or the integrated development Environment of Arduino for programming the NodeMcu Board.
3. Includes 10 digital ports D0 -D10 with one analog port A0.
4. Wi-Fi built in chip.
5. PCB antenna.
6. SPI communication and pulse width modulation (PWM) implementation.
7. Contains a PCB antenna.

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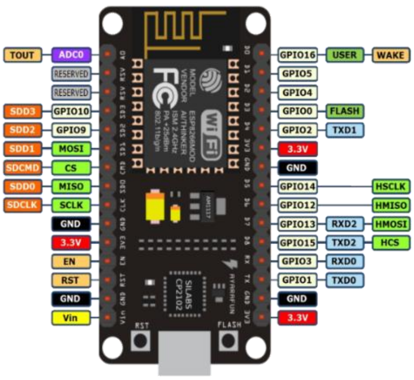

Figure 2. NodeMcu Board

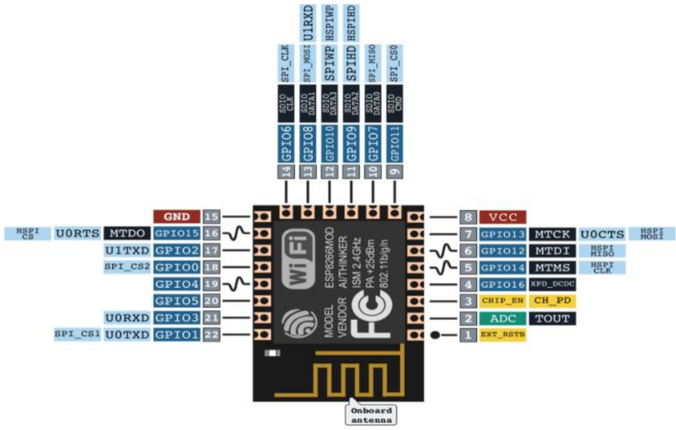

Figure 3. Esp8266 Wi-Fi chip

The programing of NodeMcu board is done by lines from Lou Script or with the development environment of Arduino (IDE).to use the Arduino IDE to program the NodeMcu we need to follow the bellow mentioned:

1. Turn on the Arduino Integrated Development Environment.
2. From the menu Bar go to file.
3. Select preferences then choose the Additional Board Manager.
4. past this URLs:http://Arduino-esp8266.com/stable/esp8266_index.json.
5. Click OK and restart the IDE.
6. Now you can starts programming your nodemcu board after select it from Boards Manager using Arduino IDE directly.

3. Easy Pulse Sensor (Version1.1)

The Easy Pulse Sensor as shown in figure 4 is designed to sense the pulse of the heart, which is based on the principle of transition of the plethysmography to detect the cardio-vascular signal from the skin surface. It employs an Infrared light source to irradiate the skin surface on one side, and a photodetector placed on the other side measures the small difference in the conveyed light intensity which is occurs due to the heart pumping the blood continuously in the body as shown in figure 5. Easy Pulse sensor can be readily interfaced with PIC, AVR, or any other microcontroller platform. The analog PPG output from Easy Pulse board is fed to an analog digital converter stage of NodeMcu board. Also, we can get a digital pulse output which is concurrent with the heartbeat. Easy pulse sensor has more than one features such as:

1. Operate at +5v power supply (Avoid using USB port to supply this board. USB port may not equip sufficient current to operate the sensor, which result in poor accomplishment)
2. Two stage filtering and amplification.
3. Digital and Analog waveform output.

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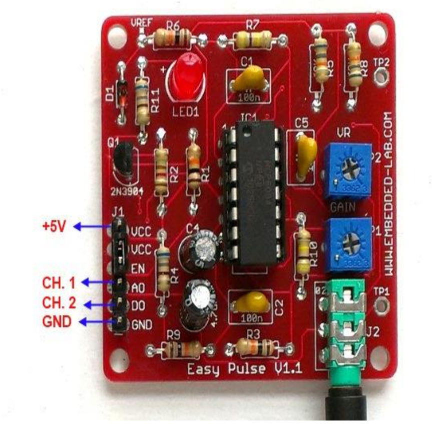

Figure 4. General Shape of the sensor

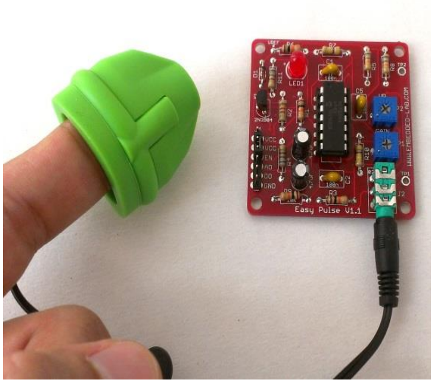

Figure 5. easy pulse board connections

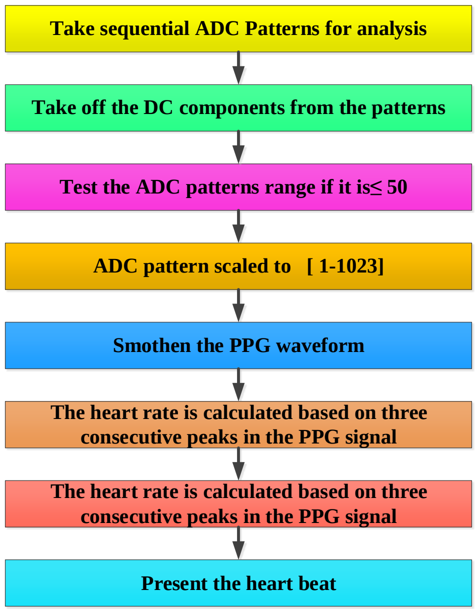

Figure 6. the steps for computing the heart beat rate

4. OLED Displayer 1.2 inch

OLED or Organic Light Emitting Diodes, as shown in figure 7 is a branch of existent conventional LED technology. LEDs are semiconducting light sources that work through electroluminescence-that is, they make photons by plopping electrons into little electron holes within the instruments emissive layer. With a simplified idea, the light comes out when the electricity goes in. the OLED are slight thickness device that immediately release colored light. The OLED Displayer has more benefits points such as:

1. Lower power consumption
2. Better picture quality.
3. Better durability and lighter weight

Figure 7. OLED 1.2-inch displayer

5. The Proposed System

It can be seen from the figure 8 and figure 9 that the core of the implemented system is the NodeMcu open source microcontroller IOT platform and all components are connecting to it. The pulse sensor V 1.1 must be powered from the outsource power of 5v DC. Connect A_0 pin of the NodeMcu board to the A_0 pin of the easy pulse sensor board. Then connect D1 and D2 pins of the NodeMcu to the SCL and SDA of OLED displayer sequentially.

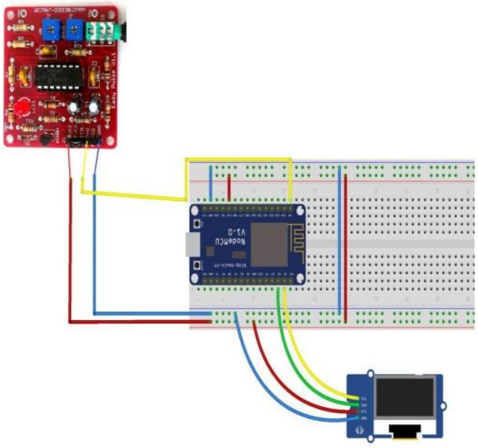

Figure 8. hardware connections

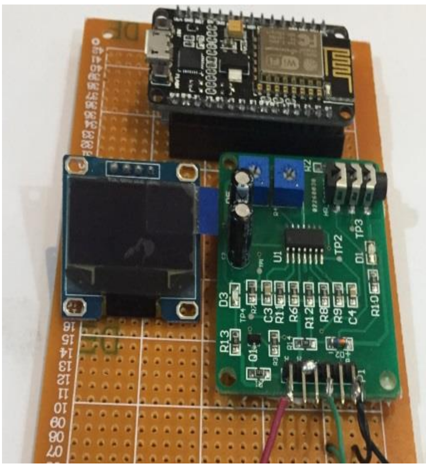

Figure 9. the entire proposed system

6. Results and Discussions

In order to examine the efficiency of the proposed system. the comparison was done between the heart pulse reading we obtained from the traditional heart pulse measuring device and the reading we got through the easy pulse sensor for four cases. The table 1 shows that comparison. As a result of the calculations of the error rate for these readings, the ratio ranged from 0 - 1.75 % as shown in table1.

Table 1. the error ratio between easy pulse sensor and traditional heart pulse readings.

No.	Easy pulse sensor V1.1 (BPM) readings	Traditional heart (BPM) pulse measuring devices	Error ratio	Figure
1	82	81	1.74 %	10
2	65	65	0 %	11
3	93	94	1.74 %	12
4	94	94	0 %	13

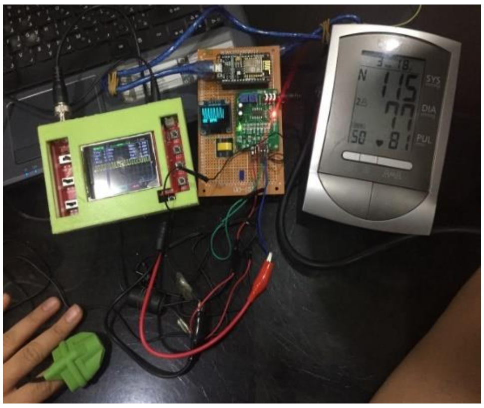

Figure 10. shows the difference in reading between the traditional heart pulse measuring device.

Figure 11. shows congruence in both readings (65 BPM).

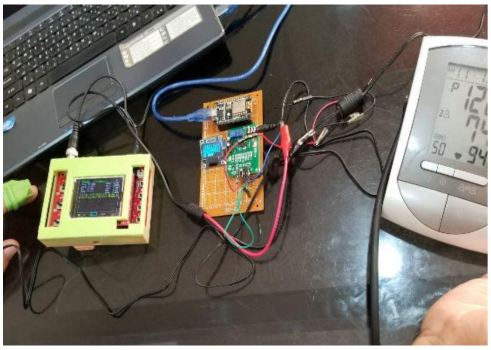

Figure 12. shows the difference in reading between the traditional heart pulse measuring device

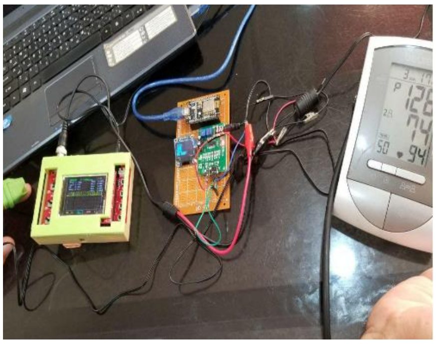

Figure 13. shows congruence in both readings (94 BPM).

Table 2 represents a comparison between the results displayed on the computer and the results displayed on the mobile after achieving the internet connections.As a result of the calculations of the error rate for these readings, the ratio ranged from 0% - 2.48% as shown in table 2.

Table 2. The error ratio between PC heart beat display and mobile heart beat display

No	Mobile heart beat display (BPM)	PC heart beat display (BPM)	Error ratio	Figure No.
1	81	80	1.74%	14
2	86	86	0%	15
3	91	91	0%	16
4	87	85	2.48	17

When applying the proposed system and comparing the results obtained with the results acquired from the traditional heart pulse measurement device, we found it more precise as well as with regard to the results achieved through the internet, the results was found satisfactory.

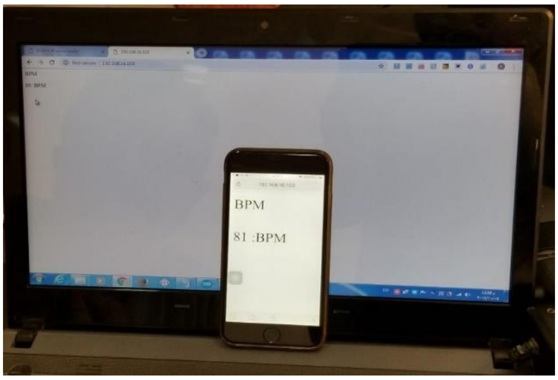

Figure 14. show the reading on the pc webpage 80 bpm and the reading on the mobile is 81 bpm.

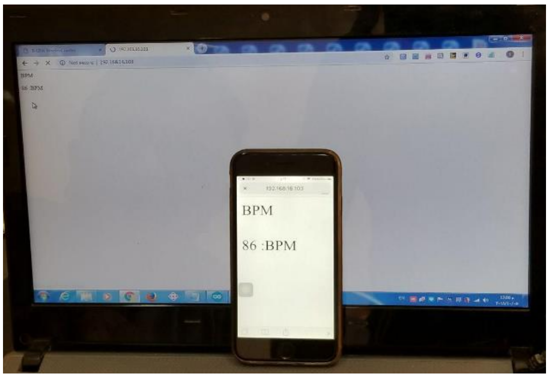

Figure 15. shows the same reading from the pc webpage and mobile (86 bpm).

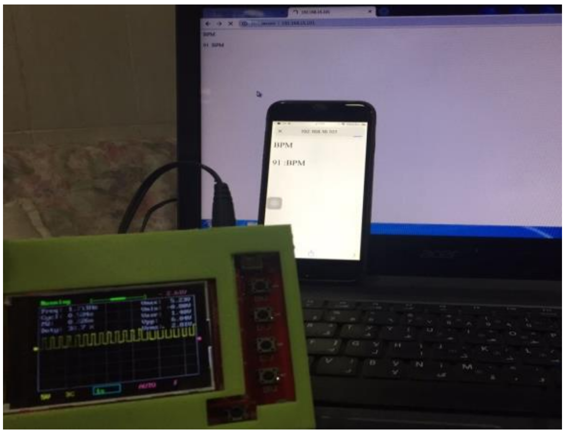

Figure 16. shows the correspondence of the computer and mobile readings.

Figure 17. reading of the mobile is 87 bpm and the pc webpage 85 bpm.

7. Conclusion

In this research, and by calculating the error rates and accuracy of the results of all cases of simulations conducted, it was found that this design is better as compared with the system based on the Arduino Uno Board. in addition, it is shown that the design is less expensive, less energy consumption and smaller size Making it easy to acquire a wide range of users, elderly health care centers and small hospitals. In addition, it provides reliable results to help make the right decision for the patient. This system could be available at a reasonable cost with great effect and accuracy. It is noticed that in fig 17 there is a difference between reading of the computer and the mobile. The reason is that the request for mobile is slower than the request for the computer. The request for the computer is linked to the mqtt of the router, so its connection is faster. When an update is made to the page in the mobile there will be a delay of 20 milliseconds from updating the page of the computer, so we noticed the difference in some readings.

References

[1] Sundara K V, Geetha G 2016 Sensor Based Healthcare Information syatem *IEEE International Conference on Technological Innovations in ICT for Agriculture and Rural Development*

[2] Risodkar Y R, Sangole M K, Amruta R V, Ravi S M, Shirsat K 2015 We Based Human-Health monitoring System *International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)* **4(**1).

IOP Conf. Series: Materials Science and Engineering **518** (2019) 052016 doi:10.1088/1757-899X/518/5/052016

[3] Rajalakhshmi S S, Nikilla 2016 Real Time Human-Health Monitoring System using Arduino *South Asian Journal of Engineering and Technology* **2** 52–60.
[4] Automatic Room Light Intensity Detection and Control Using a Microprocessor and Light Sensor by Ying-Wen and Yi-Te Ku
[5] Joephine S S 2011 Online Health Monitoring System *International Journal on computer science and engineering* **3** no. 4 April
[6] Larkai D K and Ruiheng W 2015 Wireless Heart Rate Monitor in Personal Emergency Response System in Design and Diagnostics of Electronic Circuits & Systems (DDECS) *IEEE 18th International Symposium on*, 2015, pp. 299-300.
[7] Zulkifli N S A, Harun F K C and Azahar N S 2012 XBee wireless sensor networks for Heart Rate Monitoring in sport training in Biomedical Engineering (ICoBE) *International Conference* on, 2012, pp. 441-444.
[8] Mohammad W A, Tanin S and Mohammad S A 2016 A Heartbeat and Temperature Measuring System for Remote Health Monitoring using Wireless Body Area Network *International Journal of Bio-Science and Bio-Technology* **8** No.1.
[9] Babu R, Jayashree K A 2010 survey on the role of IoT and cloud m health care *International Journal of Scientific Engineering and Technology Research* **04** 2217-2219.
[10] Sabri S 2010 *Sensors Hand book* 2nd Edition Mc Graw Hill.
[11] Sinclair I R 2001 Sensors and Trancducers 3rd ed,UK,Buteterworth-Heinemann.
[12] Jasio L D, Wilmshurst I 2008 *PIC Microcontrollers: Know It All*, 1st ed, UK, Elsevier Inc.
[13] Bishop 2006 *Electronics – A First Course* Second Edition, UK, Elsevier Ltd.