Cardiovascular Health Self-Monitoring using Free IoT Platform for Windows and Android

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Abstract

Heart disease is the world's highest cause of death. The most common types of heart disease are coronary artery disease, high blood pressure, and sudden cardiac death. The incidence of heart disease can occur at any age so it is possible to minimize the incidence by conducting regular monitors of cardiac activity. Internet-based monitoring and data acquisition using sensors has widely known as Internet of Things (IoT). Through IoT concept, people can easily monitor their heart activities using computer or smartphone. In this experiment, we were observed heart rate, rhythm, and cardiac electrical activity. The equipment used in this experiment were heart rate sensors, Arduino microcontrollers, jumper cables, ESP 8266 WiFi modules, ECG AD 8232 module, and laptop. The software used was Arduino IDE, Thingspeak.com as free IoT Platform, and ThingView (ThingSpeak Viewer) for android. Arduino microcontrollers were programmed using Arduino IDE by uploading the sketch program to be able to perform data acquisition from pulse heart rate sensors. After the data is successfully retrieved, subsequent data is sent using the ESP8266 module to the Thingspeak.com server. Test results show the heart's activity data successfully monitored in real time. Cardiac activity data can be used as early detection of abnormalities heart function. Data stored on the server can be used by doctors in conducting diagnosis and therapy so that the medication given will be more precise. The author is a lecturer at IPB University and has background in parasitic animal diseases and also concern in the development of biomedical instrumentation.

Keywords: cardiovascular health, internet of things, thingspeak, arduino

Introduction

Heart disease is the first leading causes death in the world, including in the America (Weir et al., 2016). The most common forms of heart disease include heart attacks. This evident come from the high incidence of cardiovascular cases was present in the emergency departments (Usselman, 2017). The incidence of cardiac attacks took place quickly and we can prevent this incidents by make cardiovascular health monitoring routinely. Heart activities can be seen from the electrical activities of the heart. Through observation on the electrical activity of the heart can be monitored and known early when abnormalities are found. The electrical activity of the heart consist of P-wave, QRS complex, and T-wave. By assessing the wave pattern can be known the heart status (Sampson, 2016).

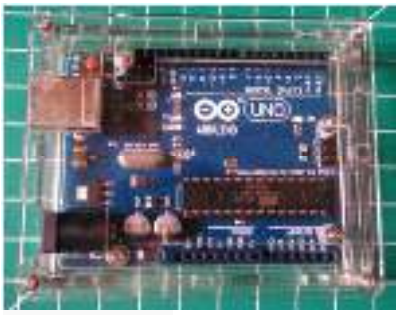
The development of technology has been delivering in the new era. Today it is widely known as the 4.0 era that characterized by the revolution of the 4.0 industry. In this era, the working system has been greatly changed because of the merger of two important system, automation/computerization and Internet system. This concept make new integration and

known as cyber-physic integration system. The application of work system based on 4.0 concept for example: Agriculture 4.0, Internet based services, work Management 4.0, Education 4.0, Industry 4.0, and Health 4.0 (Estrela et al., 2019). Through this concept, it is possible to develop a more smart working system for health system, for example using IoT to create a smart Health service (Amira, Agoulmine, Bensaali, Bermak, & Dimitrakopoulos, 2019).

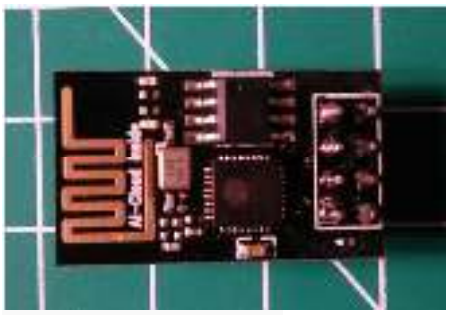
The 4.0-based health concept has been explained by some experts. Among them are changes in mindset of the organization center into person centered. One of the main concepts of a person centered is that every patient despite his awareness of his health, including actively monitoring his health (Chute & French, 2019). Heart monitoring activities can be done easily by using an Internet technology by adopting the concept of cyber-physic integration system (Gomez et al., 2018). Currently available hardware and software that is open source so that everyone can create specific project based on their needs. One of the open source hardware is the Arduino, and it's software Arduino IDE (Louis, 2018). Through the devices can be created a heart Monitor activities system and then the recording data can be monitored over the Internet (Yang, Zhou, Lei, Zheng, & Xiang, 2016). One IoT platform that can be used to monitor and store recording data via Arduino is thingspeak.com. Through assemble the Arduino, ECG sensor module, heart rate sensor module, WiFi module, and Thingspeak then can be created a real time recording and monitoring heart device.

Material and Method

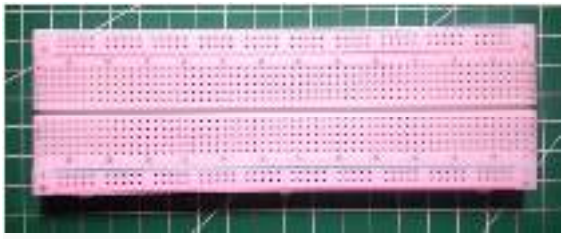
The materials used in this experiment include Arduino Uno, ESP 8266 WiFi module, pulse heart rate module, ECG module, beardboard, jumper wires, laptop, Arduino IDE software, and ThingView app. The figure of the materials and circuit diagram shown in Figure 1.

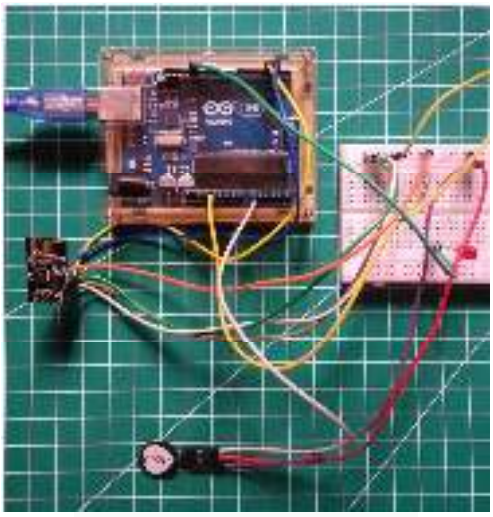


Arduino Uno


Modul ESP 8266 wifi


Modul sensor pulse heart rate


Beard board



Circuit componen diagram

Figure 1. Materials and circuit diagram

Method

The creating of heart monitor devices is started by connecting Arduino Uno with the ESP 8266 WiFi module, pulse heart rate module, and ECG module on the beardboard using jumper wires. The circuit diagram can be see in Figure 1. Furthermore, we connect it into Thingspeak.com to be able to display data in real time through the internet. To be able to Thingspeak, it is necessary to create an account and then log in. After that add a new channel and configure the Channel field on thingspeak. By creating the new channel, we will get an API key that will be used in the sketch program so that the Arduino can send the recorded data via the WiFi module to the Cloud thingspeak. When the channel in the Thingspeak is ready to use, the next step is to upload the sketch program into the Arduino board. The Arduino Board has been connected to the required modules, then filled with the sketch program via the Arduino IDE software. In the sketch program we need to configure on access point connection to WiFi and sensor connection module. In this experiment we modified sketch program from Newton (2018). Sketch programs can be seen in figure 2.

Figure 2. Program code

When an upload sketch program succeeds it will be written “done uploading” on the Arduino software. Programs that have been uploaded on the Arduino board will run a sensor to perform acquisitions and digitization data through the sensor. The data that has been acquired

can be displayed offline through serial monitor and serial plotter in Arduino IDE. On line data is also sent by Arduino via WiFi module to the channel that has been created at thingspeak.com. Data that were sent to be automatically stored on cloud thingspeak based on the IoT principle (Sathya et al., 2018).

Results and Discussion

The first data recorded was pulse heart rate data that can be seen in figure 3. Figure 3 show the data that displayed on the serial monitor. While data on the monitor plotter in Figure 4.

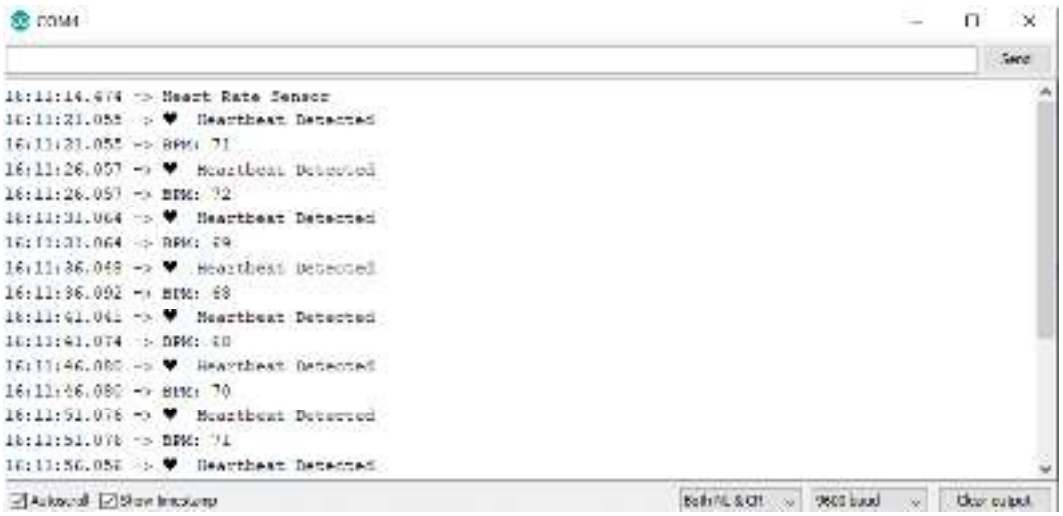


Figure 3. Pulse heart rate data in serial monitor

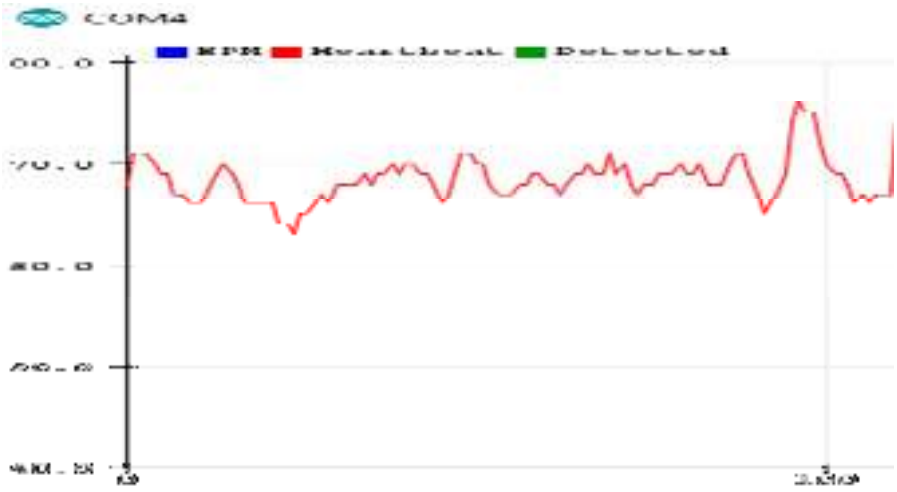
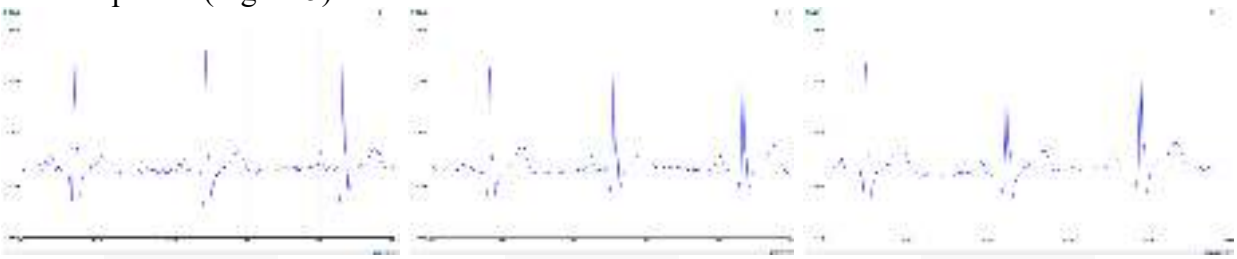


Figure 4. Pulse heart rate data in monitor plotter

The frequency of heart rate detected by the sensor about 65-75 per minute. The human normal heart rate is around 60-100 times per minute in rest conditions and will increase with increases activity. This Sensor was programmed to perform every 5 seconds of recording. The threshold used is 550 so that when the sensor detects to that limit, it will start a heart rate recording marked with a "heartbeat detected" view on the serial monitor. Next every 5 seconds will be visible recorded results of a heart rate marked with "BPM =....."

The second data recorded was the heart electrical activity/ECG data. At this experiment, the data was recorded for 3 times. For every trial recorded 3 cycles that consist from complete heart electric cycle. The ECG data from this experiment was displayed on the monitor plotter (Figure 5).



Experiment 1 Experiment 2 Experiment 3

Figure 5. ECG data from experiment 1, 2, 3

The ECG data was recorded in experiment 1, 2, and 3 show that the sensors successfully record a complete cycle of cardiac activity i.e. the P wave, QRS complex, and T-wave. In experiment 1 it still looks quite a small wave between the next cycle while on the experiment 2 and 3 show that the waves was already to be smooth. This may relates to the process of tapping the cardiac electric signal. The process of tapping the heart's electricity is very easily disturbed by the electrical activity of the other muscles so that it must be done when the volunteers is completely silent. In addition, there is a slight difference in the QRS wave complex and it is likely due to the less precise placement of the tapping point. One of the benefits of understanding this electric cycle is to know the activity of heart rhythm. A normal heart rhythm can be noticed by looking at the activity of P Wave and QRS complex which has a comparison of 1:1 and a constant PR interval between the cycle (Sampson, 2016).

Recorded data not only can be seen on serial monitors on the Arduino IDE. The data recorded from the sensors can be viewed via thingspeak and thingView real time. Recorded data from the sensor was sent by Arduino via the ESP 8266 WiFi module to the Web thingspeak.com (Figure 6). The stored Data can be used as a reference for the doctor to provide a more precise diagnose or treatment (Ramu & Kumar, 2018). In addition, the cost to build this device is relatively cheap and the application is easy to do.

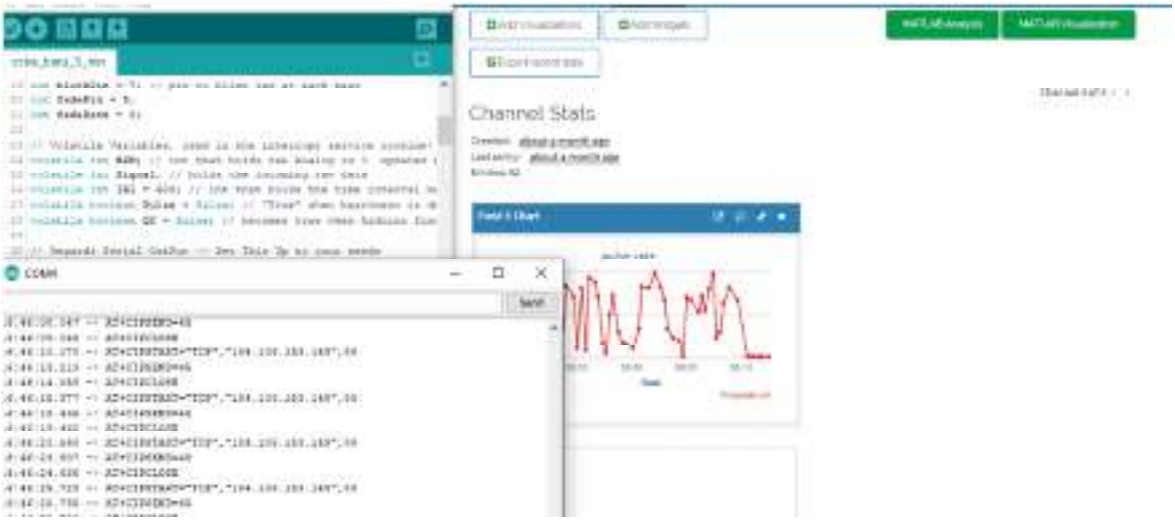


Figure 6. Data show in thingspeak and serial monitor

This experiment is still a simple prototype devices that use to monitor the heart activity by using IoT technology. In the future this prototype needs to be improved. The section can be improve include optimization of algorithm program, optimization of the acquisition and digitalization from the sensor, optimization of the ECG sensor with fewer noise, and development other alternative ways of sending data to Cloud.

Conclusion

Cardiac health Monitoring through the Internet of things can be created by using Arduino, sensors/modules (heart rate sensors, ECG sensors, ESP 8266 WiFi module) and free IoT platforms (www.thingspeak.com). Through this monitoring method, the people can easily monitor their own heart activity by their laptop or smartphone. The development of this IoT-based heart monitoring device can support the 4.0 health concept.

Acknowledgement

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