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Internet of Things (IoT) Based Healthcare Monitoring System using NodeMCU and Arduino UNO

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ABSTRACT

Today Internet has become one of the important parts of daily life. It has changed how people live, work, play and learn. Internet serves for many purposes educations, finance, Business, Industries, Entertainment, Social Networking, etc. The IoT is connected objects to the Internet and used to control of those objects or remote monitoring. A health care monitoring system is necessary to constantly monitor the patient's physiological parameters. The main advantage of this system is that the results can be viewed at any time and place. The doctors can be notified by using mobile phones messages if patient health is abnormal. In this system, heartbeat sensor, temperature sensor and blood pressure sensor are used. The system can analyze the signal to detect normal or abnormal conditions. In the system, the internet of things (IoT) is becoming a major platform for many services and applications. The IoT is generally considered as connecting objects to the Internet and using that connection for control of those objects or remote monitoring.

KEYWORDS: *Arduino UNO; Blood Pressure Sensor (ASDX 015PGAA5), Heartbeat sensor, Internet of Things, NodeMCU, Temperature sensor (DS18B20)*

I. INTRODUCTION

Today Internet has become one of the important parts of our daily life. It has changed how people live, work, play and learn. Internet serves for many purpose educations, finance, Business, Industries, Entertainment, Social Networking, etc. The IoT is connected objects to the Internet and using that connection for control of those objects or remote monitoring [1].

A health care monitoring system is necessary to constantly monitor the patient's physiological parameters. The main advantage of this system is the result can be viewed at any time and place. The doctors can be notified using mobile phones messages if patient health is abnormal. The system was using both the sensors like heartbeat sensor, temperature sensor and blood pressure sensor. The system can analyze the signal to detect normal or abnormal conditions. [2]

The blood pressure sensor used to ensure systolic pressure and diastolic pressure and pulse rate for a few seconds. The DS18B20 temperature sensor is used to measure the surface temperature of the skin. Heartbeat sensor is used to measure heartbeat which normally lies between 60-100bpm. Usually, patients with heart diseases live at home and ask for healthcare service when they feel sick. In addition, most of the patients die before they get any treatment. Therefore, the key to improve heart diseases healthcare performance and reduce the death rate is turning the passive healthcare mode into a pervasive way. Therefore, the doctor will decide when to deliver healthcare service based on patients' real-time status. The essential part of this pervasive healthcare mode is the real-time monitoring system. In this paper, an IoT-based monitoring system is proposed for pervasive diseases healthcare. Satisfactory work is done in health monitoring by using IoT and NodeMCU and Arduino UNO. IoT is the interconnecting of devices and services that reduce human intervention to live a better life. [3]

II. LITERATURE SURVEY

Several comprehensive reviews about the subject of health monitoring with wearable sensors have been previously presented in the literature. Many such reviews focus on giving a global overview of the topic. One of the related approaches was automatic Kmeena Kumari1, et al**.** discussed "Health Care System by Monitoring the Patient Health Using IoT and GSM" which was capable of detecting multiple parameters of our body such as blood pressure, temperature, heart rate, ECG& further transmitting this information on an internet of things server through 2G/3G/4G GSM technologies.

The availability of low-cost single-chip microcontrollers and advances in wireless communication technology has encouraged engineers to design low-cost embedded systems for healthcare monitoring applications. Such systems have the ability to process real-time signals generated from biosensors and transmit the measured signals through the patient's phone to the medical center's server. [3]

The second is the "IoT-based heart disease monitoring system for pervasive healthcare service". In the proposed paper, a pervasive monitoring system was proposed that could send a patient's physical signs to remote medical applications in real time. The system was mainly composed of two parts: the data acquisition part and the data transmission part. The monitoring scheme (monitoring parameters and frequency for each parameter) was the key

point of the data acquisition part, and it was designed based on interviews with medical experts. Multiple physical signs (blood pressure, ECG, SpO2, heart rate, pulse rate, blood fat and blood glucose), as well as an environmental indicator (patients' location), were designed to be sampled at different rates continuously. A sample prototype was implemented to present an overview of the system. This monitoring system fulfilled the basic needs of pervasive healthcare for heart diseases, also took the cost into consideration to ensure the pervasive mode as economical as possible. Furthermore, it could also be combined with real-time analysis algorithms to assess patients' health condition and give warnings to potential attacks in advance, which could make the pervasive healthcare more intelligent. But in the paper, the focus was based on the monitoring part. Four data transmission modes were presented taking patients' risk, medical analysis needs, demands for communication and computing resources into consideration. Finally, a sample prototype was implemented to present an overview of the system. [4]

The third related work was "Zigbee and GSM based Patient Health Monitoring System". The focus was based on the monitoring of patients. The patient monitoring system had been thought of a reliable, energy efficient. It was able to send parameters of the patient in real time. It enabled the doctors to monitor patient's health parameters (temperature, heartbeat, ECG) in real time. Here these parameters of the patient were measured continuously and wirelessly transmitted using Zigbee. In the currently proposed system, the patient health was continuously monitored and the acquired data were analyzed at a centralized ARDUINO. If a particular patient's health parameter fell below the threshold value, an automated SMS was sent to the pre-configured Doctor's mobile using a standard GSM module interfaced to the ARDUINO. Here, the system was using Zigbee for wireless transmission. The Doctor could get a record of a particular patient's information by just accessing the database of the patient on his PC, which is continuously updated through Zigbee receiver module. In the proposed system, patient's parameters such as ECG, Temperature and Heart Beat would be continuously transmitted and monitored through wireless technology Zigbee. The system was convenient and efficient in nature and had no influence on patients' daily life, so it increased interaction between patient and doctor, which made surveillance had real instantaneity. In addition, it ultimately prevented heart disease and avoided unexpected tragedy practically. [5]

III. THE PROPOSED SYSTEM

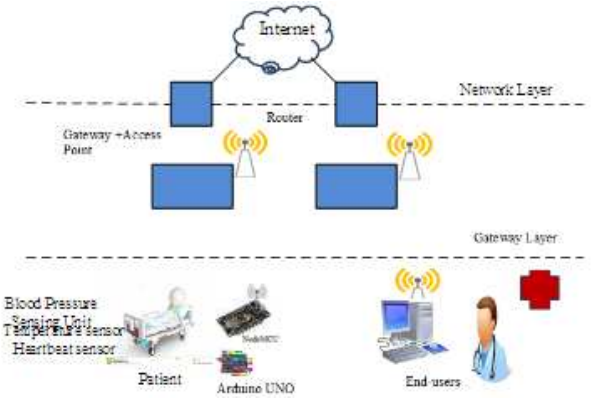

Figure1. Proposed System of (IoT) Based Healthcare Monitoring System

The proposed system design is devised into three layers: Network, gateway, and End-user layers and they are explained in the following sections with figure:

A. End-user layer

This layer includes the end-users (patient and doctor) the first one has wearable device including temperature sensor used to read the patient's temperature and send them through the other layers to the destination (Doctor) for monitoring the patient status to make decisions. As stated before, the patient's temperature continuously and periodically each t seconds configured in the microcontroller software of NodeMCU. The NodeMCU microcontroller board equipped with a low cost Wi-Fi module to enable wireless connection to a nearby gateway Wi-Fi. The interface and programming languages used are the Arduino C language. The Arduino UNO is connected with a blood pressure sensor to measure a patient's systolic and diastolic.

As shown in figure 1, the manager (PC based software) is used to display the collected data from the sensor and send them Ubidots to the Cloud to be permanently saved for any future analysis.

1. Temperature Sensor (DS18B20)

The core functionality of DS18B20 is it's direct to the digital temperature sensor. It is the ability to operate without an external power supply. The DS18B20 powers up in a low power idle state. The normal body temperature is about 37° C or 98.6 ° F. However, it can be as low as 36.1° C (97°F) in the early morning and as high as 37.2° C (99° F). The advantages of a digital temperature sensor are principal with its precision output. As the sensor outputs a calibrated digital reading, the output is an exact temperature in degrees Celsius. This means no other components, such as an analog to digital converter, are required within the electronic circuit to calibrate or amplify the signal.

Figure.2 Temperature sensor (DS18B20)[6 Mau]

2. NodeMCU

NodeMCU is similar microcontroller and it can be configured to connect to the Internet for the Internet of things (IoT). The NodeMCU development board is an open-source board based on Esp8266 microcontroller with integrated Wi Fi transceiver. NodeMCU is a complete environment of hardware and software for IoT.

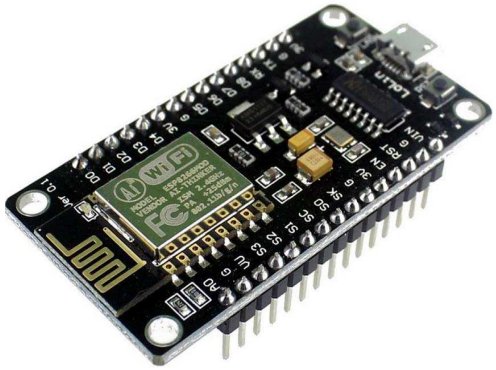

Figure.3 NodeMCU [7 Hwe]

3. Blood Pressure sensor (ASDXAD015PGAA5)

While measuring blood pressure levels, there are two different values always in pairs known as the systolic and diastolic blood pressure. Measured commonly in millimeters of mercury (mmHg), these contain the systolic pressure on the upper value followed by the diastolic pressure on the lower value. The doctor measures the maximum pressure (systolic) and the lowest pressure (diastolic) made by the beating of the heart. Both systolic and diastolic pressure measurements are important-if either one is raised, it means body has high blood pressure (hypertension).

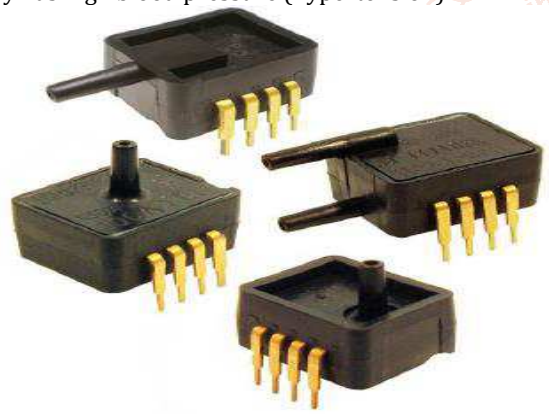

Figure.4 Blood Pressure sensor (ASDXAD015PGAA5) [8 Hon]

The optimal blood pressure reading is 120/80mm Hg, for enjoying good health. This reading lowers the risk of stroke, cardiovascular and renal diseases. This is the ideal blood pressure for people wishing to have good health. At this level, the human has a much lower risk of heart disease or stroke.

4. Heartbeat sensor (AD8232)

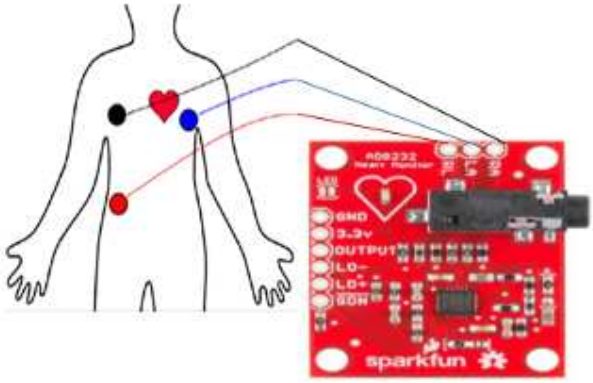

Figure.5 Heartbeat sensor (AD8232) [9 Sha]

AD8232 is an integrated front end, suitable for monitoring heart rate through had jousting bioelectricity signal of the heart. It aims at monitoring different vital signals and is an analogy front end of heart rate monitor, featuring low power consumption and single lead. Heartbeat sensor is used to measure heartbeat which normally lies between 60-100bpm. Heart rate is the speed of the heartbeat measured by the number of contractions of the heart per minute.

5. Arduino UNO

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connects it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

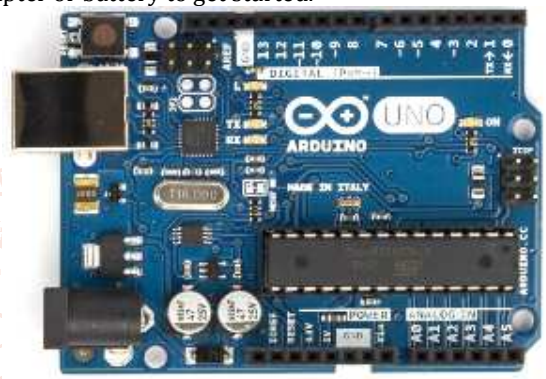

Figure.6 Heartbeat sensor (AD8232) [9 Sha]

B. Gateway layer

The gateway layer is a router-based network, which routes the traffic coming from the microcontroller to the required Cloud. It is evident that when public Cloud is used then this layer might contain single or multiple hops, and in the proposed model, it is fixed to a single router.

C. Network Layer

The Network layer is used for storing the sensor data using Ubidots and allow users 'doctor or patient' to access remotely or even to mentoring the patient state from any available device. The monitoring is done using a smart phone connected wirelessly to the Ubidots using a wireless router.

IV. Hardware and Software Implementation

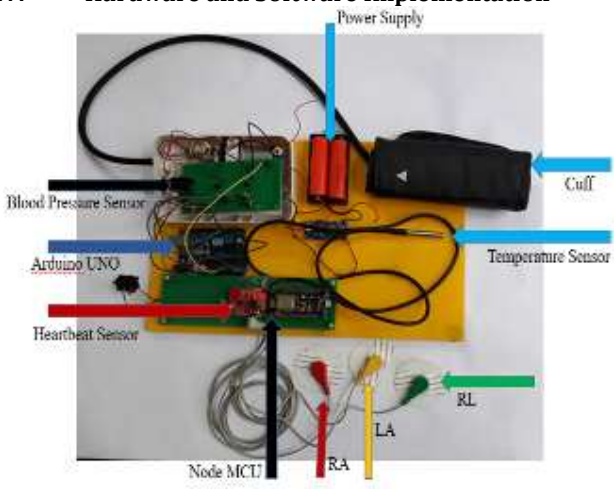

Fig. 7 Hardware implementation of the proposed system

Hardware implementation of the proposed system is shown in figure 7. The main component of this circuit is NodeMCU, temperature sensor, heartbeat sensor, blood pressure sensor, Arduino UNO and power bank. This NodeMCU is supplied with dc power. Heartbeat and temperature sensors are connected to the NodeMCU. And the blood pressure sensor is connected to the Arduino UNO, and then the acquired data connect to the NodeMCU. In NodeMCU, it is needed to store the three sensors data. These data are transmitted to the gateway and IoT. Ubidots application is used in the IoT because it displays the received data. Finally, the doctor easy to use the PC for monitoring.

Fig. 8,9 show the software development of the system. When the system is started, it will first check the Wi-Fi & internet connection. After it checks, data in Ubidots are received. And then these data collection and display the device and variable.

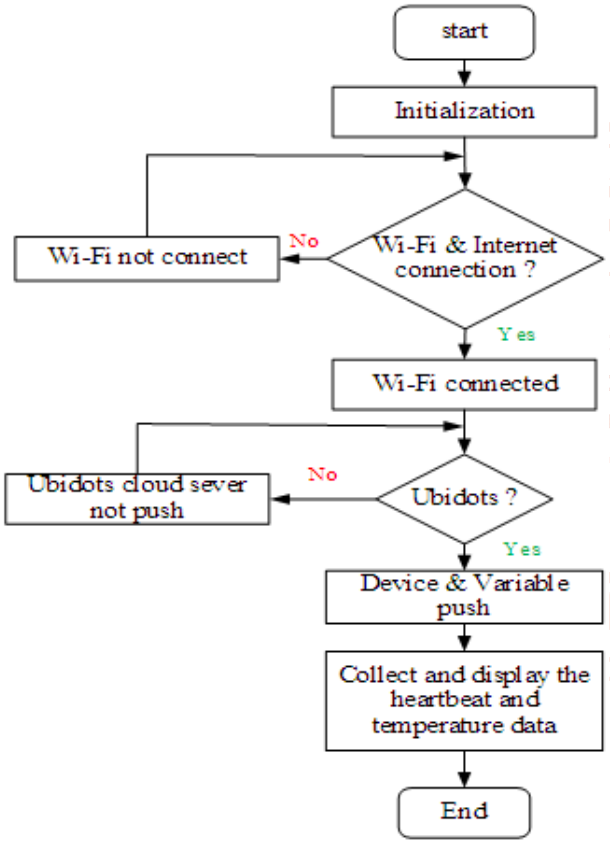

Figure.8 Flow Chart of the heartbeat and temperature

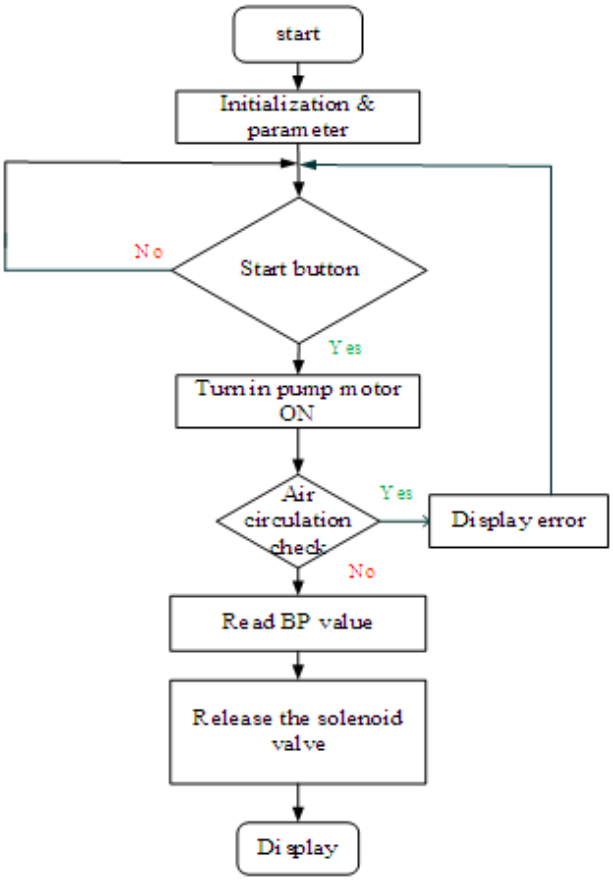

Figure.9 Flow Chart of the blood pressure

V. Simulation Results

After hardware and software implementation of the system, results are obtained and can be visualized on the Internet created on Ubidots. Figure.10, the temperature is not received in Ubidots cloud. This application is the best connect for the Internet of Things(IoT). Ubidots offers a platform for developers that enables them to easily capture sensor data and turn it into useful information. Use the Ubdiots platform to send data to the cloud from any internet-enabled device.

Figure.11 shows the chart of temperature data in Ubidots server and NodeMCU display. The result of this research is successfully obtained the body temperature of the patient. While the body is measured by a DS18B20 sensor, the temperature result arrives on the NodeMCU and then, these data are reached Ubidots server in real time as shown in the figure. 11.

Figure.10 Ubidots cloud

Figure.11 The chart of temperature data

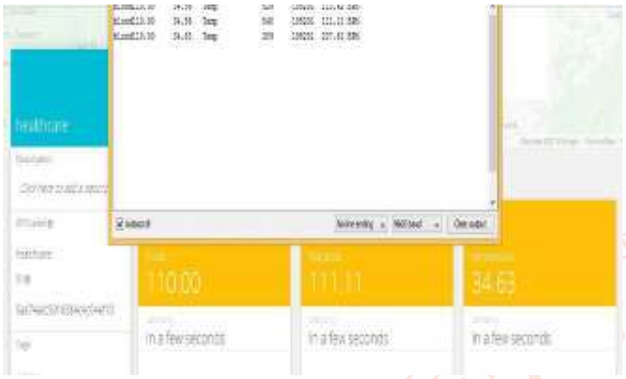

Figure.12 Temperature, Heartbeat and Blood pressure data on the Ubidots

Figure. 12 shows the comparison of Ubidots server and NodeMCU.In this figure, the heartbeat, blood pressure and temperature data are 34.63-degree Celcius, 110 mm/Hg and 111.11 bpm in the NodeMCU and Ubidots sever. The temperature, blood pressure and heartbeat data are measured from the patient's body.

VI. CONCLUSION

The proposed system can monitor, diagnose, and advice the patients all the time. The health parameters data are stored and published online. Internet of things (IoT) is expected to rule the world in various fields but more benefit would be in the field of healthcare. Health monitoring for ICU (Intensive Care Unit) patients need to monitor vital signs (heart rate, body temperature, blood pressure, etc...) from time to time. By using the system, it reduces time and hence the patient monitoring system is designed. As a result, the doctor can examine his patient from anywhere and anytime. It can be allowed the doctors or nurses easily to use the computer for checking and to save in the database. Based on the work, doctors have been able to use mobile devices and can be implemented in a global network with the help of the NodeMCU.

DS18B20 sensor is placed in chield to measure the temperature of the human body. At first, 31.94 degree Celsius is achieved in measurement but it increases to 36.50 degree Celsius after two minutes. Therefore, it can be known that the temperature values will be varied according to the surrounding, weather conditions and age. The results achieved from this thesis is from a woman of 29 years old. Temperature and heartbeat sensors are connected to NodeMCU and then the data is sent to the Ubidots clouds. By comparing the results of the heartbeat sensor (AD8232) and watch sensor, it can be seen that the result value of the AD8232 sensor is a little more. To be concluded, therefore, it can be said that the AD8232 sensor is more save than watch sensor. The blood pressure sensor is connected with Arduino Uno and then the data is sent to the Rx pin of NodeMCU from Tx pin of Arduino Uno. After that BP data from NodeMCU is sent to the cloud of Ubidots. However, systolic can only be sent to Ubidots and so it is the drawback of Ubidots. It is needed to install a cloud application in the doctor's phone handset in order to check easily the incoming data.

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