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Heartbeat and Temperature Monitoring System using ESP8266 Wi-Fi Module

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ABSTRACT: This paper represented the operating of heartbeat and body temperature measurement supported by ATmega328 microcontroller (Arduino UNO). Most of the devices that used in today's world work in offline mode however our system is such that the patients are often monitored wirelessly. Wireless system used sensor to transmit data to remote location. In this paper advance module is used to monitor the patient who are suffering from heart disease and physical disorder. Heartbeat and temperature sensing element is employed to observe patient. Heartbeat and temperature sensor give accurate result and rules out the use of traditional technologies. In this paper ESP8266 Wi-Fi module is used to continuously monitor the patient. This module provides relief to medical advisory for monitoring the patient and also to the patient.

KEYWORDS: Temperature sensor, Heartbeat, Pulse sensor, Arduino, ESP8266 Wi-Fi Module, Thingspeak .

I. INTRODUCTION

In this era of modernization, wireless technology is one of the hottest topics that are often talked about. This wireless technology is often involved around human life lately. The term "wireless" technology is to describe telecommunications in which electromagnetic waves carry signal over part or all of the communication path to convey information rather than using wired signal. There are few wireless technology nowadays that are used by human such as Global Positioning System (GPS), Global System for Mobile communication (GSM), Wi-Fi and Bluetooth. This wireless technology and communication frequently correlated with the term "IOT" which stand for Internet of Things. The internet of things describes the network of physical object things that are embedded with sensor and other technology to transfer data to other devices over the net [31]. In medical field especially in Intensive Care Unit (ICU) patient in the wards are those patients who need critical care due to acute, life threatening illness or injury. Critical care are provided by specially trained intensive care unit groups of physicians, nurses, respiratory therapists and alternative caregiver who use their expertise and skill to supply intensive resuscitation and treatment, and totally monitoring the critical patients. Usually in ICU wards, the doctor or nurses have to observe the estimation of heartbeat and temperature as a significant sign.

Pulse caused by compression of heart sends blood around the body, causing pressure on the walls of the arteries as a result. Blood vessel contraction and expansion of cardiac rhythm is called pulse. Pulse can also be explained in other words as the shock wave of the blood flow caused by the compression of the left ventricular wall of the artery expanded into a rhythm. Pulse rate, heart rate or heart beat convey the same meaning and reflect the pacing of the heart (beats per minute), by counting the beats of the artery within one minute. Heart rate varies for different age groups [32]. Standard Normal heart rates at rest at various ages are: Children (ages 6 - 15) 70 - 100 beats per minute. Adults age (age 18 and above) 60 - 100 beats per minute.

Before using radio frequency module, a wireless heartbeat and patient monitoring system has been proposed. Radio frequency module has some limitation. With the advancement of technology both the quality of security for health is increasing day by day. This paper proposed a remote patient monitoring system which measured heartbeat and temperature of patient and send the measured data to remote end i.e. mobile device using ESP8266 Wi-Fi module [11]. This will save time of both patient and doctor. Patient can also be monitored at home.

II. RELATED WORK

Akshada Ravindra Patil, Prof. Soumitra Das studied IoT Based Fetal Heart Rate Monitoring. mDoppler is attached to a computer through USB cable and communicate with the help of ESP8266 wi-fi module and data is displayed in the

thingspeak. IoT application and API is used to store and retrieve data from things using HTTP protocol over the internet [27].

Amandeep Kaur and Ashish Jasuja studied Cost Effective Remote Health Monitoring System Based on IoT Using Arduino UNO. DS18B20 temperature sensor, KG011 pulse sensor used for measuring body temperature and pulse rate. Arduino UNO is connected to ethernet to get internet connectivity. At the software end blynk is used to realize the system [28].

Rohit Kumar Dubey, Sakshi Mishra, Shreya Agarwal, Ravi Sharma, Nandita Pradhan, Vineet Saran studied the Patient’s Health Monitoring System using

Internet of Things (IoT). Three sensors have been implemented like temperature sensor, heartbeat sensor, Blood pressure sensor and ECG sensor. All these parameters are then fed to the raspberry Pi kit where the various operation is performed like comparison of different health parameters and then finally send to the gateway server. Raspberry kit read input continuously from the sensor then it sends the data to cloud by sending collected data to particular URL/IP address. Wi-fi module is developed which will send patient information every 30 second [29].

Modern healthcare system introduced new technology like wearable devices or cloud of things. It provides flexibility in term of recording patient’s monitored data and send it remotely via IoT. RFID technology is used for gathering info concerning numerous surroundings like temperature heartbeat humidity etc. RFID is used as part of IoT physical layer which is applicable for personal health care. This smart environment is of low price that used optimized resource consumption to observe patient [30].

III. METHODOLOGY

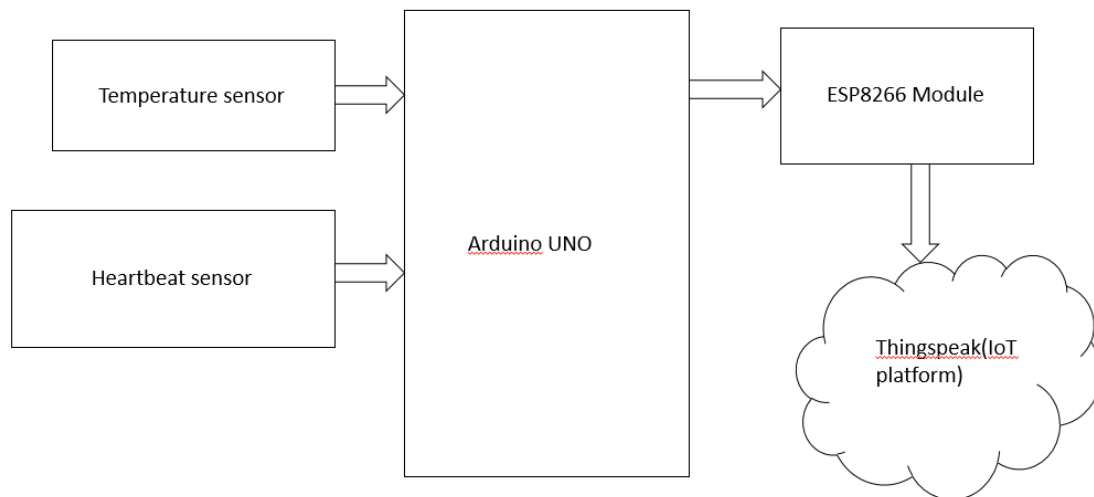


Figure 1. Block Diagram of Patient Monitoring System

Figure 1 show the block diagram of patient monitoring system for respiratory rate and body temperature measurement. The input used are LM35 temperature sensor and pulse sensor. The LM35 temperature sensor measure the temperature of the body and Pulse sensor measure the heart rate. Both sensors collect data from patient’s then transfer to the microcontroller for further calculation and then send data to the mobile user using ESP8266 Wi-Fi Module.

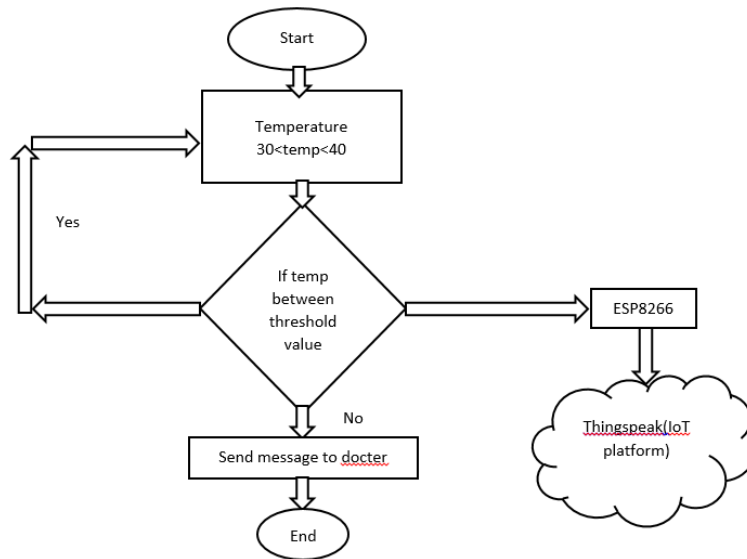


Figure 2. Flowchart of Temperature Measurement

Figure 2 show the flowchart of how the system work in order to calculate the temperature of each patient. It starts with calculating temperature if the temperature lie between the threshold value then save data on thingspeak.If temperature does not lie between the threshold value then it will alert the system and send message to the doctor and also save data on thingspeak using ESP8266 Wi-Fi module.

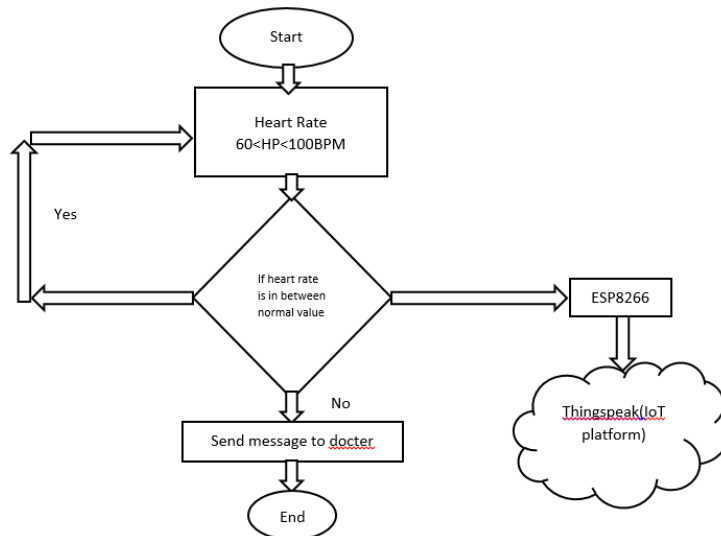


Figure 3. Flowchart of Heart Rate measurement

Figure 3 show the flowchart of how the system work in order to calculate the heartbeat of each patient.It start with calculating heartbeat if the heartbeat lie between the threshold value then saves data on the thingspeak.If the heartbeat does not lie between the threshold value then it will alert the system and send message to the doctor and also save data on thingspeak using ESP8266 Wi-Fi module.

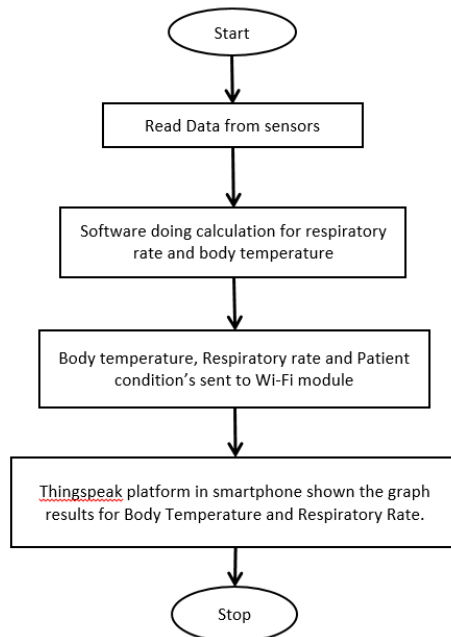


Figure 4. Flowchart for System Design

Figure 4 show the flowchart for system design. The patient monitoring system is divided into several type for hardware designs which are inputs controller and output which involves several important types such as temperature sensors LM35, Heartbeat sensors, Arduino UNO, ESP8266 Wi-Fi module.

1. Input sensors

The input that has been used are temperature sensors and heartbeat sensors. Two sensors are used (i.e. temperature and heartbeat) to observe the temperature and heartbeat of patient. A calculation is done to find the condition of patient. Temperature is similar but normal breathing rate is unsimilar with different range of age. The heartbeat sensors provide a precise measurement for normal breathing rate at different range and at the same time provide an accurate indicator or warning on abnormal condition of the patient. The group age can be seen in the table 1.

Table 1: Pulse rate table

Age	Normal Pulse Rate
0 months-1 years	100-190
1-2 years	98-140
3-5 years	80-120
6-11 years	75-118
>12 years	60-100
Athlete	40-60

2. Outputs

The output device in this system is smartphone. It is used to display the patient’s body temperature value, patient’s range of age and value of breathing rate. Furthermore, smartphone also displayed the patient condition which either normal or abnormal depending upon the calculation done by the system from the input data. It displays data on smartphone using thingspeak supported by ESP8266 Wi-Fi module.

IV. EXPERIMENTAL RESULTS

The above system works on Wi-Fi & Bluetooth as network support system. Hence, we took the survey from a sample of people (8 persons) which shows that the Wi-Fi is more commonly used network. The same is shown in the table.



Sr no	Wi-Fi	Bluetooth
1	1	0
2	1	0
3	1	0
4	1	0
5	0	1
6	1	0
7	1	0
8	1	0

Table 2: Usage of Wi-Fi and Bluetooth

Table 2 show the usage of Wi-Fi and Bluetooth module.

Hypothesis is tested using one sample t-test to check whether the hypothesis is accepted or not.

To check the hypothesis using one sample t-test steps are as under,

Step 1: Calculate the t value by using the formula.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

where

x_1 = Mean usage of Wi-Fi module.

x_2 = Mean usage of Bluetooth Module.

s_1^2 = Variance of Wi-Fi module.

s_2^2 = Variance of Bluetooth module.

n_1 = Total count

n_2 = Total count

Step 2: Calculate the mean usage of Wi-Fi and Bluetooth module.

Step 3: Calculate the variance of Wi-Fi and Bluetooth module. Variance can be calculated by using the formula.

Population Variance	Sample Variance
$\sigma^2 = \frac{\sum_{i=1}^N (x_i - \mu)^2}{N}$	$s^2 = \frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n - 1}$
σ^2 = population variance	s^2 = sample variance
x_i = value of i^{th} element	x_i = value of i^{th} element
μ = population mean	\bar{x} = sample mean
N = population size	n = sample size

Table 3: Variance Formula of Population and Sample [33].

Step 4: Calculate the total count.

Step 5: Substitute the values of step 2,3 and 4 in step 1 formula.

Step 6: Calculate the t value.

Step 7: Calculate the degree of freedom by using the formula.



$df = n_1 + n_2 - 2$

Step 8: Find the critical value by using t-table.

t Table											
cum. prob	$t_{.50}$	$t_{.75}$	$t_{.90}$	$t_{.95}$	$t_{.99}$	$t_{.995}$	$t_{.9975}$	$t_{.999}$	$t_{.9995}$	$t_{.99975}$	$t_{.9999}$
one-tail	0.50	0.25	0.20	0.15	0.10	0.05	0.025	0.01	0.005	0.001	0.0005
two-tails	1.00	0.50	0.40	0.30	0.20	0.10	0.05	0.02	0.01	0.002	0.001
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	0.000	0.679	0.848	1.045	1.296	1.671	2.000	2.390	2.660	3.232	3.460
80	0.000	0.678	0.846	1.043	1.292	1.664	1.990	2.374	2.639	3.195	3.416
100	0.000	0.677	0.845	1.042	1.290	1.660	1.984	2.364	2.626	3.174	3.390
1000	0.000	0.675	0.842	1.037	1.282	1.646	1.962	2.330	2.581	3.098	3.300
Z	0.000	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.291
	0%	50%	60%	70%	80%	90%	95%	98%	99%	99.8%	99.9%
	Confidence Level										

Table 4: t-table [34]

For finding critical value, look at the confidence level given at the bottom row of the table; this tell us which column is required. After intersecting this column with the row by using df (degree of freedom) we get the critical value (or the t value) for confidence interval.

Step 9: After finding critical value, compare the t-value with the critical value. If the t-value is greater than critical value then null hypothesis is rejected and alternative hypothesis is accepted. If the t-value is less than critical value then null hypothesis is accepted and alternative hypothesis is rejected.

In this paper,

Null hypothesis is

H_0 : Mean usage of Wi-Fi module is same as mean usage of Bluetooth module.

And alternative hypothesis is

H_1 : Mean usage of Wi-Fi module is different than mean usage of Bluetooth module.

Sincet-value is 4.2 and critical value is 2.14.This show that null hypothesis is rejected and alternative hypothesis is accepted.

V. CONCLUSION

Mean usage of Wi-Fi module is significantly different than mean usage of Bluetooth module(one sample t-test $t=4.2$). The usage of Wi-Fi module gets an average of 0.875 than that of Bluetooth module.

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