HEALTH MONITORING SYSTEM USING BIOSENSORS

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***Abstract*—Good health is important in human life. Therefore, for good health better healthcare system is needed for continuously monitoring the health in the NGO run Organizations in Goa in order to reduce the burdens on these organizations especially of financial burdens. Therefore, it is highly needed to monitor continuously health parameters such as temperature, heartbeat rate, and respiratory rate. This has done using various using biological sensor such as temperature sensor, heart rate sensor, and respiration sensor. After receiving the sensed value, if the sensed values have abnormality rate, an alarm is generated through buzzer, and the same is transmitted to the control office and received using wireless internet of things technology. The control office after receiving and analyzing the same finds that the values are exceeding the normal rate necessary preventive action is taken such as informing the doctors or medical health center. Also, SMS based alert is sent to the mobile's phones to the concerned doctor. The above health monitoring system has analyzed using fuzzy logic system.**

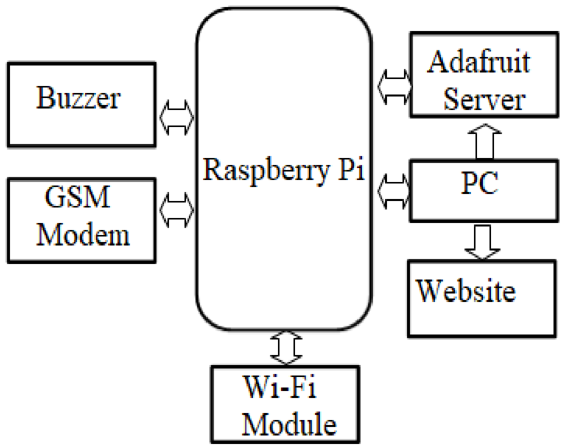
Keywords— Health, Raspberry Pi, Bio-Sensors, Wi-Fi, Data Acquisition, monitoring, temperature, heartbeat, respiration Adafruit server, fuzzy logic.

I. INTRODUCTION

Health monitoring means monitoring and examine the changes in the human body such as temperature which to monitor the fever, heart rate to monitor cardiac arrest, and respiratory rate to monitor airborne viruses such as SARs (severe acute respiratory syndrome) and coronaviruses. NGOs run organizations in various parts of India especially the state like Goa are lacking real-time health care monitoring systems and hence the aged people and children under these organizations have been facing tough times for timely health care especially during this ongoing COVID-19 situation. Hence, the authors thought of writing this research paper in order to minimize the workload and save time in taking care. In this research paper, authors have proposed real-time health care monitoring systems for NGO run organization. Authors have used raspberry pi as a microcontroller which is an Internet of things-based device. In this system, various biological sensor have used such as respiration sensor for detecting breathing rate or respiratory rate and also monitoring symptoms of SARs and corona viruses, temperature for monitoring fever, and heart rate for monitoring cardiac arrest. The proposed system has two parts one is health parameters sensing and transmitting to control unit or office through the internet of things based wireless technology such as Wi-Fi andother transmitting module and other part is receiving and monitoring and taking required precautions or preventive action such as informing doctor and medical health care centre in nearby by area. Further, the received data gets uploaded and displayed on the internet through the Ad fruit server. Also, SMS based alert is sent to concern controlling officer or doctor through the Global system of mobile (GSM) communicationtechnology.

This proposed health monitoring system is analyzed using one of the soft computing techniques called fuzzy logic or fuzzy inference system. Fuzzy logic is a mathematical tool which provides human reason capabilities. Fig. 1 is showing the working principle of the Fuzzy Inference System (FIS). It is made up of important Module functional blocks: (1) Fuzzy Rule Base for generating fuzzy IF-THEN rules using an expertise Knowledge and storing the membership functions (2) Fuzzification Module for transforming the crisp inputs into a degree of membership for linguistic terms of fuzzy sets unit for operating on the different rules, (3) Fuzzy Inference Engine simulating the inputs and id-then rules based on human reasoning, (4) Defuzzification Module for converting the fuzzy quantities into crisp quantities [17]. There are 2 types of methods available one is Mamdani FIS and the other is Sugeno FIS. In our simulation, we have used Mamdani FIS.

The IoT based patient health monitoring system is proposed only for monitoring temperature and heart rate and only for old age patients whereas the proposed system is for monitoring temperature, heart rate, and the respiratory rate which gives satisfying parameters or symptoms of coronaviruses [1]. The Smart health monitoring system is proposed which again used only for monitoring temperature and heart rate. Also, it is not a real-time system [2]. The wireless patient health monitoring system is proposed only to monitor heart rate and body temperature. Also, it uses Zigbee wireless technology for transmission and reception whereas the proposed system uses advanced wireless technology [3]. The smart health monitoring system using IoT technology is developed for applications of IoT such as smart health which measures heart rate, IFTTT which is web-based service, and



android phones for viewing health parameters [4]. The network of Mamdani fuzzy inference is developed for learning intricate fuzzy patterns in the data of air compressor vibration intelligible to human [5]. Using a fuzzy method, monitoring only respiratory rate for human on bed using optical fiber sensor is proposed [6]. Health monitoring system for underground miners to detect heartbeat and respiration [7].

II. Methodology

This research paper deals with two sections, one is Data acquisition and transmitting through wireless technology system and other is receiving through wireless technology and monitoring section.

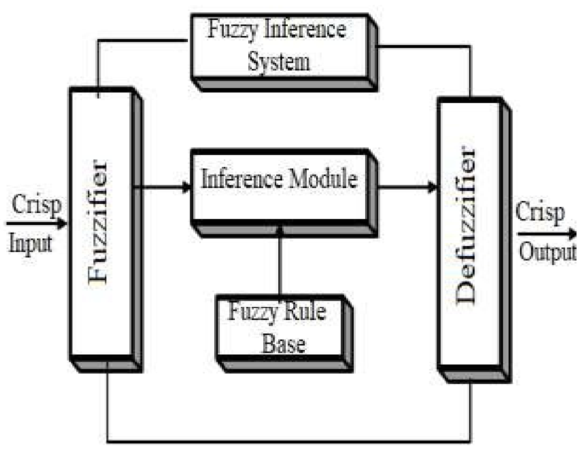


Fig. 1. Block Diagram of Fuzzy Inference System.

A. Data acquistion and transmitting unit

Fig.3 shows the view of data acquisition and monitoring block diagram. Here the biological parameters such as temperature of the human body in degree/Centigrade, heartbeat rate in beats per minute, and respiratory rate breaths per minute has been detected and sensed using a temperature sensor, heartbeat rate, and respiration rate and data is sent wirelessly to the receiving unit or controlling office.

Fig. 2. Block Diagram of data receiving and monitoring unit.

B. Data receving and monitoring unit

Fig.2 shows the view of data receiving and monitoring block diagram. In this unit, biological sensor parameters are received using wireless technology and if any detected parameters have above the normal rate the buzzer alarm gets ON and monitored by the control office. The control office, in turn, takes the necessary preventive action such as informing the nearby health care or any medical doctor. Also, SMS is received on their registered phones.

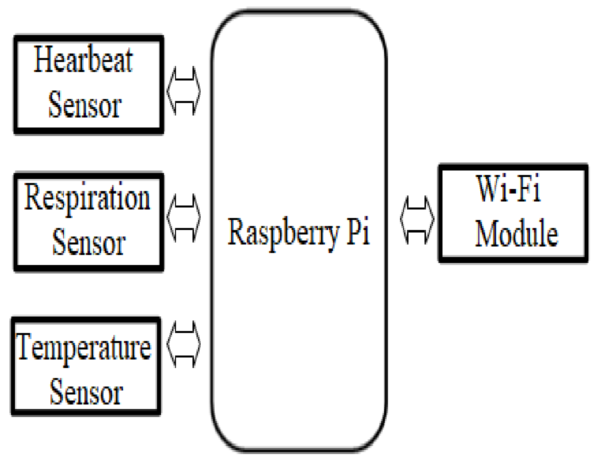


Fig. 3. Block Diagram of data aquistion and transmitting unit.

III. Flowchart

Fig. 4. Shows the flowchart used by authors which describes the real-time monitoring of health status using a temperature sensor, heartbeat sensor, and respiration sensor.

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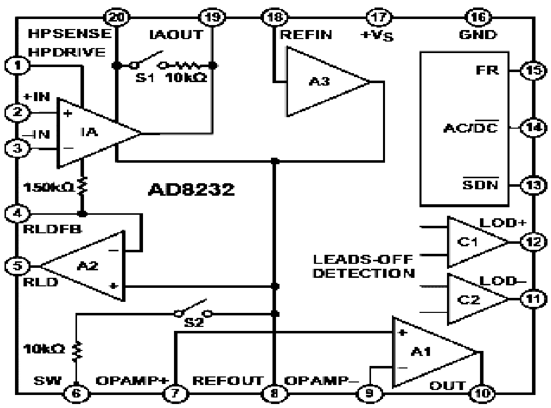


Fig. 4. Flowchart

IV. System Details

A. *Temperature sensor*

The temperature sensor MAX30205 has used for measurement of temperature of human body. This sensor is digital thermometer sensor having accuracy of 0.1°C in the measurement range between 37°C -39°C and resolution bits over 16 bits [8]. It has thermostat threshold which allow for temperature hysteresis or for alarm setting. It operates having supply voltage from 2.7V-3.3V and 600µA supply current. The Fig.5 shows the application circuit diagram of temperature sensor [10].

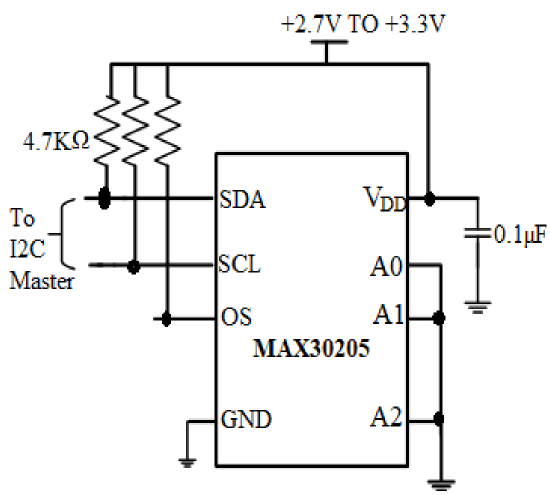


Fig. 5. Circuit diagram of the temperature sensor.

B. *Heartbeat sensor*

The sensor that has used for measuring the heartbeat or electrical activity in the heart is AD8232 built with an integrated signal conditioning block for measuring biopotential applications such as ECG(Electrocardiogram). In order to obtain an energy-efficient ECG waveform with less distortion, the sensor has a configuration of 0.5 Hz two-pole high-pass filter along with two-pole, 40Hz, low-pass filter. Also, it has low power analog to digital converter for acquiring a good output signal. Fig. 6. Shows the functional

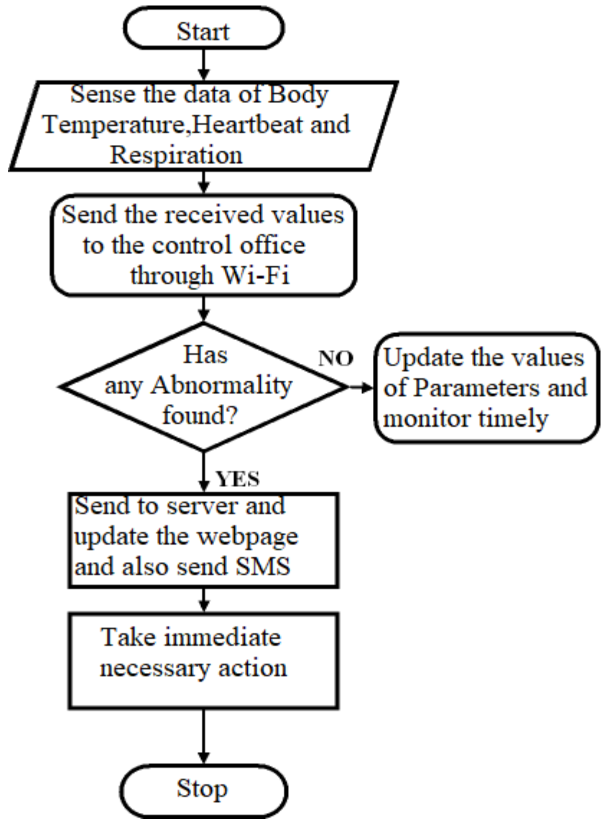


diagram of heartbeat sensor [11].

Fig. 6. Circuit diagram of the heartbeat sensor.

C. *Respiration sensor*

The respiration sensor that has used for sensing respiration rate is Novelda XeThru X4M200 which can detect breathing rate during movements on people that are either lying on the bed or sitting still as it has a breathing pattern. This sensor has high integration of X4 system-on-chip (SoC) which gives high accuracy for measuring breathing rate. This sensor has a specific configuration called respiration profile. This configuration is projected for measuring respiration frequency and entering breathing state when the measured respiration frequency is between 8 and 30 respiration per minute. It has a

16-pin connector intended for interfacing a host board. The

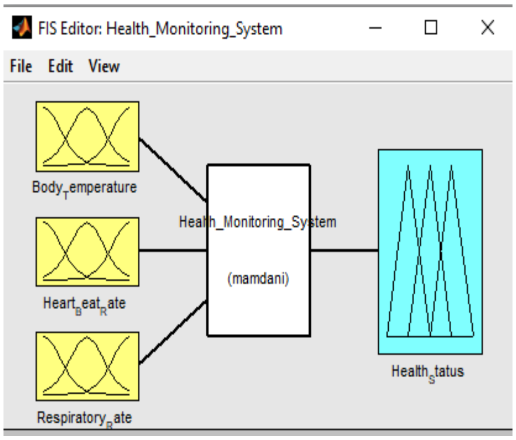


Fig.7. shows a block diagram of Respiration sensor [12].

Fig. 7. Block diagram of a Respiration sensor

D. Raspberry Pi 4

Raspberry Pi 4 Model B has used which is an improved version of Raspberry Pi range of computers with increased connectivity, enhanced memory, good processor speed, and excellent performance of multimedia compared to the previous version. The key features include [13]:

- It has a high-performance Broadcom Quad-core Cortex-A72 (ARM v8) processor with System on Chip @ 1.5 GHz.
- Good 4GB SDRAM memory.
- Dual-display supporting at high resolutions up to 4K.
- Good hardware decoder up to 4GB of RAM Gigabit Ethernet, USB 3.0, Bluetooth 5.0, dual-band 2.4 GHz or 5.0 GHz wireless LAN.
- Good quality of power supply of 2.5A.
- Good operating temperature 0- 50°C

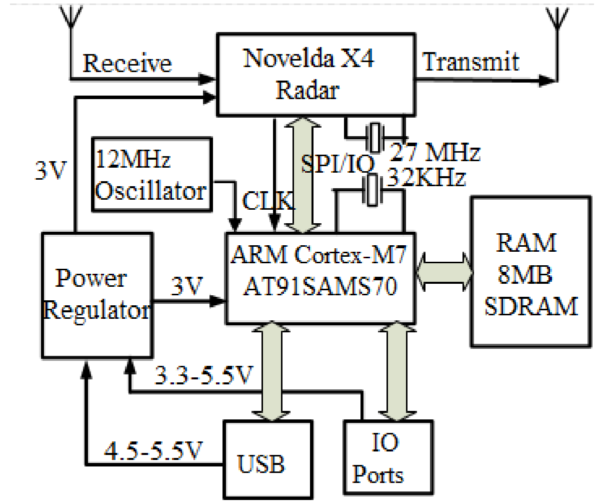
E. Adafruit server

The Adafruit server has cloud service, which means one can upload, display, and monitor the sensed information via internet and making system IoT enabled. It has good features such as displaying online real-time data and make systems interconnected. Adafruit.io can visualize and handle feeds of data [14].

V. Analysis of Health status using MATLAB

The Fuzzy logic system has used for analyzing the health status using MATLAB. In this, the authors have proposed Mamdani type fuzzy inference system which is shown in Fig. 8. The health parameters such as the temperature of the human body, heartbeat, and respiration rate are taken as input variables in their specific health range [15,16] as shown in TABLE I. Each of the input variables has fuzzified based on linguistic sets and display range such as temperature, heart-beat and respiration as Low, Normal, and High. The steps involved for the computation of output from the fuzzy inference system are [8]

- To determine the set of fuzzy rules.



- Using membership functions to fuzzified the inputs.
- To join the fuzzified inputs with respect to the fuzzy rules for obtaining rule strength.
- To establish the consequent of the rules by merging the rule strength with the output membership function.
- To add all the consequents to obtain the output.
- Lastly, using defuzzification methods, calculate a defuzzied output.

Fig. 8. Proposed design of the Fuzzy inference system using MATLAB.

TABLE I. HEALTH PARAMETERS RANGE

Input linguistic Variable	Output LINGUISTIC SETS		
	Good	*Normal*	*Bad*
Temperature (°C)	Below 36.5	36.5-37.5	Above 37.5
Heartbeat (bpm)	Below 60	60-100	Above 100
Respiration (bpm)	Between 12-15	15-20	Above 20 and below 12

A. Implementation of Fuzzy rules

The following fuzzy rules have defined for monitoring health status:

1) If Body Temperature is Normal and Heartbeat Rate is Normal and Respiration Rate is Normal then Health Status is Normal.

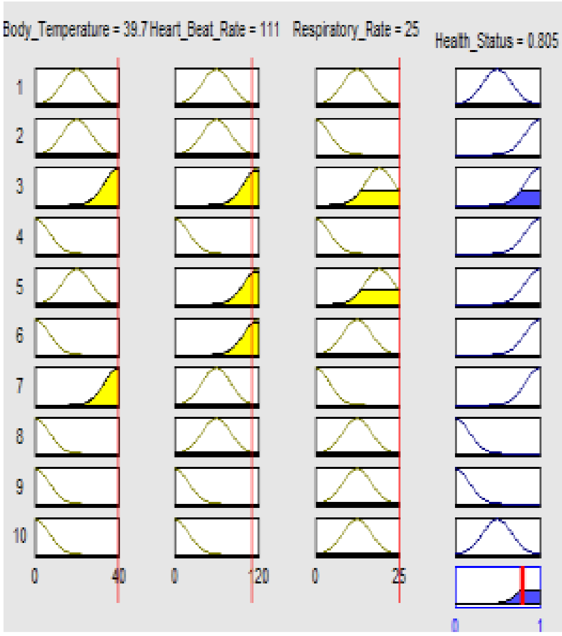
2) If Body Temperature is Normal and Heartbeat Rate is Normal and Respiration Rate is Low then Health Status is Bad.

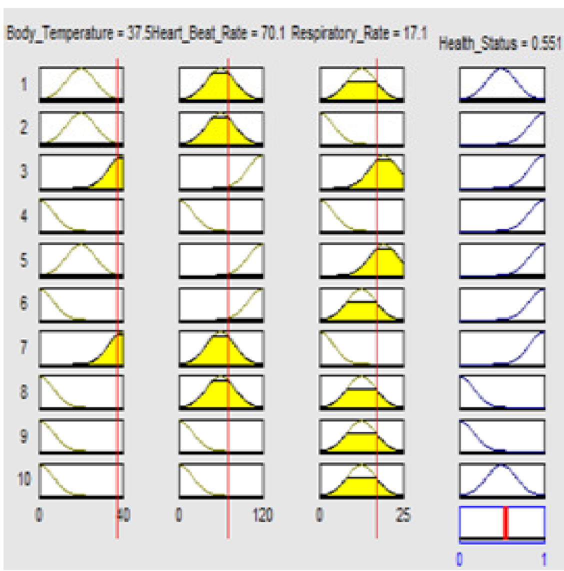
3) If Body Temperature is High and Heartbeat Rate is High and Respiration Rate is High then Health Status is Bad.

4) If Body Temperature is Low and Heartbeat Rate is Low and Respiration Rate is Low then Health Status is Bad.

5) If Body Temperature is Normal and Heartbeat Rate is High and Respiration Rate is High then Health Status is Bad.

6) If Body Temperature is Low and Heartbeat Rate is High and Respiration Rate is Normal then Health Status is





Bad.

7) If Body Temperature is High and Heartbeat Rate is Normal and Respiration Rate is Low then Health Status is Bad.

8) If Body Temperature is Low and Heartbeat Rate is Normal and Respiration Rate is Normal then Health Status is Good.

9) If Body Temperature is Low and Heartbeat Rate is Low and Respiration Rate is Normal then Health Status is Normal.

10) If Body Temperature is Normal and Heartbeat Rate is Low and Respiration Rate is Normal then Health Status is Good.

B. Diffuzication using centriod method

The Fig.10(a), Fig.10(b) and Fig.10(c) is showing the defuzzification output for each output variable i.e. the health status using linguistic terms Good, Normal and Bad calculated using Centroid method as [8]

$$X^* = \frac{\int x.\mu_c(x)dx}{\int \mu_c(x)dx} \quad (1)$$

where, X^* is the x-coordinate of center of the gravity and, $\int \mu_c(x)dx$ is the area of the region bounded by the membership curve μ_c.

a) View of Good health status

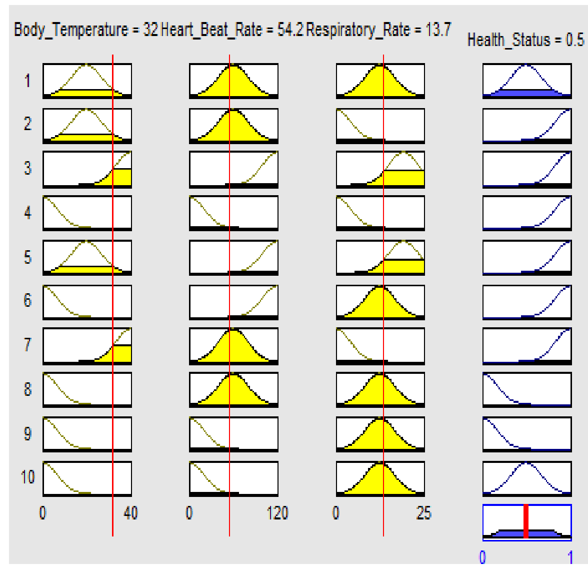


Fig.10(a) Rule viewer of Good health status

b) View of Normal Health Status using rule viewer

Fig.10(b) Rule viewer of Normal health status.

c) View of Bad Health status using rule viewer

Fig.10(c) Rule viewer Bad health status

VI. Conclusion and Futurework

The current system has the ability to lifesaver of children, elderly people, and senior citizens taken care by NGOs run organization especially in Goa by monitoring their health status on real-time and also reducing the burdens of NGOs working hard to take care of these people. This system can also be widely used for home care, Ashrams, old age homes, health care centres, anganwadis, village panchayats, etc. However, these systems could be little expensive as there are advanced sensors, as well as latest raspberry pi, has used. For further research work, the system could be modified and worked on by analyzing other soft computing techniques.

References

[1] D.Shiva R.Krishnan, Subhash C. Gupta and Tanupriya Choudhury, “An IoT based Patient Health Monitoring System,” IEEE, International Conference on Advances in Computing and Communication Engineering, Paris, France, 2018.

[2] Tarannum Khan and Manju K.Chattopadhyay B, “Smart Health Monitoring System,” IEEE, International Conference on Information, Communication, Instrumentation and Control, Indore, India 2017.

[3] Deepesh K.Rathore, Ankita Upmanyu and Deepanshu lulla, “Wireless Patient Health Monitoring System,” IEEE, International Conference on Signal Processing and communication , Noida, India, 2013. J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.

[4] S.Ananth, P.Sathya and P. Madhan Mohan, “Smart Health Monitoring System through IOT,” IEEE, International Conference on Communication and Signal Processing, Chennai,India, 2019.

[5] Arun K.Sharma,Vikas Singh and Nishchal K.Verma , “Condition based Monitoring of Machine using Mamdani Fuzzy Network,” IEEE, Progonostics and System HJealth Management Conferencem , China ,2018.

[6] Hayato Yamaguchi, Masahiro Kurono, Kazuhiko and others, “fuzzy processing respiratory rate monitoring system by optical fiber sensor,” IEEE, world Automation congress, Hawaii,USA,2008.

[7] John Colaco and R.B.Lohani, “Health Monitoring System for underground miners,” Indian Mining and Engineering Journal, August,2016,Volume 55,no.8.

[8] S.N.Sivanandam and S.N. Deepa, Principles of Soft computing Textbook. Wiley, 2018.

[9] https://os.mbed.com/components/MAX30205-Human-Body-Temperature-Sensor/

[10] https://datasheets.maximintegrated.com/en/ds/MAX30205.pdf

[11] https://www.analog.com/media/en/technical-documentation/data-sheets/ad8232.pdf

[12] http://laonuri.techyneeti.com/wp-content/uploads/2019/02/X4M200_DATASHEET.pdf

[13] https://www.raspberrypi.org/products/raspberry-pi-4-model-b/

[14] https://iotdesignpro.com/projects/control-raspberry-pi-gpio-with-adafruit-io-totrigger-an-led.

[15] https://www.urmc.rochester.edu/encyclopedia/content.aspx?ContentTypeID=85&ContentID=P00866.

[16] https://my.clevelandclinic.org/health/articles/10881-vital-signs.

[17] K. Saroj and T.Sunita, “Soft Computing Fundamentals,Techniques and Applications Textbook, McGraw Hill, 2018.