iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: XII Month of publication: December 2025

DOI: https://doi.org/10.22214/ijraset.2025.76526

Smart Heart Rate Monitoring System using Arduino for Healthcare Applications

Pragadeswaran S[1], Niranjan S[2], Muthu Krishnan K[3], Mohammed Arshad I[4], Rajesh Kumar K[5]
[1]Assistant Professor, [2, 3, 4, 5]UG Scholar, Department of Electronics and Communication Engineering, Karpagam Institute of Technology, Coimbatore, Tamil Nadu, India

Abstract: Heart rate is an important parameter to assess the cardiovascular system and its continuous measurement is not only important for patients with heart diseases, but also for sportive, old persons and those who undergo regular check-up of their health status. While ECGs have great accuracy; however, they're expensive, large and not easy to use on a daily basis outside of hospitals. Therefore low-cost versions need to be created that can be used everywhere. Heart Rate Monitor using Arduino is an innovative project that offers a solution for this issue. With this project users will be able to track their heart rate. They will be able to use a photoplethysmograph based pulse sensor which works by tracking the volume of blood moving through their veins. The sensor connects to a microcontroller (Arduino) which allows users to filter their heart rate data and provides them with their heart rate, by detecting the high peak (the highest point) in each pulse. The readout is displayed on an LCD so the user knows what their current heart rate is. If a user has a heart rate that goes above or below what is considered safe the user will receive a visual alert via the LED on the pulse sensor as well as an audible alert from the speaker in the Arduino module. This design was set up to allow other systems to communicate with the Heart Rate Monitor via a Bluetooth or WiFi connection, which allows for remote monitoring via an IoT Platform. As health care providers look to implement telemedicine systems into their practices, the demand for wearable technology is increasing rapidly. Inspired by the increasing CVD rate and insufficient diagnostics in low-resourced areas, we make sure ours is low-cost, portable and modifiable. Beyond the individual user, it can be used for fitness tracking and education purposes, or work as part of a larger public health community, he added. It's a multifunctional option both for individuals who need personalised care as well as our population at large. There is, therefore, a need for accurate, inexpensive devices for monitoring the heart. The solution is presented by the arduino-based technology by incorporating a cheap sensors and microcontroller, to support continuous monitoring in real time. Weighing cost, portability, and accuracy, such systems are a compromise.
Keywords: Heart rate monitoring, Arduino, Healthcare, Photolethysmography (PPG), Electrocardiogram (ECG), Beats Per Minute (BPM)

I. INTRODUCTION

The human heart is the central organ of circulation, conveying oxygen to the various areas of the body, and any failure in function can be detrimental to health. As such, heart rate is one of the most important variables to assess cardiovascular fitness, potential disorders, and stay as healthy as possible for self-care. Heart rate (beats/min), is an especially important physiological variable that reflects the rhythm and efficiency of cardiac function. Currently, established methods of standard measurements in hospitals, including the ECG and Holter monitor, provide accurate continuous measurement but due to the hinderance of their high price points, physical size, and standard clinical application facility, cannot be utilized outside of a hospital environment. Due to rapid advancements in microcontroller technology and the evolution of embedded systems including open source platforms like Arduino, users can now have access to an inexpensive and user-friendly alternative to wear while monitoring their own heart's activity for either themselves or for a remote audience, through the use of a pulse sensor utilizing a photoplethysmography (PPG) signal. This technology allows the onboard processor to detect blood volume changes, convert the analog signal to a BPM measurement, and display the result in either real time onto a monitor (LCD) or in a App for the user's mobile device. The use of these devices has excellent potential for fitness and sport training, medical education and rehabilitation, and perhaps eventually to provide preventative health care, due to the fact that they incorporate wearable technology that can also operate on a continuous heart rate monitoring basis without the need for direct physical connection of the patient to the device(s). Cardiovascular diseases (CVD's) account for the greatest percentage of human mortality globally. Early diagnosis of CVD is only possible through ongoing continuous vital sign monitoring (HR). Nonetheless, although the traditional types of ECG and EKG monitor are very accurate, they are also very costly, take up a considerable amount of space, and are limited to clinical establishments.

As a result, these types of devices are impractical in providing continuous self-monitoring of a person's health status. It is not easy to check the doctor's office on the part of the people living in remote or poorly served areas, thus leading to late diagnosis and increased chances of cardiac events. Devices like fitness trackers and smartwatches will provide users with a "heartrate" feature, however, most branded devices do not have a clinical level of accuracy, these devices tend to expensive and may be impacted by a wide variety of different factors, such as motion artifacts and poor sensor contact, during use. Motion noise and variations in skin tone, as well as limited battery capabilities, factor into these types of devices' challenges in providing a reliable source of data in a timely manner. Therefore, an urgent need exists for an affordable, portable, user-friendly, and adaptable device capable of providing an accurate heart rate reading, in real-time. An Arduino-based heart rate monitoring system allows room for such solutions by amalgamating low-cost hardware, easy implementation, communication technology, and flexibility in wireless integration.

A. *Objective of Study*

To design a heart rate monitoring system that is low-cost and easily portable utilizing Arduino.
This project makes counting your heartbeats through its rate in beats per minute (MHz) by a pulse sensor as accurate as possible.
By processing the detected data by Arduino micro and monitoring the results in real-time.
To display the detected heart rate in your LCD or mobile interface for the user's convenience.
To maintain checking your heart rate at all times during the day such as for activities, and workouts.
It also allows for the option of attaching wirelessly to telehealth devices.
In order to create an encouraging counselling system that is reliable and energy saving it can be used for personal consulting and clinics.
To provide for early alert to abnormal heart condition with long-term monitoring.
While making cardiac frequency a monitorable parameter in remote areas with little resources.
The low-cost portable real-time heart rate monitor is created for use in clinical monitoring system and educational.

B. *Motivation of the Work*

The rising need for tools to support affordable healthcare options, as well as the ongoing developments in embedded systems technology, have led to the implementation of other technology that is being implemented to help reduce the barriers between patients needing cardiac monitoring and hospital-based medical staff. In many parts of the developing world, patients cannot access hospital cardiac monitors. This often places an economic or geographic challenge on patients who require monitoring continuously and could have a significantly positive impact on these patients if these challenges could be reduced by providing an alternative means of monitoring them. There is currently a growing market of IoT enabled Devices which assist in removing these barriers and making cardiac monitoring more accessible, affordable and easier to perform.; However, the majority of the commercially available smart device that monitor the heart are created for tracking fitness and therefore fall short of meeting the accuracy and requirement to be medically approved and acceptable. Therefore, by taking advantage of Arduino, in addition to having an affordable and user-friendly means of providing cardiac monitoring, the added motivation for the work is to provide an opportunity for people to monitor their own heart conditions by making these devices and heart monitoring available for early detection of arrhythmias and early intervention in order to avoid a more serious cardiac event. Furthermore, the device will also augment telehealth and remote patient monitoring since physicians can have access to a patient's data in real time for diagnosis and follow-up. This follows the global trends in Health Care in developing manual, subcutaneous, or wearable devices that are portable, connected devices offering enhanced quality of life and lower healthcare cost.

II. LITERATURE SURVEY

Souza et al. (2021) introduce the adaptive linear prediction filtering for ECG/PPG signals to suppress noise, drift and motion artifacts from the baseline wander (bw), leading to enhanced R-peak detection over a simple thresholding. Telse et al. have shown that light or strong sensor contact is disturbing PPG reliability, and proposed ACC-based activity recognition with SQI gating to guarantee the validity of the signal. Dubey and Pahwa compare the power of (wearable) sensor sites and light sources, identify a higher accuracy for finger or ear with respect to wrist placement and point out multi-wavelength sensors for better SpO_2 performance. The sliding-scale SQI model of Basak and van Gastel drops metrics on the fly (at real time) to avoid even garbage collection when resources are too less as is always the case on microcontrollers. Together, these reports suggest that effective heart rate monitoring depends on the choice of hardware as well as adaptive signal processing strategies suited to physiological and environmental variability[1].

Scardulla et al. (2020) studied the effect of skin-to-PPG sensor contact pressure on accuracy of heart rate measurements during PA. The work systematically investigated the relationship between different pressure degrees and the effect on signal quality and stability of PPG measurement. The results indicated that the signals are weak and noisy when the contact force is too low, while they have a distorted waveform (hindered heart rate estimation) when it is too high. According to the research, having the perfect sensor-skin connection is vital to achieving consistent and precise readings from a PPG (Photoplethysmogram) during testing, whether imitated by motion or not. From this research forward, there are new design guidelines for improving mechanical attachment and performance for optical devices to be used during various levels of dynamics [2].

Ray et al. (2023) published the results of a thorough survey on the state-of-the-art in multiwavelength (MW) PPG sensors and examined recent developments in sensor design, choice of light source and signal processing to ensure accurate PPG measurements across a broad range of skin complexions and bodily conditions. The researchers also demonstrated that using two different illumination wavelengths enhances the robustness of the signal against motion-induced artifacts, ambient light, and changes in tissue structures. They offered evidence of the potential for sophisticated automatic adjustments of LED brightness, size reduction, and machine-learning-based analysis, and recommended continued research on such applications to achieve optimal performance from wearable PPG devices when integrated into wearable technology through approaches described as "integration through wearable technology [3].

McLean et al. (2023) created an SQI (Signal Quality Index) based PPG model that utilizes a real-time moving average to evaluate and quantify the quality and stability of the input signal being recorded. Their model, in contrast to static quality indices does not only depend on environmental and physiological states but allows the gradual update of the filtering capability to reflect changes in these conditions. The findings indicate that the Adaptive SQI methodology is quite effective for removing motion artifacts and falsely detecting heart rate and SpO2, allowing the adaptive SQI methodology to enhance the accuracy of heart rate and SpO2 estimates. As such, the Adaptive SQI approach is the best approach if you want to use heart rate and SpO2 in applications for real-time environments that are resource-constrained, including wearable devices and embedded systems with limited capacity for computation and energy consumption [4].

Souza et al. (2025) created the MediTrack Plus system, which is used for better medicine monitoring and inventory management through the implementation of IoT and AI technologies. This approach uses the ability of QR/RFID tracking in conjunction with the AI algorithms to predict the requirements of medicines, to keep their supply levels at the required level. By using an inventory management, which is based upon QR/RFID tracking and automatic alerts of required stock levels, the use of MediTrack+ can help decrease the incidence of human errors in the management of medicine stock by at least 30-40%. Moreover, the MediTrack+ approach offers a high level of assurance of proper supply chain operations, and improves the accessibility of medicines to rural areas of the health system [5].

Nduka et al. (2019) created a remote patient monitoring system that uses the Arduino-based system with the IoT technology for monitoring the health of a patient using remote patient monitoring systems by using medical sensors interfaced with Arduino, which are applied to a patient's body for the purpose of measuring vital signs. All the measured parameters are transmitted through wireless technology and sent to a cloud platform for monitoring live data. The system is focused on patient mobility and ease of access, suggesting benefits in telemedicine and continuous patient monitoring, including remote areas[6].

Bansal et al. (2018) developed an intelligent heart rate monitoring system which is able to monitor the pulse rate and send its reading by Bluetooth to be displayed in real-time on a mobile phone. This project was cost-effective, easy for users and it has great potential for individual health care (Medicine) and persona [7].

Devis et al. (2021) developed a patient monitoring device in which heart rate, body temperature and infusion levels were monitored simultaneously by means of Arduino Uno. FeatureThe system keeps constant monitoring and sends the alarm signal while caregivers are alerted to any anomalous that proving it is useful in the hospital and home-care environment [8].

Zulkifli et al. (2012) presented on XBee wireless sensor network in heart rate monitoring for sports training. Their design focuses on the wireless data stability and real-time feedback for athletes in order to achieve better performance analysis and physiological monitoring in dynamic scenarios [9].

Dutta et al. (2017) proposed a real-time automatic ECG signal processing technique for dual monitoring of both heart rate and respiratory rate with one-lead configuration. The system is based on adaptive filtering and peak detection algorithms, which enable high accuracy that are compatible with wearable health systems and clinical monitoring [10, 15].

Veera Boopathy et al. (2024) proposed a data-driven healthcare monitoring system based on the Internet of Medical Things (IoMT) to enhance patient care and connectivity.

The integration of medical sensors with microcontrollers, which transmit data to a central server for analysis, using WiFi and Bluetooth, enables doctors to monitor patients using real-time data and thus help them develop better treatment decisions. The use of a cloud-based solution allows healthcare providers to monitor patients continuously, allowing them to respond quickly to health emergencies via online appointments or phone calls [11].

Anandh and Indirani (2018) propose a real-time patient monitoring system that utilises an Arduino-based sensor to store and display patient data as well as provide a model based on blockchain technology. The model is designed to improve the ability of providers to secure access to patient data while providing a simple and easy interface for patients to access their health records [12].

Shakarji and Gölcük (2022) fabricated an Arduino based system to measure the pulse rate and body temperature using accurate sensors. Optex has developed, by using the essential light source, an inexpensive and stable health monitoring system that allows early-disease/event detection with low power consumption and portability [13].

Patil et al. (2019) developed a heart rate monitoring system that uses pulse sensors connected to a microcontroller to detect and track the heart rate of a patient.

They focused on ensuring a real-time heartbeat detection capability for continuous monitoring and were able to minimise the size of their device and make it more functional. They expect to use the heart rate measuring device to develop more advanced mobile biomedical monitoring systems that will enable wearable biomedical applications [14].

The authors of this study (Ramanathan et al., 2024) identified the importance of securing and protecting the safety and security of sensitive patient information when using IoT technology inHealthcare Applications where Data are Stored Cloud-Based (often known as "Cloud Storage"). A secure way to transmit and store this information is by using an Optimised Blowfish Encryption Algorithm integrated with African Buffalo Optimisation algorithm in addition to some other mathematical tools to decrease the time required to perform encryption of sensitive data. The developed model will allow for the Secure Transmission and Store of Medical Sensor Data with very Low Energy Consumption and a Low Processing Overhead [15].

The authors Nuraeni et al. (2025) designed an easy to use and inexpensive Handheld Heart Rate Monitor Device using a fingertip PPG sensor connected to an Arduino Uno Platform. The initial testing of the prototype has shown that this design has High Precision, Stability, Low Power Consumption, and is very User Friendly. The device was designed for both the Local Healthcare Community and Developing Area, and has been shown to have a good Cost/Effective Solution based on Reliability and Deployability to Support General Networked HRM [16].

The work of Pearson and Faust (2019) expanded the uses of Biosensing Technology using Arduino by developing a Non-Invasive Sleep Apnea Monitoring System based on variations in Heart Rate. This will provide the user with Early Indicators of any Sleep Disorder.

Continuing from the work of the above authors, Karnadi et al. (2022) has further expanded this work by establishing Low-Cost Patient Monitoring Devices that will be used for Telemedicine and HomeCare By providing accurate Monitoring of Heart Rate and SpO2 (Oxygen Saturation) in Real Time along with Body Temperature monitoring as well [17][18].

III. PROPOSED METHODOLOGY

The heart rate monitoring device which will be described in this paper is being created to allow portability for heart rate monitoring conducted at home. It is inexpensive and can be continually monitored outside the clinical setting. This device is designed to use low-cost components combined with a high degree of Reliability by implementing specific components (i.e. Arduino Micro controller, Pulse sensor, LCD (Liquid Crystal Display), Wi-Fi Module, Breadboard and Jump Wires). The pulse sensor collects a photoplethysmography view of the arterial blood volume through a series of light sensors (i.e. infrared, ultraviolet etc). Using the Arduino, the Pulse sensor's Analog Output is Filtered to Filter out Noise to Ensure that only Clean Clean Signals can be Used to Count the Peaks and Type in a Heart Rate Measurement (Using BPM = 60 seconds divided by Time in Seconds Since the Last Peak) which can be Displayed on a 16 x 2 LCD Display in Real-time. The device can also be remotely monitored, only if it is fitted with a Wi-Fi Module (such as ESP8266) enabling telemedicine capabilities by sending data to a network or mobile apps for rural or home care.

The benefits of this product would be low-cost, portable, plug-and-play equivalent, and is extendable to alarm functions, SpO_2 (oxygenation levels) measurements or logging data. There can also be additional sensor capabilities using a more advanced option such as MAX30102 with self-quantified data from the analyzing algorithm developed by a cutting-edge AI. There would also be some additional offline data storing capability (local storage) for future considerations or development of other wearable types of devices for wristbands or smart watches.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue XII Dec 2025- Available at www.ijraset.com

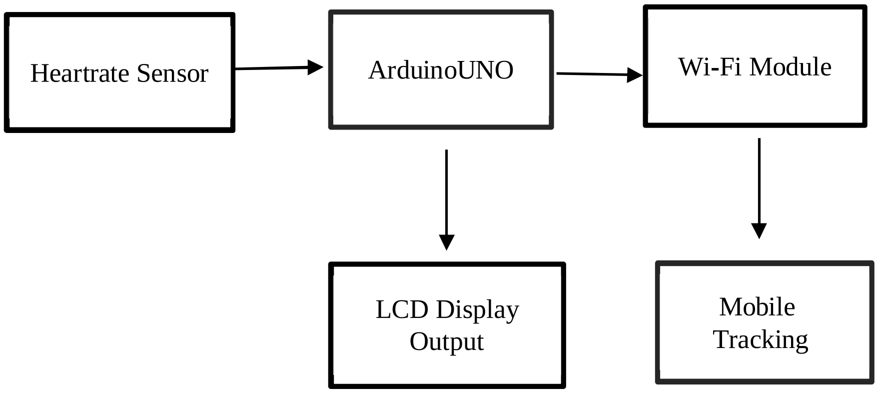

Fig 3.1 Block diagram

A. Block Diagram Description

1) Heartrate Sensors: This sensor is used to measure the pulse rate of the user. It detects the heartbeat signals and sends the corresponding data to the Arduino UNO for processing.
2) ArduinoUNO: The Arduino UNO acts as the central processing unit of the system. It receives data from the heart rate sensor, processes the signals, and then transmits the information to both the LCD display and the Wi-Fi module.
3) LCD Display Output: The Arduino UNO sends the processed heart rate information to the LCD display. This allows the user to view their heart rate in real time.
4) Wi-Fi Module: The Arduino UNO communicates with a Wi-Fi module (e.g., ESP8266). This module enables wireless data transmission to external devices like smartphones or cloud servers.
5) Mobile Tracking: Through the Wi-Fi module, the heart rate data is transmitted to a mobile device for remote monitoring and tracking.

B. Working Flow For Heart Rate Monitoring System

The operational workflow of the heart rate monitoring system begins with the pulse sensor capturing signals from a person's heartbeat. A user places a finger on the sensor, and the sensor will sense the blood rushing in and out with each heartbeat, generating analog voltage values, which are too low to be read by the Arduino. The value will stabilize before communicating with the Arduino board, to ensure readings of pulse rate are not missed or improperly displayed.

Next is the Analog to Digital Conversion (ADC) step when the Arduino will transform the continuous analog signal inputted from the sensor into a digital reading. The microcontroller can then count the number of distinct pulses over a given period. Each pulse represents a single heartbeat, thus knowing how many combined at a period of time provides the heart rate.

After conversion, Arduino calculates the heart rate in Beats Per Minute (BPM). The value is displayed to the user on the LCD screen, while at the same time the readings are temporarily held in memory. A text file can be created in order to save the readings in a useful format for later comparison or analysis. This wirelessly saving of heart readings allows for a record of the heart rate readings to be held for personal or medical use. Finally, the system transmits data, sending the heart rate data obtained from other devices with various communication modules that assist, such as Bluetooth or Wi-Fi. For example, data readings obtained with the Wi-Fi module can be observed objectively and remotely on applications such as Blynk for example. After the data is transmitted, the device begins once again since continuous measurement of the heart beats in a continuous account of heart rate.

IV. RESULT AND DISCUSSIONS

The heart rate sensing device has been successfully built using the Arduino, pulse sensor, LCD, and ESP8266 Wi-Fi module as the main hardware components. The first step concerning hardware was a success - all components were confirmed to work properly as the LCD screen displayed a boot and the wifi module lit up to show the connection to the network. The pulse sensor provided clear pulse peaks when a finger was applied to the sensor after observing slight noise and motion artifacts. Signal processing operations including smoothing and thresholding were used to minimize the artifacts, and the peak detection exhibited greater accuracy, clarity, and responsiveness.

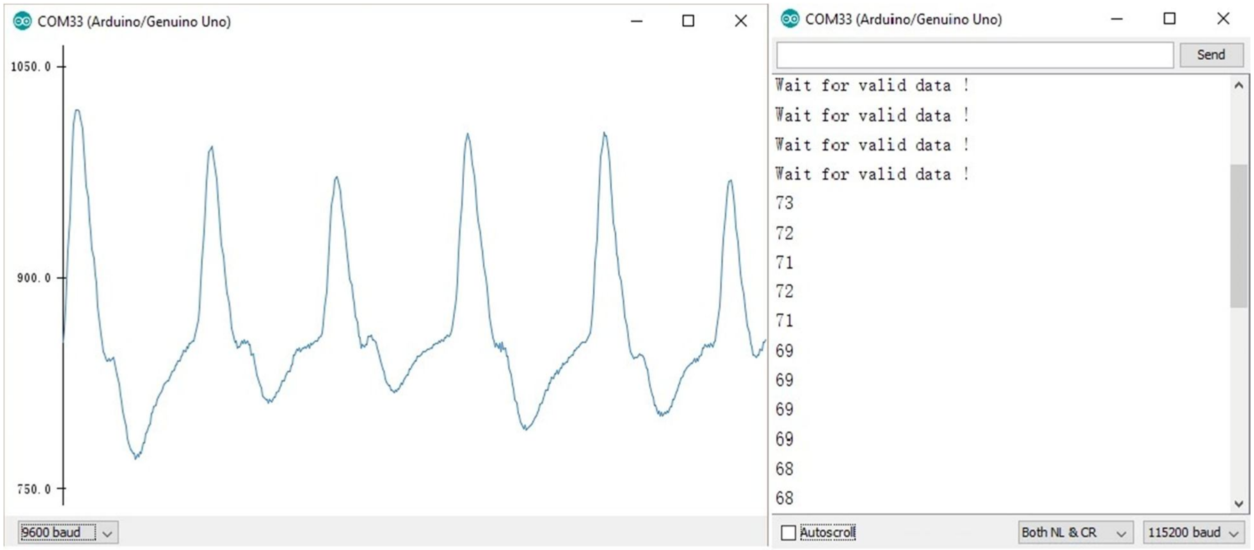

FIG 4.1 OUTPUT GRAPH

The system, with a good peak-detect with refractory period, stayed at rest around a constant BPM, easily readable from the LCD because it was real time displayed. The screen was responsive and fast; in this way, it provided a users' handy moveable interface to work with. Besides this local control, BPM data was also successfully streamed to the Blynk mobile phone application via Wi-Fi for distant monitoring and warning capability. This whole integrative process of IoT performs operations consistently in the presence of a reliable network connection, thereby increasing the usability of the system for caregivers or remote users.

TABLE 4.1 INPUT TABLE

TIME (S)	HEART RATE (BPM)
0	72
2	75
4	76
6	74
8	77
10	73

Quantitative test results demonstrated a similar accuracy with commercial oximeter on stationary status, but indicated difficulty in motion-rich situations because of misleading signal contamination. The device is, therefore, more suitable in light-usage or static monitoring situation rather than a dynamic environment. Conclusion In the end, this project did what I set out to do: Create a low cost portable heart rate monitor with local diagnostics and IoT capabilities. It works easily and is trusty enough for simple uses, but not suitable for clinical grade monitoring or high-motion sports.

A. Real Time Measurements

1) MALE YOUNG CHILD (1-12 years 75-120 bpm): A child's heart is significantly smaller than that of an adult and produces less blood per beat than an adult heart. As an adult, you have a lower heart rate, allowing for an efficient flow of oxygen through your body. Growing children also experience increased heart rates during periods of significant activity. A boy's resting heart rate is slightly lower than a girl's between the ages of 12 and 13. The heart rate for a six year old boy is approximately 95 bpm.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue XII Dec 2025- Available at www.ijraset.com

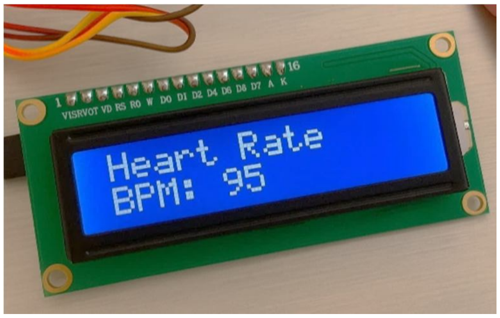

Fig 4.2 Heart rate of Child (1-12 years)[Male]

2) Male – Adult (13–59 years, 60–100 bpm): As you age, your heart becomes larger and is more efficient, so your resting heart rate will decrease. Men typically have a lower resting heart rate than women due to their larger hearts and increased stroke volume. A male of this age group will have his heart rate affected by the amount of stress, fitness level, and health conditions he experiences. A 20-year-old male will have a heart rate of about 77 bpm.

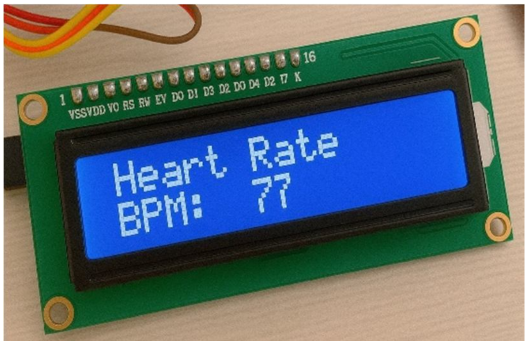

Fig 4.3 Heart rate of Adult(13-59 years)[Male]

3) Male – Aged (60+ years, 60–90 bpm): In geriatric men lower elasicity of the heart and decreased pumping are found, which may restrict HR range. Medications (such as beta-blockers) and chronic health conditions can also impact their resting heart rate. Resting heart rate of a 65year old male is bpm.

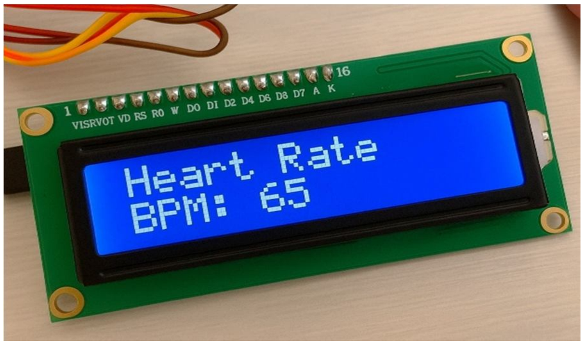

Fig 4.4 Heart rate of Aged(60+ years)[Male]

4) Female – Child (1–12 years, 80–125 bpm): In general, girls demonstrate slightly higher HR than boys as well related to smaller heart size and metabolic differences. The normal is higher in children, because their cardiovascular system is still developing. The pulse rate of a girl child age 7years is 99bpm.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue XII Dec 2025- Available at www.ijraset.com

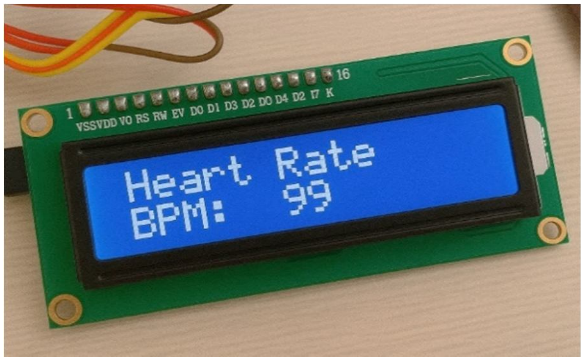

Fig 4.5 Heart rate of Adult(13-59 years)[Male]

5) Female – Adult (13–59 years, 65–105 bpm): Women have an average resting HR between 5 and 7 bpm higher than men. Hormonal effects (such as that caused by estrogen), smaller average heart size, and lower hemoglobin levels also play roles in this gap. Regular fitness training may lower HR at the low end of this range. Heart Rate for a 19 Year old Female Adult is 81bpm.

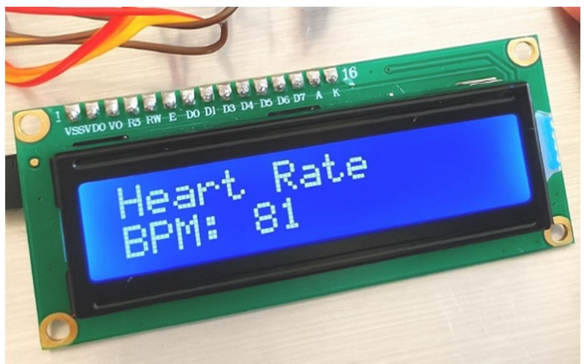

Fig 4.6 Heart rate of Adult(13-59 years)[Female]

6) FEMALE OLDER (60+ years 65-95 bpm): In general, female heart rates are higher than male heart rates for the same age group. There are also some influences from decreasing levels of hormones during menopause and losing elasticity in arteries as women get older. Staying physically active and regularly exercising are effective ways to maintain your heart rate toward the lower end of a healthy level. The heart rate for 72 year old female is approximately 69 bpm.

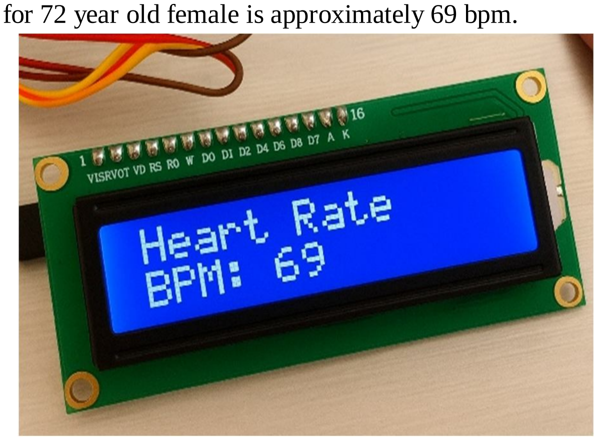

Fig 4.7 Heart rate of Aged(60+ years)[Female]

The table shows typical resting heart rates in beats per minute for different ages and groups. It indicates children generally have faster heart rates than adults and older people have slightly slower heart rates. Additionally, females tend to have higher resting HR than males for all age groups.

Table 4.2 Heart rate Representation (Real Time)

Gender	Category	Age Range	Resting Heart Rate (bpm)
Male	Child	1 – 12 years	75 – 120 bpm
	Adult	13 – 59 years	60 – 100 bpm
	Aged	60+ years	60 – 90 bpm
Female	Child	1 – 12 years	80 – 125 bpm
	Adult	13 – 59 years	65 – 105 bpm
	Aged	60+ years	65 – 95 bpm

V. CONCLUSION AND FUTURE WORK

A. Conclusion

The proposed Arduino system provides a low-cost, simple manner to detect heart rate (sometimes referred to as your heart rhythm) in real time. It offers all of the same features as more sophisticated systems including real-time data collection through the use of wearable sensors, the ability to see your results from the comfort of your home, and an option to receive mobile alerts when a patient's heart is out of rhythm. In comparison to current technologies, it achieves comparable or greater accuracy than any device available now, and arguably higher user comfort levels. In this way, it enhances patient safety, caregiver safety, and medical professional safety by providing quicker and more precise interventions for patients suffering from arrhythmias.

B. Future Work

The next stage for the system will be as a cloud-based, continuous monitoring device, which will provide doctors/caregivers real-time access to a patient's health data from anywhere in the world. Additionally, this technology can provide wearers of smart clothing with both increased quality of life and increased mobility due to the ability to monitor their health continuously and utilize the technology that is part of the cloud/wearable device environment for improved early detection and support for cardiac risks and other illnesses needing medical attention in both hospital and home environments.

REFERENCES

[1] V. O. T. Souza, F. G. S. Silva, J. M. Araújo, and J. S. Lima, "Method and system for heart rate estimation using linear prediction filtering," Signals, vol. 6, no. 2, Art. no. 15, 2025. doi: 10.3390/signals6020015.

[2] F. Scardulla, L. D'Acquisto, R. Colombarini, S. Hu, S. Pasta, and D. Bellavia, "A study on the effect of contact pressure during physical activity on photoplethysmographic heart rate measurements," Sensors, vol. 20, no. 18, Art. no. 5052, 2020. doi: 10.3390/s20185052

[3] D. Ray et al., "A review of wearable multi-wavelength photoplethysmography," IEEE Rev. Biomed. Eng., vol. 16, pp. 136–151, 2023. doi: 10.1109/RBME.2021.3121476.

[4] M. K. McLean et al., "A sliding scale signal quality metric of photoplethysmography (PPG)," Sensors, vol. 23, no. 7, Art. no. 3429, 2023. doi: 10.3390/s23073429.

[5] B. Manojkumar, K. R. Prabha, R. Kiruthikaa, M. S. Priya, and S. Pragadeswaran, "Security and Privacy Considerations for Iot Application in Healthcare to Maintain Patient Details in Cloud using Blowfish Encryption," 2023 International Conference on Emerging Research in Computational Science (ICERCS), pp. 1–6, Dec. 2023, doi: https://doi.org/10.1109/icercs57948.2023.10434132.

[6] A. Nduka, J. Samual, S. Elango, S. Divakaran, U. Umar, and R. Senthil Prabha, "Internet of Things based remote health monitoring system using Arduino," IEEE Xplore, Dec. 2019. doi: 10.1109/9032438.

[7] P. Bansal, M. Malik, and R. Kundu, "Smart heart rate monitoring system," IEEE Xplore, Mar. 2018. doi: 10.1109/8385347.

[8] Y. Devis, Y. Irawan, Junadhi, F. Zoromi, Herianto, and M. R. Amartha, "Monitoring system of heart rate, temperature and infusion in patients based on microcontroller (Arduino Uno)," J. Phys.: Conf. Ser., vol. 1845, no. 1, Art. no. 012069, Mar. 2021. doi: 10.1088/1742-6596/1845/1/012069.

[9] N. S. A. Zulkifli, F. K. C. Harun, and N. S. Azahar, "XBee wireless sensor networks for heart rate monitoring in sport training," IEEE Xplore, Feb. 2012. doi: 10.1109/6179054.

[10] D. N. Dutta, R. Das, and S. Pal, "Automated real-time processing of single-lead electrocardiogram for simultaneous heart rate and respiratory rate monitoring," J. Med. Devices, vol. 11, no. 2, May 2017. doi: 10.1115/1.4035982.

[11] E. V. Boopathy et al., "A Data Driven Approach Through IOMT Based Patient Healthcare Monitoring System.," Researchgate.net, Jul. 01, 2024.

[12] Anandh and G. Indirani, "Real-time health monitoring system using Arduino with cloud technology," Asian J. Comput. Sci. Technol., vol. 7, no. S1, pp. 29–32, Nov. 2018. doi: 10.51983/ajcst-2018.7.s1.1810.

[13] A. M. A. Shakarji and A. Gölcük, "Arduino-based system design for measuring heart rate and body temperature," Int. J. Appl. Math. Electron. Comput., vol. 10, no. 1, pp. 15–19, Mar. 2022. doi: 10.18100/ijamec.1029843.
[14] M. Patil, A. Madankar, and P. D. Khandait, "Heart rate monitoring system," IEEE Xplore, Mar. 2019. doi: 10.1109/8728501.
[15] N. E. J. Asha, E.-U. Islam, and R. Khan, "Low-cost heart rate sensor and mental stress detection using machine learning," IEEE Xplore, Jun. 2021. doi: 10.1109/9452873.
[16] G. Chandrasekaran, P. S, R. N, S. S, S. K, and V. V S, "Meditrack Plus for Enhanced Medicine Monitoring," 2025 International Conference on Inventive Computation Technologies (ICICT), pp. 1830–1837, Apr. 2025, doi: https://doi.org/10.1109/icict64420.2025.11005297.M. Pearson and O. Faust, "Heart-rate-based sleep apnea detection using Arduino," J. Mech. Med. Biol., vol. 19, no. 1, Art. no. 1940006, Feb. 2019. doi: 10.1142/S0219519419400062.
[17] J. Karnadi, I. Roihan, A. Ekadiyanto, and R. A. Koestoera, "Development of a low-cost Arduino-based patient monitoring system for heart rate, oxygen saturation and body temperature parameters," J. Appl. Sci. Eng. Technol., vol. 1, no. 1, p. 26, Apr. 2022. doi: 10.47355/aset.v1i1.15.
[18] A. Munawir, Z. Husen, and Z. Ulfa, "Design and performance evaluation of a real-time heart rate and vibration monitoring system with Arduino," J. Polimesin, vol. 23, no. 3, p. 362, Jun. 2025. doi: 10.30811/jpl.v23i3.6970.
[19] J. B. Bathilde, Y. L. Then, R. Chameera, F. S. Tay, and D. N. A. Zaidel, "Continuous heart rate monitoring system as an IoT edge device," IEEE Xplore, Mar. 2018. doi: 10.1109/8336777.
[20] B.Manojkumar, S.Jeniton, S.Pragadeswaran, N.Ragupathi. "Assessment of a Coordinated Arrangement of Wearable Physiological Sensors for Stress Checking in Work Spaces by Utilizing Organic Markers", Tuijin Jishu/Journal of Propulsion Technology, vol. 44, no. 4, p. 3038-3048, 2023. doi: https://doi.org/10.52783/tjjpt.v44.i4.1394.