iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** VII **Month of publication:** July 2021

DOI: https://doi.org/10.22214/ijraset.2021.36353

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VII July 2021- Available at www.ijraset.com

Heart Rate Monitoring using Arduino

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Abstract: Heart rate monitoring plays a vital role in our day to day life. But first what is heart rate - It is the number of times the heart beats per minute. It mirrors our body conditions in so many ways like our body physiological condition, stress, anxiety etc,. So, it is mandatory to monitor our heart beat. Next question is how do we do that? There are many ways to monitor the heartbeat. This heartbeat can also be found using the ECG waveform when the blood is passing forcely through the regular heart contractions. In this paper we will see heart rate monitoring using Arduino. It is one of the techniques of measuring heart beat. It works on the principle of photoplethysmography (PPG).
Keywords: Heart rate, cardiovascular system, stethoscopes, Aurdino, Actuator.

I. BACKGROUND

We are using an electronic device to measure the heartbeat. Normally, heart rate is nothing that the speed of the heart beat.if we want to keep our body healthy,we want to monitor such things like body temperature, heart rate and blood pressure etc..,we use a device called thermometer to measure the body temperature and sphygmomanometer to measure the blood pressure.we can measure our heartbeat by manually checking the pulse and another method to measure the heartbeat by using the heartbeat sensors.it is very important for athletes and patients to measure their heart rate. there are several methods to measure heart rate, in that Electrocardiography is very important technique. But, using a heart beat sensor is too easy to measure the heartbeat. This heartbeat sensor is available nowadays like wrist watch, smart phone and chest straps etc. Heartbeat is measured in bpm, that bpm indicates how many times heart is contracting and expanding within a minute normally we use photoplethysmography principle in the heartbeat sensors. Photoplethysmography principle states that the change in volume of blood is measured by the change in intensity of light.in this, IR LED will be the source of light and detector will be the photodiode.by using these light sources and detectors we can arrange them like transmissive sensor and reflective sensor. In transmissive sensors we can arrange the light source and detector opposite to each other, and finger of the patient must placed between these two. But, in reflective sensor the light source and detector must be arranged adjacently. and the finger of the patient must be placed front of the sensors.in this heartbeat sensor the IR LED and photodiode are arranged on the clip of the device.

II. INTRODUCTION

Generally Heart rate shows us the sound of our heart. By using this heart rate we can know about our cardiovascular system.It is not same for all. Heart rate
may differ to all. It is based on the person how much of the muscles absorb the oxygen from the atmosphere and how much of carbon dioxide releases. For example, when we are sleeping the heart rate is different because our muscles are at rest,it may be low. And when we are doing some works like running the heart rate is comparatively very high because when running all our muscles doing work,our muscles absorbs more oxygen. So, on that time the heart rate is very high And monitoring the heart rate is the technique to know the heartbeat per every minute.
Temperature of the body also can tell the body condition.it also may differ from person to person and place to place.we also know that if the body temperature is very high, our blood vessels are expanded .And if the body is too cool,we can understand that the blood vessels are narrow. on that time when our body is became cold we want rapid contraction with muscles.
Arduino is a sensing device which is ùsed to find the heart beat and body temperature. Aurdino can receive inputs from different types of sensors and also affect its surroundings by using Actuators. Now, we are going to see how to measure heartbeat using Arduino software. Generally normal heartbeat is 72 bpm. if heartbeat is lower than 72 bpm it means bradycardia. Bradycardia is the indication of the condition when the heartbeat is lower than normal heartbeat. And if it is higher it means that is the condition called tachycardia. Similarly body temperature is also different from person to person and temperature around the surroundings. Temperature also may vary throughout the day. normally the temperature is low at morning times,so the body temperature is also low at morning time. And at Afternoon time the temperature is high, so our body temperature is also high in the afternoon and evening time. Normal body temperature is 37 degree Celsius and 98.6 Fahrenheit.

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Volume 9 Issue VII July 2021- Available at www.ijraset.com

We can also find the body temperature by using different types of sensors like thermocouples, thermistors, resistance temperature detectors (RTD), and integrated circuit (IC) sensors. The sensors which are used to measure temperature produce analog output voltage, and this analog output voltage is proportional to the temperature.

These temperature sensors work based on analog to digital converters because the output is in the form of analog and later it is converted in the form of digital. This output is normally in contact with the front part of the MEGA328R-PU Arduino Uno. The output will be displayed on the LCD, which is processed by Arduino Uno. And sends it to the other part called the receiving end to display the output to the remote place.

Now, we are going to see in this paper about designing and preparing a low cost. The paper describes the design of a very low-cost patient monitoring system using a remote, which is used to measure the patient's body temperature and heartbeat. By using these we are going to send the data to the remote end. At the remote end, the output data will be displayed .With the help of this data the doctor will know the condition of the patient. This heartbeat monitoring system using Arduino will be much helpful in emergencies to save the patient's life.

A. Significance of Heart

In our body, it is the center of the circulatory system. It is the most important organ in our body. If our body wants to work properly the pumping of blood to each organ is very important. The heart plays a very important role in our body.it circulates oxygen and blood in our body. And it also supplies nutrients to our body. We can't live without a heart. In the heart, the right atrium receives the oxygen from the veins in the body and the left atrium receives the oxygenated blood in the lungs.

1) External biasing
2) First stage signal conditioning
3) Second stage signal conditioning.

These are some methods proposed to design the Arduino to detect the heartbeat by using various sensors.

III. EXISTING APPROACHES

There are some existing methods to develop and design the measurement techniques of the heart rate. But, Nowadays there are several methods to measure the heart rate like optical and electronic methods.But these two approaches are failed due to inaccurate results. These results are inaccurate because the analog signals are varied from person to person. These are failing to calibrate with the measurement of the analog signal of pulse to every person. Some have developed some methods, for example, M.M.A Hashem develops a device to measure heart rate, with the help of infrared technology. And body temperature can be measured with the help of an analog temperature sensor.

This method is advanced Because we can calibrate the analog signal of each person. In optical and electrical methods it is difficult to measure the analog pulse of each person, it may give inaccurate results from person to person. But in this method, we get exact results. In this device, we can use the wireless terminal and wireless receiver. the data is transferred from the terminal to the receiver.

A serial port is used to send the data to the computer. The web server can receive all this data on the computer by internet. We can see the result anywhere by using this web browser. This device also has some drawbacks like having a computer to receive information and it requires the internet for a web browser.

Later Mr.N.Navale developed a telemedicine system. In this telemedicine system the patient can carry a hardware device that is connected to the android application with Bluetooth. With the help of this device, the patient is going to measure the heart rate and body temperature continuously and this information can be stored in that android application. If the patient is having any trouble like a heart attack, then this device can send a message to the consultant doctor from the current location of the patient.

Then K.K Patil developed a device that can be used for the patient healthcare monitoring system. This device is going to work with the help of different sensors like temperature, heart rate measuring sensor, eye blink detection sensors to find the current status of the patient's health. This is a very useful device, even though the person is unable to speak and unable to move his hand. At that time. if the patient blinks his eye 5 times, then the message goes to the caretaker about the current condition of the patient. This application is running continuously on the caretaker's phone. With that, the caretaker can know the current condition of the patient and the doctor can analyze the condition easily.

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IV. PROPOSED METHOD

There are different types of methods proposed to determine the heart condition. Now, we are going to see some of the methods.

A. System Descrimination

This technology is having the monitors like Optical and electrical monitors. In these two monitors. The electrical method is used to strap around thePatient's chest. But for the optical method, does not Require any strap. We can use the optical method More conveniently than the electrical method.in, Sensing the heart rate first, we want to determine The pulse. The most efficient method to find the pulse is using a combination of led and photosensor.

1) *Electrical Method:* This method is used to strap around the chest Around the patient's body.When our heartbeats some electric volts are produced, these electric volts are monitored by using electrodes. these information van reaches the receiver with the help of a radio signal from the strap which is around the chest of the patient. By using this information the receiver can detect the heart rate of our body. In a radio signal, there is some special code called "coded signal" which can help to stop getting the signals from the radio signal from other nearby transmitters. This sometimes can corrupt our data. By using this electrical. The method has a lot of disadvantages like inaccurate hectic wired connections over the body.
2) *Optical Method:* This technique is better for the capillaries to patch with the skin, and it can help to better blood supply. This method also can be used in the time of expansion and contract with the heartbeat. This rhythmic change can be sensed by the ordinary infrared LED/phototransistor pair. This rhythmic change is small, but it can be detectable for variations in skin contrast. In this optical method, we are going to use transmittance and reflectance principles. It is not going to involve finding the heart rate. And in this method, we didn't attach or insert anything on the body. The cost is also effective for this method.

B. Circuit Description

For Arduino, we are going to implement the circuit in three steps.

1) External biasing
2) First stage signal conditioning
3) Second stage signal conditioning.

These are some methods proposed to design the Arduino to detect the heartbeat by using Various sensors.

V. LITERATURE REVIEW

For patient monitoring, we are going to use wearable sensors like emerging wireless technology (ex. Bluetooth). Because it is advantageous for mobility and it also consumes low power.

1) Based on the priority of that disease, treatment can be given to the patients. They will treat the patient according to how he/she is in a critical position. This is one of the best advantages.
2) These types of sensors which are used for measurement can be worked only for a shorter distance and for a short duration. Some studies are going on to determine which types of vital signs are used by the doctors.
3) These signs are normally used to find the body temperature, pulse rate, and detection of falls.
4) It is more complex to measure the direct temperature of the peripheral tissue than the core temperature measurement.
5) By a biomedical system using Zigbee, we are going to monitor the patient's body condition of vital signals.
6) This system can be used for gathering and processing biomedical signals.
7) First, we are going to the biosensors on the body and then, it is processed by a local base station by using some raw data transmitted by the normal mobile device.
8) Nowadays Smart wearable remote health monitoring systems are increasing with good quality in health services for our requirements. and all that equipment with low cost, by avoiding unnecessary hospitalizations and to ensure urgent care.
9) According to the patient condition the System contributes to the enhancement to prevent the disease with A cost-effective with the help of Telemedicine method.
10) The network comes to deal with monitoring and analyzing the patient's health for physiological measurements. The data is gathered and transmitted from the sensors to the server with the help of the network. This physiological parameter
11) The data is gathered and transmitted from the sensors to the server with the help of the receiver and displayed on the monitor.

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Volume 9 Issue VII July 2021- Available at www.ijraset.com

This health monitoring system has a data processing module, data communication module, and data sensing module. In which the data sensing has various sensors which perform different actions like temperature sensor which senses the temperature of the body and heartbeat sensor which monitors the heart rate of the host. And the data collected by these sensors are transmitted to the PIC microcontroller which is located in the data processing module. This module studies the received input signals. The medicine is given to the patient when the processed value of the cleaned noise signal is more than the normal value and is shown on the screen with the help of GUI. And finally the communication module as in name it is used as the communication tool between the patient and the devices which means it transfers data. Whenever needed this information is sent to doctors that the patient needs treatment.

VI. WORKING

The main theme is to promote an automatic health monitoring system that displays the temperature and the rate of the heartbeat of the patient using a technology called NRF. The other option is to continuously monitor the temperature and the heartbeat of the patient so much equipment is needed for the process and the record of these should be kept for reference. For simple understanding, let's see the circuit diagram.

In the transmitter section, we have the temperature sensor and the heart rate monitoring sensor which senses the temperature and heart rate of the patient. These readings are transferred to ATmega328.

With the help of the nRF module, the transferred signal is encoded in sequential data, then the patient temperature can be viewed on the display with the antenna, and data is transferred to the receiver end.

A. Heart Rate Monitoring System Using Arduino And Android Device

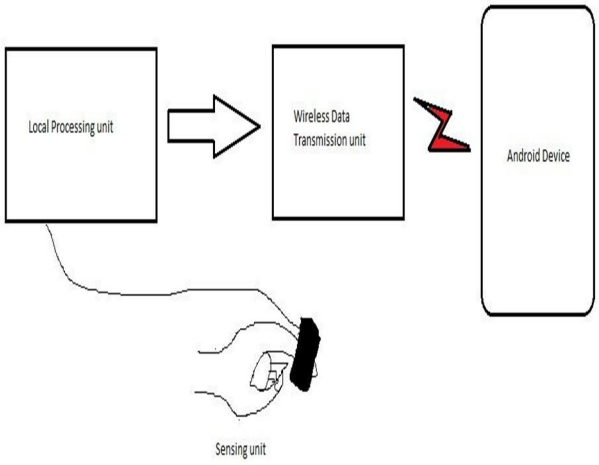
We need infrared Tx and Rx to measure the pulse by the change in blood flow in one of the fingers. With the help of these infrared Tx and Rx, we can construct an affordable device to measure heart rate. If we want to remove the unwanted noise and interference, we need a noise filter. The main reason for creating the noise is the small movement of the finger. To count the pulse rate, we use the microcontroller of the Arduino UNO board. And it is also used to send the information which is used to develop the "Heartmate" Android application by using Bluetooth. The following figure is given more information about the process.

B. Heart Rate Sensing

We use a heartbeat optical sensor to measure alternation in blood volume at the fingertip. It is used to measure the sensor unit which consists of IRTx and IRRx which are arranged in side by side order. The IRTx is used to transmit with the help of infrared light into the fingertip. Similarly, IRRx senses the light depending on the blood volume which is inside the fingertip and the light which can be reflected back. By using this the heartbeat after the amount of reflected infrared light that can be detected by IRRx.

By proper conditioning of this sensor, we can observe a little change in amplitude of the reflected light that can be converted into a pulse.

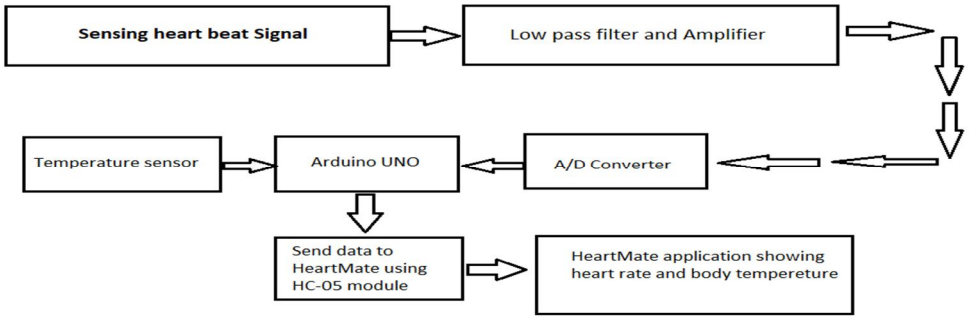
This sensor is used to project TCRT500. The TCRT500 is a reflective optical sensor that contains an infrared light emitter and photo-transistor.



System diagram of proposed systems

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Volume 9 Issue VII July 2021- Available at www.ijraset.com



Function block diagram of a system

These two can be arranged side by side. The light emitter and phototransistor are enclosed inside the leadèd package, it will help to The effect of surrounding visible light will be minimum. By connecting the enable pin to the voltage 5V of Arduino, will be helpful to turn the IR emitter to LED. Fingertips are placed on the sensor which can act as the reflector of incident light. The figure shows how the pulse detector will give the synchronous waveform as output with a heartbeat. Even Though it is a weak signal, it contains a lot of noise which is superimposed on the AC signal and it is filtered by the series of signal processing circuits with the help of Quad Op-Amp LM324N. If we want to get rid of the DC component, the signal must pass through the RC high pass filter. The cut-off frequency of the high pass filter is 0.7Hz. The low pass filter is used to build an Op-Amp circuit in the second stage. The gain of the low pass filter is 101 and the cutoff frequency is 2.35Hz. With the help of the combination of low pass filter and high pass filter, we can easily remove unnecessary noise in DC. The below figure shows the filtering and amplification of the output from first signal conditioning. Because of this reason, the total voltage gain will be 101*101=10201.

These two stages can convert the input signal to near Transistor-Transistor Logic(TTL). We have to fix the potentiometer at the output of the first signal conditioning stage. The total gain in these two stages is less than 1021. An LED is connected and the output will blink when it detects a heartbeat. We are going to implement a buffer at the final stage. This buffer will help to lower the output impedance. When we are reading these amplified PPG signals through the ADC channel. It will be helpful to detect the heartbeat.

When we connect the output to the Arduino UNO of digital pin 8. The below diagram shows how the IR emitter and IR receiver are in a relationship with the finger. We have broken down the remote patient's wellbeing by observing the arrangement of temperature and heartbeat of people utilizing nRF24L01. The heartbeat was estimated with the assistance of a photodiode and brilliant LED while the temperature was estimated by utilizing exactness incorporated temperature sensor LM35. Both the information were handled in the Arduino Uno also, shipped off the far-off end remotely by utilizing the nRF transmitter and gotten at the far-off end by utilizing the nRF beneficiary. The information was handled in the Arduino Uno and the information estimated was shown effectively with the assistance of LCD at the distant end. The remote correspondence was favored because it gives more prominent versatility to the sensor gear and diminishes the expense wherein there are multi-communicating areas. The gadget can be associated with a PC by utilizing sequential yield so that deliberate heartbeat and temperature can be shipped off PC for additional on the web or disconnected investigation.

VII. FUTURE APPLICATIONS AND DEVELOPMENTS

A. Cautioning for anomalies of ailment can be shown.
B. Sound can be added to the gadget with the goal that the gadget makes a sound each time a heartbeat is gotten and an alert is begun for strange medical issues.
C. The yield can be shipped off cell phones by utilizing a GSM module or Bluetooth module for additional investigation.
D. More boundaries (like pulse) can be added to the gadget.
E. Notwithstanding the framework can likewise give more than one number with the goal that beyond what one client can get a crisis message.
F. As indicated by the accessibility of sensors or improvement in biomedical patterns more boundaries can be sensed and screened which will improve the proficiency of the remote checking framework in the biomedical field.

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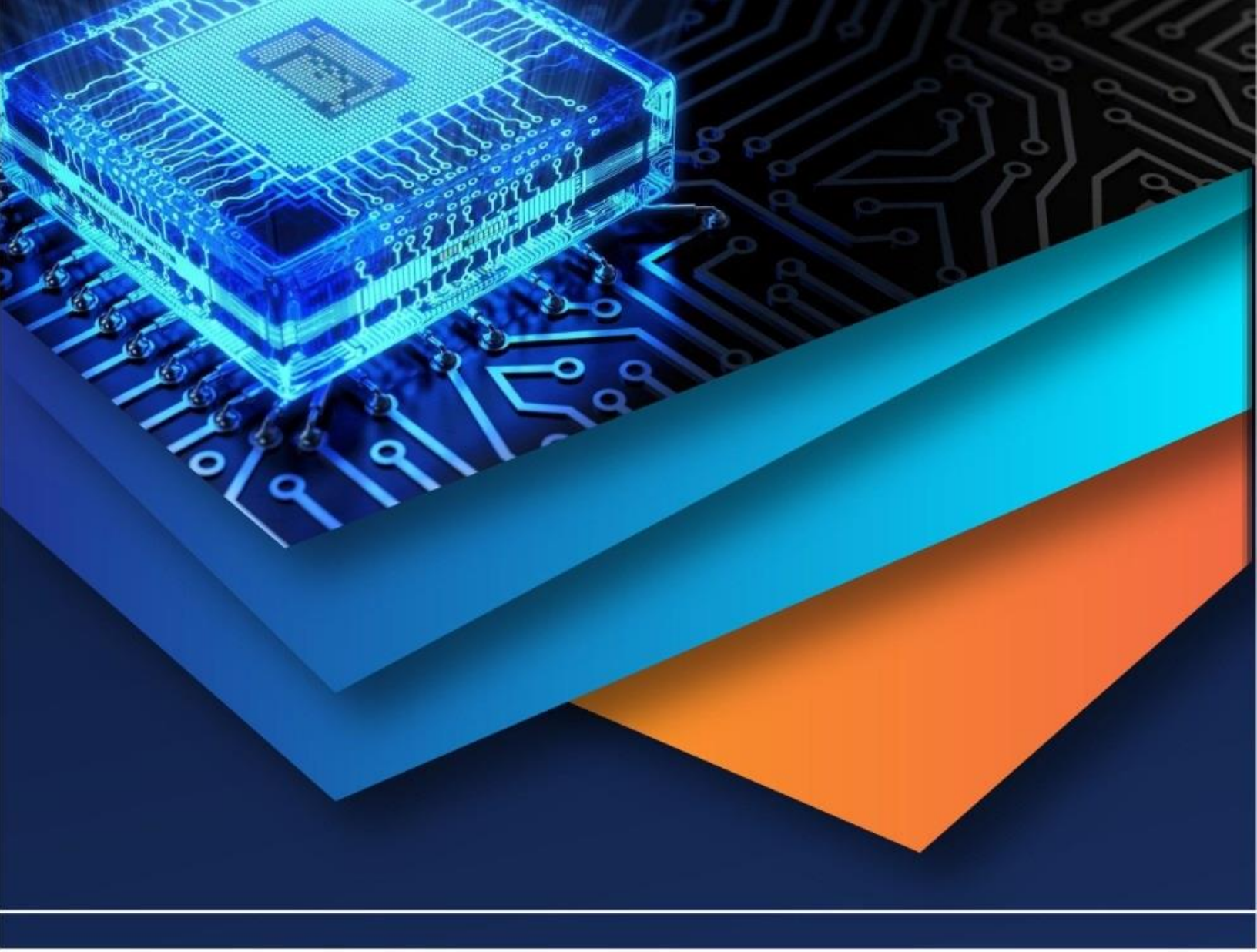
VIII. CONCLUSION

In this paper, we have shown a plan of a pulse and internal heat level estimating inserted framework. The last result of our methodology is an android based versatile pulse
furthermore, internal heat level estimation framework with an appropriate
engineering which can be material in clinical and home apparatuses in persistent wellbeing observing framework. The framework has been tried for some substantial sign, for example, pulse and body
temperature. The framework gives relatively preferred execution over old hand estimating framework.Carefully sense internal heat level and pulse utilizing gardenia can show the precise outcomes will be shown on the LCD monitor.This gadget will permit to quantify consistently the mean blood vessel pressure (MAP) in around one moment and the precise internal heat level will be shown on the LCD screen. Presently I'm thinking of making an android application for sending the cautions and showing the consequences of internal heat level also, circulatory strain consistently at a specific timespan.

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