DEPARTMENT OF ELECTRONICS AND
COMMUNICATION ENGINEERING
Periyar Nagar, Vallam Thanjavur - 613 403, Tamil Nadu, India
Phone: +91 - 4362 - 264600 Fax: +91- 4362 - 264660
Email: headece@pmu.edu Web: www. pmu.edu

ELECTRONICS AND **COMUNICATION ENGINEERING ,**
U24EC203 - SENSORS AND ACTUATORS

TITLE

Submitted by

G. GOKULAKANNAN
1240120131154
II year

Heart Rate Sensor

Introduction:

A heart rate sensor is a biomedical device used to measure the rate at which the heart beats per minute (BPM). It is one of the most important physiological parameters that indicates the health condition of a person. The human heart continuously pumps blood throughout the body, and by measuring the pulse rate, we can detect abnormalities such as stress, fatigue, or heart diseases.
Heart rate sensors are widely used in **medical instruments, fitness bands, smartwatches, and hospital monitoring systems**. With the advancement of technology, modern sensors are small, accurate, and can continuously track heart activity in real time.

Working Principle:

The working of a heart rate sensor is based on the **Photoplethysmography (PPG)** principle.
PPG is an **optical measurement technique** that uses light to detect the blood volume changes in the microvascular tissue beneath the skin.
When the heart beats, the blood volume in the arteries increases, and during relaxation, it decreases. These changes affect the amount of light absorbed or reflected by the blood.

1. The **LED (Infrared or Green)** emits light onto the skin surface (usually the fingertip or wrist).
2. The **Photodiode or LDR** receives the reflected or transmitted light.
3. When blood flow increases, more light is absorbed and less is reflected.
4. The **difference in light intensity** is converted into an electrical signal.
5. The **Operational Amplifier (LM358)** amplifies this weak signal.
6. Finally, the **Microcontroller (e.g., Arduino, ESP32)** processes the signal and calculates the **beats per minute (BPM)**.

This method is non-invasive and provides accurate real-time monitoring of the heart rate.

Hardware Components Used:

1. **Infrared / Green LED:** Emits light through the skin to detect blood flow changes.
2. **Photodiode / LDR:** Detects the reflected light from the skin.
3. **LM358 Operational Amplifier:** Amplifies the weak pulse signal from the photodiode.
4. **Resistors & Capacitors:** Used for filtering and biasing in the circuit.
5. **Microcontroller (Arduino / PIC / 8051):** Processes the signal and displays the heart rate value.
6. **Display (LCD or OLED):** Shows the heart rate in BPM.

Software Implementation:

The software part involves reading the sensor output, filtering noise, detecting peaks, and calculating BPM.

1. The analog signal from the sensor is read by the microcontroller.
2. The microcontroller counts the number of pulse peaks in a given time (usually 15 or 30 seconds).
3. It multiplies the count to convert it into **beats per minute (BPM)**.
4. The calculated BPM value is displayed on an LCD or transmitted wirelessly (Bluetooth/Wi-Fi) to a smartphone or computer.

Applications:

- **Medical Monitoring:** Used in hospitals to continuously monitor patient heart rate.
- **Fitness Devices:** Smartwatches and fitness trackers use heart rate sensors to monitor activity levels and calories burned.
- **Sports Training:** Helps athletes track their performance and maintain safe workout intensity.
- **Stress Detection:** Monitors heart rate variability to estimate stress levels.
- **Telemedicine:** Enables remote health monitoring for elderly or critical patients.

Advantages:

- Non-invasive and painless measurement.
- Compact, lightweight, and easy to use.
- Provides real-time and continuous monitoring.
- Low power consumption.
- Can be easily integrated with wireless devices for data transfer.

Limitations:

- Accuracy can be affected by body movement or poor sensor placement.
- Skin color and ambient light may interfere with optical readings.
- Requires calibration for different individuals.

:

Conclusion

🚗

The heart rate sensor is an essential biomedical device in today's healthcare and fitness industries. It provides an accurate, simple, and continuous way to monitor the heart's performance. The integration of heart rate sensors with wearable and IoT-based health systems has made personal health monitoring easier and more efficient. With future advancements, these sensors will become even more precise and play a vital role in preventive healthcare and early disease

🚗 Coolant Temperature Sensor (CTS)

🔹 Introduction:

The **Coolant Temperature Sensor (CTS)** is one of the most important sensors used in modern automobile engines.
It measures the **temperature of the engine coolant**, which indicates the **overall operating temperature** of the engine.
The data from this sensor is sent to the **Electronic Control Unit (ECU)**, which uses it to control critical engine functions such as **fuel injection, ignition timing, and cooling fan operation**.
Maintaining the correct engine temperature is very important for achieving **better fuel efficiency, reduced emissions, and longer engine life**.

When the engine is started cold, it needs a **richer air–fuel mixture** to run smoothly. As the engine warms up, the ECU gradually leans the mixture.
This adjustment is done automatically using the signals from the Coolant Temperature Sensor.

🔹 Location:

The CTS is usually located:

- On the **engine block** or **cylinder head**,
- Near the **thermostat housing**,
- Or in a coolant passage where coolant continuously flows.

This location ensures that the sensor gets a **true and quick reading** of the coolant temperature as soon as the engine starts operating.

🔹 Construction:

The Coolant Temperature Sensor is generally a **thermistor type sensor**.
It consists of: 1.