SENSORS AND ACTUATORS

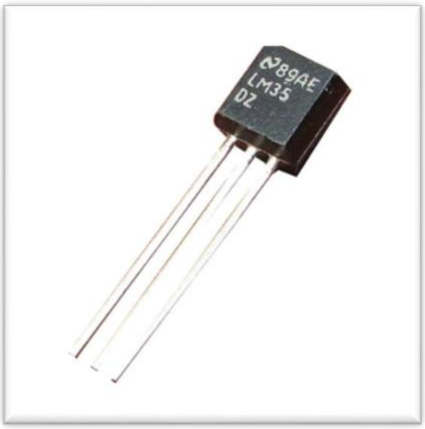
Assignmemt

HEALTH CARE SENSORS

Healthcare sensors are devices that detect and measure physiological parameters (like heart rate, temperature, oxygen level, or blood pressure) from the human body and convert them into electrical signals for monitoring, diagnosis, and treatment.

Temperature sensor

A temperature sensor is a device that detects and measures heat energy (temperature) and converts it into an electrical signal that can be read or recorded.



Working principle

- The sensor detects changes in temperature of its surroundings.
- These changes cause a variation in physical property (like resistance, voltage, or current).

- The variation is converted into an electrical signal proportional to the temperature.

Advantages

- High accuracy and sensitivity
- Fast response
- Easy integration with controllers (Arduino, PLC)
- Available for both contact and non-contact use

Respiration sensor

A respiration sensor is a biomedical sensor used to measure the breathing rate (number of breaths per minute) by detecting chest or abdominal movements, airflow, or temperature changes during respiration.

Working principle

A respiration sensor works by sensing changes that occur during inhalation and exhalation, such as:

Chest expansion/contraction

Air pressure or temperature change

Airflow movement through the nose or mouth

These changes are converted into an electrical signal proportional to the breathing rate.

Advantages

- Non-invasive and safe
- Enables continuous monitoring
- Useful in both clinical and home settings
- Early detection of breathing disorders

Optical sensor

An optical sensor is a device that converts light (visible, infrared, or ultraviolet) into an electrical signal to detect the presence, intensity, or changes in light.

Working principle

The sensor detects light intensity or changes using a photodetector.

Light may be emitted from a source or reflected from an object.

The photodetector converts light into an electrical signal (voltage or current) proportional to the light received.

This signal is used for measurement, detection, or control.

Advantages

- Non-contact measurement
- High accuracy and fast response
- Immune to electromagnetic interference

- Can be miniaturized for wearable devices

Heart rate sensor

A heart rate sensor is a biomedical sensor that measures the number of heartbeats per minute (BPM) by detecting the electrical activity of the heart or blood flow changes.

Working principle

There are two main types of heart rate sensors:

1. Electrical (ECG-based) Heart Rate Sensor
    - Detects electrical signals generated by heartbeats.
    - Electrodes placed on the skin pick up the ECG waveform.
    - The sensor processes the signal to calculate heart rate (BPM).
2. Optical / Photoplethysmography (PPG) Heart Rate Sensor
    - Uses light (green or infrared LED) and a photodiode.
    - Measures blood volume changes in arteries during heartbeats.
    - Converts these changes into an electrical signal representing heart rate.
    - Commonly used in smartwatches and fitness trackers.

Advantages

- Non-invasive (especially PPG type)
- Real-time monitoring of heart rate
- Can be integrated with mobile apps and wearable devices
- Helps detect arrhythmias or irregular heartbeat.

Pulse oximeter sensor

A pulse oximeter is a non-invasive medical device that measures the oxygen saturation (SpO_2) of a patient's blood and their pulse rate.

It is widely used in hospitals, clinics, and home monitoring, especially for respiratory or cardiac patients.

Working principle

Based on photoplethysmography (PPG).

The device has LEDs (red and infrared) and a photodetector:

1. Red light (≈660 nm) and infrared light (≈940 nm) pass through the fingertip or earlobe.
2. Oxyhemoglobin (HbO_2) absorbs more infrared light.
3. Deoxyhemoglobin (Hb) absorbs more red light.

The photodetector measures the transmitted light, and the sensor calculates the ratio of oxygenated to total hemoglobin to determine SpO_2.

The device also measures pulse rate from blood volume changes in arteries.

Advantages

- Non-invasive and painless
- Real-time measurement
- Portable and easy to use
- Helps in early detection of oxygen deficiency

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