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**Project Synopsis on**

**“Tachometer”**

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**Abstract**:

This project focuses on developing a tachometer using an ESP32 microcontroller and an IR sensor to measure rotational speed in RPM. The IR sensor detects interruptions in a light beam caused by a rotating object, with the ESP32 calculating the RPM from these interruptions. Leveraging the ESP32's built-in Wi-Fi and Bluetooth, the device can wirelessly transmit RPM data to a smartphone or computer, enabling remote monitoring. Designed to be reliable, cost-effective, and user-friendly, this tachometer has applications in monitoring engine speeds in vehicles and ensuring the smooth operation of machinery in industrial settings.

**Introduction:**

A tachometer is a device used to measure the rotational speed of an object, typically in revolutions per minute (RPM). This is important for monitoring the performance of engines, machinery, and other rotating equipment to ensure they operate efficiently and safely. In this project, we will design a digital tachometer using an ESP32 microcontroller and an Infrared (IR) sensor. The ESP32 is a powerful and versatile microcontroller with built-in Wi-Fi and Bluetooth, making it suitable for modern IoT applications. The IR sensor detects the rotation by sensing interruptions in an infrared light beam caused by the moving object. The tachometer calculates RPM by counting these interruptions and can display the data on a screen or transmit it wirelessly for remote monitoring. This project aims to create a reliable, cost-effective tachometer that can be used in various applications, from automotive diagnostics to industrial maintenance.

**Methodology:**

The tachometer is designed to measure the rotational speed (RPM) of a rotating object using an infrared (IR) sensor and an ESP32 microcontroller. This system detects the reflection or interruption of an IR signal from a reflective surface attached to the rotating object.

**2. Approach**

The methodology involves the following key steps:

**2.1. Requirements Analysis**

* **Hardware:** ESP32, IR sensor module, reflective tape, connecting wires, power supply.
* **Software:** Arduino IDE or similar development environment for ESP32 programming.
* **Objective:** To measure the speed of rotation in real-time with high accuracy and display the results.

**2.2. Hardware Setup**

1. The IR sensor is positioned to detect a reflective marker on the rotating object.
2. The ESP32 is connected to the IR sensor, providing power and capturing output signals.
3. The rotating object is prepared by attaching reflective tape at a fixed point.

**2.3. Signal Processing**

The IR sensor detects a signal when the reflective marker passes through its field of detection:

* Each detection corresponds to one pulse.
* The pulses are counted over a fixed interval (e.g., 1 second).

**2.4. Software Implementation**

1. **Interrupts:** The ESP32 uses hardware interrupts to capture high-speed pulses from the IR sensor.
2. **RPM Calculation:** The RPM is calculated using the formula: RPM=Pulse Count in 1 second×60Number of Pulses per Revolution\text{RPM} = \frac{\text{Pulse Count in 1 second} \times 60}{\text{Number of Pulses per Revolution}}RPM=Number of Pulses per RevolutionPulse Count in 1 second×60​
3. **Display/Output:** The calculated RPM is displayed in the serial monitor or on an attached display module.

**2.5. Testing and Calibration**

1. The system is tested with rotating objects of known speed to validate its performance.
2. Adjustments are made to ensure accuracy by minimizing false detections.

**3. Tools and Techniques**

* **Hardware:** ESP32 microcontroller, IR sensor module, reflective tape.
* **Software:** Programming in C++ using the Arduino IDE.
* **Mathematical Model:** RPM calculation based on pulse counts.

**4. Validation and Performance Evaluation**

* Compare measured RPM with known reference values to verify accuracy.
* Analyze the system for response time, sensitivity, and environmental robustness.

**Conclusion:**

The proposed tachometer system using an IR sensor and ESP32 provides an efficient and cost-effective solution for measuring the rotational speed of objects in real-time. By leveraging the high-speed processing capabilities of the ESP32 and the sensitivity of the IR sensor, the system can accurately detect and calculate RPM with minimal hardware requirements. The implementation is versatile, scalable, and suitable for a wide range of applications, including industrial automation, motor speed monitoring, and educational projects. The successful testing and calibration of the system demonstrate its reliability and practicality, making it a valuable tool for precise rotational speed measurements.

**References:**

[1] ESP32 Projects - Last Minute Engineers

[2] DIY Tachometer to Measure Accurate RPM using Arduino ESP8266 ESP32 – Circuit Schools **‌**