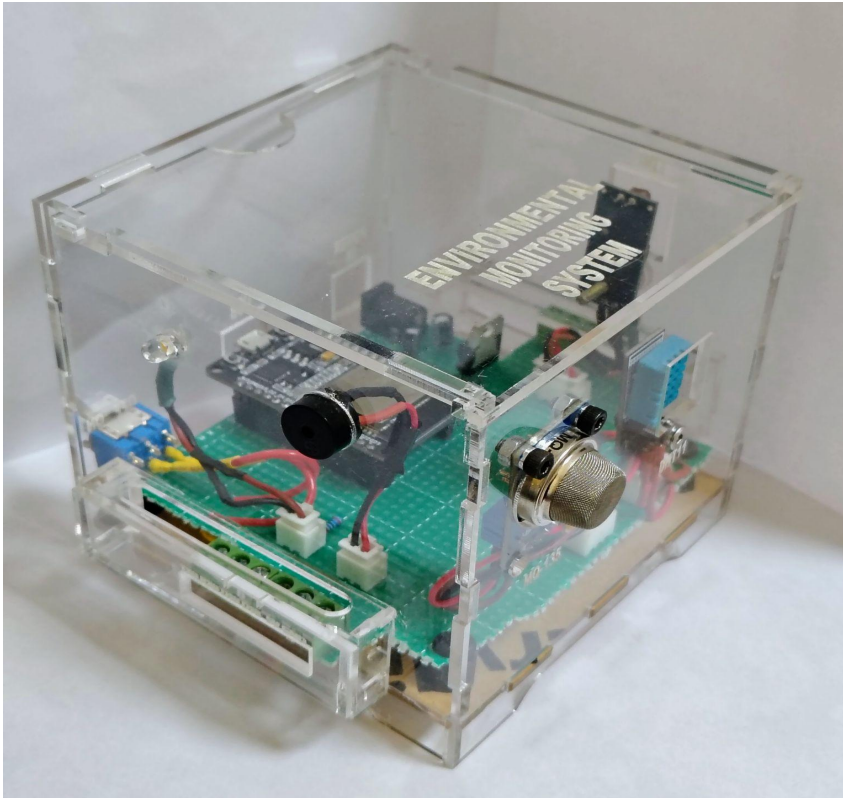


Experimental Study of iCPS Nodes



Environmental Monitoring System



[Link to environmental monitoring](#)

- Uses ESP32 with DHT11, MQ135 air quality, and LDR sensors for environmental monitoring
- Triggers LED/buzzer alerts based on air quality and lighting conditions
- Transmits environmental data to ThingsBoard for real-time monitoring

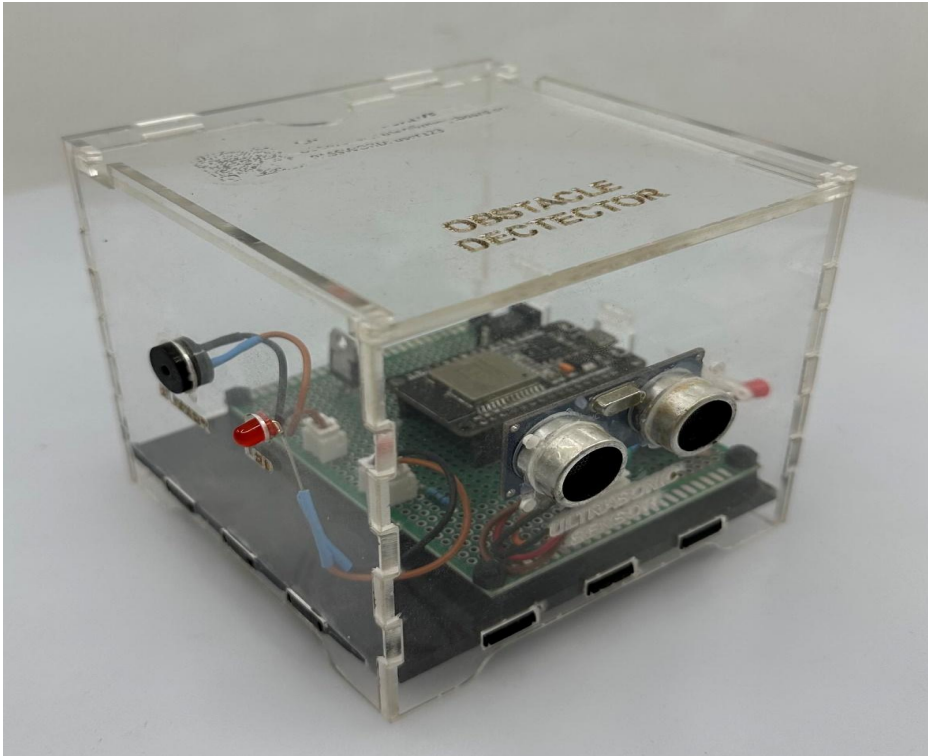
Pin Connections:

- **DHT11:** Data→GPIO23, VCC→3.3V, GND→GND
- **MQ135:** Analog→GPIO34, VCC→3.3V, GND→GND
- **LDR:** Digital→GPIO22 (via LM393), **LED**→GPIO21, Buzzer→GPIO5

Communication Protocols:

- Digital/Analog: DHT11 and MQ135 sensor data communication
- Digital: LDR sensor via comparator for light detection
- Wi-Fi/MQTT: Cloud connectivity for ThingsBoard transmission

Obstacle Detector



[Link to Obstacle Detector](#)

- Uses ESP32 with HC-SR04 ultrasonic sensor for distance measurement and obstacle detection
- Triggers buzzer and LED alerts when objects are detected within threshold distance
- Shares sensor data to ThingsBoard for real-time monitoring

Pin Connections:

- **HC-SR04:** VCC→3.3V, GND→GND, Trig→GPIO5, Echo→GPIO18
- **Red LED:** Anode→GPIO21, Cathode→GND
- **Buzzer:** Positive→GPIO19, Negative→GND

Communication Protocols:

- **Digital Communication:** Between ESP32 and HC-SR04 sensor
- **Wi-Fi:** Internet connectivity for cloud data transmission
- **MQTT:** Lightweight messaging protocol for ThingsBoard communication

Temperature Control System



[Link to Temperature Control Code](#)

- Uses ESP32 with LM35 temperature sensor for precise temperature monitoring and automatic fan control
- Triggers LED alerts and activates relay-controlled fan when temperature exceeds thresholds
- Transmits temperature data to ThingsBoard for real-time monitoring and analysis

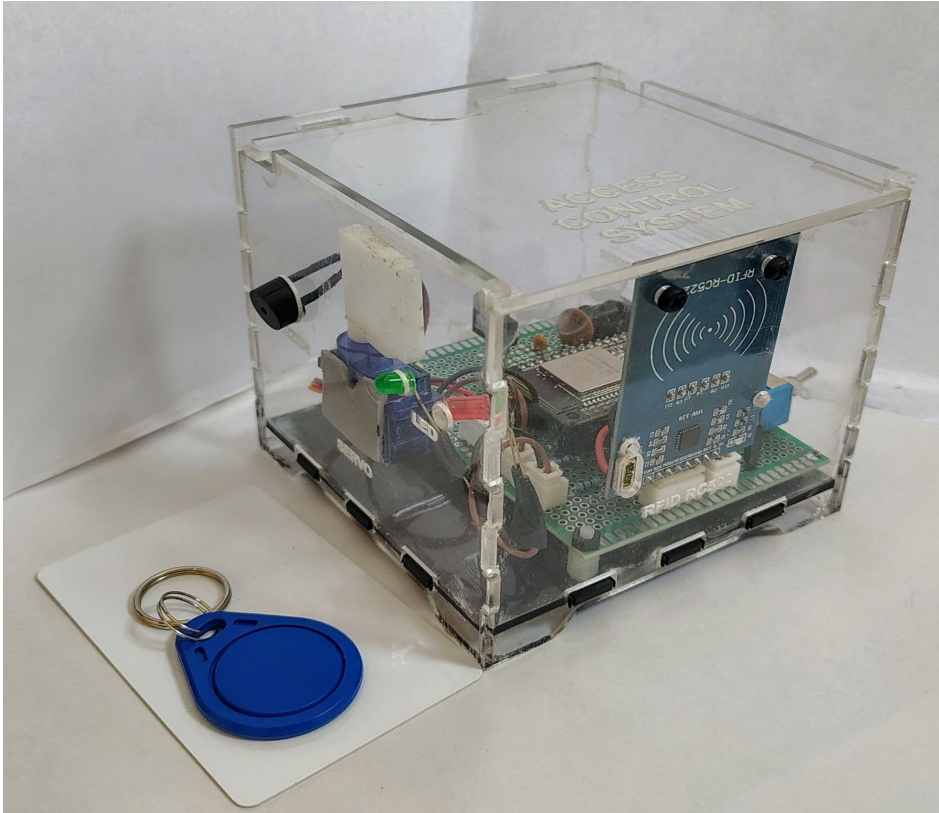
Pin Connections:

- **LM35 Temperature Sensor:** VCC→3.3V, GND→GND, Signal Out→GPIO32
- **Red LED:** Anode→GPIO12, Cathode→GND
- **Fan Relay:** VCC→3.3V, GND→GND, Signal In→GPIO14

Communication Protocols:

- **Analog Communication:** Direct voltage signal from LM35 sensor
- **Wi-Fi:** Internet connectivity for cloud data transmission
- **MQTT:** Lightweight messaging protocol for ThingsBoard communication

Access Control System



[Link to Access Control Code](#)

- Uses ESP32 with RC522 RFID Reader for secure access control
- Enhances security by allowing or denying entry based on authorized credentials. Integrates with IoT platforms to monitor access in real time and log entry data to the cloud for efficient management.

Pin Connections:

- **RC522 RFID:** VCC → 3.3V, GND → GND, SDA → SPI0 CSn, SCK → SPI0 SCK, MOSI → SPI0 RX, MISO → SPI0 TX, RST → GP10
- **Green LED:** Anode → GPIO6, Cathode → GND
- **Red LED:** Anode → GPIO7, Cathode → GND
- **Servo Motor:** VCC → 3.3V, GND → GND, PWM → GPIO9
- **Buzzer:** Positive (+) → GPIO8, Negative (-) → GND

Communication Protocols:

- **SPI Protocol:** Sensor data communication between RC522 RFID and ESP32
- **Wi-Fi:** Internet connectivity for cloud data transmission
- **MQTT:** Lightweight messaging protocol for ThingsBoard server communication

Experiments

1. Flash the given code onto the nodes and display the sensor data on both the Serial Monitor and ThingsBoard.
2. Modify the actuator triggering pattern and observe the response.



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