Project Report: Smart Sensor System with RFID and IoT Integration

1. Introduction

This project integrates various sensors and modules to create a smart system capable of monitoring environmental data and controlling access using RFID cards. The system uses an ESP8266 Wi-Fi module to send data to the ThingSpeak IoT platform, allowing real-time monitoring of temperature, humidity, gas concentration, light intensity, and motion detection.

The project also incorporates RFID technology to manage access control. A servo motor acts as a physical barrier (e.g., door lock), opening only when an authorized RFID card is detected.

2. Hardware Components

The following hardware components are used in this project:

2.1. Microcontroller

- Arduino Uno: Manages sensor data collection, RFID card detection, and communication with the ESP8266 module.

2.2. Sensors and Modules

- DHT11 Sensor:
  - Measures temperature and humidity.
  - Digital pin connection: D3.
- MQ2 Gas Sensor:
  - Detects gases such as LPG, CO, methane, and smoke.
  - Analog pin connection: A0.
- LDR (Light-Dependent Resistor):
  - Measures light intensity.

  - Analog pin connection: A0.

- PIR Motion Sensor:

  - Detects motion.

  - Digital pin connection: D2.

- RFID Module (MFRC522):

  - Detects RFID cards and retrieves their unique IDs.

  - Pin connections:

    - SDA: D10

    - RST: D9

    - MOSI: D11

    - MISO: D12

    - SCK: D13

- Servo Motor:

  - Controls a physical barrier (e.g., door lock).

  - Digital pin connection: D5.

2.3. Communication Module

- ESP8266 Wi-Fi Module:

  - Sends sensor data to ThingSpeak.

  - Pin connections:

    - TX: D7

    - RX: D6

2.4. Power Supply

- The Arduino Uno is powered via USB or an external 5V power source.

- The RFID module and sensors are powered by the 3.3V and 5V pins of the Arduino.

3. Circuit Connections

The following table summarizes the pin connections:

Component	Pin on Module	Pin on Arduino
RFID (SDA)	SDA	D10
RFID (RST)	RST	D9
RFID (MOSI)	MOSI	D11
RFID (MISO)	MISO	D12
RFID (SCK)	SCK	D13
DHT11 (Data)	DATA	D3
MQ2 Sensor (Analog)	A0	A0
PIR Motion Sensor	OUT	D2
LDR Sensor	Analog Out	A0
Servo Motor	PWM	D5
ESP8266 (TX)	TX	D7
ESP8266 (RX)	RX	D6

4. Software Implementation

The software is implemented using the Arduino IDE. The key functionalities include:

4.1. Sensor Data Collection

- The DHT11 sensor measures temperature and humidity.

- The MQ2 sensor provides a raw analog value indicating gas concentration.

- The LDR measures light intensity as a raw analog value.

- The PIR sensor detects motion and returns a binary value (HIGH/LOW).

4.2. RFID Card Detection

- The RFID module reads the unique ID of nearby RFID cards.

- If the card ID matches a predefined authorized ID, the servo motor unlocks the door.

4.3. Data Transmission to ThingSpeak

- The ESP8266 module sends collected data to ThingSpeak using HTTP GET requests.

- The data is displayed on ThingSpeak's dashboard in real time.

4.4. Code Structure

- Setup Phase: Initializes sensors, RFID module, servo motor, and ESP8266 Wi-Fi module.

- Loop Phase: Continuously reads sensor values, checks RFID cards, and sends data to ThingSpeak.

5. Workflow

1. The system powers on and connects to the specified Wi-Fi network.

2. Sensors collect data, which is processed and sent to ThingSpeak every 20 seconds.

3. The RFID module monitors for card activity:

   - If an authorized card is detected, the servo motor unlocks the door for 3 seconds.

   - Unauthorized cards trigger a warning message on the serial monitor.

6. Results

The system successfully:

- Monitors temperature, humidity, gas levels, light intensity, and motion.

- Logs real-time data on the ThingSpeak IoT platform.

- Controls access using RFID technology.

7. Conclusion and Future Work

This project demonstrates a practical application of IoT and sensor integration. Future improvements could include:

- Adding a mobile app for real-time alerts.

- Enhancing security by implementing encrypted communication.

- Expanding the system to support multiple RFID cards.

8. References

- Arduino Documentation

- ThingSpeak API Documentation

- MFRC522 RFID Library

Appendices

A. Schematic Diagram

(A diagram can be included here if available.)

B. Source Code

(The full source code can be included here if necessary.)