IoT Project: LED Control via MQTT, Temperature Monitoring, and IoT Gateway with Node-RED

M. Masuod

June 8, 2024

Abstract

This report outlines the implementation of three interconnected IoT projects using a Raspberry Pi: controlling LEDs via MQTT, monitoring temperature with a DHT sensor, and integrating various IoT devices through an IoT gateway using Node-RED. Detailed steps for setting up the hardware and software, deploying Node-RED flows, and visualizing data using Grafana are provided. The project successfully demonstrates efficient IoT solutions with real-time data monitoring and control capabilities.

1 Introduction

The Internet of Things (IoT) has revolutionized how devices communicate and operate autonomously. This report details three completed projects that leverage the capabilities of a Raspberry Pi, Node-RED, and MQTT protocol to demonstrate efficient IoT solutions. The projects include:

- LED control via MQTT

- Temperature monitoring with a DHT sensor

- IoT gateway integration using Node-RED

These projects collectively form a robust framework for real-time monitoring and control of IoT devices.

2 Prerequisites

2.1 Hardware

The hardware components used in this project include:

- Raspberry Pi

- LED and resistor

- DHT11 or DHT22 temperature sensor

- Additional motion sensors (for the IoT gateway)

2.2   Software

The software stack includes:

- Raspberry Pi OS

- Node-RED

- Mosquitto MQTT broker

- InfluxDB

- Grafana

- Python 3

- Node-RED nodes for dashboard and MQTT

3   Setup Instructions

3.1   Raspberry Pi Initialization

To set up the Raspberry Pi, follow these steps:

1. Install Raspberry Pi OS on a microSD card.

2. Boot the Raspberry Pi and complete the initial setup.

3. Update the system:

   ```
   sudo apt update
   sudo apt upgrade
   ```

3.2   Software Installation

3.2.1   Mosquitto MQTT Broker

Install and set up the Mosquitto MQTT broker:

```
sudo apt install mosquitto mosquitto-clients
sudo systemctl enable mosquitto
sudo systemctl start mosquitto
```

3.2.2   Node-RED

Install Node-RED using the setup script:

```
bash <(curl -sL https://nodered.org/setup.sh)
```

3.2.3 InfluxDB

Install and configure InfluxDB:

```
sudo apt install influxdb
sudo systemctl enable influxdb
sudo systemctl start influxdb
```

3.2.4 Grafana

Integrate Grafana using Grafana Cloud Server and Prometheus credentials for advanced data visualization.

3.2.5 Python 3

Install Python 3 and pip:

```
sudo apt install python3 python3-pip
```

4 Node-RED Flow Deployment

Node-RED facilitates intuitive flow-based programming for IoT applications. The following sections detail the deployment of Node-RED flows for the three projects.

4.1 LED Control via MQTT

To control the LED via MQTT:

1. Connect the LED and resistor to GPIO21 of the Raspberry Pi.

2. Open Node-RED and create a new flow.

3. Add an MQTT input node configured to subscribe to the `led/control` topic.

4. Add a switch node to control the LED based on the received MQTT messages.

5. Deploy the flow.

4.2 Temperature Monitoring with DHT Sensor

To monitor temperature using a DHT sensor:

1. Connect the DHT sensor to the Raspberry Pi.

2. Add a Python script to read data from the DHT sensor and publish it to an MQTT topic.

3. In Node-RED, add an MQTT input node to subscribe to the temperature topic.

4. Add a function node to process the temperature data.

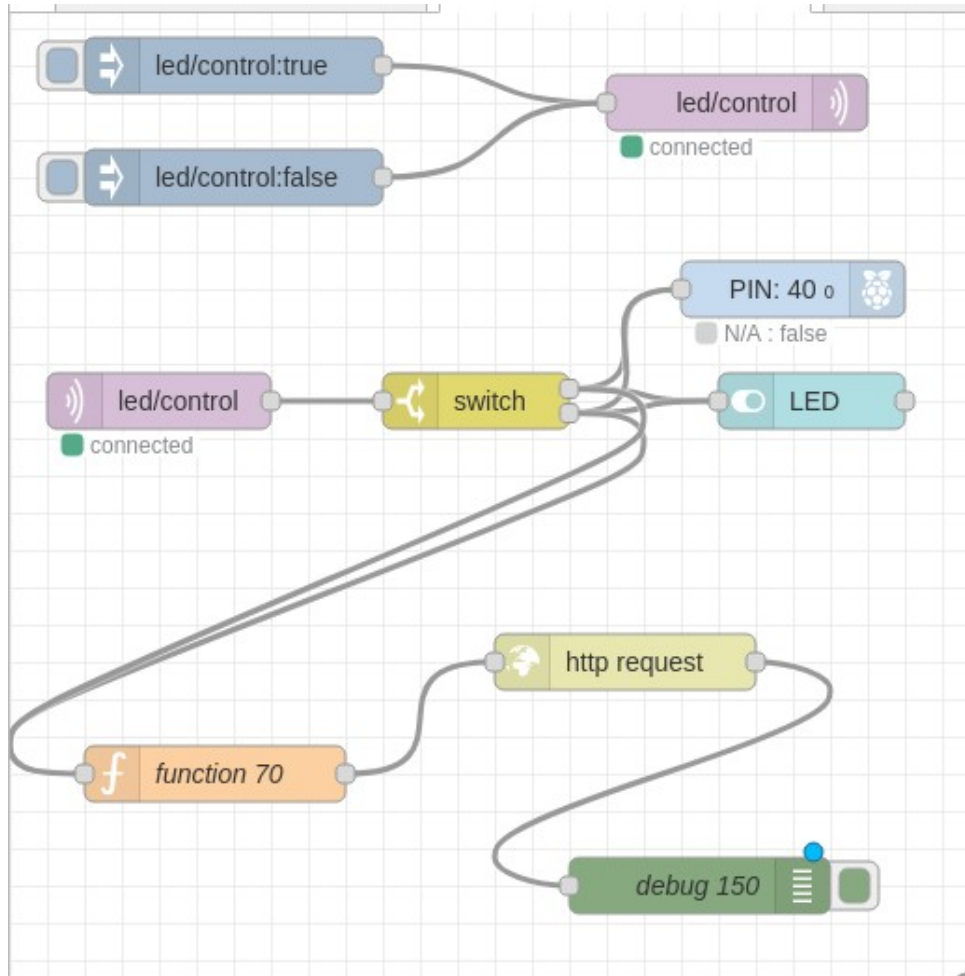5. Deploy the flow and visualize the data on the Node-RED dashboard.

Figure 1: Node-RED Flow for LED Control

4.3 IoT Gateway with Node-RED

To integrate various IoT devices through Node-RED:

1. Integrate the LED control and temperature monitoring flows.

2. Add motion sensors to the setup.

3. Create flows to manage data from multiple sensors and publish to the MQTT broker.

4. Deploy the integrated flow.

5 Data Visualization with Grafana

5.1 Sending Data from Node-RED to Grafana

To visualize data using Grafana:

1. Configure Node-RED to send data to InfluxDB.

2. Install and configure the HTTP request node for Prometheus integration.

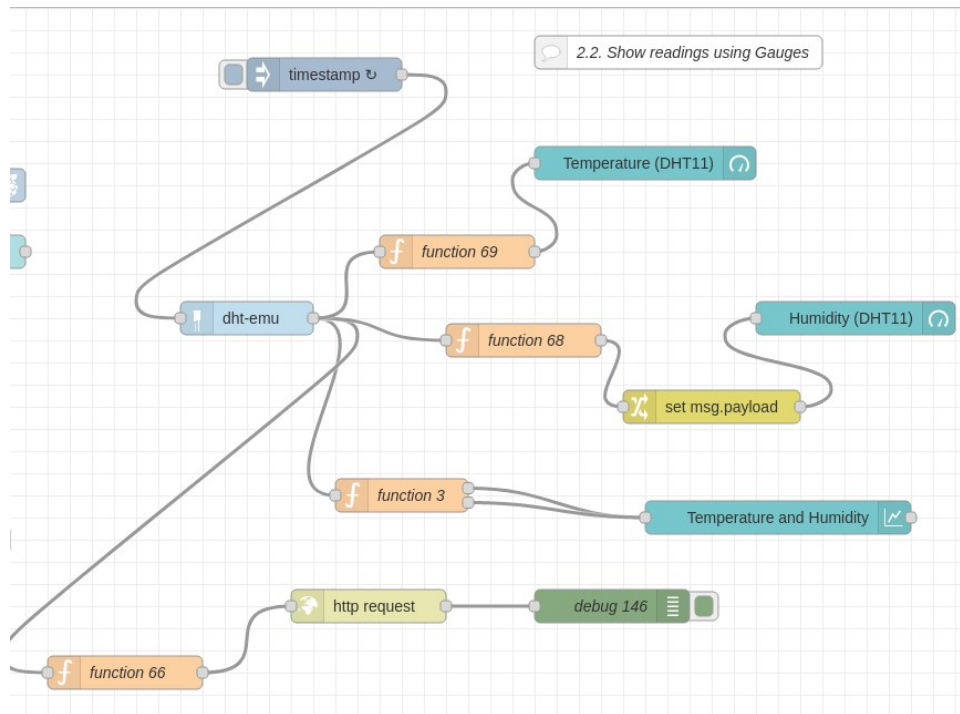3. Ensure data is properly formatted and sent to Grafana.

Figure 2: Node-RED Flow for Temperature Monitoring

5.2 Creating Grafana Dashboards

To create dashboards in Grafana:

1. Open Grafana and create a new dashboard.

2. Add a new panel and configure it to visualize data from InfluxDB.

3. Use different graph types to display temperature data from the DHT sensor.

4. Save and deploy the dashboard.

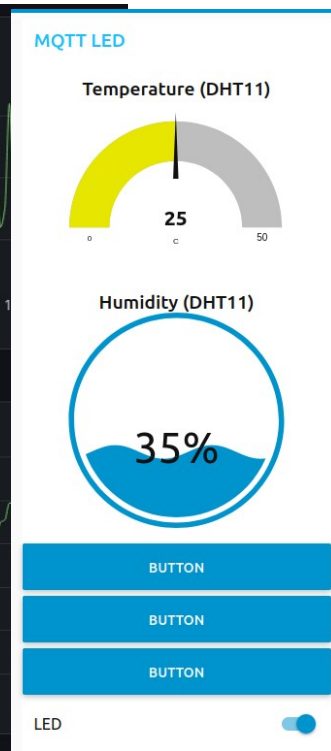Figure 3: Grafana Dashboard for Temperature Monitoring

Figure 4: NodeRED Dashboard for Humidity Monitoring

6 Conclusion and Future Work

This report demonstrates the successful implementation of LED control, temperature monitoring, and IoT gateway integration using a Raspberry Pi and Node-RED. The project effectively showcased real-time monitoring and control capabilities of IoT devices.

Future work can include expanding the sensor network, implementing advanced data analytics, and enhancing the user interface for better interaction with IoT devices.