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Embedded Systems

Introduction

The proposed Weather Prediction System aims to provide accurate and timely weather forecasts by integrating several technological components. The system will consist of:

1. an MQTT broker
2. a telemetry server with a PostgreSQL database
3. a dashboard for data visualisation
4. a Random Forest model for predicting rainfall

This comprehensive approach enables efficient data collection, storage, visualization, and prediction, which can be utilized for various applications such as agriculture, event planning, and emergency preparedness.

Objectives

1. Collect and store weather-related telemetry data, including temperature, humidity, wind speed, and rainfall, in a PostgreSQL database.
2. Develop a dashboard that provides users with real-time and historical weather data, allowing for flexible viewing across different timeframes.
3. Implement a Random Forest model to predict rainfall for the next day based on the mean metrics of the current day.
4. Integrate an MQTT broker to enable real-time communication between weather sensors, the telemetry server, and the dashboard.

System Components

1. MQTT Broker
    a. A lightweight messaging system that facilitates communication between weather sensors and the telemetry server. It ensures efficient data transfer and supports scalability for additional sensors in the future.
2. Telemetry Server
    a. A server that collects data from weather sensors via MQTT, processes the data, and stores it in a PostgreSQL database. This server will also handle data preparation for the prediction model.
3. PostgreSQL Database
    a. A robust relational database to store and manage weather-related data. The database will support queries for data analysis and visualization on the dashboard.
4. Dashboard
    a. A user interface that allows users to view real-time and historical weather data. The dashboard will offer customizable timeframes and data visualizations such as graphs and charts.
5. Random Forest Model
    a. A machine learning model used to predict rainfall based on the day's mean metrics. This model provides robust predictions and handles complex relationships in the data.

Project Scope

The Weather Prediction System will cover the following areas:

1. Data collection from weather sensors.
2. Storage of collected data in a PostgreSQL database.
3. Real-time and historical data visualization via a dashboard.
4. Rainfall prediction using a Random Forest model.
5. Integration with an MQTT broker for seamless communication.

Cons

While the Weather Prediction System offers significant benefits, there are some drawbacks to consider:

1. Complexity
    a. Integrating multiple components requires careful planning and coordination. The complexity may lead to longer development times and increased risk of integration issues.
2. Resource Requirements
    a. The system may require significant computational resources, especially for training and running the Random Forest model.
3. Data Quality
    a. The accuracy of the prediction model depends on the quality of the collected data. Inconsistent or inaccurate sensor data could impact the reliability of the predictions.
4. Scalability Challenges
    a. As the number of weather sensors and the volume of data increase, the system's scalability must be carefully managed to avoid performance bottlenecks.
5. Maintenance
    a. Maintaining the system, including the MQTT broker, telemetry server, database, and dashboard, requires ongoing effort and technical expertise.

Conclusion

The proposed Weather Prediction System offers a comprehensive solution for collecting, storing, visualizing, and predicting weather data. By addressing the cons and mitigating risks through careful planning, the system can provide valuable insights for various applications.