IoT Project: Log Data from Your Bike Rides

Real-Time Remote Bike Ride Monitoring Using a Sustainable IoT System and Integrated Android App

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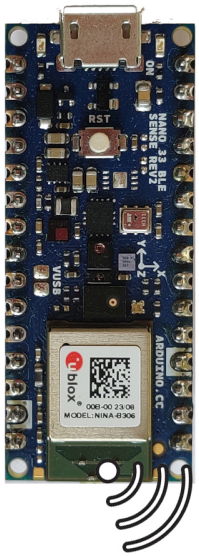
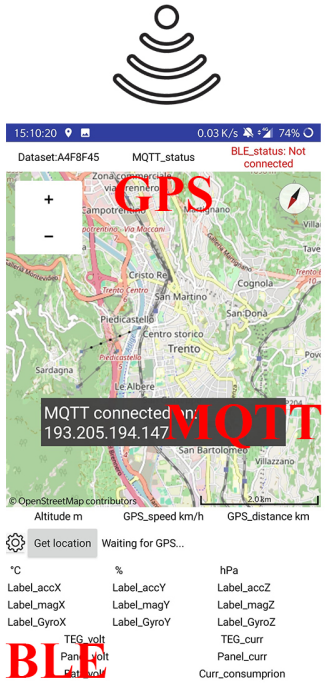
Project Overview

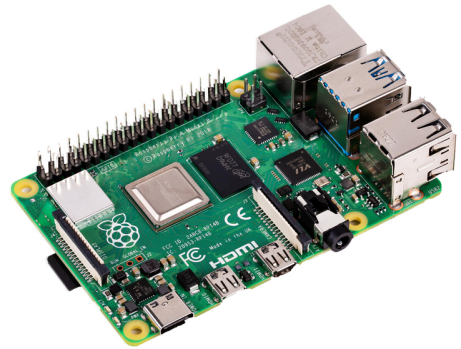
- This project presents a sustainable IoT system for real-time bike ride monitoring, optimizing energy consumption and simplifying design.
- **Key Changes:**
  - **Energy Efficiency:** Removed GPS module to reduce power consumption.
  - **Energy Harvesting:** Uses only Thermoelectric Generators (TEGs), eliminating solar panels.
- A custom Android app collects data via Bluetooth Low Energy (BLE) and integrates it with smartphone GPS.
- Collected data is transmitted to an MQTT server, stored in InfluxDB, and visualized using Grafana for real-time monitoring.

System Architecture

- **Components:**
  - Arduino Nano 33 BLE Sense Rev2
  - Raspberry Pi 4 for data storage (InfluxDB, Grafana)
  - Android smartphone with RideSyncIoT app
- **Communication:**
  - Bluetooth Low Energy (BLE) for data transmission
  - MQTT for data upload to the cloud







Grafana

telegraf → influxdb

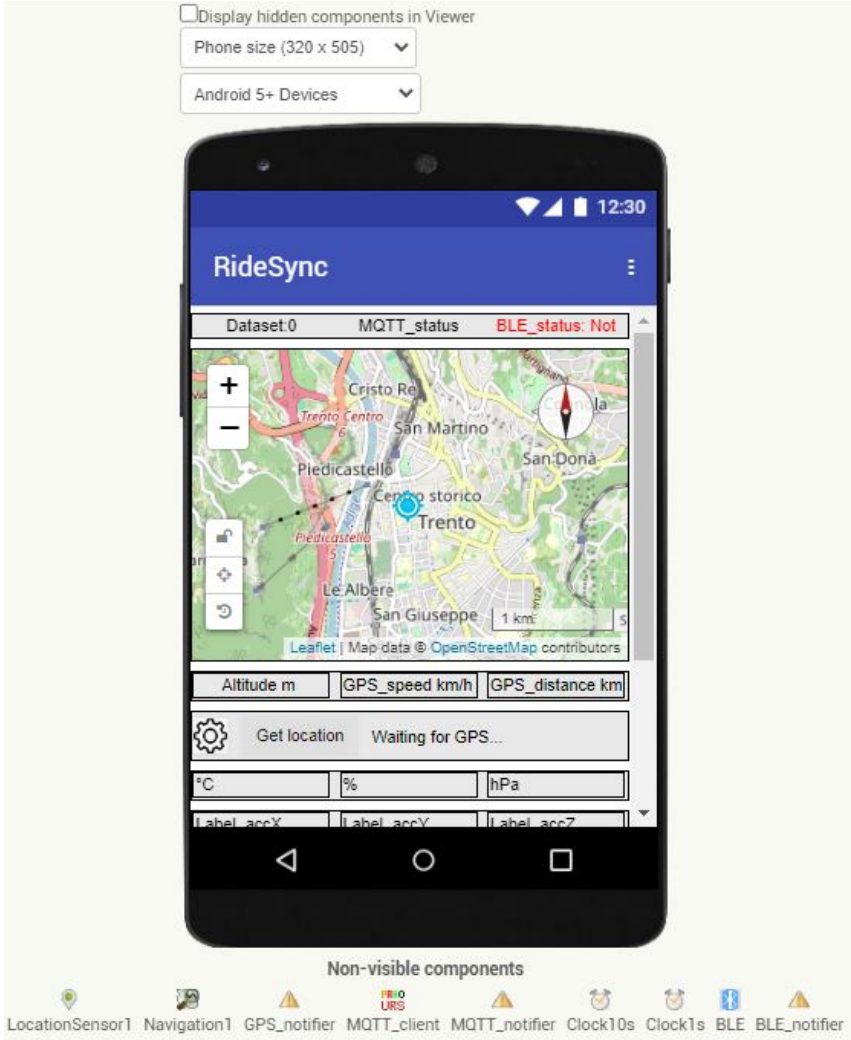
MQTT

Data Collection

- **Sensors and Data Types:**
  - **IMU (BMI270 and BMM150):** Tracks acceleration, angular velocity, and magnetic heading for real-time motion and orientation.
  - **Temperature and Humidity (HS3003):** Measures environmental conditions, crucial for evaluating energy harvesting efficiency.
  - **Barometric Pressure (LPS22HB):** Monitors altitude changes, valuable for hilly terrain.
- **Data Transmission and Simulation:**
  - BLE services and characteristics created using `ArduinoBLE.h` for efficient, reliable data transmission.
  - Simulated power consumption/harvesting data to mimic energy management system (future TEG integration).
- **Data Transmission Intervals:** Optimized for power savings:
  - IMU data: every 2 seconds.
  - Environmental data: every 20 seconds.
  - Simulated power data: every 1 second.

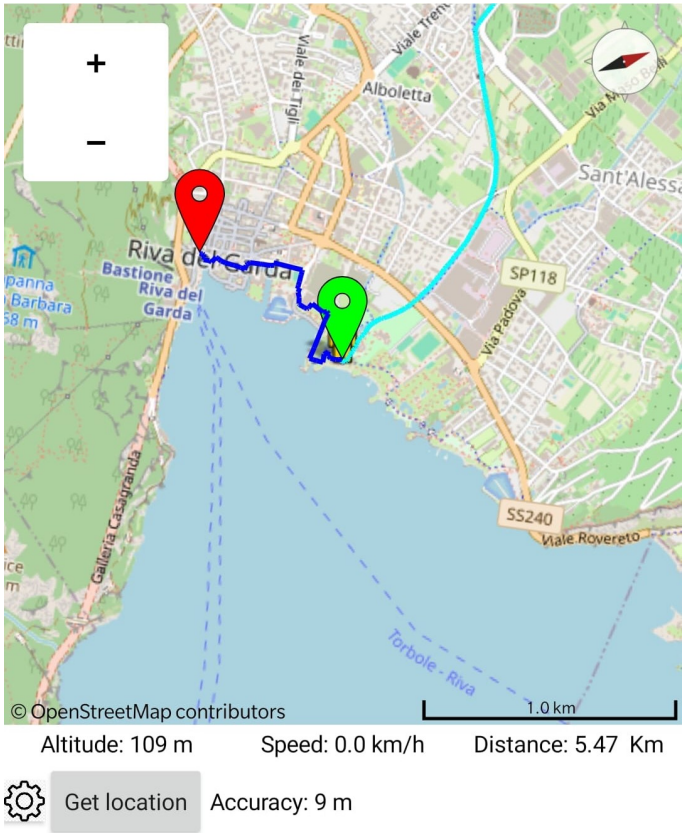
RideSyncIoT App

- **Key Functions:**
  - **Bluetooth Connection:** Maintains a seamless BLE connection to receive data from the Arduino.
  - **GPS Data Collection:** Uses the smartphone's GPS to log real-time location data.
  - **MQTT Publishing:** Sends both sensor and GPS data via MQTT.
- **User Interface:** An interactive map displays real-time GPS and sensor data, ensuring a user-friendly experience while processes run in the background.



Navigation with OpenRouteService

- **Navigation and Route Guidance:**
  - Set a destination by long-pressing on a Point of Interest (POI) within the map.
  - The app calculates and displays the optimal route using the OpenRouteService (ORS) API.
  - Provides turn-by-turn directions, estimated distance, and alternative routes.



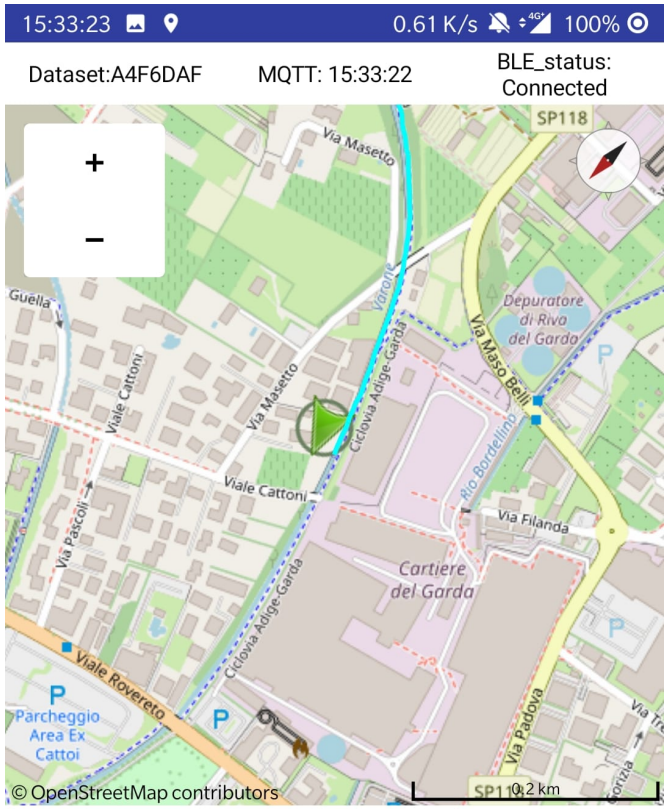
Raspberry Pi Configuration

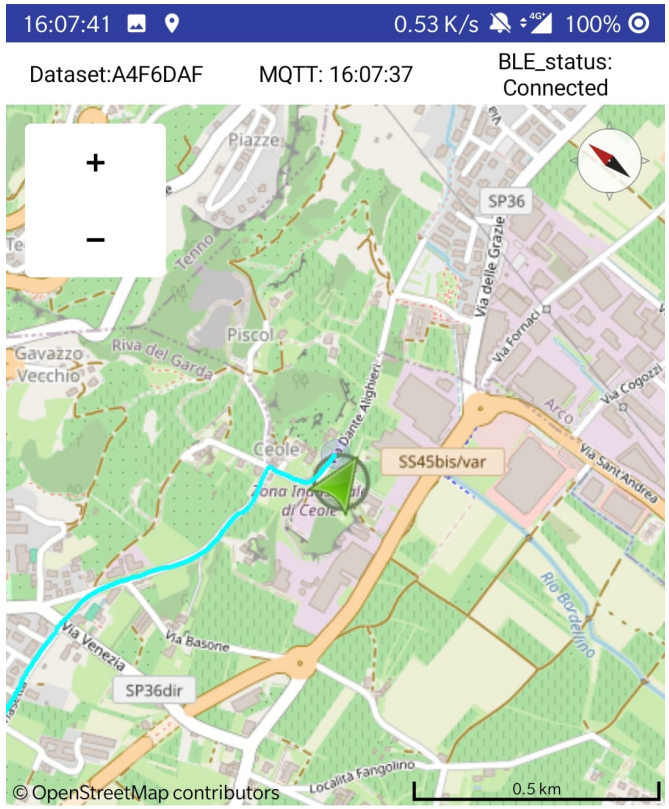
- **Data Storage and Management:**
  - InfluxDB: Time-series database for efficient IoT data storage.
  - Telegraf: Collects MQTT data and forwards it to InfluxDB.
- **Data Flow:**
  - MQTT messages from RideSyncIoT are ingested by Telegraf.
  - Data is stored in InfluxDB on the Raspberry Pi 4.
  - Real-time analysis and monitoring are done using Grafana.

Bike Setup and App Testing

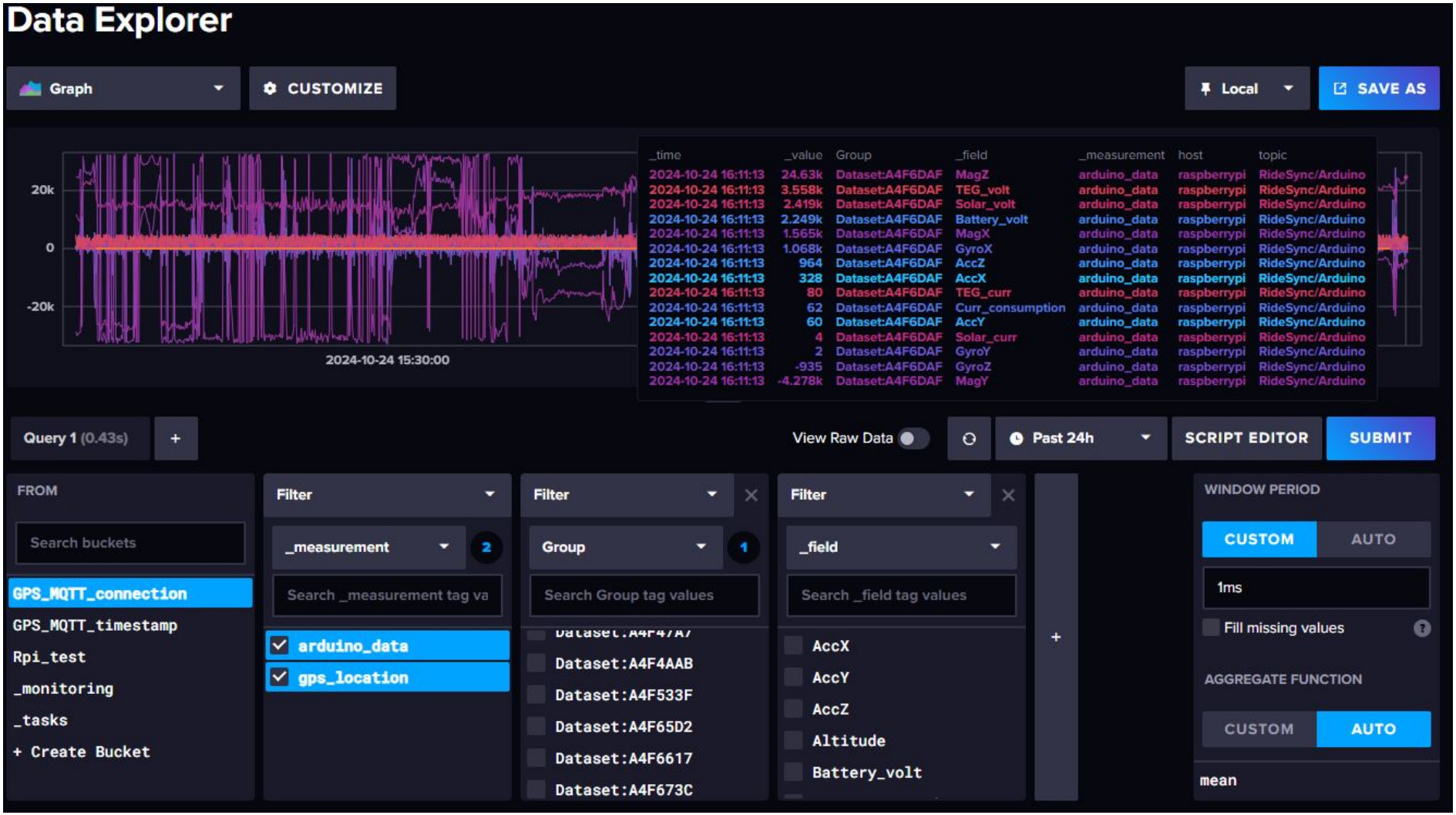
- **Setup:**
  - Smartphone mounted on bike using a holder.
  - Arduino Nano 33 BLE Sense Rev2 on the handlebar.
  - Powered by a portable power bank.
- **Testing Focus:**
  - Stability of IoT system.
  - Reliability of BLE and MQTT connections.
- **Testing Criteria:**
  - Data visualization accuracy.
  - GPS data accuracy.
  - Configuration functionality.
  - Navigation directions using OpenRouteService.
  - Connection stability and error handling.

RideSyncIoT App



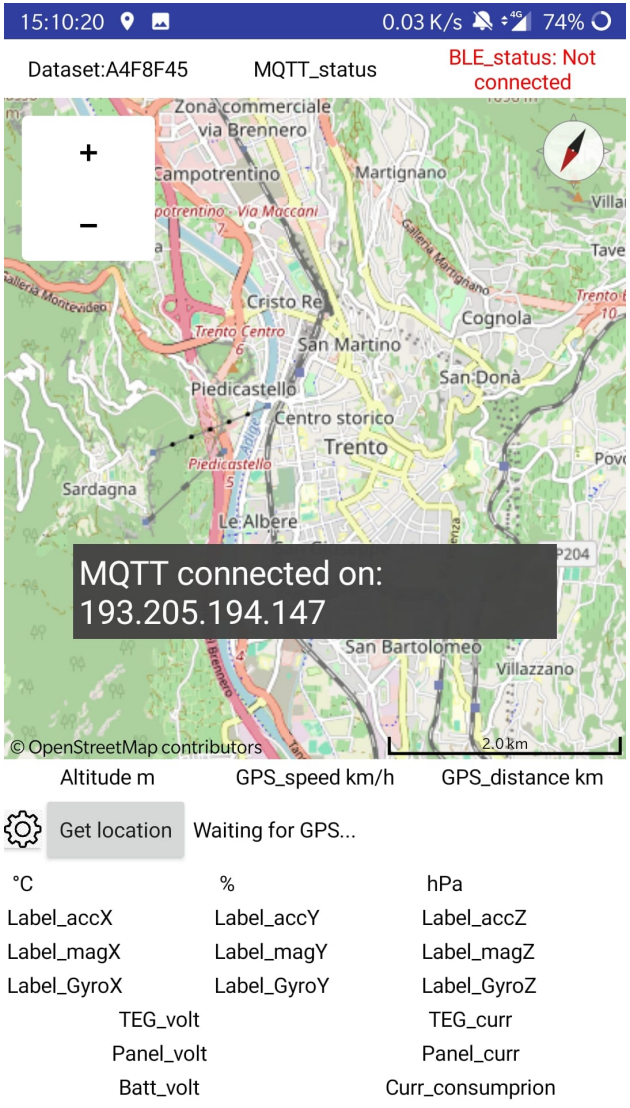


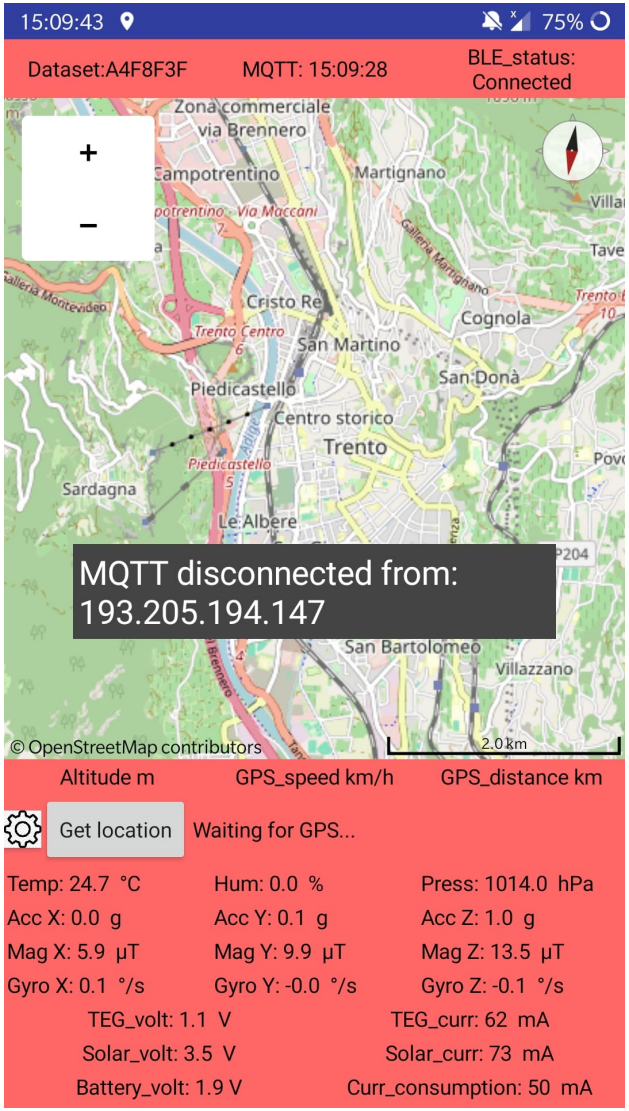
InfluxDB Data Explorer



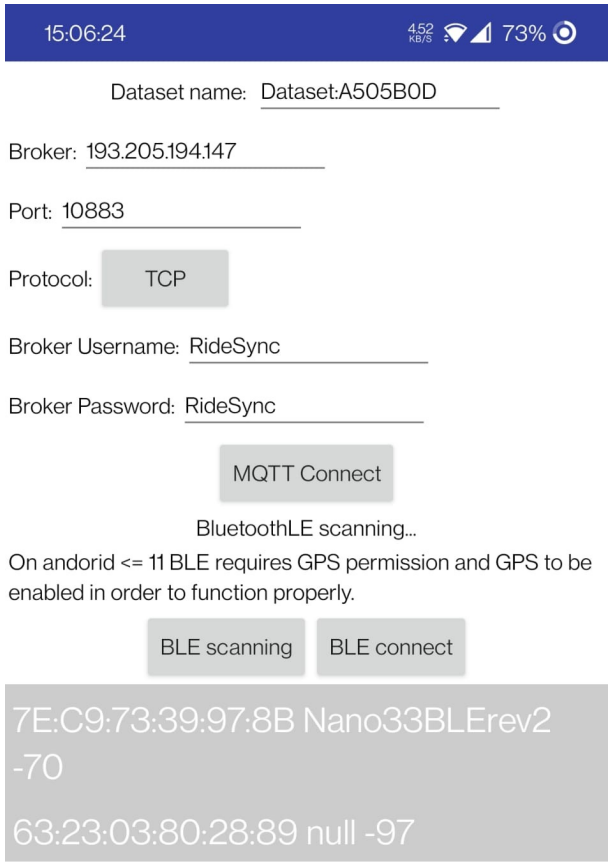
Grafana Dashboard

Error Handling Capabilities





RideSyncIoT Configuration Screen



- **MQTT Broker Parameters:**
  - Specify IP address, port, and protocol settings.
- **Bluetooth Device Selection:**
  - Scan and connect to available Bluetooth devices.
- **Dataset Configuration:**
  - Create and manage unique dataset identifiers for InfluxDB.

Future Work

- Focus on advancements in energy harvesting:
  - Optimization of thermoelectric generator module.
  - In-depth evaluation of energy consumption metrics.
- Continuous monitoring of energy harvesting efficiency to enhance autonomous performance.
- Explore further applications in sports monitoring and rider localization to improve performance tracking.

Conclusion

- The RideSyncIoT system effectively collects, transfers, stores, and visualizes bike ride data.
- Significant energy reduction: 80% compared to previous models by integrating smartphone GPS.
- Potential applications in:
  - Sports analytics: Real-time performance data.
  - Downhill and urban contexts: IoT connectivity for improved safety and monitoring.
- Successful testing confirmed stability and accuracy in data visualization and error handling.