GPS Position Tracking and Data Visualization Using IoT Technologies : BestPos

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1. Introduction

The goal of this project is to design and implement an IoT-based positioning system that collects geographic location data, improves its accuracy using signal processing techniques, and visualizes the results in real time.

The system combines **mobile GPS data**, **edge processing using an ESP32**, and **cloud-based data storage and visualization**. The main challenge addressed in this work is improving the reliability of GPS positioning, especially in environments where signal quality may fluctuate.

2. System Architecture

The system is composed of five main components:

1. **Mobile Device (Phone)**
2. **ESP32 Microcontroller**
3. **MQTT Broker (Mosquitto)**
4. **Time-Series Database (InfluxDB)**
5. **Visualization Platform (Grafana)**

2.1 Data Flow

1. The mobile phone provides raw GPS data (latitude, longitude, altitude).
2. The ESP32 receives this data and performs local processing.
3. A Kalman filter is applied to improve the accuracy of the position.
4. The filtered data is published to an MQTT broker.
5. Telegraf subscribes to MQTT topics and writes the data to InfluxDB.
6. Grafana queries the database and displays the position on a map.

3. Hardware Used

- **ESP32 development board**
- **Mobile phone with GPS and Wi-Fi**
- **Wi-Fi access point**
- **Local server (Docker-based services)**

The ESP32 was selected due to its built-in Wi-Fi capability, low power consumption, and suitability for edge computing tasks.

4. Software and Technologies

4.1 Communication

- **MQTT (Mosquitto broker)**
  Used as a lightweight and reliable communication protocol for IoT devices.

4.2 Data Collection and Processing

- **Telegraf**
  Subscribes to MQTT topics and converts incoming JSON data into InfluxDB measurements.
- **InfluxDB**
  Stores time-series data such as GPS coordinates with timestamps.

4.3 Visualization

- **Grafana**
  Used to visualize geographic positions on a map using the Geomap panel.

5. Position Accuracy Improvement

5.1 Kalman Filtering

To improve GPS accuracy, a **Kalman filter** was implemented on the ESP32.
The filter reduces noise by combining:

- Raw GPS measurements from the phone
- Environmental information inferred from nearby Wi-Fi signals

This approach helps estimate the device position more accurately between GPS updates.

5.2 Wi-Fi Assisted Estimation

The ESP32 scans nearby Wi-Fi networks and uses the average signal strength (RSSI) to dynamically adjust the Kalman filter parameters. Strong Wi-Fi signals indicate stable conditions, while weaker signals increase the filtering effect.

6. Data Format and MQTT Publishing

Filtered data is published in JSON format:


```
{
  "id": "person1",
  "lat": 35.806742,
  "lon": 10.607441,
  "alt": 99.8,
  "wifi_rssi": -54
}
```


Each message represents the estimated position at a specific time.

7. Database Design

- **Measurement:** `gps_position`
- **Tags:** `id`, `topic`, `host`
- **Fields:** `lat`, `lon`, `alt`, `wifi_rssi`

This structure allows efficient querying and real-time visualization.

8. Visualization in Grafana

Grafana connects directly to InfluxDB and uses **Flux queries** to retrieve the most recent position data. The Geomap panel is configured to display latitude and longitude as map coordinates, allowing real-time tracking of the device.

9. Results and Discussion

The system successfully:

- Collects GPS data continuously
- Improves location stability using Kalman filtering

- Stores data efficiently in a time-series database
- Displays real-time positions on a map

The results show smoother and more consistent movement compared to raw GPS data alone.

10. Conclusion

This project demonstrates how IoT technologies can be combined to build a complete positioning system, from data acquisition to visualization. Edge processing using the ESP32 reduces noise before data transmission, improving overall system performance.

Future improvements could include:

- Sensor fusion with accelerometers
- Multi-device tracking
- Power optimization for mobile use