A Graph-SLAM based Approach for RSSI Fingerprinting

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Research Project Final Presentation

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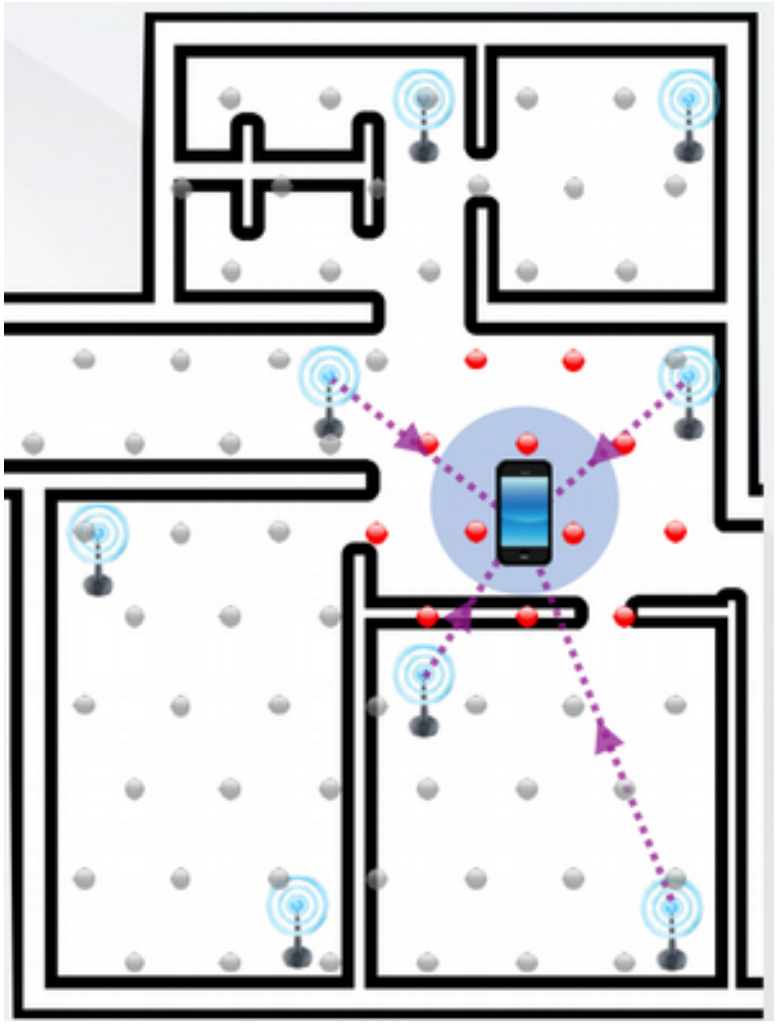
1. Problem Statement

- Indoor Positioning with Smartphone
  - Fingerprinting
    - Wi-Fi
    - Bluetooth
    - Magnetic Field
- How about the map?
- And, how to maintain this map?

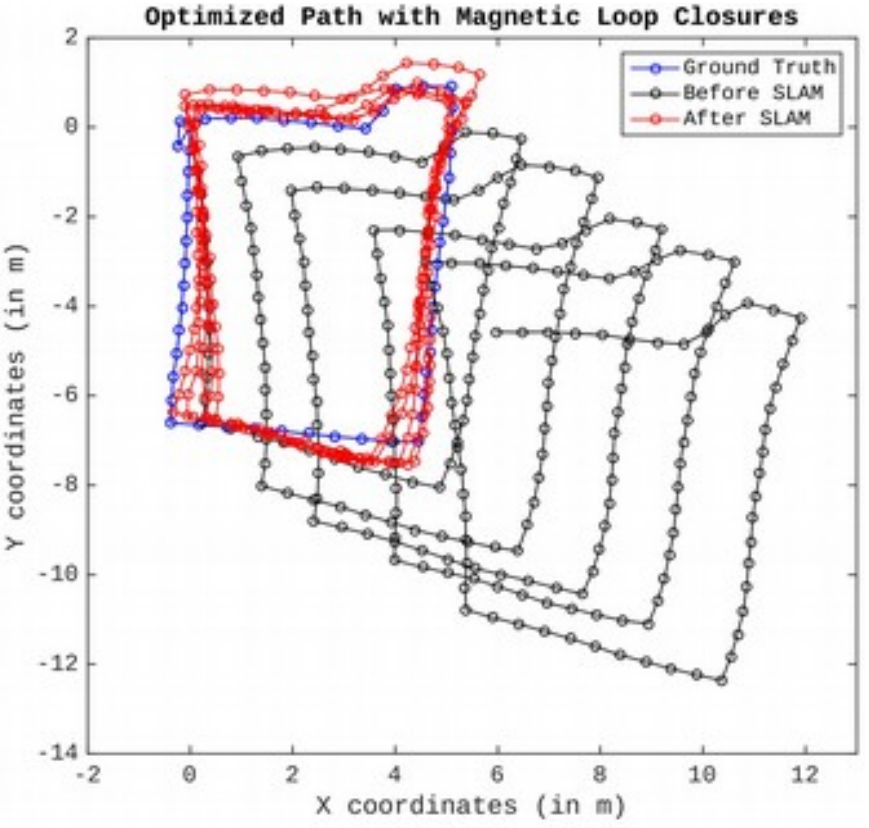


2. Research Question

- How can I build an indoor map along with the fingerprint information by using a commercial smartphone?

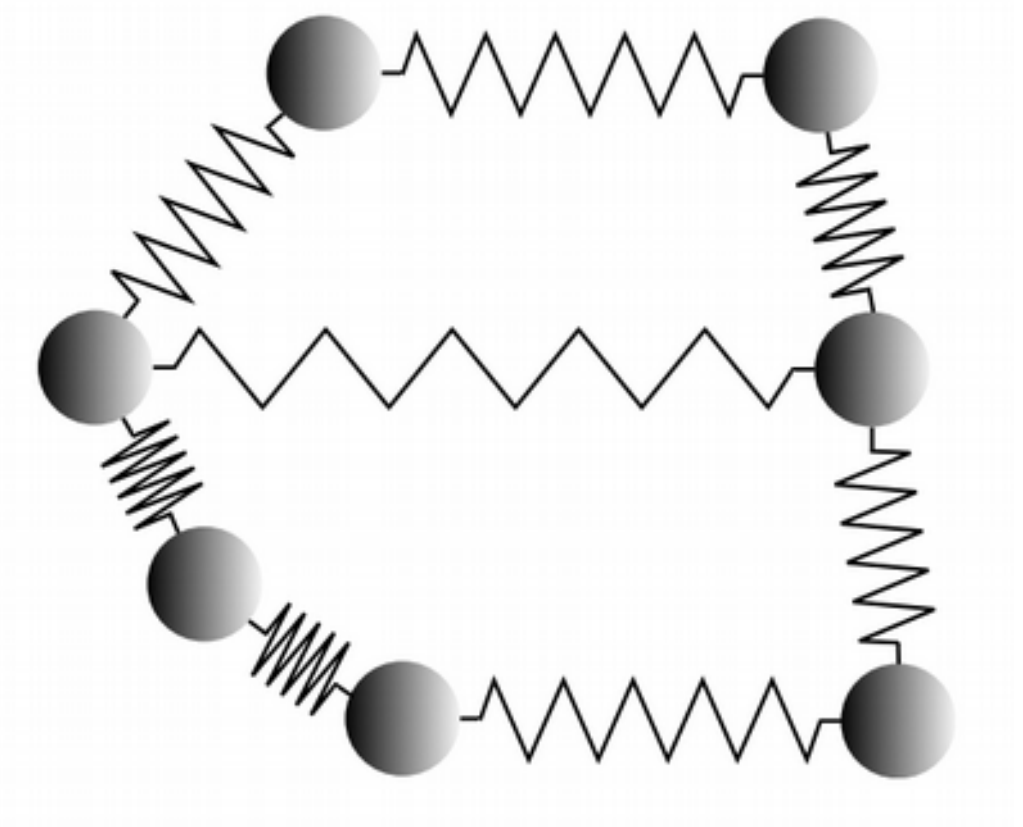
3. Research Methods

- Pedestrian Dead Reckoning (PDR)
- Graph-based Simultaneous Localization and Mapping (SLAM)
  - Loop closure detection
    - Wi-Fi
    - BLE
    - Magnetic Field



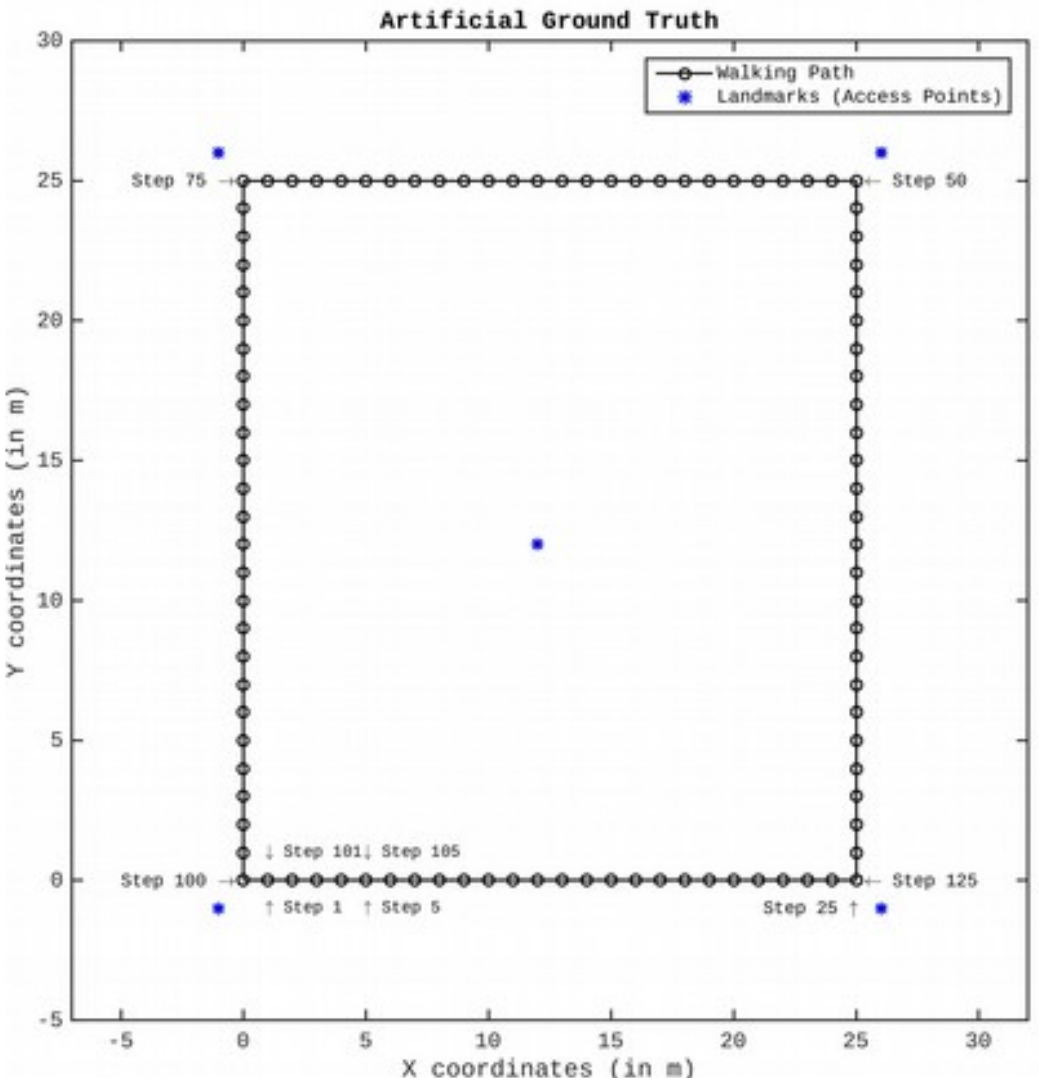
4.1. Intuitive Analogy of SLAM

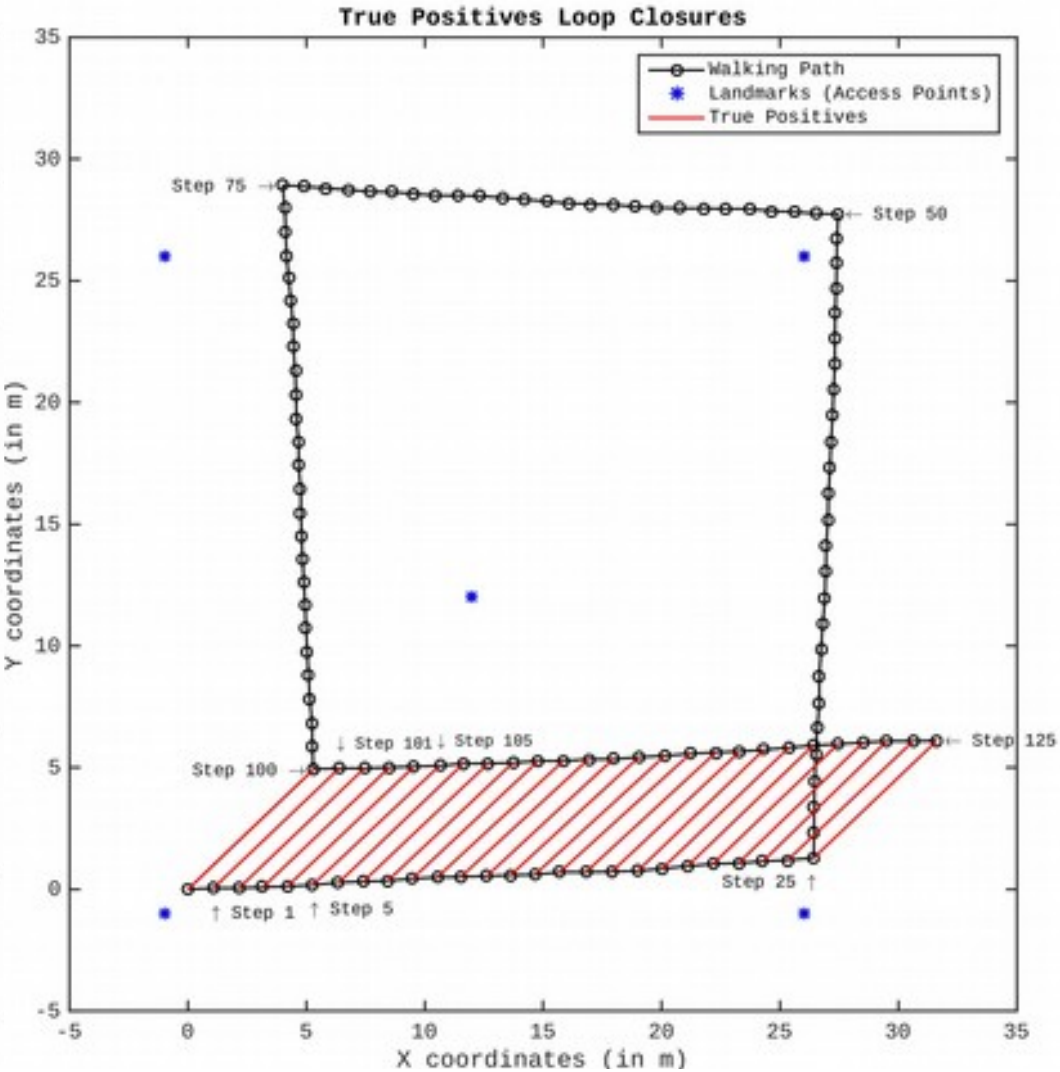
- Each ***mass*** is pose (unknown variable).
- Each ***spring*** is constraint.
- How do we get the ***minimum energy configuration***?



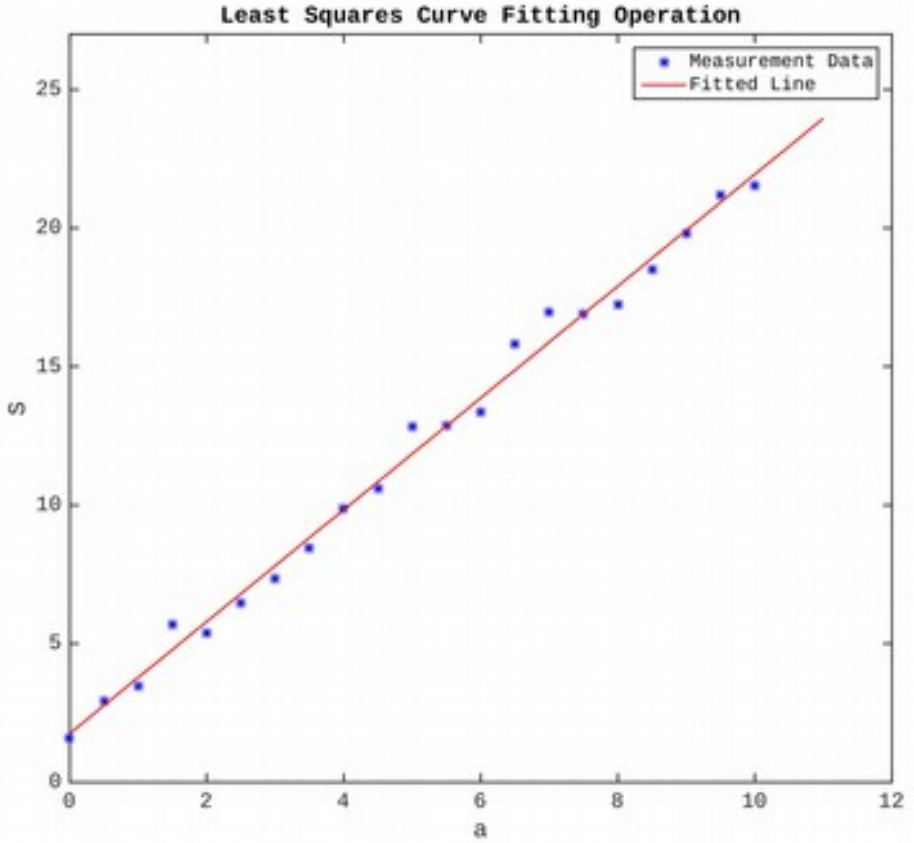
Ref. Figure-1: **[Sün12]**

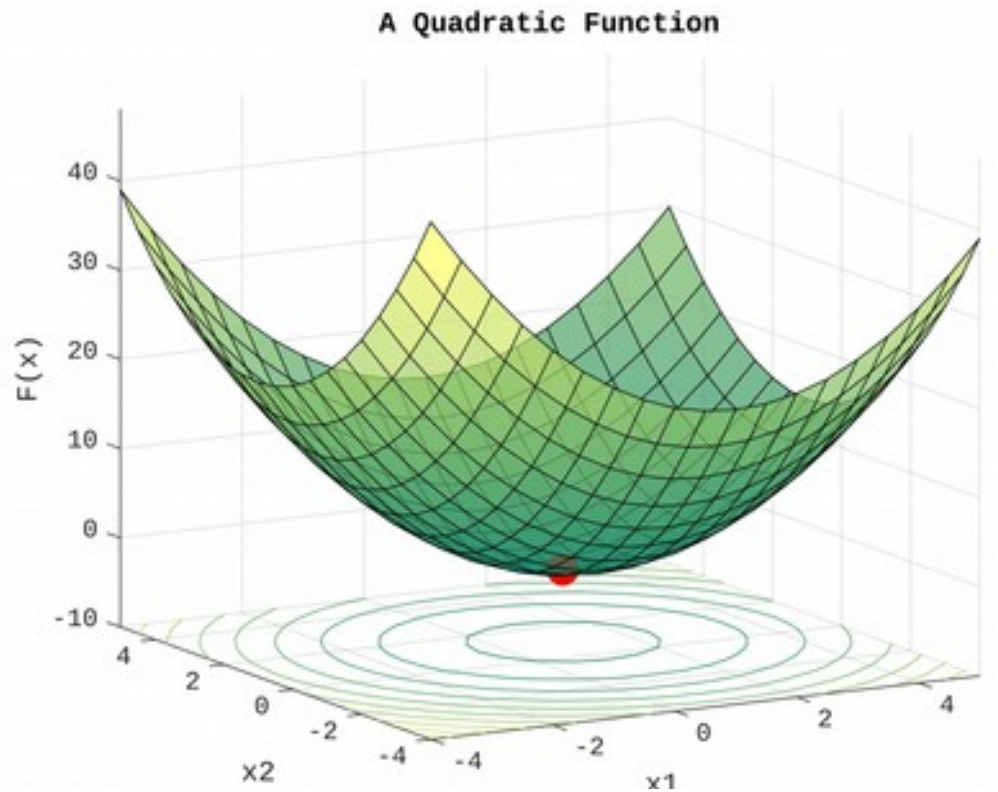
4.2. Graph SLAM





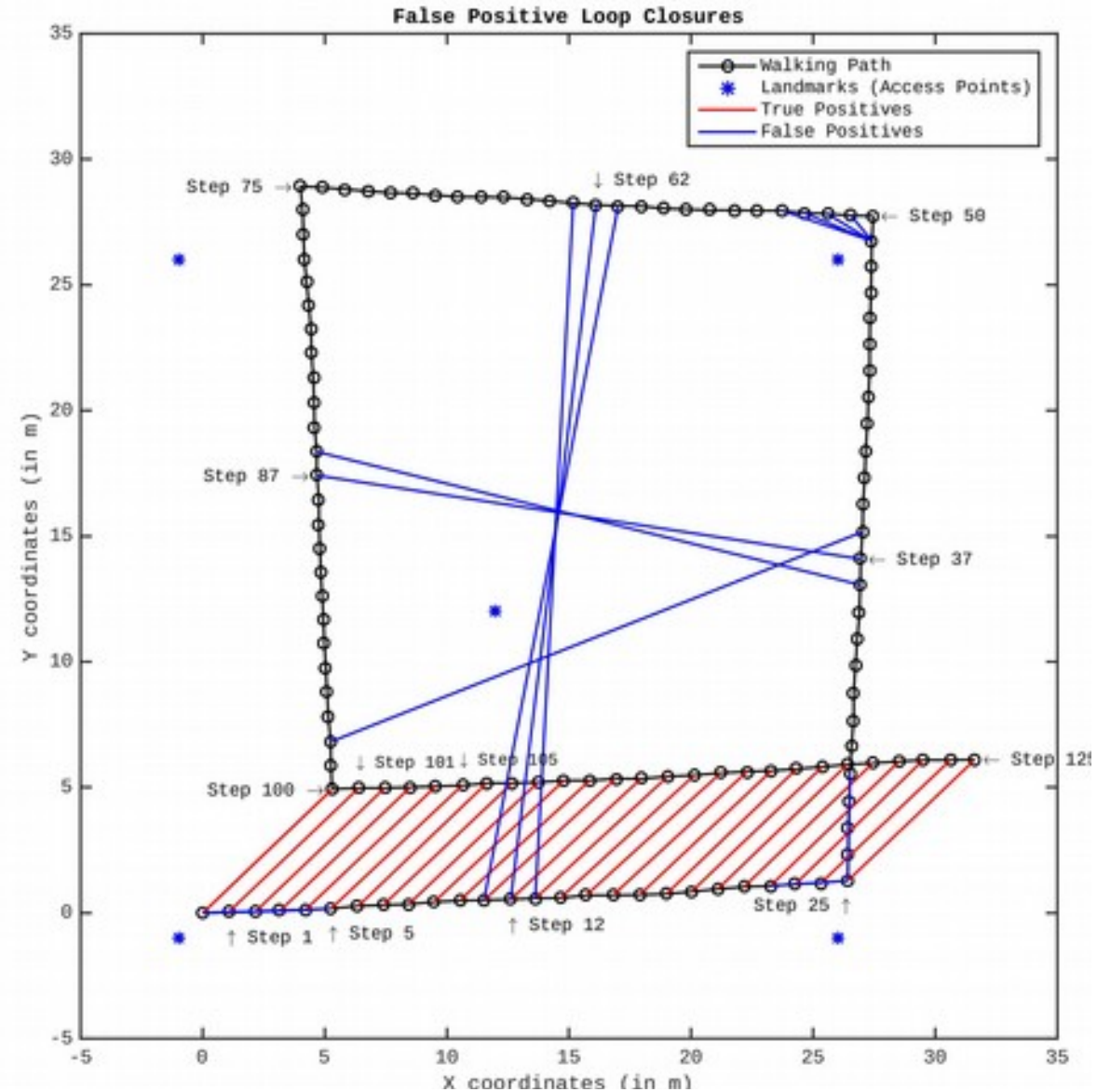
4.3. Least Squares Optimization

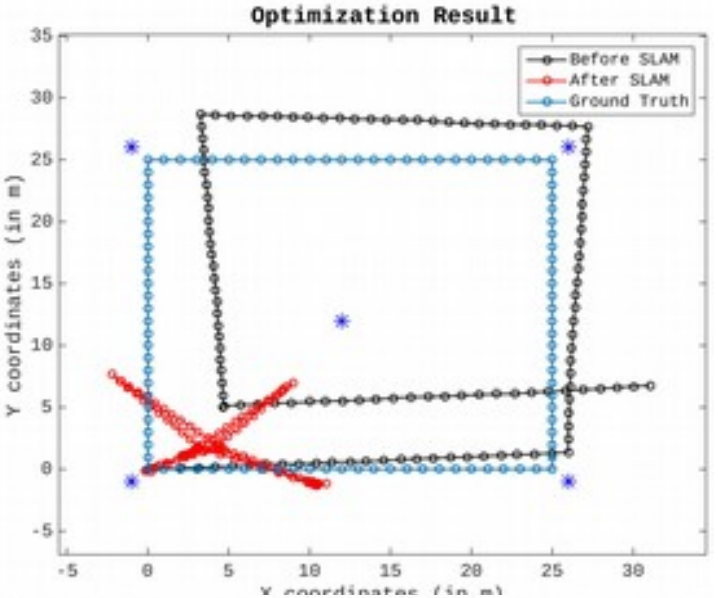


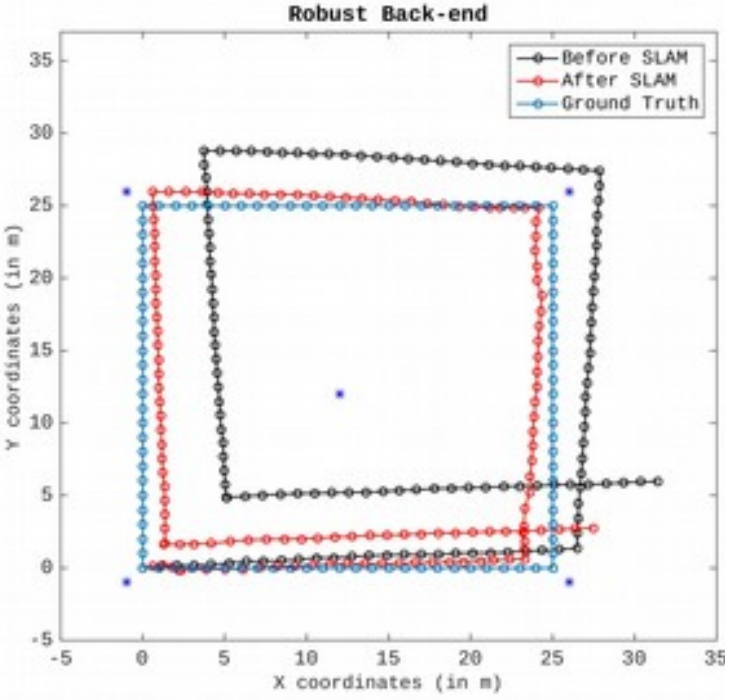


$$X^* = \arg\min_x F(x) = \sum_{i=1}^{m} (g(x; a_i) - S_i)^2$$

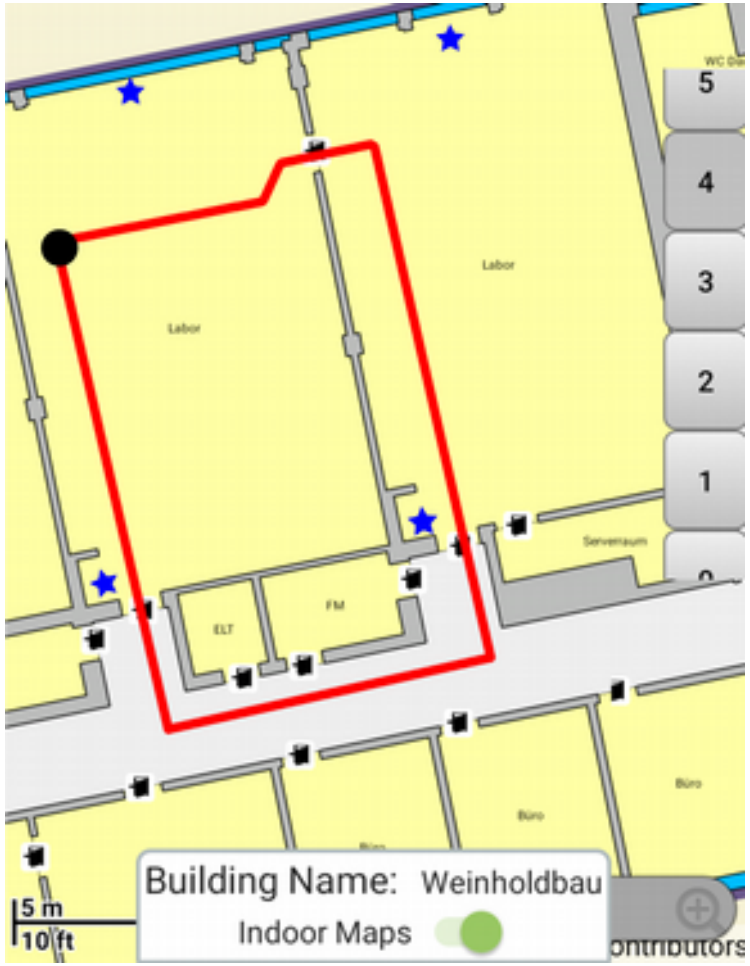
4.4. False Positive Loop Closures

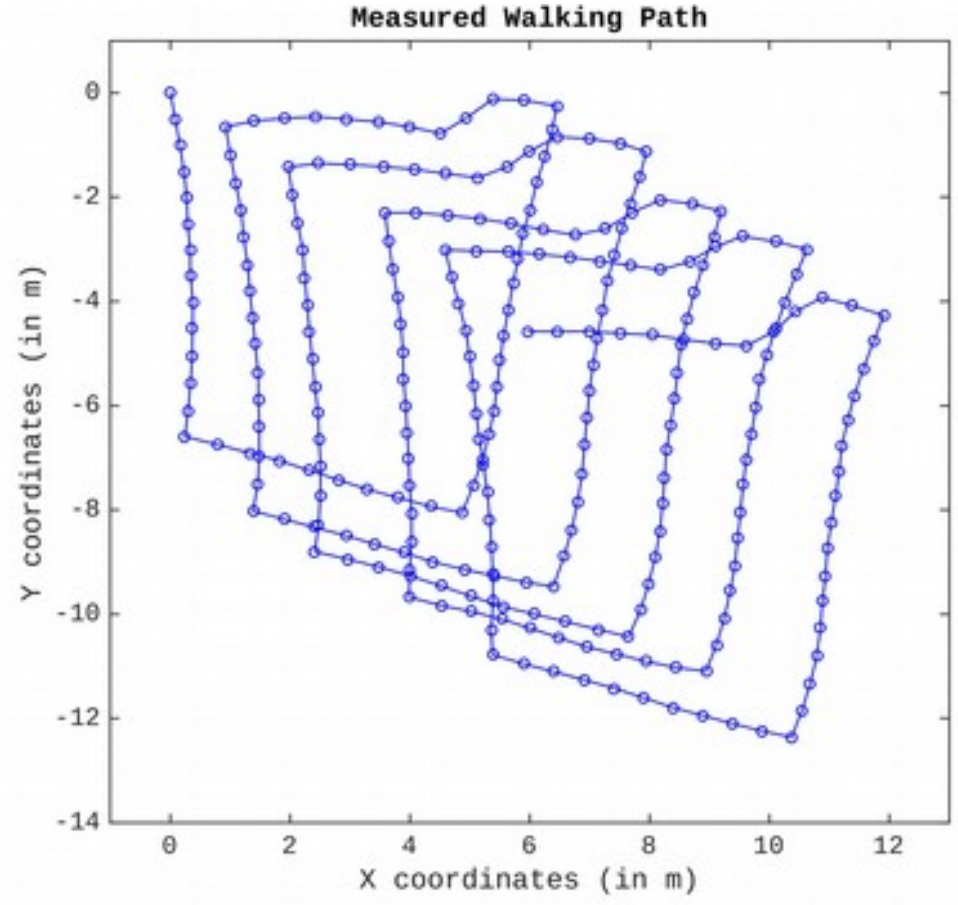




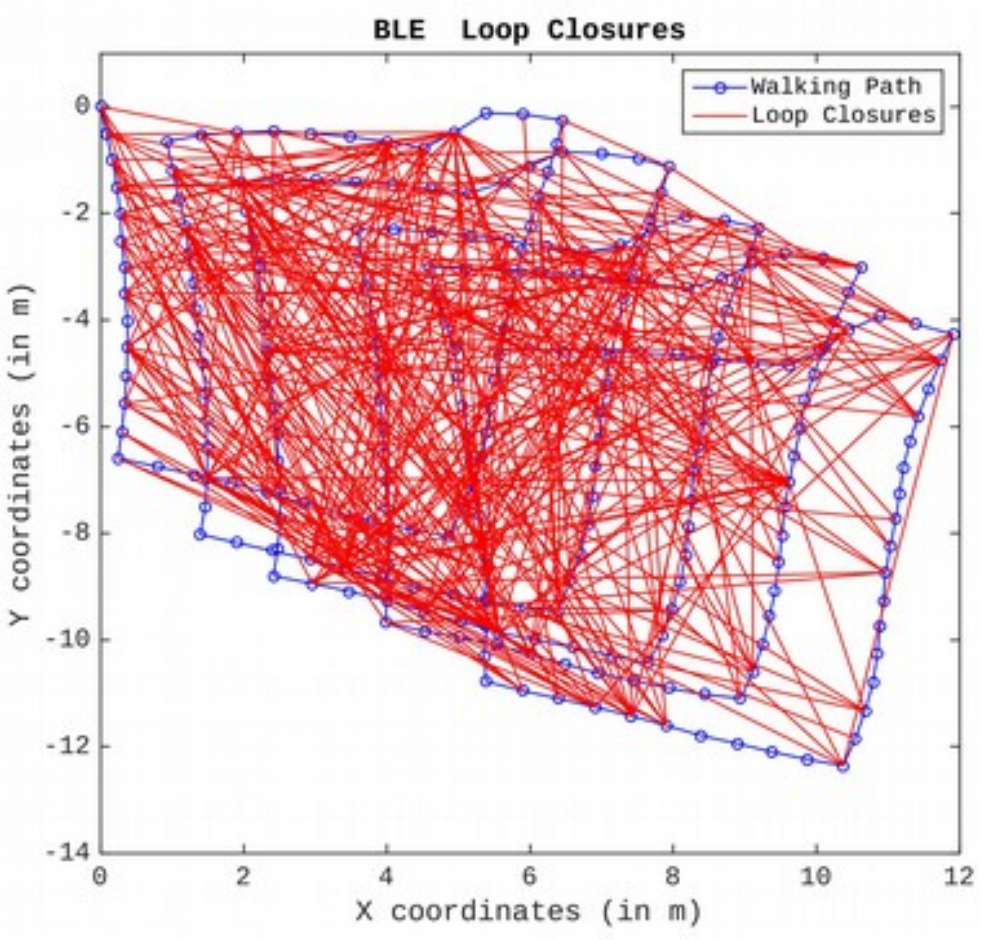


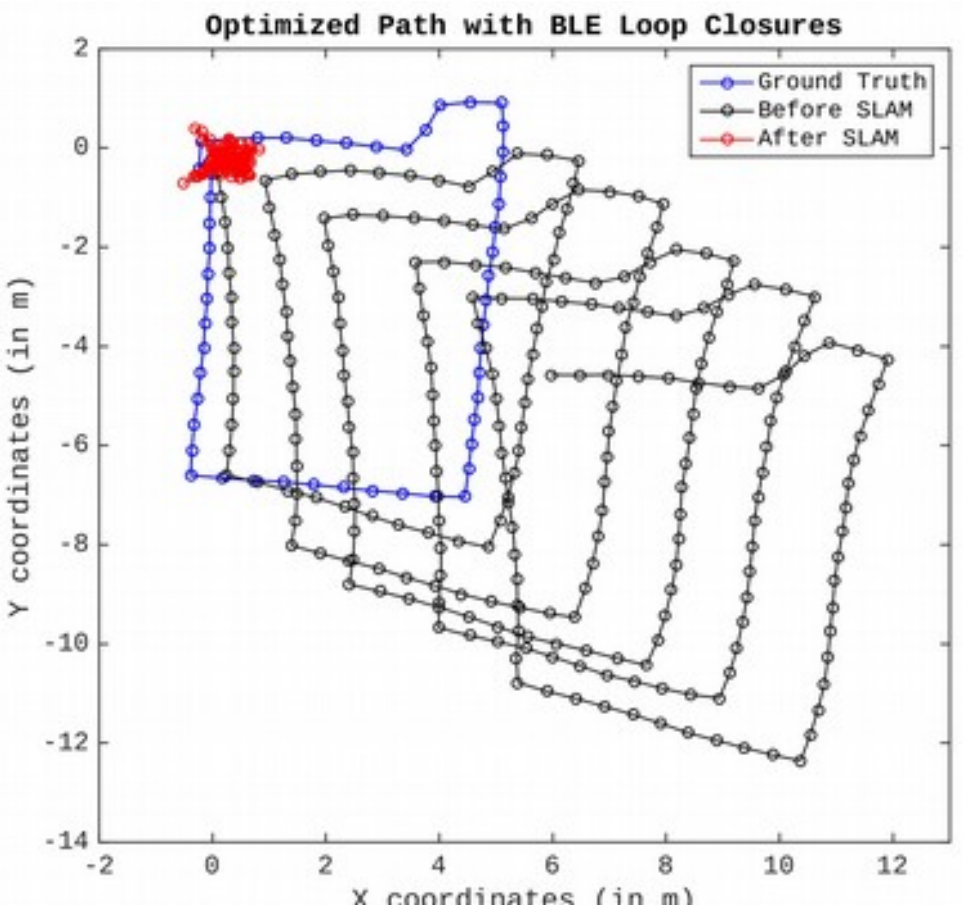
5. Evaluation



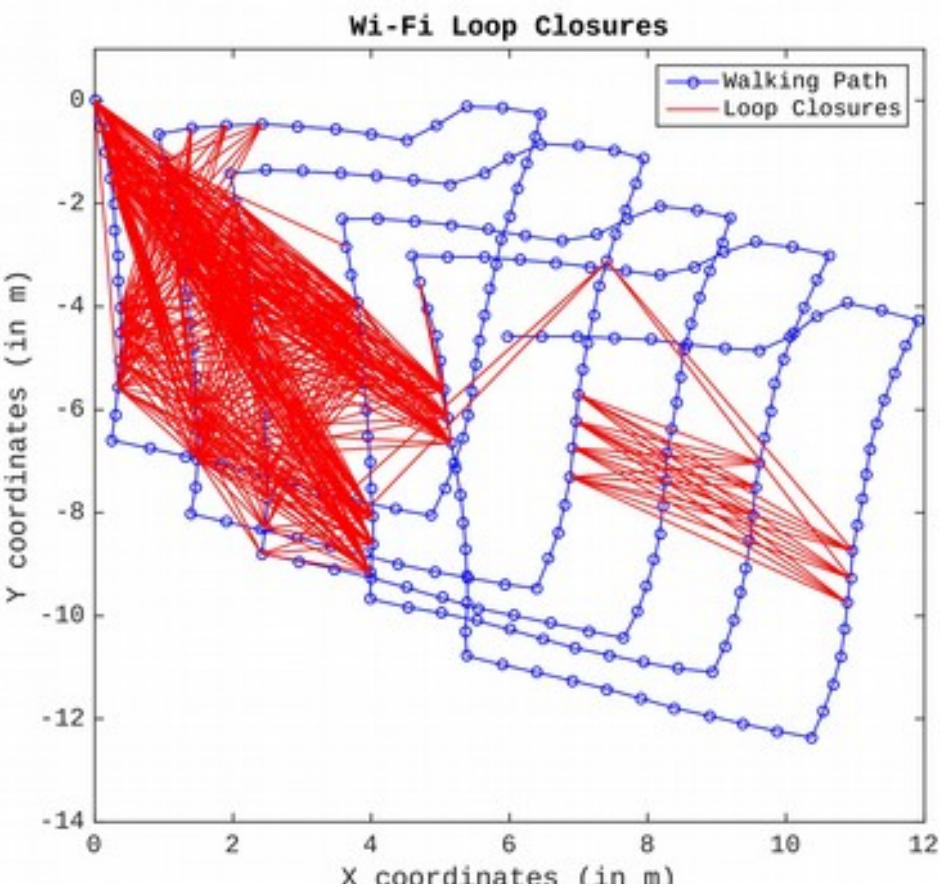


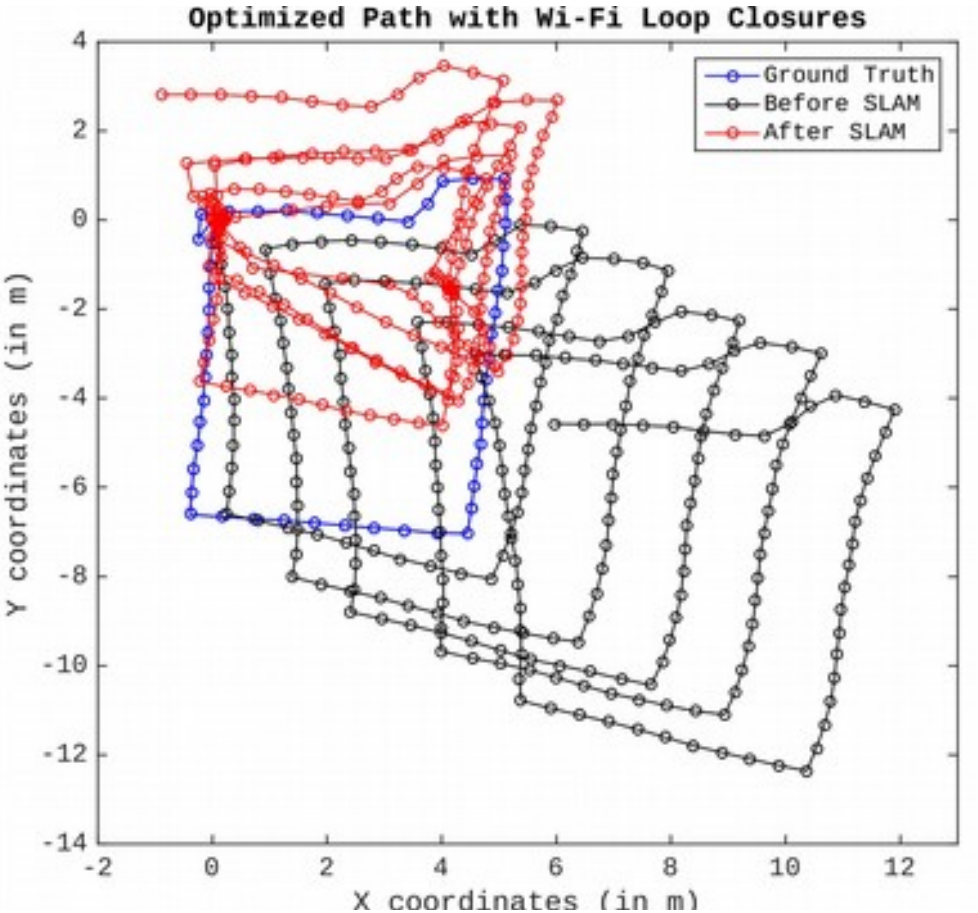
5.1. BLE Loop Closures



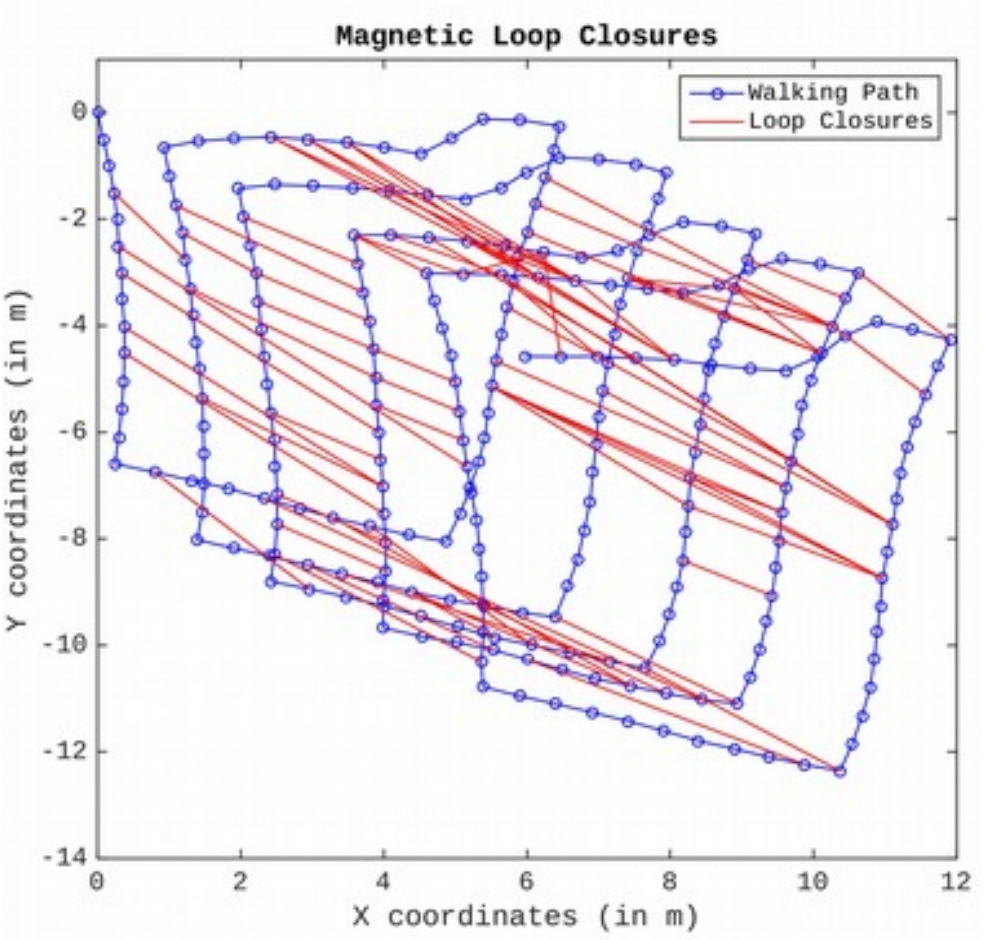


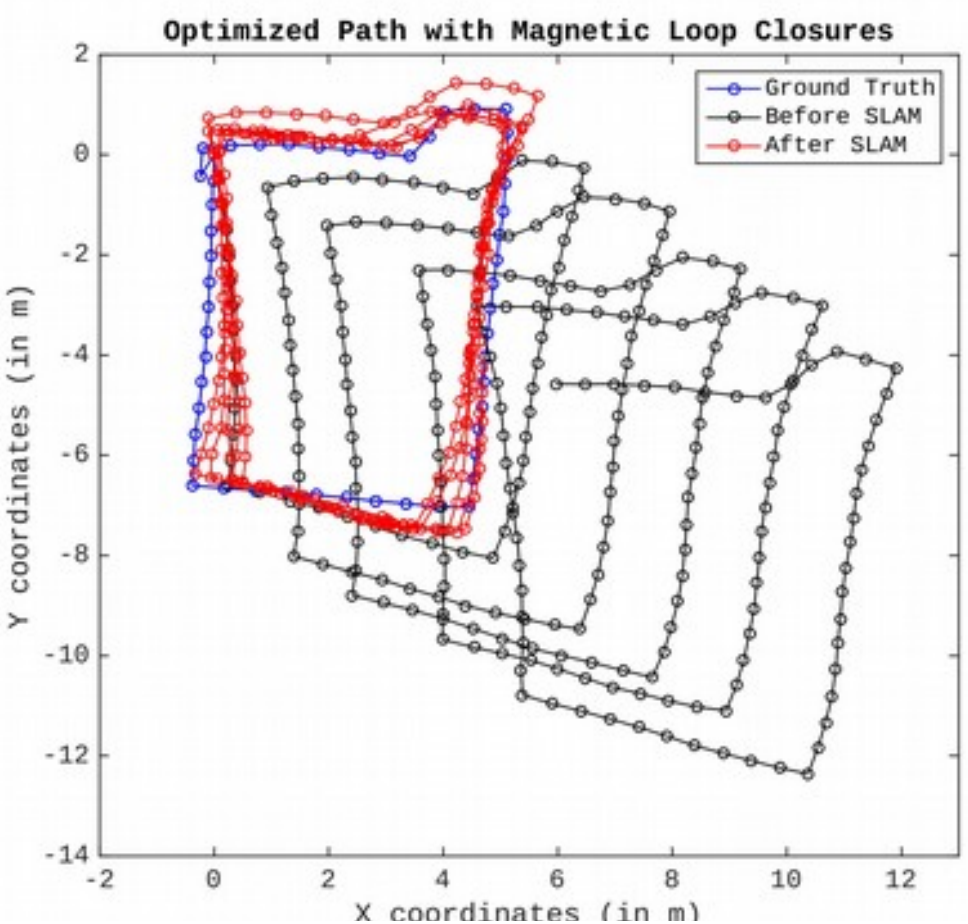
5.2. Wi-Fi Loop Closures



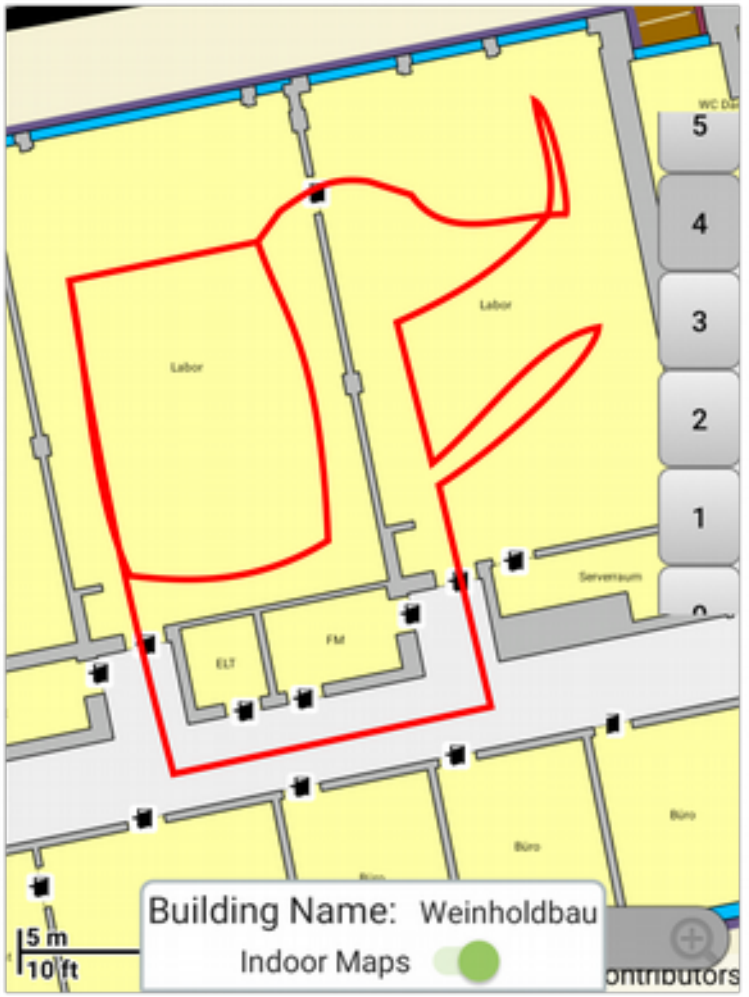


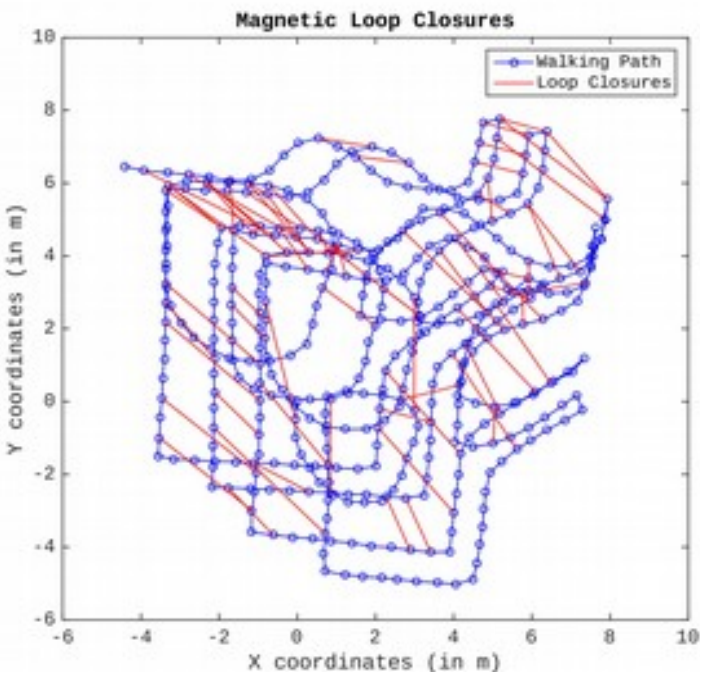
5.3. Magnetic Loop Closures

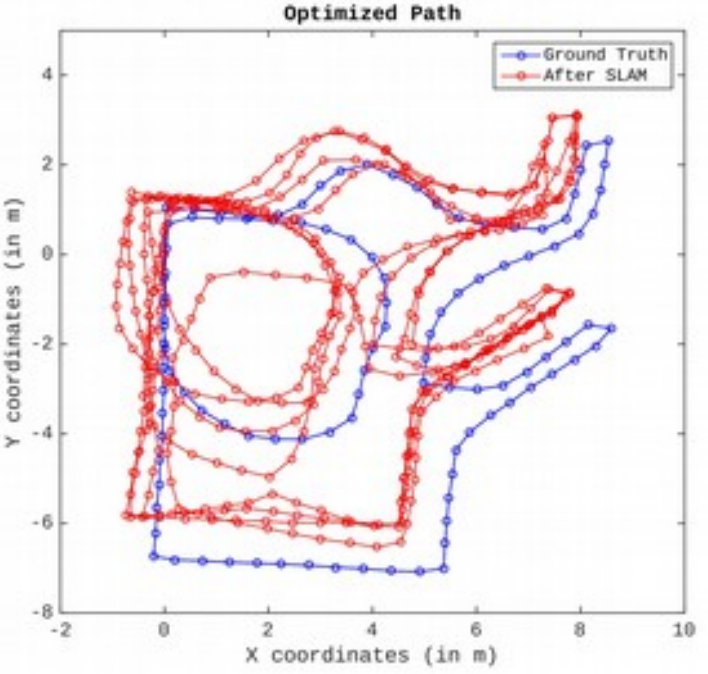




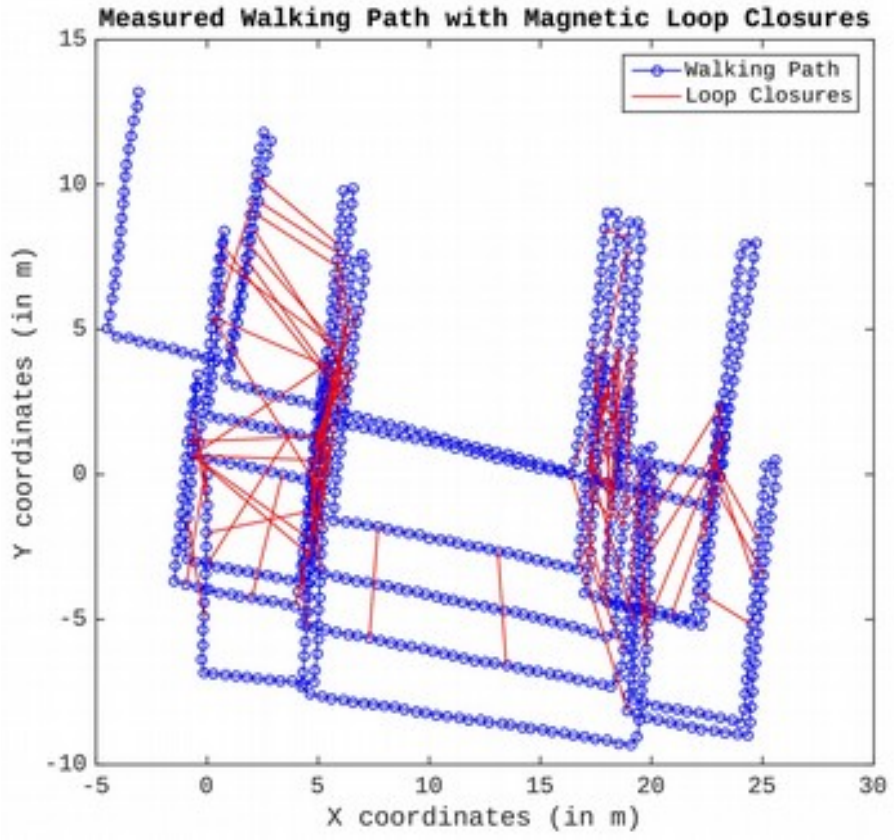
5.4. A More Challenging Route

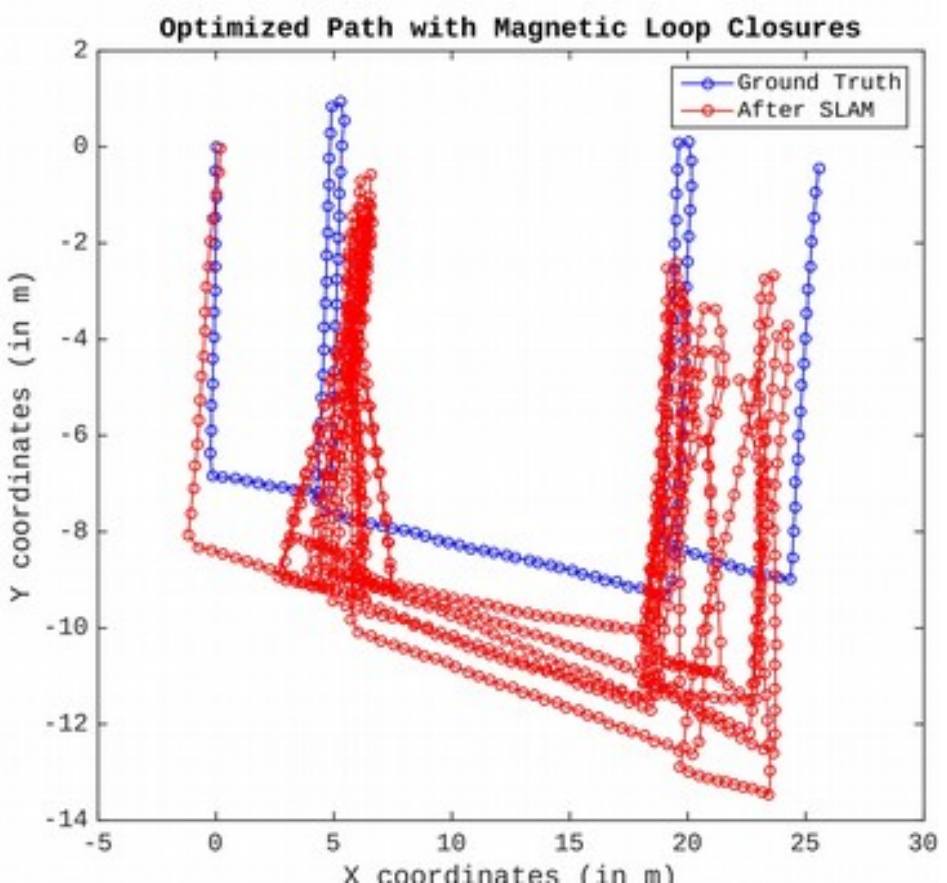






5.5. Even More Challenging Route





6. Conclusion

- Discoveries
  - Graph SLAM is a powerful ***recovery mechanism*** against drift problem.
  - ***Magnetic field*** outperforms Wi-Fi and BLE at loop closures.
- Limitations
  - ***Long corridors and halls*** can be problematic.
  - More ***sophisticated fingerprint matching*** algorithm is required for better accuracy.

7. Reference

- **[Sün12]** Niko Sünderhauf. Robust Optimization for Simultaneous Localization and Mapping - PhD Thesis. pages 1–231, 2012.