WiP Abstract: A Magnetic Fingerprinting-based Precise Automobile Localization using Smartphones

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I. Introduction

Precise automobile position tracking is important in terms of safety. A driver who is on a wrong lane may try dangerous lane changes (e.g., exit from a freeway, get in the correct lane to make a turn), which increases car accidents (1). The state-of-the-art navigation frequently fails to provide precise outdoor localization especially in urban areas due to GPS errors. The GPS errors sometimes get worse over 15 meters especially in obstructed urban environments (2). To track vehicle position, conventional approaches have used particle filter algorithm containing estimated vehicle position and weight values. Based on the particle filter algorithm, a lane level accuracy can be achieved by classifying valid GPS sensor data and using landmarks such as stop sign, corner and speed bump (3). The research has a limitation of real-time computing for uploading/downloading a cluster of particles when a vehicle is approaching the landmarks, but it shows the highest performance (about 1.5m errors) when it has more than 12 landmarks. Our approach is to provide a precise magnetic fingerprinting-based outdoor localization. Our intuition is that many landmarks can improve accuracy of tracking algorithm, and we propose a precise magnetic fingerprint map for many landmarks. To achieve our approach, three research problems are considered:

- What landmarks are made by magnetic fingerprinting in each road?
- How to update dynamic traffic situations in magnetic fingerprinting map?
- How to design the particles which are consisting of vehicle positions and weights of the particles?

We preliminary tested magnetic fingerprinting features on the road in our university. To provide feasible and reliable magnetic fingerprinting features, we will further investigate the features in diverse conditions such as in-vehicle magnetic field, magnetic feature variation according to lateral vehicle positions, external magnetic effects (e.g., parked car, electric poles, traffic lights or iron fence), time variances and differences between different smartphones.

II. Experimental Results and Conclusion

We tested a magnetic intensity feature of the road in our university. We divided the road into 9 different roads as shown in Fig. 1-(a), and magnetic sensor data are collected on the passenger seat in a car. The car was driven with a constant speed of about 20km/h, which means there was no acceleration. The results showed that each road has its own magnetic fingerprinting feature as shown in Fig. 1-(b). We expect the magnetic features can reduce estimation errors of traveled distance since they have their own distinct slope of the magnetic intensity depending on the distance. The magnetic fingerprints could be effective landmarks for alleviating the GPS error problem since there are many infrastructures such as electric poles, traffic lights or iron fence in urban area.

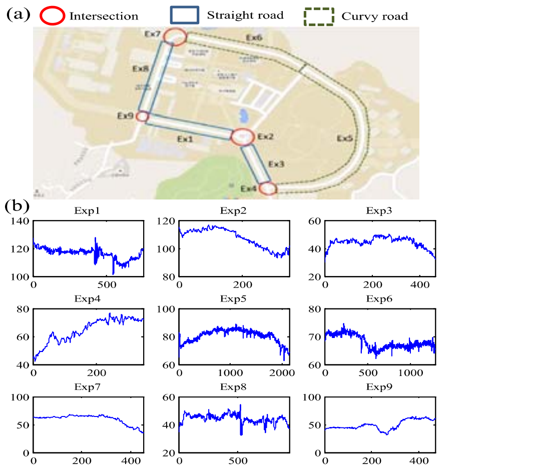

Figure 1. Preliminary experiment for magnetic fingerprinting; (a) Data collection areas, (b) Magnetic intensity features for each road

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