Real-Time Indoor Localization System Using WiFi Scanning

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Abstract

Location tracking is an important part of many ubiquitous computing applications. Unfortunately, global positioning systems (GPS) only provide sufficient tracking coverage in an outdoor setting, unavailable to many users in an indoor setting. With the popularity of wireless access points, and WiFi-capable mobile devices, the use of this wireless infrastructure can become a viable option for instant and portable indoor tracking. We investigate and purpose deploying a quick real-time indoor location system that accounts for obstacles and wireless instability for mobile devices without fingerprinting locations. We discuss the actual performance and accuracy of tracking both stationary and moving targets in a structure by incorporating common mobile device tracking features, and applying predictive heuristics to account for inaccuracies such as structural boundaries.

Provided with only a passive based collection of WiFi based signal strength readings, an indoor localization system relies on achieving accuracy by using the built-in orientation features present in many existing mobile devices, and does not rely on any costly additional sensor/external feedback. By using the collected signal strength readings, a position map is formulated and used with both predictive and deterministic algorithms to derive the estimated location of the WiFi node. We compare the performance of the algorithm with several other approaches, including fingerprinting approaches. Our real life walkthroughs collecting data samples indicate that once a indoor structure is passively scanned, our system is sufficient enough to derive accurate location estimates of nodes with decent accuracy. With such information easily obtainable, a scalable context-aware multimedia interactive application was developed to demonstrate a context-dependent, multimedia interactive application.

Method

Signal Consistency from Controlled Stationary Access Point

It is often the case that indoor localization trackers are unaware of the access points. Rather then construct a model of the existing wave propagation and tracing the source, we develop a model that follows the existing signal trend per access point and takes into account both new mobile tracking technologies (accelerometers, GPS), and signal incongruences that result question the accuracies of other wireless models. Tracking targets in real-time involves complexities such as moving obstructions, variations in readings, and other signal discrepancies.

A signal’s propagation behavior that is generated from a IEEE 802.11 WLAN access point in free space has a well-known signal model. However, the fluctuation of signal strength values (RSSI) in indoor environments demonstrates that even an adjusted free-space path loss (FSPL) signal curve is still insufficient in compensating for obstructions for location tracking.

The Hybrid WiFi Propagation Model takes these considerations into account. The red area represents the trackable area in which higher signal strengths remained preserved, while lower signal strengths follow the FSPL model of a second order polynomial. A minimum of 3 samples are needed to formulate this curve, while a desirable higher sample count will achieve higher accuracy to correct any signal inconsistencies during sampling itself.

It was observed that the best result is achieved with a Linear interpolation model. This was the most consistent with the simulation, as well as the most efficient to compute. For environments where higher accuracy is needed, other models could be used, but with increased computational cost.

Objectives

Accuracy
- Predictive localization algorithm (given obstacles, direction, and scan information)

Convenience
- Passive (non-automatic) collection of flagged location information
- Requires no knowledge about the source of the access points

Portability
- Only uses publicly available access point information
- Deployable on mobile handheld devices

Affordability
- Uses existing established WLAN/Wi-Fi standards
- Ability to run on any mobile platform without additional sensor feedback

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