Indoor Localization Technology and Algorithm Issues

[Extended Abstract]

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1. INTRODUCTION

Localization [2, 4] is the basis for novel features in various location based applications. Despite more than a decade of research, localization service is still far from pervasive indoors. The latest industry state-of-the-art, Google Indoor Maps [1], covers about 10,000 locations in 18 countries, which are only a fraction of the millions of shopping centers, airports, train stations, museums, hospitals and retail stores on the planet.

There are two major obstacles behind the sporadic availability. First, current mainstream indoor localization technologies largely rely on RF (Radio Frequency) signatures from certain IT infrastructure (e.g., WiFi access points [2] and cellular towers)Obtaining the *signature map* usually requires dedicated labor efforts to measure the signal parameters at fine grained grid points. Because they are susceptible to intrinsic fluctuations and external disturbances, the signatures have to be re-calibrated periodically to ensure accuracy. Some recent research has started to leverage crowdsourcing to reduce site survey efforts, but incentives are still lacking for wide user adoption. Thus the progress is inevitably slow.

Second, the floor plans of most indoor environments are not easily accessible to localization service providers. Google Indoor Maps has a web page where building owners or operators can upload their floor plans. However, the floor plan itself is a valuable business asset. Unless there are compelling business gain, the owners and operators may not necessarily want to share it with service providers. That is why explicit business negotiation and arrangement are usually required to have the coordination of the building owners or operators.

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Such manually process inevitably incurs high cost and long latency.

We present two pieces of work towards addressing the two obstacles. First, we explore an alternative approach that has comparable performance to the industry state-of-the-art but without relying on the RF signature. Specifically, we leverage environmental physical features, such as logos of stores, paintings on the walls. Users use the smartphone to measure their relative positions to physical features, and the coordinates of these reference points are used to compute user locations. This has a few advantages: 1) Physical features are part of and abundant in the environment; they do not require dedicated deployment and maintenance efforts like IT infrastructure; 2) They seldom move and usually remain static over long periods of time. They are not affected by and thus impervious to electromagnetic disturbances from microwaves, cordless phones or wireless cameras. Once measured, their coordinates do not change, thus eliminating the need for periodic re-calibration.

Second, we describe a mobile crowdsensing [3] based approach to build indoor floor plans, such that service providers can leverage various kinds of data (such as images and motion) collected from common users without the need of business negotiation with building owners or operators. Given enough number of images of an indoor element (e.g., a store), one may infer the sizes and relative positions of the element to the locations where images are taken. Users may also provide additional input from inertial sensors about the relation between different locations, such as the angle rotated or distance traveled. Such input constitutes various constraints about the relative positions among elements. By formulating and solving an optimization problem that takes into consideration the sizes, relative positions among elements and image locations, we can produce a global map with the absolute coordinates of all elements in the floor plan.

2. REFERENCES

[1] Google indoor maps http://maps.google.com/help/maps/indoormaps/.
[2] P. Bahl and V. N. Padmanabhan. RADAR: An in-building RF-based user location and tracking system. In *IEEE INFOCOM*, 2000.
[3] R. Ganti, F. Ye, and H. Lei. Mobile crowdsensing: current state and future challenges. *Communications Magazine, IEEE*, 49(11):32–39, 2011.
[4] H. Liu, Y. Gan, J. Yang, S. Sidhom, Y. Wang, Y. Chen, and F. Ye. Push the limit of wifi based localization for smartphones. In *ACM Mobicom 2012.*