Diplomarbeitsbeschreibung

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1 Diploma Thesis

1.1 Working Title

Dilution of Precision Metrics for Wireless LAN-based Indoor Location Systems

1.2 Summary

The geometric strength of satellite configurations influences the precision of the *Global Positioning System* (GPS). If the satellites, that are visible to a receiver, are close to each other the geometry is weak. That means, the position reckoning is likely to be inaccurate because of measurement errors. In contrast, if the satellites are far apart from each other, the geometry is strong and the position is likely to be less inaccurate. To describe the geometric strength of a constellation the *Dilution of Precision* (DOP) metric is used. A high value indicates a high inaccuracy and a low value denotes a low inaccuracy. Actually, the DOP contains four different values that have been defined by means of mathematical formulas. They measure the vertical, horizontal, position (in 3D) and time dilution of the precision. The four DOP values can be used to estimate the positioning error that is inherent in the result [3].

Recently, various indoor location systems based on Wireless LAN have been proposed (e.g., [2], [1], [5]). These systems utilize the network infrastructure that has been built for communication purposes to determine the position of the object in question. Basically, Wireless LAN-based indoor location systems work as follows: access points periodically transmit beacons and every mobile device that receives beacons from at least two access points is able to estimate its position. Due to effects caused by the physical characteristics of the wireless channel, it is not possible to accurately estimate the distance between a mobile device and an access point [4]. The error introduced by the wireless channel prohibits the use of lateration algorithms.

The so-called *fingerprinting* technique is applied by many Wireless LAN-based indoor location systems to cope with the drawbacks of the channel. Fingerprinting approaches work in two stages: in the training phase a database that stores the physical coordinates and radio fingerprints of the measurement points is created. A radio fingerprint comprises the signal strength values of access points in communication range at a particular position. The database is then used in the online phase to compute the position of mobile devices.

If a mobile device wants to know its position, it collects the signal strength values of the access points in its communication range and matches this samples with the data stored in the database. If no direct match can be found the nearest fingerprint is selected and based on the selected fingerprint the position is derived.

As shown in[2], the aforementioned Wireless LAN-based indoor location systems work well in various indoor conditions and provide location accuracy up to a few meters. However, none of these systems provides a metric to estimate or classify the positioning error generated by the system.

1.2.1 The Thesis

Subject of this thesis is the conceptual design, the implementation and the evaluation of DOP algorithms for Wireless LAN-based indoor location systems. In a first step, a simple Wireless LAN-based indoor location system has to be implemented (e.g., the one described in [2]). The main focus in this implementation shall be the functionality of creating databases of fingerprints. These databases will later be used to evaluate and test different DOP algorithms.

The second task is to create an idealized environment where DOP algorithms can be implemented, tested, and evaluated. The idea behind this testbed is that stable and reproducible conditions improve and simplify the analysis of the DOP algorithms. The databases created in step one shall be used as one basic component for this purpose. A testbed for positioning algorithms is already available (at the “Lehrstuhl für Praktische Informatik IV”) and shall be extended to support DOP algorithms. This framework is called *Loceva*.

In a third step an implementation of DOP algorithms shall be provided. The implementation should contain algorithms that have been proposed for GPS as well as the design and implementation of novel DOP algorithms that make use of Wireless LAN specific properties. Furthermore, these algorithms have to be evaluated and tested by utilizing the *Loceva* framework. Finally, the two most promising DOP algorithms have to be integrated in a ready-to-use indoor location system.

Literatur

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[2] P. Bahl and V. N. Padmanabhan. Radar: An in-building rf-based user location and tracking system. In *In Proceedings of IEEE Infocom*, volume 2, pages 775–784, Tel Aviv, March 2000. IEEE.

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[4] T. S. Rappaport. *Wireless Communications: Principles and Practice*. Prentice Hall PTR, second edition, December 2001.

[5] M. Youssef and A. Agrawala. The horus wlan location determination system. In *Proceedings of the 3rd international conference on Mobile Systems, Applications, and Services (Mobisys)*, pages 205–218, 2005.