MA: Smartphone-Based Indoor Localization

This document describes the subject and the general time schedule of the master thesis of Pascal Bissig, beginning in the autumn term 2011. Adaptations or changes can be agreed upon by the advisors.

Subject

The public availability of the GPS system and the decreasing price of GPS hardware have rendered it possible that almost all new smartphones come with a built-in GPS module. This allows the users of smartphones to be localized all around the world within a precision of a few meters. Knowing the precise location of a user is not only important for navigation, but reveals also a lot about the current context of a person. For example, the device might behave differently if the user is in a meeting room, in the canteen, or in his office. Therefore, it is desirable to know the location of a person also indoors. However, while GPS works well outdoors, does not work at all in buildings. In fact, efficient and precise indoor localization is still an open research problem.

Several different approaches have been proposed to solve the problem of indoor localization. Some, such as ultrasonic-based localization or RFID-based localization, rely on additional hardware infrastructure. These techniques normally feature a high precision, but have the disadvantage that they only work with specialized hardware and at locations, that have been prepared for it. Others, such as localization using Wi-Fi signals or GSM-signals, try to exploit the existing installations but come with the disadvantage of a low precision.

The goal of this thesis is to use the existing hardware of state-of-the-art Android smartphones to perform indoor localization as precise as possible. The localization algorithm should make use of all available (and meaningful) sensors and combine this information in an appropriate way. These are (at least): The magnetic field sensor, the gyroscope, the accelerometer, the GSM-signal, the Wi-Fi signal, and visible GPS satellites.

In a first step, Pascal will have to develop an algorithm that uses the sensors to determine the absolute orientation of the smartphone in the presence of synthetic magnetic fields. Thereafter he will have to develop a program that allows determining the motion of the subject. In a third step he will combine the relative position signals (from the motion) and the absolute signals to optimally localize the smartphone.
Versus the end, a demonstration application will be developed that visualizes the indoor localization in an attractive manner.

Time schedule (Total: 25 weeks)

- Study related work [**]
- Design, implement, and test algorithm to determine absolute orientation [*]
- Design, implement, and test algorithm to determine movement-speed [**]
- Adapt the SLAM algorithm to the observations of smartphones [***]
- Program a cool demo application [**]
- Evaluate the localization system [*]
- Write the report [**]

The Students' Duties

- One meeting per week with the advisers.
- Regular check-ins of the progress using the Subversion system
- One intermediate presentation (15 min).
- One final presentation (15 min).
- A final report (15 to 40 pages, English or German), presenting work and results.
- Two copies of the report (each containing a CD with relevant code, etc.) should be handed in in the end.

General

- Independent working is expected
- A possibility to work in the ETZ is provided. It is also possible to work at home

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