

Visualization of Location Fingerprints in a Positioning System based on RFID

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Abstract — *The development of pedestrian navigation and guidance services for indoor environments is a challenging research topic. As satellite positioning (GNSS) does not usually work indoors, alternative technologies have to be employed. In our approach in the project UCPNAVI (Ubiquitous Cartography for Pedestrian Navigation) active RFID (Radio Frequency Identification) in combination with INS (Inertial Navigation Systems) is employed for positioning. The most accurate positioning method using RFID is location fingerprinting. In this study the principle of operation of location fingerprinting and the visualization of the fingerprints is discussed.*

I. INTRODUCTION

Radio-frequency identification, or RFID, is a technology for data transmission via radio waves with or without line-of-sight contact. Nowadays, the technology of RFID is also used for positioning, because the location estimation can be based on RSSI (received signal strength indication) which is a measurement of the power present in a received radio signal. The receiver can compute its position using various methods based on RSSI (e.g. range-based positioning using trilateration, location fingerprinting). Three different methods have been developed in a research project at the Vienna University of Technology, i.e., cell-based positioning, trilateration using ranges to the surrounding RFID tags deduced from received signal strength measurements, and RFID location fingerprinting (see Fu and Retscher, 2009). This contribution concentrates on the positioning of a pedestrian user with location fingerprinting.

II. POSITIONING USING ACTIVE RFID

Thanks to the RFID technology, data can be transmitted from RFID tags to a reader via radio waves even without line of sight contact. The transmitted data might include the ID and the information of the position of the RFID tags. In the presented work only one reader but several active tags are used. The user is equipped with a portable RFID reader (e.g. a reader in form of a PCMCIA card that can be plugged into a laptop) and the RFID tags are placed in the surrounding environment at known locations (so-called active landmarks). If the user moves within the surrounding of the RFID tags, the tags' ID, signal strength RSSI, known location and time can be obtained. The position is a function f as shown in equation (1):

$$\text{position}(t) = f(\text{ID}, \text{RSSI}, \text{known location}) \quad (1)$$

at a certain time t (see Fu and Retscher, 2009).

III. RFID LOCATION FINGERPRINTING

The principle of operation of RFID location fingerprinting is similar to that used in WiFi networks (see Retscher et al., 2007). Here the measured signal strength is used directly to obtain the location of the user. In an off-line or training phase the RSSI is measured at known locations in the test area to all surrounding RFID tags. The measured values are stored in a database. Then in the positioning phase (or so-called on-line phase) the current RSSI measurements obtained at a unknown location are compared to the values in the database to estimate the position fix. The current location of the user is calculated using the Nearest Neighbour in Signal Space (NNSS) algorithm. This algorithm uses the Euclidian distance

between the strength of the signal and the fingerprint in the database in the so-called signal strength space. Positioning accuracies on the 1 to 2 m level can be achieved. Fingerprinting can therefore be used in indoor environments as it provides a sufficiently high level of positioning accuracy.

For the visualization of the location fingerprints a software has been developed in our study (Pongracz, 2010). Figure 1 shows an example of a location fingerprint in an office building of the Vienna University of Technology which was used as a test bed for our system development. By a simple mouse click on the floorplan the location fingerprint for that particular location can be represented from the database of RSSI measurements from the off-line phase. Then the current location fingerprint can be compared with the one from the database for position fixing and the user's location is obtained if the location fingerprint is correctly matched.

IV. CONCLUSION

RFID tags transmit useful information such as ID, position and signal strength to the RFID reader. This information is recorded in a database and can be used for determination of the

position of the RFID reader. Based on the principle of RSSI measurement location fingerprinting has been employed. To study the location fingerprints a software has been developed for their on-line visualization.

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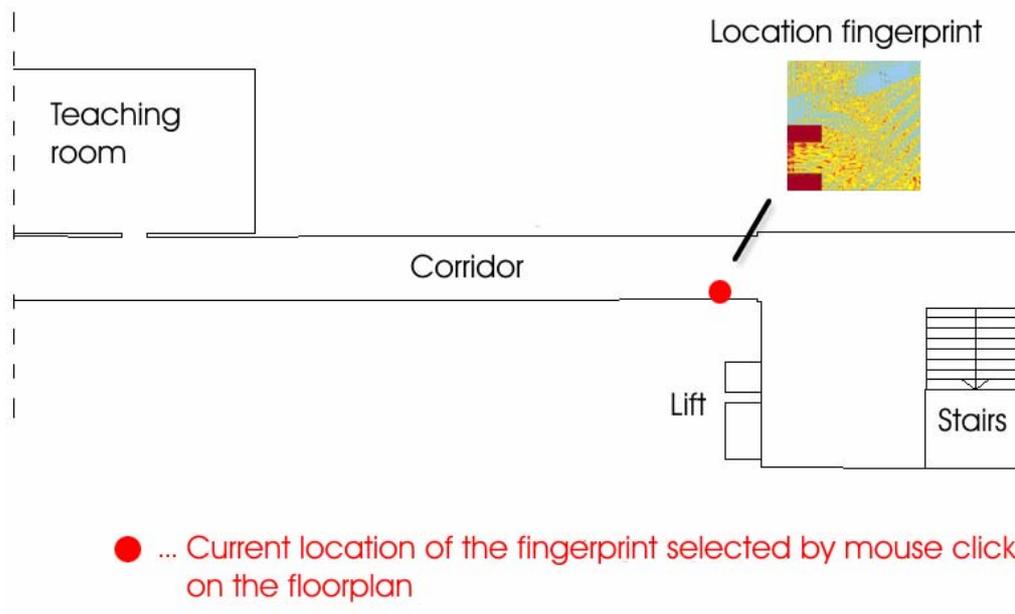


Figure 1: Visualization of a location fingerprint in the test bed at the Vienna University of Technology (The different colors in the location fingerprint show the signal level on this position. The red rectangles on the left side show errors caused by electromagnetic field interference.)