LOCATION OF GSM TERMINALS USING A DATABASE OF SIGNAL STRENGTH MEASUREMENTS

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ABSTRACT. A GSM location trial using a database of measured signal strength values is described in this presentation.

INTRODUCTION

Several cellular location techniques have been introduced lately, most of them being based on signal timing or angle of arrival measurements, see e.g. *Drane et al.* (1998). These techniques suffer from degraded accuracy when no line of sight between the mobile and the base stations exist. This is typical in densely built urban areas where high buildings often block the line of sight and signal propagates with less attenuation along street canyons than through the buildings. However, accurate location in city centres is desirable since location services will most probably find a lot of users there.

The accuracy degradation caused by non-line-of-sight propagation can be avoided with the Database Correlation Method (DCM). In this method, the signal strength values and/or the propagation time delays, as a function of geographical position, are stored in a database. For location determination, a correlation-type algorithm is used to find the best match between the values measured by a mobile terminal and the entries of the database. The values stored in the database can either be measured or calculated using a network planning tool. A location system employing calculated signal strength values is already in use in Japan (*Koshima & Hoshen* [2000]).

LOCATION TRIAL

We have conducted a DCM location trial in an operating GSM network. In this trial, the received signal levels of the serving cell and six strongest neighbours were measured as a function of position. This information is measured by standard GSM phones to facilitate handover. The trial area was a street grid in the centre of Helsinki, covering an area of approximately 3 km^2. Most of the measurements were performed with a phone and a laptop computer inside a car. The speed of the car varied from 0 to 40 km/h and 2 measurement samples per second were collected. The ‘true’ coordinates for the measurement samples were obtained by mouse-clicking marker points on a map during the measurement. The database was formed by averaging all measurement samples inside each square of a location grid, with neighbouring grid points spaced 20 m apart. In addition to the measurements forming the database, a 8.5 km long test route through the area was driven.

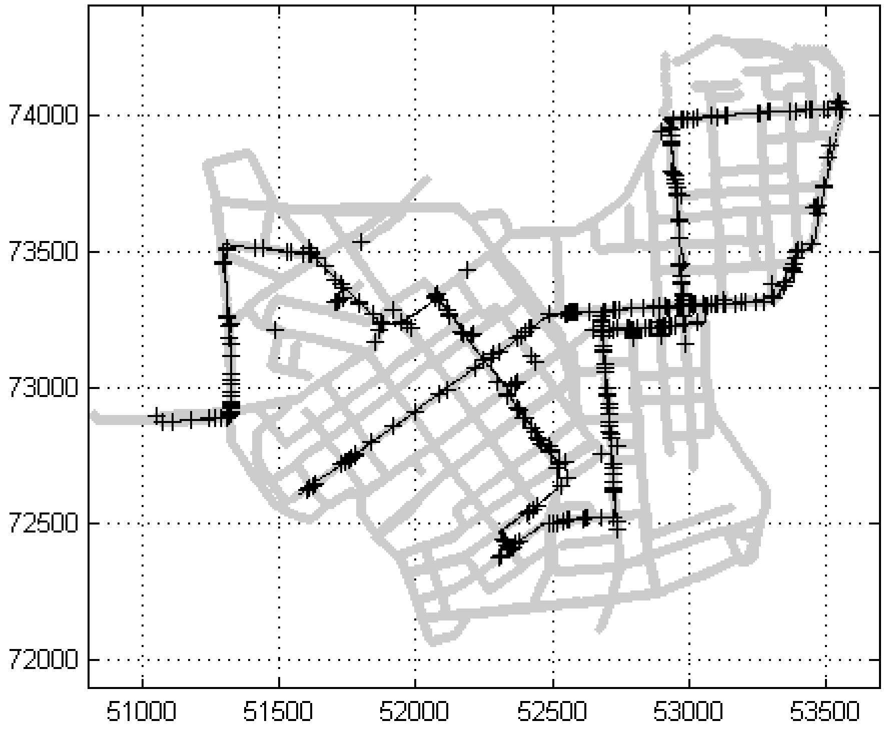

Figure 1. Measured street grid (grey), test route (solid black line), and the coordinates returned by the DCM algorithm ('+'-marks).

RESULTS

The test route, as well as the locations returned by the DCM for all the test samples, are depicted in Figure 1. Few clearly deviated results can be seen, but most of the location results are on the route. However, there are sections on the route where no location results are found. The location error is typically directed along the route. The mean location error is 43 m, and the 67th and 95th percentiles are 49 m and 108 m, respectively.

CONCLUSIONS

The signal strength –based DCM is a competitive alternative for cellular location especially in city centres. In restricted areas, the required database can be easily formed by measurements. For large-scale implementation, an accurate field-strength prediction tool would probably be needed.

REFERENCES

Drane, C., M. Macnaughtan and C. Scott, 1998: Positioning GSM telephones. *IEEE Communications Magazine*, Vol. 36, No. 4, 46-59.

Koshima, H. and J. Hoshen, 2000: Personal locator services emerge. *IEEE Spectrum*, Feb. 2000, 41-48