TIADPE
Advanced Pervasive Computing
Location based services and mean/median denoising of position data

Practicalities

About:	This note covers **half** a module. A module consists of two consecutive lecture days.
Lecturer:	Christian Fischer Pedersen, office E-311, cfp@eng.au.dk
Revision:	November 25, 2014

Subject

This module introduces Location Based Services (LBS) which is a class of IT based services that utilize geographical location data to support service features. The rapid growth of the tablet and smart phone market has demonstrated a range of LBSs within application areas such as, gaming, social networking and healthcare. Further, as position data are fundamental to LBSs and such data often are noisy, we consider some basic methods for denoising position data.

Agenda

Day 1

- L1: Location based services and mean/median denoising of position data
- E1: Exercise

Readings

1. J.E. Dobson, P.F. Fisher, "Geoslavery", IEEE Technology and Society Magazine, 2003, pp. 47–52
2. E. Martin, O. Vinyals, G. Friedland, R. Bajcsy, "Precise Indoor Localization Using Smart Phones", ACM International Conference on Multimedia, 2010, pp. 787–790
3. Y-A. de Montjoye, C.A. Hidalgo, M. Verleysen, V.D. Blondel, "Unique in the Crowd: The privacy bounds of human mobility", Nature, Scientific Reports, 2013, pp. 1–5

Exercises

Location based service

1. What is a location based service (LBS)?
2. Why is geographical position data relevant for LBS in general?
3. Discuss some of the common LBSs you can think of
4. Discuss LBS privacy issues, e.g. how to design a LBS with privacy in mind.

Mean and median filtering of RSSI data (use Matlab)

†1. Acquire BT and WiFi RSSI data as functions of Tx-to-Rx distance, d, in two ways

- Fixed distance data, $\mathbf{x}_F$:
  600s of data sampled at 1Hz at distances $d_{BT,F}$ and $d_{WF,F}$
- Multiple distances data, $\mathbf{x}_M$:
  120s of data sampled at 1Hz at distances $D = (d_i)_{i=1}^{5}$ where $d_{i+1} - d_i = 1\text{m}$

†2. For the fixed distance BT and WiFi RSSI data, $\mathbf{x}_F$

- Mean and median filter – with window sizes $ws = \{1, 3, \ldots, 11\}$ – the data to achieve $(\mathbf{x}_{F,Mean,i})_{i \in ws}$ and $(\mathbf{x}_{F,Median,i})_{i \in ws}$ respectively
- Plot $(\mathbf{x}_{F,Mean,i})_{i \in ws}$ and $(\mathbf{x}_{F,Median,i})_{i \in ws}$ to illustrate the filtering effects appropriately
- Plot the mean and standard deviation of $\mathbf{x}_{F,Mean}$ and $\mathbf{x}_{F,Median}$ as functions of window length
- Elaborate the plots and the effects of filtering

†3. For the multiple distances BT and WiFi RSSI data, $\mathbf{x}_M$

- Mean and median filter – with window size $ws = 3$ – the data to achieve $(\mathbf{x}_{M,Mean,d})_{d \in D}$ and $(\mathbf{x}_{F,Median,d})_{d \in D}$ respectively
- Find the minimum distance step size needed to achieve a statistically significant distance separation at the 95% confidence level. Apply Students t-test for the mean and median filterings individually. Let the test statistic be the mean RSSI, i.e. null hypotheses are equal means. In other words, we want to find out how far we need to move (spatial resolution) in order for the RSSI mean values to have increased/decreased to such an extend that we can statistically conclude the movement: is it 1m, 2m, ..., 5m for BT and WiFi?
- Consider what the spatial resolution situation would be like without filtering
- Discuss whether mean or median filtering is most appropriate for the RSSI spatial resolution case
- In your own words: under which type of noise conditions would you choose a mean filter over a median filter and vice versa?

Note on exercises

I will mark with a star ($\star$) those exercises I consider to be most important; if none are marked, they are all equally important. Mandatory hand-ins are marked with a dagger (†). The exercises are to help you fully understand the contents of the course, and master the theories, methods, and techniques presented in the lectures. Also, doing the exercises helps you gain a self confidence that most often shines positively through in an exam situation. When you have done all exercises it is good idea to think critically about the course material covered. Spend a few moments to think about the following:

- Summarize the main topics of this module and reconsider what you learned
- How did you succeed in your learning, and can you improve your learning process?
- How can the teaching-learning process be improved?

Of course, I will be happy to discuss the exercises and the course contents with you; however, before coming to me, it is very important that you engage in a discussion with your fellow students. Most often, the challenges you encounter are also challenges for others. Discussing with your fellow students is a good and social way of learning.