Mobile Sensing

T-110.5150 - Applications and Services in Internet
Deadline: 5th December 2015, 23:59 Helsinki Time

1 Introduction

This assignment aims to familiarize you with mobile sensing and indoor localization. After this assignment, you should have basic knowledge about mobile phone sensors and gain certain experience on how to utilize sensor data in a real situation.

2 Description

In this assignment you will develop a simple indoor localization application. You will use mobile phone sensors and existing measurement data to position yourself.

2.1 Basic features

2.1.1 Indoor localization literature review (20 pts)

Due to weak GPS signal in indoor environment, indoor localization and navigation uses other information sources instead of GPS, including magnetic sensor, accelerometer, Wi-Fi, and gyroscope, to name a few.

This section expects you familiarize yourself with the current indoor localization solutions. You are required to study the indoor localization solution based on Wi-Fi fingerprint, and then compare this solution with other solutions (at least TWO). There are several key points that should be described in the report (max ONE page).

- What is the general idea of the solution and how it works?

- What are the strengths and weaknesses of the solution?

- Is there any commercial usage of the solution currently?

- Compare it with Wi-Fi fingerprint solution.

2.1.2 Simple application for indoor localization (50 pts)

In this section, you are required to develop a simple indoor localization application based on Wi-Fi fingerprint. You can choose the platform you like, Android, iOS or others. Its functionality will be tested at demo session.

a. Acquire the available sensors on your device (5 pts)

Familiarize yourself with your mobile device. You are required to list all the sensors available on your device, and show them on the screen of your device during the demo session. Remember to include your device information in the report (OS, manufacturer, sensors).

b. Obtain Wi-Fi fingerprint (10 pts)

You are required to obtain Wi-Fi fingerprint from your mobile device and show part of them on the screen. For example, how many Access Points (APs) can be sensed from this location? what is the status (signal strength etc) for each AP? Conduct experiments at the same location at different time of the day. Compare Wi-Fi fingerprint variations at different time.

c. Compare Wi-Fi fingerprint with reference data to estimate location (35 pts)

Step 1: Develop an algorithm for localization (20 pts)

The reference data are in the attachment of this assignment. The data consist of 6 locations in the A-corridor of the CS building (first-floor). There are also measurement data measured at two random locations in the same corridor. Your task is to estimate the location where measurement data were measured by comparing them with reference data. Explain how you estimate the location in your report.

Hint: One possible approach to estimate the location is to compute the Euclidean distance between two Wi-Fi fingerprints and the distance can be defined as

$$D=\sqrt{\sum_{each\ BSSID}\left(SL_{measurement}-SL_{reference}\right)^2}$$, where *SL* is the signal level.

You may also use other formulas to better compute the distance.

Step 2: Localization with your own mobile device (15 pts)

You are required to conduct measurements nearby the room A141 in the A-corridor using your own mobile device, and localize yourself using that data accordingly. You will be also given measurement data nearbycd room A141. Your task is to check whether your algorithm will return the same location with both data (your own measurement and given measurement data). If not, explain why.

2.2 Additional features (30 pts)

In this section, you should improve your application and provide a new feature to your application. There are three alternatives for this task. You can choose either one of them.

(1) Build reference data by yourself (30 pts)

Build your own reference data using your mobile device, similar to the reference data we have given. Use this reference data together with the localization algorithm you developed to position yourself.

OR

(2) Calculate the distance between two reference points. (30 pts)

You can use additional sensors, for example accelerometer, to estimate moving distance. Refer to Google Android API (http://developer.android.com/guide/topics/sensors/sensors_motion.html) to acquire data from accelerometer. Then develop your algorithm to estimate moving distance.

OR

(3) Propose your own feature (30 pts)

You are encouraged to propose your own idea and implement it accordingly. Your idea should relate to using mobile phone sensors in a meaningful way. Be creative and use the other sensors of your mobile phone.

2.3 Submission (40 pts)

2.3.1 Report (20 pts)
The final report should include the following elements:

- The experiment, results, and analysis for each basic feature.

- The experiment and other related contents for each chosen additional feature.

- Time estimate on this assignment.

- Feedback about the assignment.

Please create a new directory called "assignment_2" in your Git repository. The contents of the directory are:

```
assignment_2/
        src/
        README
        Report.pdf
```

Report.pdf is your report in PDF format. All source code of the programs used in this assignment go into src/. Please describe briefly in README each file in src/. Failure to comply with submission instruction may have a negative effect on your grade.

We encourage you to work with Git throughout the assignment. Avoid doing a big commit right before the deadline. You are advised to reorganise your repository if your submission for first assignment did not follow the submission instruction.

2.3.2 Demo (20 pts)
The demo session is max 30 minutes, which includes 5 minutes for setup, 20 minutes for presenting the application, and 5 minutes for questions. You must check out the source code from the Git and build your application from source on the site during the demo session. Both team members are required to be present at the demo session.

The basic requirements are:

- Measure access point signal strengths.

- Locate yourself using a given measurement data or your own measurement data.

3 Grading

Experimenting with basic features is enough to pass the assignment. You gain more points by trying some additional features. The basic features are rather fixed, but you have free hands to try out additional features. With freedom comes responsibility, you should report your experience with proper documentation.

• Basic features: 70 points
• Additional feature: 30 points
• Demo: 20 points
• Final report: 20 points

fail — < 70 points or a missing basic feature or no report.
1 — ≥ 70 points.
2 — ≥ 80 points.
3 — ≥ 90 points.
4 — ≥ 100 points.
5 — ≥ 120 points.

4 Other information

1. It is easy to get Wi-Fi information from the 'ScanResult' class of Android API. Remember to add the "ACCESS_WIFI_STATE" permission to the AndroidManifest.xml file when you try to get data from 'ScanRestult'.
   (http://developer.android.com/reference/android/net/wifi/ScanResult.html)

2. If you are using an Android device, you can use the the method "GetSensorList" method from Android API documentation
   (http://developer.android.com/reference/android/hardware/SensorManager.html#getSensorList(int)). For displaying the result on the screen, you can show the result in TextView, ListView or any other form you want.

3. For Android development, check the official documentation of Google
   (http://developer.android.com/develop/index.html). You can choose either development based on Eclipse + ADT or Android studio.

4. Since Android emulator does not support Wi-Fi feature, you should work on a real Android device. We can provide a few Android devices for short usage based on request only. You are free to develop the application on iOS, Windows Phone or even HTML5 application.