Mobile Sensing

T-110.5150 - Applications and Services in Internet P

Deadline: 7th December 2014, 23:59 EET

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.

Some references that can be useful:
http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=944052
http://link.springer.com/chapter/10.1007/11428572_8
http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4144757&tag=1
http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4517384

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 another one or two (1-2) solutions. There are several key points that can be followed in the report (max one page).

a. What is the general idea of the solution and how it works?
b. What are the strengths and weaknesses of the solution?
c. Is there any commercial usage of the solution currently?
d. Compare Wi-Fi fingerprint solution with the others (1-2 solutions).

2.1.2 Simple application for indoor localization (50 pts)

In this section, you are required to develop a simple indoor localization application. 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 the Wi-Fi fingerprint you obtain with the referenced data and estimate location. (35 pts)**

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

   There is a **reference** data set in the attachment of this assignment. The data set consists of 6 locations in the A-corridor of the CS building (first-floor), i.e., calibration data. There are also two **measurement** data sets from two random locations of the same corridor. Your task is to pick one of the measurement data sets and compare the **measurement** data set with the **reference** dataset to estimate the location of the **measurement** data. Explain how you estimate the location and how the number of measurement points affects your estimation.

   The **reference** data set is included in ‘measured_data.zip’ with 6 locations in CS building; A112, A118, A124, A130, A136, and A141. The data sets are provided in two formats “csv” and “json”. In the “csv” format file, only three parameters are provided, i.e., Basic Service Set Identification (BSSID), Service Set Identification (SSID), and signal strength. While in the “json” format file, the entire information of Wi-Fi status is provided, including frequency information etc. You can use either of them. Similar data are provided for the **measurement** data sets which is also included in ‘measured_data.zip’. Check the measurement detail in ‘measurement_note.txt’.

One possible approach to estimate location is to use the Euclidean distance (http://research.microsoft.com/en-us/people/padmanab/infocom2000.pdf) of the Wi-Fi fingerprint. You can calculate the Euclidean distance of the **measurement** data with all the 6 **reference** locations. You can also modify the Euclidean distance yourself to meet the requirements.

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

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

2.2 Additional feature of the application (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 only one of them.

(1) Build a calibration database (30 pts)
Build your own calibration data set using your mobile device, similar to the data set that was given to you in the basic features part. Use this calibration database with the localization algorithm you developed earlier to position yourself. **You should be able to acquire higher than 70% accuracy when measuring 6 random points on the corridor.**

OR

(2) Calculate the distance between two reference points. (30 pts)
You can use additional sensors, e.g., 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.

3 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. The latter one is the newest IDE based on gradle published by Google but lack supports of NDK for now.

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. However, our assistance is limited to Android platform only.

4 Submission

The final report should include the following elements:
• The process of the experiment, results, and analysis for each basic feature.
• The process of the experiment and other related contents (mentioned in the requirement) 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.

5 Demo

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. To reduce the influence of device specific measurement difference, there could be two options: either you are given a new measurement data at the demo for localization or you can build your own measurement data sets and localize yourself with those data sets.

The basic requirements are:

- Measure access point signal strengths.
- Locate yourself using measurement data with a given measurement data set or localize yourself with your own measured datasets.

5 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.