Embedded & Pervasive Systems, SS2016
Project Assignment - Smart Watch
Due Date:
M1: May 10, 2016 12:00 (noon)
M2: June 21, 2016 12:00 (noon)

Institute for Pervasive Computing
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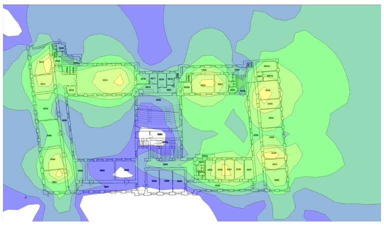
Exercise Group: maybe G1

TA / Points:

Please note that there is compulsory attendance in the exercise lesson!

Location information is an essential resource for building intelligent, context aware systems. Location information can be used to provide instant services to people dependent on their current location (e.g., departure times of trams for the current station, menus at the Mensa Market, ...). Technology for outdoor positioning is available on the market and is already integrated into a vast amount of today's smart phones and smart watches. The majority of this technology is based on the GPS System (Global Positioning System). GPS is a space-based satellite navigation system that provides location and time information anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. The major drawbacks of the system is its high-energy demand, that is especially a problem for mobile devices, and the need of a line of sight to the satellites. Due to the line of sight, GPS is not useable in indoor environments.



RSSi Based Map

To be able to use location information in closed environments, alternative methodologies have to be used. One of these technology named “WiFi based positioning system (WPS)ss is used where GPS is inadequate due to various causes including multipath and signal blockage indoors. WiFi positioning takes advantage of the rapid growth in the early 21st century of wireless access points in urban areas. Commercial providers of this type of positioning service are, amongst others, Google, Infsoft or Navizon. The localization technique used for positioning with wireless access points is based on measuring the intensity of the received signal (received signal strength indication, RSSI) and the method of “fingerprinting”. The accuracy depends on the number of positions that have been (manually) recorded in the database. The possible signal fluctuations that may occur can increase errors and inaccuracies in the path of the user.

Smart Watch

During this project you will implement a Realtime Smart Watch Location Sensor based on the MotoACTV. The watch features various sensor technologies (i.e., GPS, WiFi, Bluetooth) that can be used for positioning. The main aims of the project are 1) to determine the “best sensor setup” for positioning, 2) to implement a real time Android App which is able to use positioning at the level of semantic information in indoor and outdoor locations (e.g. around the JKU campus: “HS1”, “Mensa”, “Science Park Cafe”) and 3) cooperation between watches.

Assignment Part	Points	Score
Positioning Identification . . .	20	
Pervasive Smart Watch Project	28	
Total:	48	

1. **Positioning Identification . . . . 20 Points**

   In the first Milestone you have to identify the sensors on the SmartWatch that are utilizable for RSSI fingerprinting. After you have identified them, write an android App[1] that consist of two components:

10 (a) (i) A Service component that stays in the background and does the actual work in autonomously reading the sensor data (RSSI values) of the available WiFi-Access-Points. This should be performed as close to "real-time" as possible for the demands of an indoor-location-service. (ii) An Activity that implements a simple GUI to control the service, which offers at least the following possibilities:

   - Start and Stop the SensorBackgroundService to record the sensordata (RSSI). Think about how many RSSI values from different station you log (all, just the n-best,. . .) and argue your decision. Also think about if a time discrete logging process (e.g., 1sec interval) is beneficial compared to a continues one regarding learning the RSSI map (explain your findings!).
   - Specify the LogFileName where the annotated sensordata is stored. The LogFile is a simple csv-file containing, as the first element the semantic position followed by the recorded station (MAC) and RSSI value pairs (see example below).
   - Set the current semantic position to annotate the recorded sensor data (RSSI) (e.g., HS1, Mensa, . . .).

```
Mensa,00:A0:C9:14:C8:29,28,00:A0:C9:17:C1:25,65,....
Mensa,00:A0:C9:14:C8:29,31,00:A0:C9:17:C1:25,62,...
Mensa,00:A0:C9:14:C8:29,35,00:A0:C9:17:C1:25,54,...
HS1,00:04:C0:14:C8:29,78,00:04:C0:14:C1:23,54,...
HS1,00:04:C0:14:C8:29,72,00:04:C0:14:C1:23,56,...
HS1,00:04:C0:14:C8:29,74,00:04:C0:14:C1:23,53,...
```

Listing 1: Semantic Positioning Data

10 (b) Write a project proposal with a detailed description for a distributed "pervasive" smart watch app, which incorporates the following aspects:

   - Required: Location based on WiFi fingerprinting
     - Absolute (x,y[,z]) in a reference "coordinate" system.
     - Semantic Positioning (e.g., HS1, Mensa, . . .)
   - Required: Cooperation of more than one smart watch
   - Optional but Encouraged: Other Sensors (Accelerometer, ...)

   If your project proposal gets approved you can use it to implement the second milestone.

   ☐ Approval Requested

   ☐ We will implemented the proposed project.

With the project milestone one you should have a running Android App that collects RSSi values and annotates them with their semantic location. The App will be extended in the next milestone to implement a real time semantic positioning service.

[1] A template to get started: https://www.pervasive.jku.at/Teaching/lvaInfo.php?key=411&do=material

28 2. **Pervasive Smart Watch Project .... 28 Points**

If you proposed your own idea for implementation and it got approved proceed to (b) otherwise do (a).

(a) Some people are really bad at remembering names, faces or where the first have met someone. While exchanging business cards might have worked in the 20^{th} century, most people don't have one these days, so you decide to change this analog ritual to a 21^{st} century digital one. While sketching out ideas you found that the following to be the best solution in terms of pervasiveness and ease of use. Basically if you shake hands with someone you exchange the same digital contact information as you do in person: a name, a face and a joined location. Write a Pervasive Smart Watch App with the following functionality:

- Users are able to map RSSi Readings to an "absolute location" (e.g. (x/y[/z]) of campus map) and a semantic location (e.g. HS1)
- Users are able to store and change contact information. (name [required], photo [optional])
- Real-time Positioning using trained RSSI Map and Sematic Location generated in (a). For the estimation of the position use the Euclidian Distance defined as follows: $d = \sqrt{(SS_{ci1} - SS_{m1})^2 + ... + (SS_{cin} - SS_{mn})^2}$ †
  For each known location identified during the training/learning phase, you have to calculate the likelihood of being at this position based on the real time gathered RSSI values. The most likely one therefore is your current position.
- Write a **simple** hand-shaking detection algorithm (Hint: Accelerometer).
- Extend your application such that if two person are shaking their hand with each other their contact information (given name [required], photo [optional]) and their meeting place (semantic location) gets exchanged (e.g. other persons details are displayed on the watch) and stored for later reference.

Verification To test the accuracy of your implementation, your application will need to perform this in a real world scenario, e.g. you will shake hands with multiple persons (wearing your watch/software) in class and should have afterwards a LogFile containing the semantic position in the map, the estimated (absolute) position, the MAC:RSSI tuples used for identification and the contact information of the users you shook hands with.

(b) Implement the "Pervasive Smart Watch App" based on 1.b.

Verification To test the accuracy of your implementation, your application will need to perform the specifed use case in a real world scenario. If you are unable to reproduce this in class you are required to record a video along with the corresponding LogFile containing the semantic position in the map, the estimated (absolute) position, the MAC:RSSI tuples used for identification and events that took place or were triggered by your application. You will be questioned by the lecturers and your colleagues about your implementation.

† SS_{ci1}: RSSi Value (Calibration Phase, Position i, Basestation 1), SS_{cin}: RSSi Value (Calibration Phase, Position i, Basestation i), SS_{m1}: RSSi Value (Positioning Phase, Basestation 1), SS_{mn}: RSSi Value (Positioning Phase, Basestation n)