



Accurate Outdoor/Indoor Positioning

You are required to design and implement a location application that will point out your location on a Google map as accurately as possible. The application should have outdoor-indoor handover for positioning transition from outdoor to indoor or vice versa.

You should use the Fused Location Provider as the starting point to get location. You can start by getting the last known location of the device, which is usually equivalent to the user's current location. Details on how to use the Fused Location Provider for this can be found in Reference [1].

For continuous added accurate positioning indoors, the application should use the magnetic (EMF) sensor values, Wi-Fi received signal strength (RSS), and any other information such as unique features extracted from location images captured using the camera.

You are required to build the indoor part of the application to consist of 2 phases; training phase and positioning phase.

- **Training Phase**

- In this phase, you will record EMF values/Wi-Fi RSS scans/image features for multiple different locations and store these on the phone.
- The recorded data are essential as reference values for comparison during the positioning phase.
- You can use a database to record these values. A guideline on how to create and use a database is given in "Guide on Creating a Database" on Learn.
- It is required that the training phase be a continuous one. That is, given a start and end locations, the application should automatically pick sample location information as the user moves from the start location to the end location and record EMF/Wi-Fi/image feature/etc. values for these.
- The distance between the start and end locations, and the number of sample locations are your choice. However, you should keep these within reasonable limits, especially for demonstration purposes.
- Moreover, further training sessions should add to already collected samples rather than replace them.
- The steps in the training phase are as follows:
 - EMF readings (X, Y and Z axes)/Wi-Fi scans (SSID, BSSID and level)/image features and related information (X and Y coordinates) are recorded and saved into a database.
 - Any other information (e.g., other sensors) can be recorded as well, depending on the application (positioning algorithm).
 - Several EMF values/Wi-Fi scans/image features are recorded at different locations such as location coordinates (1, 1); (1, 2); (1, 3) to (n, m). These readings are referred to as Reference Points (RPs).

- The distance between two consecutive RPs is not fixed. It can be from 1 meter or more, but the smaller the gap, the better accuracy it would have.

- **Positioning Phase**

- In this phase, you will take EMF reading/Wi-Fi scans/image captures at your position and compare these with the RPs to determine your current position on a Google map or a floor plan.
- The steps in the positioning phase are as follows:
 - The EMF values/Wi-Fi scans (SSID, BSSID and level)/image features of the user's position are recorded.
 - The values are then compared with the information in the database (RPs recorded during training phase).
 - The X and Y coordinates from the database with the nearest value to the Wi-Fi scans at the user's position are returned to the user.
 - Any additional information may be passed to the user depending on the application.

- Challenges you should address.

- There are signal noises which will affect the value of the EMF readings/Wi-Fi scans. A filter can be added to improve the readings.
- It is generally good to make the calibration phase as automatic and easy as possible. The more the calibration cost/time, the more expensive is the process.

- Optional features you can add:

- A picture can be taken using the application in the positioning phase and displayed either directly on the map or attached to the map marker using the accurate positioning you developed.
- A step counter can be added to improve the positioning even further and/or to simplify the training phase.
- Use any other sensors you can think of to improve the accuracy. For example if your phone has special sensors such as barometers then you can detect level information as well as the horizontal information.
- You can use publicly available building floorplan information and overlay these on Google map for indoor navigation.
- Add navigation features from point A to point B.
- Be able to store/tag points of interest (with pictures if possible) in areas extending indoors.
- Navigation and guidance for people with special needs such as the blind.
- Any other innovative features. Generally explore the area of Location based services and see what you can extend indoors.

- **NOTE:** If you have any other ideas in mind as to the nature of the application and features for the assignment, please feel free to contact the course organizer (Prof Tughrul Arslan, t.arslan@ed.ac.uk) to discuss this.

Reference [1] - <https://developer.android.com/training/location/retrieve-current.html>