Abstract: Indoor Localization with Multi-modalities

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Executive Summery

In this contest abstract, we are going to demonstrate two point-based localization approaches. The first approach uses existing WiFi infrastructure and the geomagnetic field. The second approach further leverages the illumination LEDs which will be instrumented. We provide more details about each approach below.

Approach 1: WiFi, Magnetism + IMU sensors

Today, WiFi and IMU sensors (accelerometer, magnetic, and gyroscope) are widely available on commodity phones. Our first approach is motivated by a few key observations: (1) In modern venues like shopping malls and airports, wireless access points (APs) are widely available, which enables the usage of WiFi signals to distinguish different locations. (2) IMU sensors make it possible to use phone to track the users movement with dead-reckoning as shown in [1]. (3) The geomagnetic field is disturbed by the building complex which yields anomalies associated with locations, which can be exploited to differentiate locations.

Our approach features with an augmented particle filtering to fuse signals from WiFi, magnetic field and IMU sensors for off-the-shelf smartphones. It begins with an off-line bootstrapping phase, during which we construct a database with WiFi and geomagnetc fingerprints calibrated at various locations. During the online inference phase, the location is determined using particle filter which executes on a per-step basis. Particles are initially uniformly distributed across the whole interested area. When a step is detected by the accelerometer with a robust step detection algorithm, we update the location of each particle by a certain step length and direction following Gaussian distributions. Then, we compare the measured WiFi and geomagnetic field signals with the database and update the weight for each particle. Specifically, we higher the weights of particles with observed WiFi and geomagnetic field readings close to the stored values in the database, and lower those in contrast. Afterwards, a resampling process is carried out to filter out those particles with low weights. The above procedure executes iteratively to continuously track the location of the user.

Approach 2: Visible Light Localization

Recent years have witnessed the widespread of LED based lighting systems due to its high illumination efficiency, long lifespan, and environment friendly. One feature of LED is that it can be turned on/off instantaneously, which makes it possible to communicate over visible light. We envision that, in the near future, off-the-shelf LED bulbs are capable of transmitting signals embedded in the visible light, such that we leverage the illumination system for accurate localization. Our LED based localization system is called *Epsilon* [2], where each LED light source beacons information including ID and location on a certain optical channel. The client (smartphone) receives and decodes the signal with a light sensor. The distance from the client to each light source is calculated with a model based on the received signal strength (RSS), and the location is determined using trilateration. More details on the localization algorithm can be found in [2] which is omitted here due to the space limitation.

1. REFERENCES

[1] F. Li, C. Zhao, G. Ding, J. Gong, C. Liu, and F. Zhao. A reliable and accurate indoor localization method using phone inertial sensors. In *Ubicomp*, 2012.

[2] L. Li, P. Hu, G. Shen, C. Peng, and F. Zhao. Epsilon: A visible light based positioning system. In *NSDI*, 2014.