Uhuru: An Inbuilding Location Tracking System
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**Goal:** Build and explore various aspects of an RF based inbuilding location tracking system

**Motivation**
Build RF based in-building Location Tracking System

**Sample Application:** Allow authorized users to track other users in building, iff users are willing!

**Location Tracking System**

No need for human guides in places of interest

*users in building, iff users are willing!

**Location Detection With Uhuru**
Involves two stages (Naïve Algorithm):

**Off Line Phase:** User manually informs program of location within building

- Record information about radio signal as function of user’s location
- Wireless card put into “Scan Mode”
- Record signal strength, location, direction tuples

**Real Phase:** Compare measured signal strengths against those from Off Line Phase

- Simple table lookup in order to ‘guess’ location
- Metric: ‘Euclidean Distance in Signal Space’
  \[ d = \sqrt{ (O_1 - R_1)^2 + (O_2 - R_2)^2 + \ldots + (O_n - R_n)^2} \]

**History Monitoring Algorithm**

- To improve accuracy, devised and implemented History Monitoring algorithm
- Maintain graph of building,
  - Vertices represent locations where signal strength readings were taken in Off Line Phase
  - Edges model possible transition paths from one such location to another
- Don’t report best physical location from table lookup, but maintain list of k closest signal strength matches
- Look these up, closest in signal space first, against window of n nearest neighbors of previously reported location value
- Report best value as obtained from table lookup that leads to a physical location in n neighbors

**Heuristic for Base Station Placement**

- Investigation of placement important to get better accuracy with a given number of base stations
- \[ PL(d) = PL(d_0) + 10 \log(d/d_0) \]
  - Model predicts two points equidistant from same base station records identical signal strengths
  - Distance affects signal strength more when point is closer to base station than when it is farther away
  - Deploy majority, say 50% of base stations on second floor
- Arrange base stations (say k in number) randomly on second floor so that minimum distance between any two stations \((d_i, d_j)\), \(i \neq j\), is \(D\)

**Algorithms in Action**

**Results**

**Research Directions**

- Adopt more efficient algorithms and data structures for faster search of signal space, imperative when signal space is bigger (eg: optimal k-nearest neighbor search)
- Combine multiple types of technologies: Infrared, Bluetooth etc.
- Deploy base stations according to heuristic and quantify improve ments