

Bachelor Thesis: Indoor Localization with iBeacon/iOS

Patrick Hodel
University of Bern

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Seminar FS17

Outline

- 1 Thesis proposal
 - Goal of the project
 - iBeacon and BLE
- 2 Approach
- 3 Achievements & Challenges
 - Current app
 - API Restrictions
 - Signal are not always reliable

A Real-time Indoor Tracking System in Smartphones

- Project from Jose Luis Carrera
- Indoor tracking to support continuous tracking and positioning
- Enhanced particle filter to fuse:
 - Range information from RSSI
 - IMUs information
 - Floor plan information
- Double resampling method in the particle filter
- Real-time system, which runs on commodity smartphones

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Alternative: Implementation using Apple's iBeacon protocol

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BLE (also Bluetooth Smart™)[3]

Much lower consumption (1% to 50%), lower range and data rate compared to Classic Bluetooth technology

Advertising mode

- One-way discovery mechanism
- Packet transmission every 20ms to 10 seconds
- Can be set up to operate in non-connectable advertisement-only mode
- Used for iBeacon operation

Connecting mode

- Allows reading and writing of values
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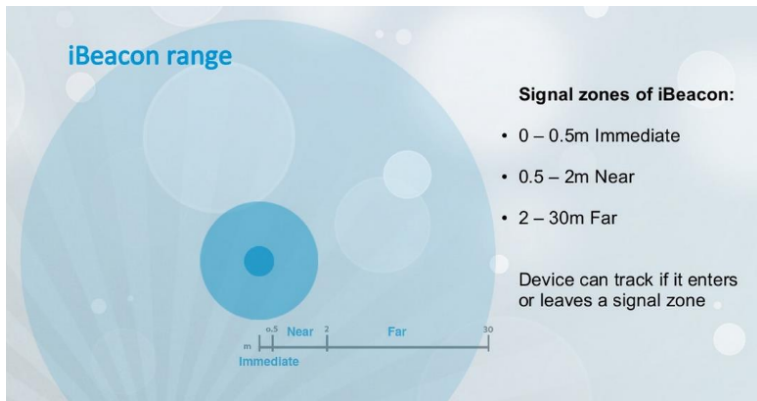
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iBeacon

iBeacon technology is not intended to be used for specific location identification.[2]

iBeacon zones



BLE Propagation model[5]

$$\text{RSSI} = R^0 - 10\gamma \log \left(\frac{\hat{d}}{d^0} \right) \implies$$
$$\hat{d} = 10^{(R^0 - \text{RSSI})/10\gamma}$$

R^0 is a calibrated RSSI value corresponding to one-meter distance
 γ is a calibration parameter for the path loss exponent

Hardware[4]

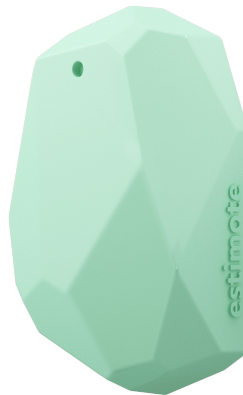
- Beacons available from different vendors
- Different shapes, battery sizes, chipset, firmware



Estimote Beacons[1]

Characteristics

| | |
|--------------|---|
| Battery life | 2 years |
| Range | 70 meters |
| Price | 59\$ for 3 beacons |
| Features | Multiple sensors Configuration & Monitoring Tools |



Overview



Overview



Learning Estimate &
Swift programming

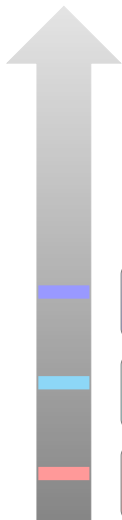
Overview



Understand current Wi-Fi-based positioning system

Learning Estimote & Swift programming

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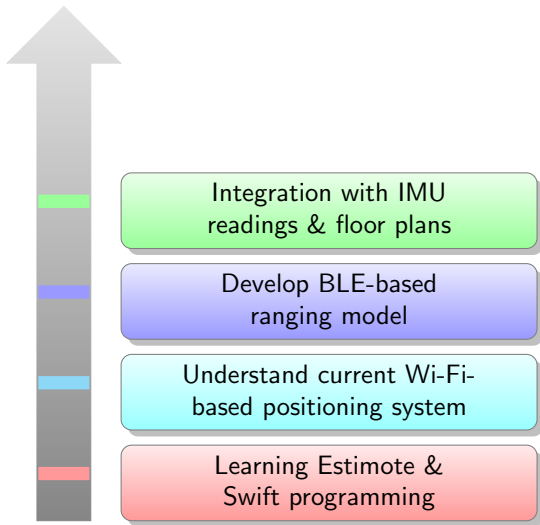


Develop BLE-based
ranging model

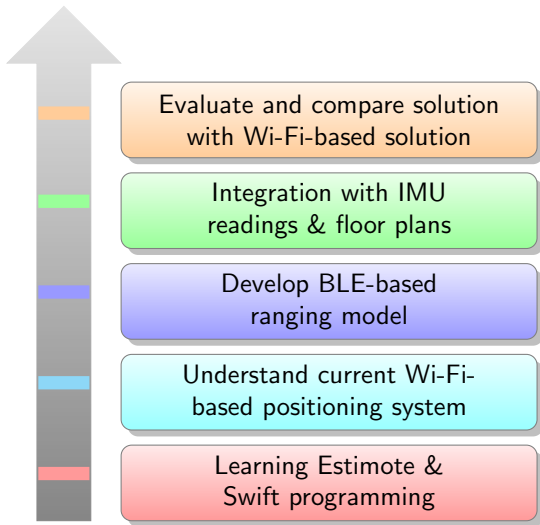
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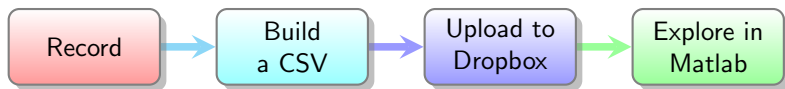
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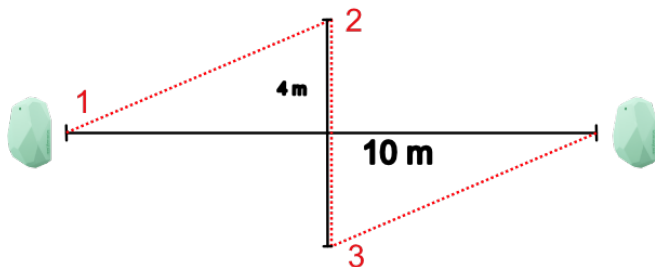
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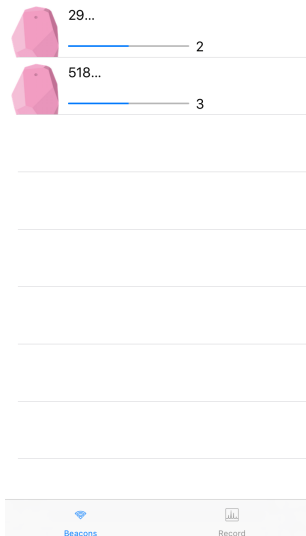
Prototyping Workflow



Walking



Screenshots / Demo



00:06:33

filename.csv

Stop

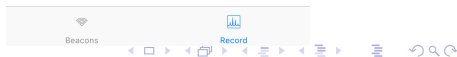
Current phase

0

Next phase

| | | | |
|--------|--------|-------|--------|
| AccelX | 0.077 | GyroX | -0.019 |
| AccelY | -0.559 | GyroY | -0.038 |
| AccelZ | -0.834 | GyroZ | -0.026 |

| Beacons | Proxim... | Ac... | RSSI |
|------------|-----------|-------|--------|
| 34251:2... | 2 | 1.80 | -79 |
| 38445:5... | 3 | 10.59 | -96 |
| AccelZ | Label | Label | AccelX |



Scanning Frequency

CoreLocation Ranging updates only once per second

- Low frequency of RSSI updates impede's reliable location prediction
- Alternative: Use CoreBluetooth methods
 - Association between scanned RSSI values and iBeacon missing
 - Guessing might be unreliable
 - Other Bluetooth devices can interfere

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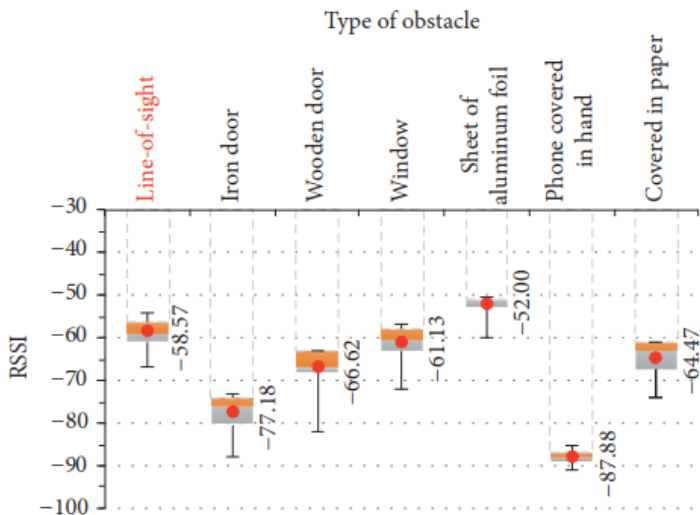
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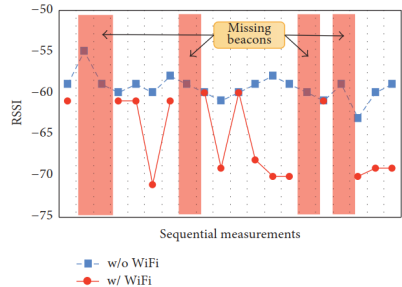
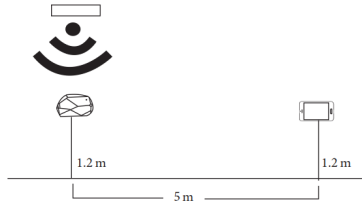
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Obstacles[5]



WiFi Interference[5]



Bibliography I



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Questions

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