Real-Time Arrival Departure Detection

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Why "Arrival/Departure Detection" instead of "Indoor Localization"

- Localization needs multiple beacon deivces installed nearby, which is not applicable in real world for large scale applcaition like city-range food delivery system.
- RSSI fluctuation (fast fading) makes BLE beacon not suitable for indoor localization. This is also supported by our experiment as well as Apple's claim in the technique report.

Why not simple filtering

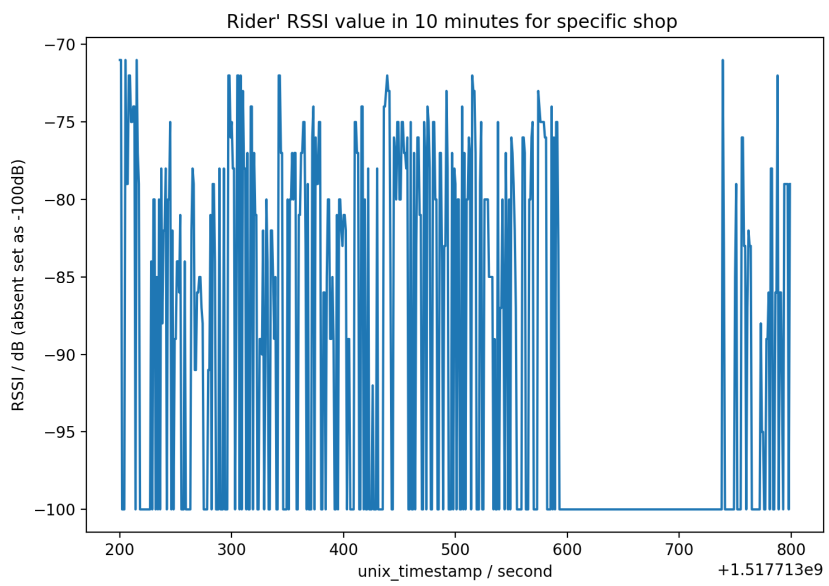
In the beacon filtering blog, we discuss the arrival and departure detection using filtering. However, this method is an off-line method based on the entire dataset. While in some scenarios, such as rider dispatching, we need **real time** information of people's arrival and departure at some indoor/outdoor environment.

In this post, we discuss real time arrival departure detection using beacon RSSI data. We will illustrate several techniques to achieve this.

Short range low pass filter

For the short range low pass filter method, we assign a low pass filter to each rider-shop-pair and move the filter as time goes on.

For a specific (rider, shop) pair, the RSSI values are as follows

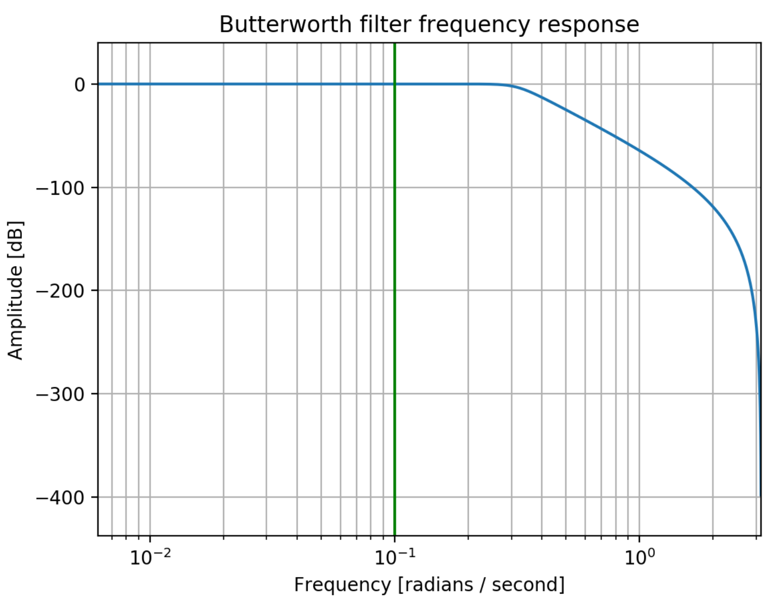


We can design a low pass filter based on what we have discussed in the beacon filtering blog.

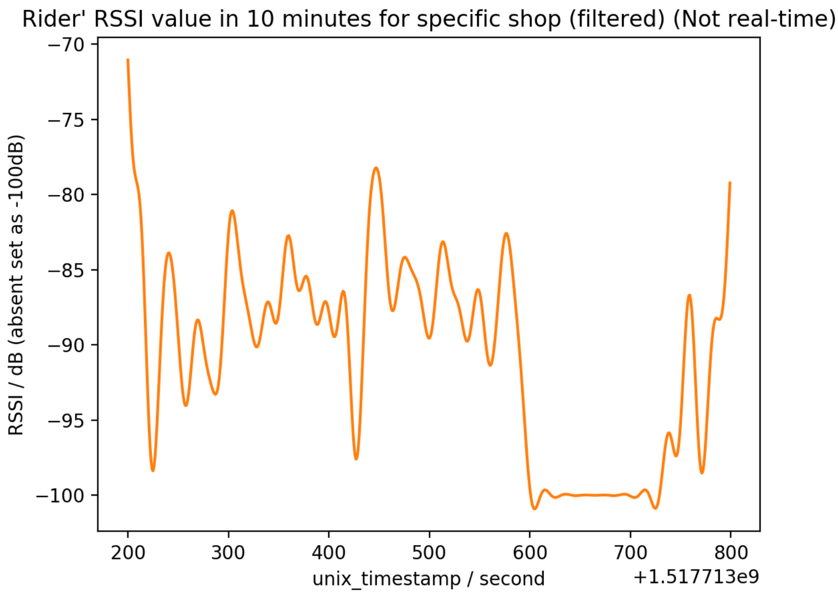
Here we choose a digital Butterworth low-pass filter with the following form:

$$G(z) = \frac{B(z)}{A(z)} = \frac{b(1)+b(2)z^{-1}+\ldots+b(n+1)z^{-n}}{a(1)+a(2)z^{-1}+\ldots+a(n+1)z^{-n}}$$

We set the cutoff frequency as $\omega_c = 0.1$ since the sampling frequency of the system is $f_s = 1\mathrm{Hz}$, we assume that signal changes faster than ω_c is due to fast fading but not human movements. The frequency response plot of the filter is as follows:



If we don't need the rider's real-time arrival/departure information, we can design an offline filter working on the entire dataset. The result will be like follows:



After the filter and shaving, the result are as follows:

By introducing a short range moving window low pass filter (LPF), we can set a window (say 10 seconds) and filter the RSSI value in the window and do the in-region recongnition and decide the arrival/departure momoments.

(The implementation of short range moving window LPF is to be done.)

This method (moving window LPF) can give us an relative accurate method (compared with offline detection), but is too complicated to maintain for large system, given tens of thousands of riders and restaurants working at the same time. That is, we need some more light-weight application that can achieve arrival/departure detection.

Light weight arrival/departure detection algorithm

TBD

(One possiblity is single moving filter for one rider (but not rider-shop pair))