CS4222 Assignment 4 Report

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1. Quick Start

This assignment is written in python2.7. To run the code,

1. Install paho-mqtt.
   ```
   > pip install paho-mqtt
   ```
2. Make sure *unicast_receiver.c* code is running on the Indra testbed. Then start listen to the MQTT server:
   ```
   > python receiver.py
   ```

2. The algorithm

2.1.Indoor/Outdoor Detection

Let the sliding window size to be 5.
We basically followed the algorithm describe in the IO Detector paper but only use the light sensor data as the input. However, instead of the recommended threshold of 2000 lux, we set threshold T=450. If the average luminosity in a given window is larger than T, the state is INDOOR. Otherwise, the state is OUTDOOR.

2.2.Idle/Walking Detection

Let the sliding window size to be 100.
Once we receive an accelerometer reading (x, y, z), the square root sum

$$sqrtsum = \sqrt{x^2 + y^2 + z}$$

is calculate and stored. Then get all records in the sliding window, i.e. the latest 100 records. The range of these 100 records is calculated. If the range is larger or equals to 0.5, the state is WALKING. Otherwise, the state is IDLE.

2.3.Floor Change Detection

Since altitude changes lead to pressure changes, we use barometer sensor data to detect floor change.
Let the initial window's mean barometer reader be x.

For each subsequent window, we calculate the difference between the mean and x. If the absolute value of current x is bigger than the threshold and the previous difference is smaller than the threshold, or the absolute value of current x is smaller than the threshold and the previous difference is bigger than the threshold, we detect a floor change. Otherwise, there is no floor change.

3. Measurement of Accuracy

Algorithm/ Dataset	walk_1		walk_2	
	Number of detected events*	False positive count	Number of detected events*	False positive count
Indoor/Outdoor Detection	0 / 2	0	2 / 2	2
Idle/Walking Detection	4 / 4	2	4 / 4	0
Floor Change Detection	2 / 4	2	6 / 8	2

* An event is considered detected if it appears within 30000 contiki second range (around 30s) after a ground truth event has happened.

4. Limitations and Improvements

4.1. Quality of the Original Dataset

We notice the given dataset, *walk_1* and *walk_2, both* have some inconsistency between the numbers and the ground truth. This created some challenges for us to test our algorithm. For instance, we initially considered employing a Bernoulli Naive Bayes model to classify indoor and outdoor readings soon found out the given data could not be trained to give reliable predictions. Also, in our indoor/outdoor detection algorithm, we have to lower the threshold value from a recommended value of 2000 to 450 in order cope with the existing data. This could potentially lower the overall accuracy rate.

4.2. Packet Lost

The given u*nicast_send_from_usb.c* transmits data with best effort and no reliable transmission protocol is implemented. Given the low sampling rates of light sensor and barometer(approximately 0.1Hz for barometer, 0.05Hz for light sensor), the packet loss in transmission is untolerable. The missing packet results in great fluctuation in detection result and accuracy rate. Furthermore, since the sliding window algorithm picks the latest N packets for calculation, any packet loss will be translated into a larger sliding window time, rendering more deviation in the final result.

4.3. Spectrum Response Range of Light Sensor OPT3001

The light sensor OPT3001 on CC2650 has a spectral response matching to human eyes. According to its datasheet, 99% of the IR is rejected. This makes the sensor tag unsuitable for indoor/outdoor detection tasks because the algorithm used heavily relies on the light intensity change to differentiate indoor and outdoor scenes. In natural, the sunlight comprises a large portion of invisible IR as compared to indoor light sources which only produce visible light. For indoor/outdoor detection tasks, this means the sensor will give a larger flux reading at outdoor and thus produce more distinguishable data.

5. Reference

[1] Mohammad, Mobashir, Raj Joshi, and Mun Choon Chan. "EleTrack: Ultra-Low-Power Retrofitted Monitoring for Elevators," International Conference on Embedded Wireless Systems and Networks (EWSN) 2018.

[2] Zhou, Pengfei, et al. "Iodetector: A generic service for indoor outdoor detection." Proceedings of the 10th acm conference on embedded network sensor systems (Sensys) ACM, 2012.