Sidewalk Anomaly Detection using Mobile Sensor

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Introduction

1. Sidewalk plays an important role in sustainable transportation systems [1]. Bad conditions of sidewalks will bring risks to pedestrians, wheelchairs users, travels as well as persons carrying heavy loads [2]. According to the Americans with Disabilities Act of 1990, sidewalks must be 'accessible to and usable by ' people with disabilities, who make up nearly one-fifth of the American population [3]. The quality of sidewalk becomes one of the most significant factors for city sustainable planning.
2. However, tradition road condition monitor methods including 3D reconstruction, vibration and vision based are labor-intensive and costly, which limits the sustainable city planning [4].
3. This research aims to use mobile sensors to collect anomaly-related data efficiently and create an anomaly map for our campus.

Data and Methodology

The research has three main steps, shown as figure 1, including:

1. Using phones mounted in a scooter to collect acceleration data when we rode through a sidewalk, then use Euler Angle to reorient acceleration data.
2. Developing algorithms to detect sidewalk anomaly with information of location. There are three parameters in the algorithm, the first one is used to detect peak points, the second one is used to remove noises and the third one is used to select peaks with very high values. The processes are:
   Firstly, all the peak points are detected using Robust peak detection algorithm.
   Secondly, peak points with noises are removed by setting a threshold.
   Finally, peaks with predefined patterns are obtained using pattern filter, and peaks with very high values are retained using the third parameter. The detection steps shown as figure 1.
3. Create sidewalk anomaly maps using mobile phone GPS signals and detected anomaly points.
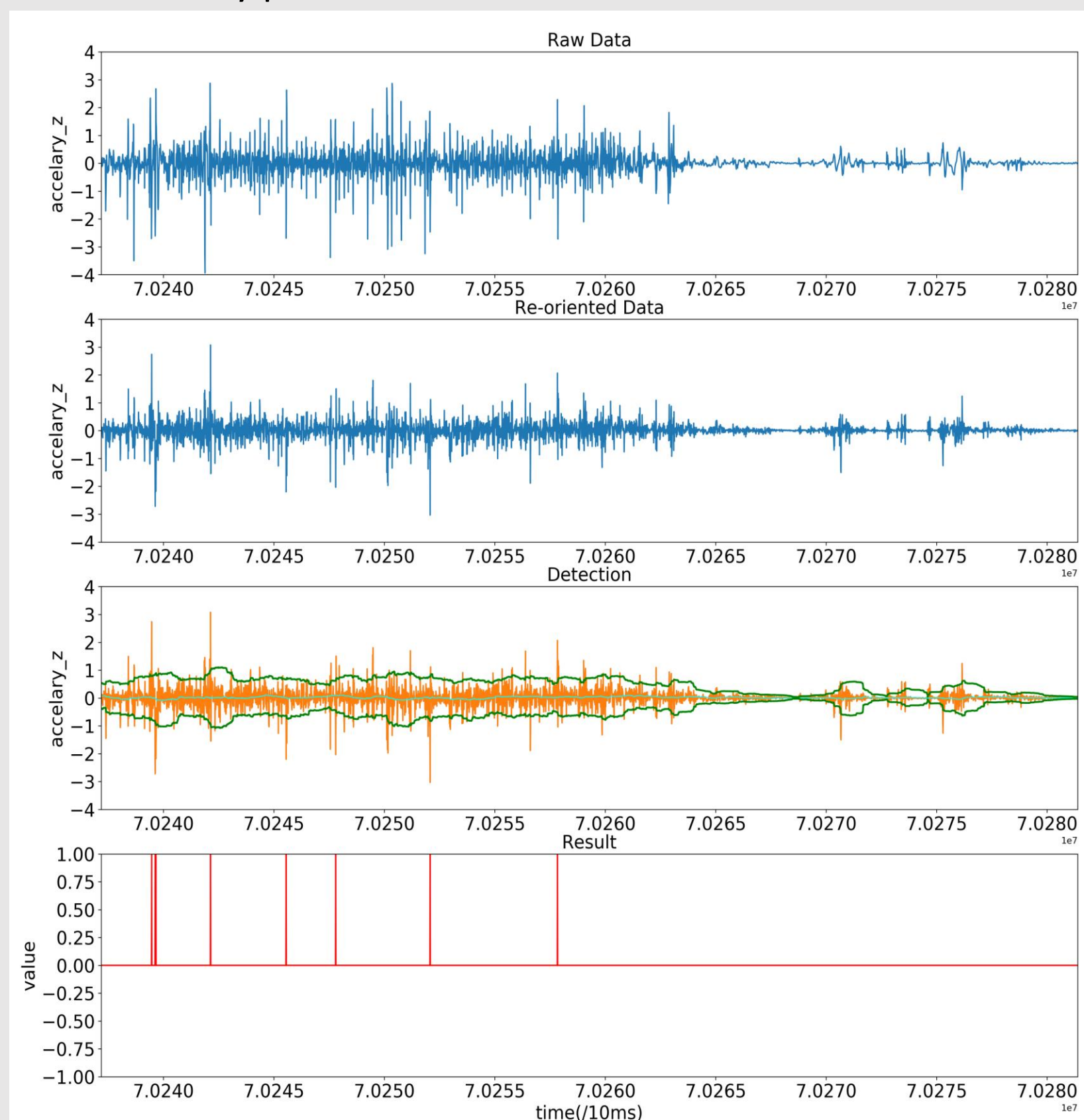

Figure1. Detection process

Result

This research obtains the accuracy of IOS and Android system in different speed by changing threshold parameters, shown as figure 2. We can find that the accuracy of IOS system gets the best accuracy of 90% with the speed of 5m/s and the parameters of '2, 1.7, 2'. The accuracy of Android system gets the best accuracy of 30% with the speed of 5m/s and the parameters of ' 2, 5, 6'

Then the research uses IOS system with setting 2, 1.7, 2 as threshold and keep the speed of 5m/s to get the campus anomaly map, shown as figure 3.

Finally, a campus sidewalk anomaly map is built using the IOS system and coefficient combination of '2, 1.7, 2' . The sidewalk anomaly map and some anomaly examples are shown as figure 3.
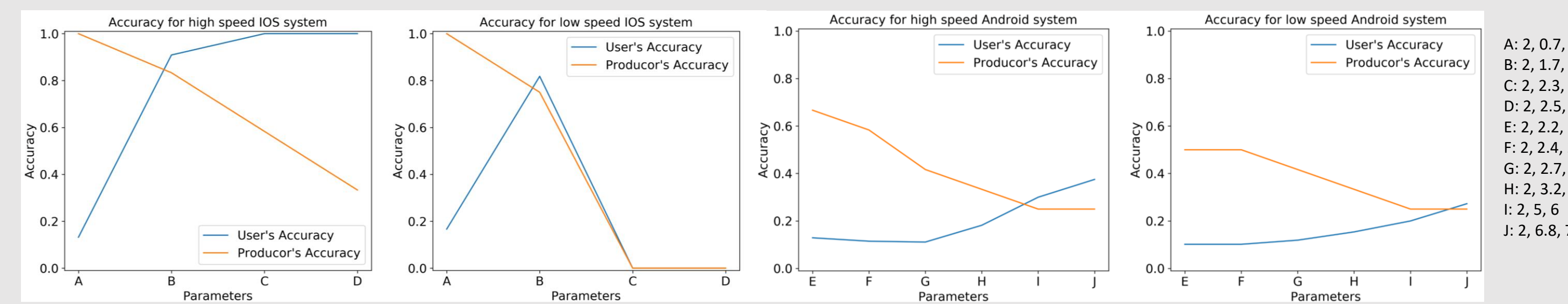

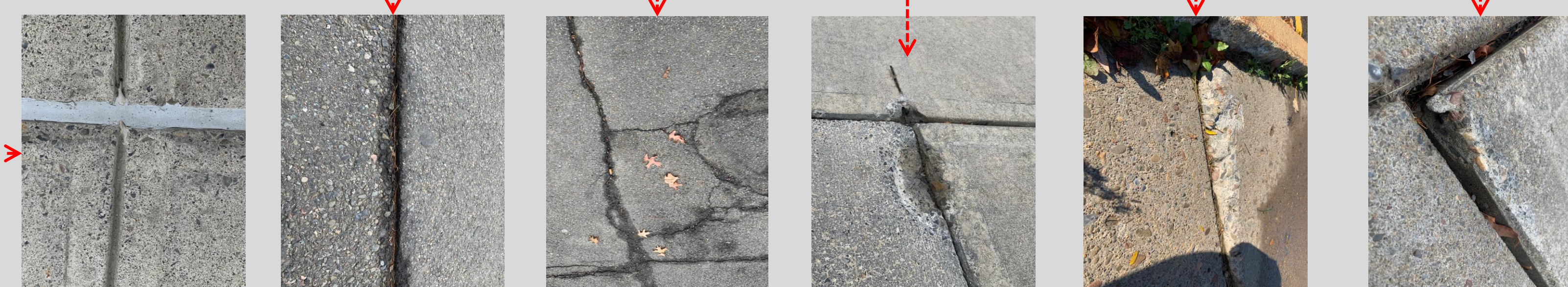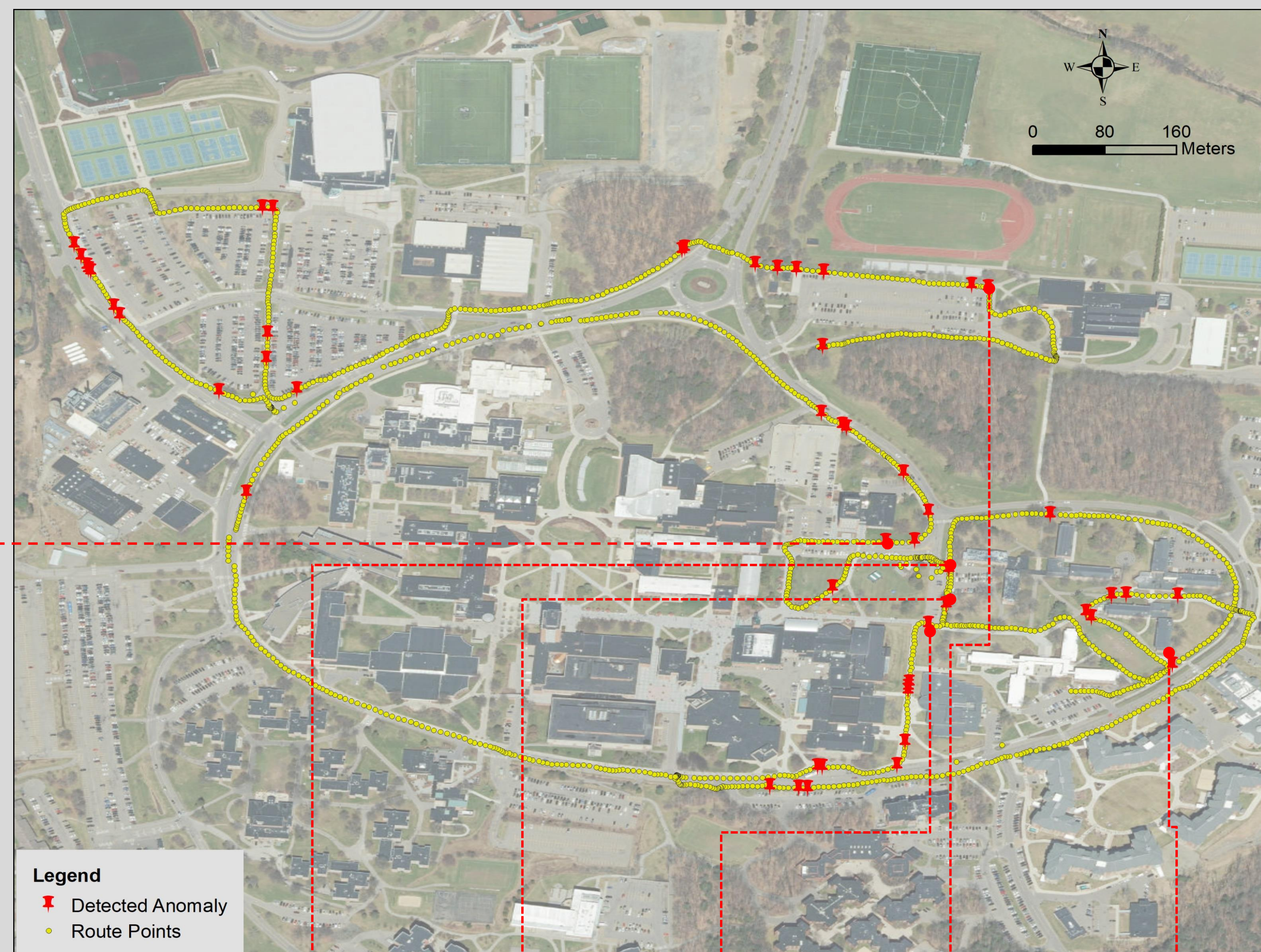**Figure 2.** Accuracy of different coefficient combinations in four conditions

Figure3. Campus anomaly distribution map

Discussions

1. In this study, we use mobile sensor to detect sideway anomaly and compare the IOS system and Android system with different riding speed(2m/s and 5m/s).
2. The highest accuracy of IOS system reaches 90% and Android system is only 30%.
3. The speed can also influence the accuracy of the algorithm. We can get the highest accuracy with the speed of 5m/s: 90% for IOS system and 30% for android. Lower speed makes lower accuracy: 80% for IOS system and 25% for Android system.
4. From the anomaly map for Binghamton University we can see that some points are over estimated. This is because of the change of speed when yielding to pedestrians.

Conclusions

1. Mobile sensor can detect sidewalk anomaly efficiently.
2. IOS system with speed 5m/s gets the highest accuracy.
3. The Sidewalk Anomaly Detection Algorithm is sensitive to speed.

Acknowledge

References

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