E-Scooter Mobility Sensing for Smart City Public Safety and Asset Management

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NSF | CENTER FOR SMART STREETSCAPES

Background

- Incorporates the Center for Smart Streetscapes' Situational Awareness thrust.
- Roads and sidewalks are essential for connecting people.
- Bumpy riding surfaces are unsafe, especially at high speeds and in adverse weather conditions.
- Smooth surfaces reduce accident risk for wheelchairs, strollers, scooters, etc.
- How do we quantify and classify these surfaces?

Objective

- Use accelerometers on e-scooters to classify riding surface types.
- Applications include detection of surfaces for unsafe ride prevention.
- Riding surfaces in poor conditions can be reported for maintenance.

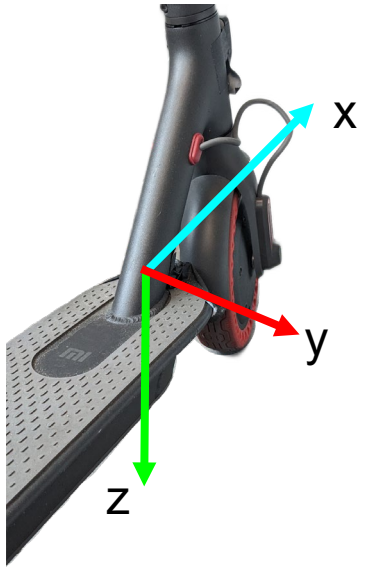
System Design

Hardware
- Xiaomi Scooter
- Camera (Logitech C920)
- Raspberry Pi
- IMU (Accelerometer)
- GPS

Software
- LCM (Lightweight Communication Protocol)
- BLE (Bluetooth Low Energy)
- Phidget22 Library
- Raspbian OS/Systemd/OpenCV

Data Collection

- Collected accelerometer data on three surface types.

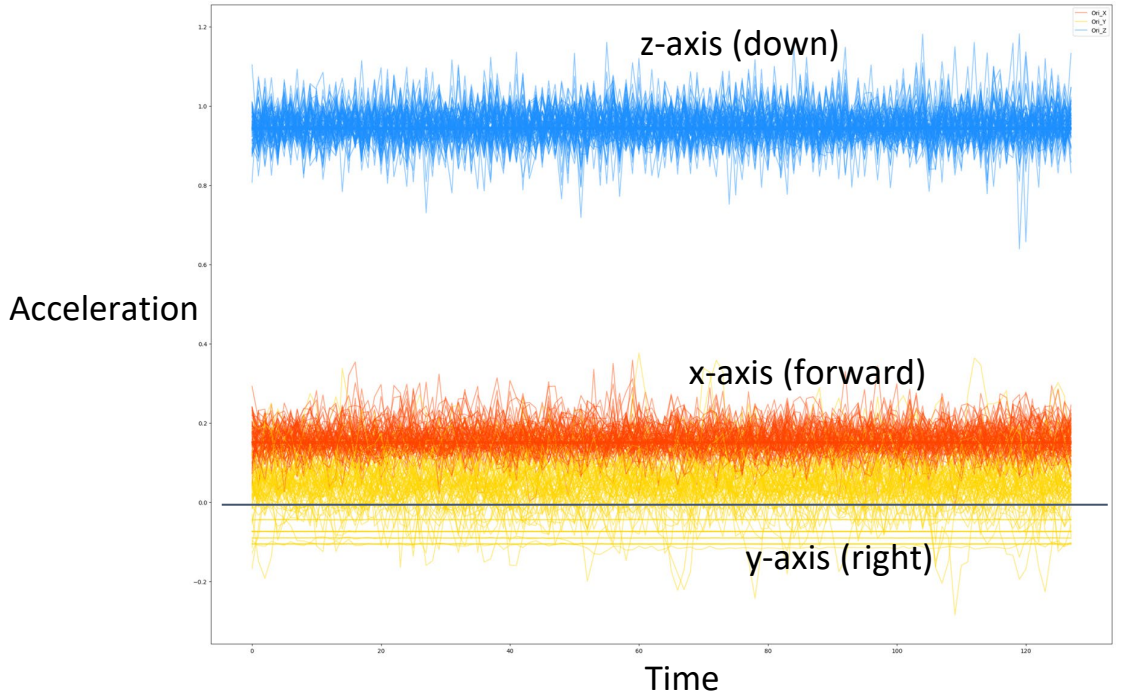


Data Stream

Acceleration		
0.19646	0.04279	1.06407
GPS		
26.372973	-80.100547	10.9
Speed		
8.83		

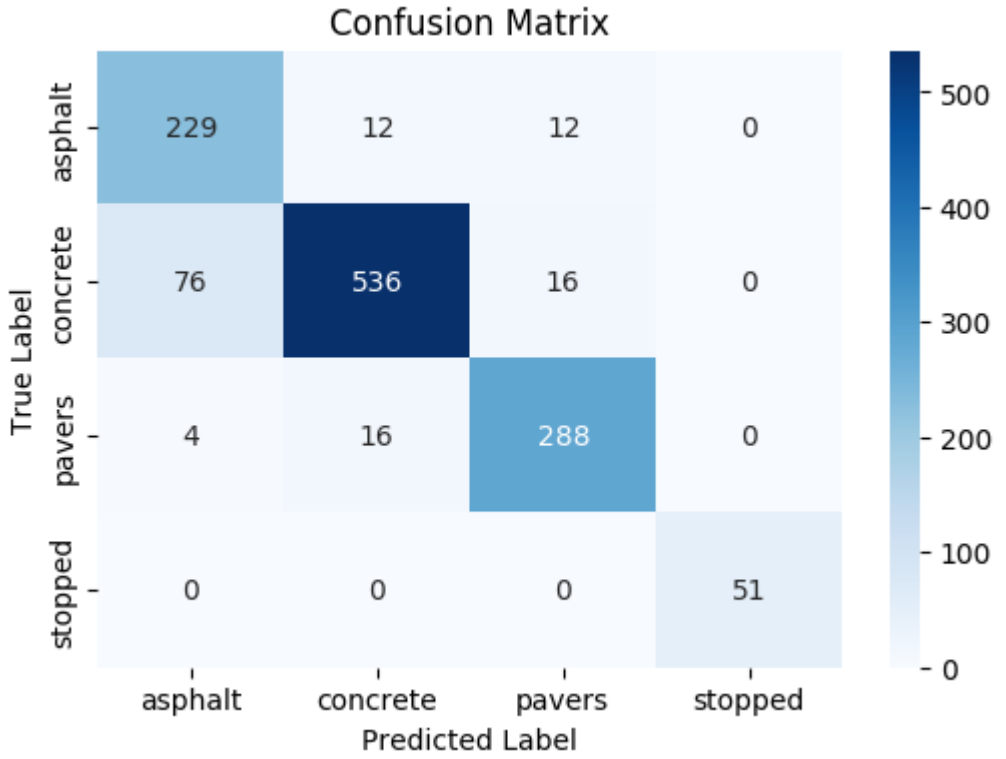
Data Processing

- Split data into segments of 128 data points (around 10 seconds each).
- Labeled each segment as one of the four surface types using the video reference.
- Used each segment/label pair as the input/output for training the Machine Learning model.



Machine Learning

- Implemented a LSTM Recurrent Neural Network using PyTorch, with poor (~50% accuracy) results.
- Trained a model using Fast Fourier transform and tsfresh feature extraction with 80% accuracy.



Conclusions

- Prepared e-scooter for data collection using IoT devices.
- Collected over three hours of data on different surface types.
- Applied Machine Learning models to the collected data.

Future Work

- More data collection on more varied surfaces.
- Put GPS data, and potentially speed data, to use.
- Fine-tune machine learning model for greater accuracy.
- Equip the Raspberry Pi to run the model in real-time.

Questions & Feedback