

Detecting and Propagating Traffic Accident Events Using Sensors in Smartphones

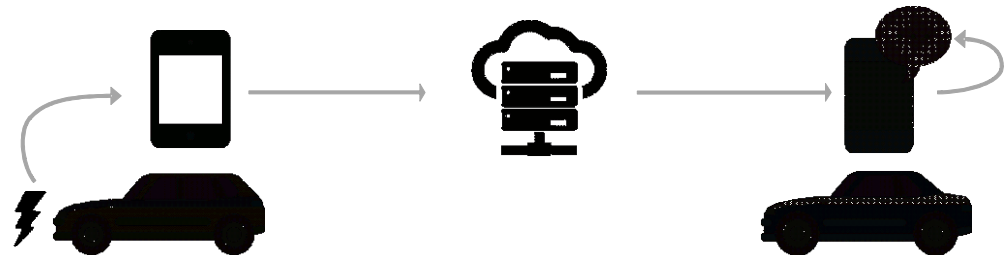
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SK Telecom**

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- Introduction
- Challenges
- Approach
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- Analytics
- Propagation of events
- Preliminary Result
- Future Work

Introduction

- **V2X communication has been around for several years**
 - 802.11p (aka WAVE): draft from 2005, finished in 2010
 - LTE-V2X: first version is included in LTE Rel.14
- **However, the commercialization of V2X has been delayed due to various reasons, such as**
 - Lack of interest from car OEMs
 - Delay of regulation requiring mandatory V2X connectivity
- **Some of the scenarios of V2X is possible to implement without full-fledged V2X communication**
 - Many V2I scenarios
 - Some V2V scenarios

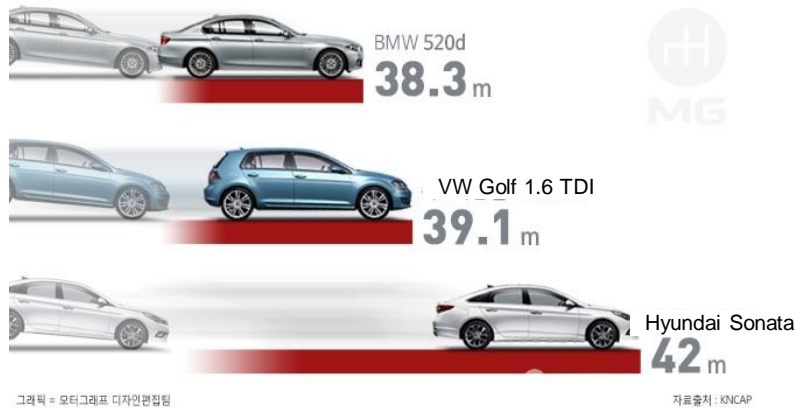


Detecting of 'hard braking' and propagating to the following cars

Challenges

Hard to detect hard breaking using inertial sensors

- Gravity is larger than the acceleration when sudden stop



	Dist. (m)		Accel. (g)	
	Wet	Dry	Wet	Dry
Avante	43.32	45.91	0.91	0.86
<u>Carnibal</u>	42.9	45.5	0.92	0.86
Grandeur	41.9	42.4	0.94	0.93
BMW 520d	38.3	39.6	1.03	0.99

Source: KNCAP

Issues:

- Deviation is high among devices, and noise is common in the result
- It is essential to minimize the delay – the event should be emitted ASAP
- Care should be taken not to drain the battery heavily

Approach

To improve the performance and portability:

- Gyroscope and sensor fusion should be used to compensate rotation effect
- The acceleration in the direction of driving is used as the primary feature
 - If it is larger than the threshold, SVM is used to validate if a hard breaking happened
 - Three features are used as the input to SVM
- SVM is chosen because of
 - its low complexity (compared to CNN) and applicability to smartphones, and
 - the existence of open-source solution (LIBSVM, MIT license)
- Key algorithm is written in C for portability among OSes (Android and iOS)

Data collection

Have collected data for about 800 km, using 11 handsets, with various mounts



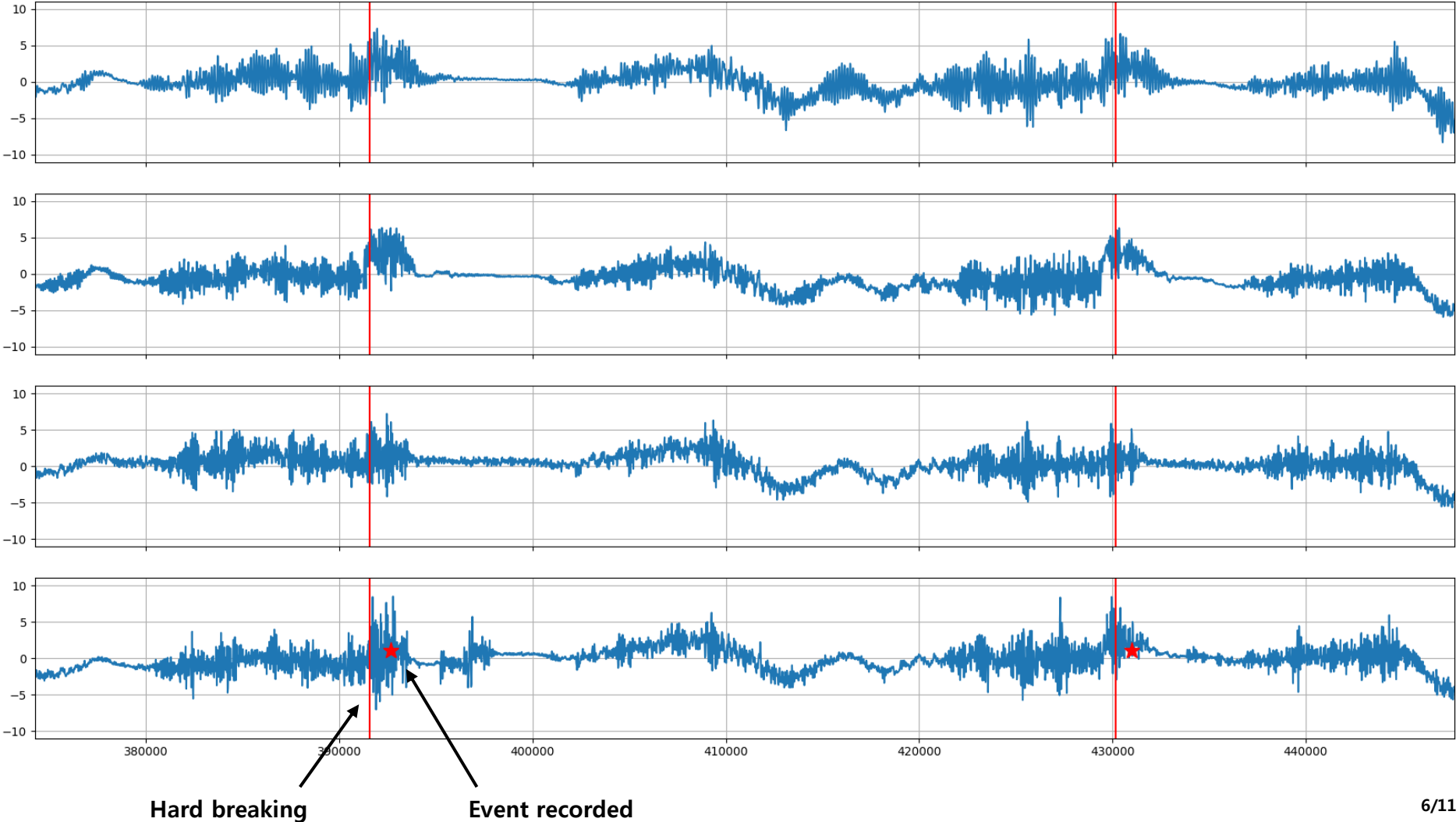
[Mounting positions]



[Driving records]

Data Preparation

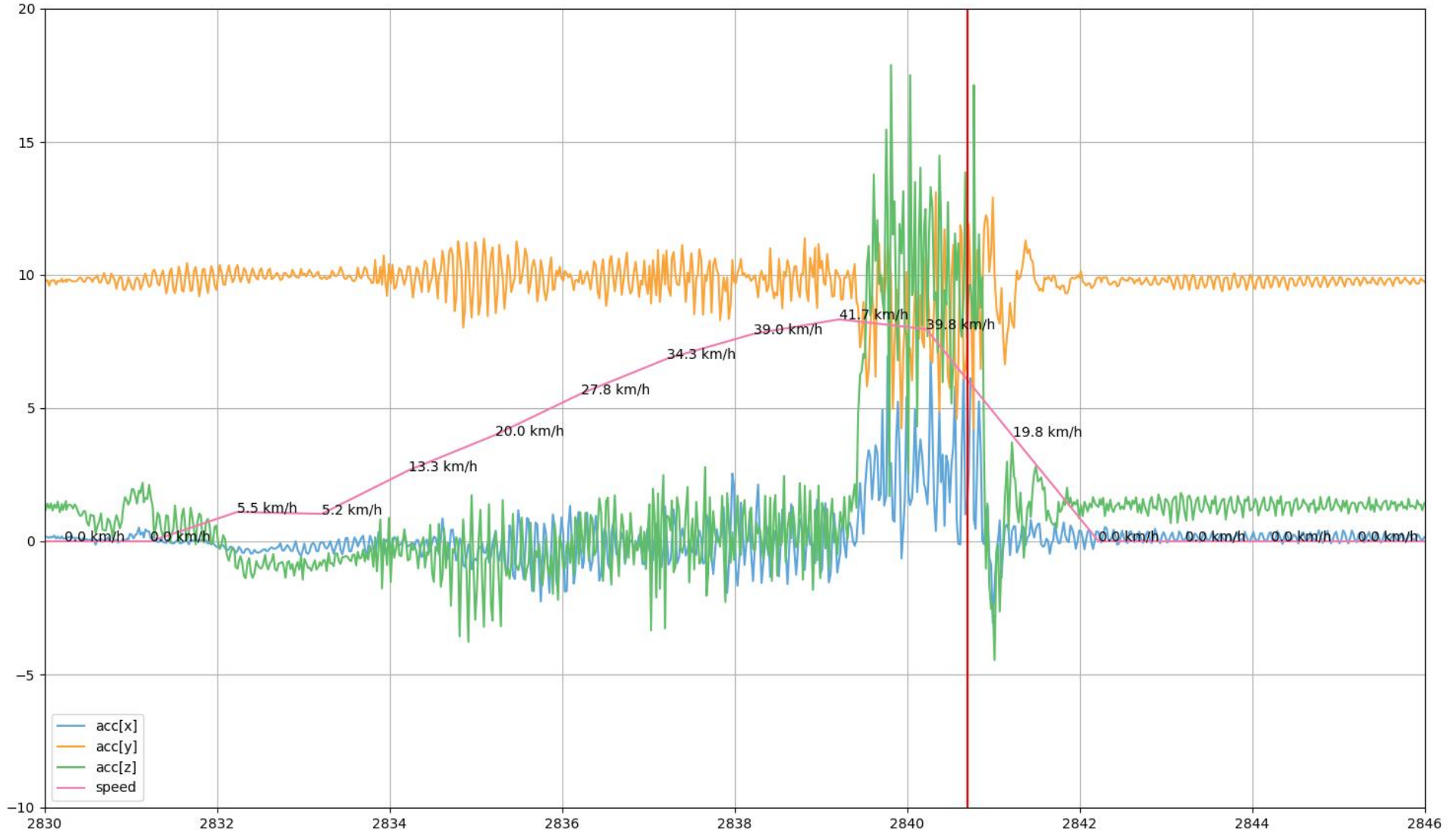
Event edit tool: recording, marking, synchronizing, etc



Analytics

Comparing motion-sensor and GPS

○ GPS is slow to detect hard braking – Delay of 1~3 sec is inevitable

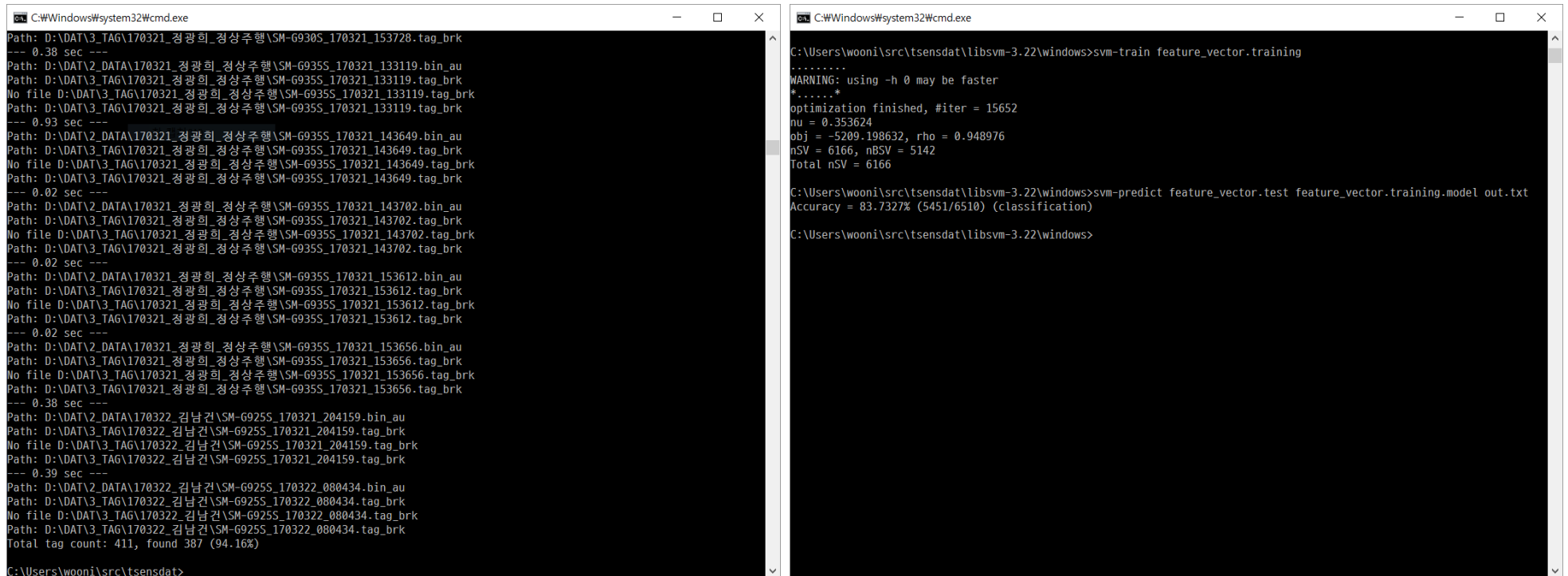


Acceleration over threshold is detected



Analytics: SVM

- When a segment exceeds the threshold, SVM is used to validate
- Trained using 70% of samples, and validated using 30%



```
C:\Windows\system32\cmd.exe
Path: D:\DAT\3_TAG\170321_경광희_정상주행\SM-69305_170321_153728.tag_brk
--- 0.38 sec ---
Path: D:\DAT\2_DATA\170321_경광희_정상주행\SM-69355_170321_133119.bin_au
Path: D:\DAT\3_TAG\170321_경광희_정상주행\SM-69355_170321_133119.tag_brk
No file D:\DAT\3_TAG\170321_경광희_정상주행\SM-69355_170321_133119.tag_brk
Path: D:\DAT\3_TAG\170321_경광희_정상주행\SM-69355_170321_133119.tag_brk
--- 0.93 sec ---
Path: D:\DAT\2_DATA\170321_경광희_정상주행\SM-69355_170321_143649.bin_au
Path: D:\DAT\3_TAG\170321_경광희_정상주행\SM-69355_170321_143649.tag_brk
No file D:\DAT\3_TAG\170321_경광희_정상주행\SM-69355_170321_143649.tag_brk
Path: D:\DAT\3_TAG\170321_경광희_정상주행\SM-69355_170321_143649.tag_brk
--- 0.02 sec ---
Path: D:\DAT\2_DATA\170321_경광희_정상주행\SM-69355_170321_143702.bin_au
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Path: D:\DAT\3_TAG\170321_경광희_정상주행\SM-69355_170321_143702.tag_brk
--- 0.02 sec ---
Path: D:\DAT\2_DATA\170321_경광희_정상주행\SM-69355_170321_153612.bin_au
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Path: D:\DAT\3_TAG\170321_경광희_정상주행\SM-69355_170321_153612.tag_brk
--- 0.02 sec ---
Path: D:\DAT\2_DATA\170321_경광희_정상주행\SM-69355_170321_153656.bin_au
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--- 0.38 sec ---
Path: D:\DAT\2_DATA\170322_김남건\SM-69255_170321_204159.bin_au
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No file D:\DAT\3_TAG\170322_김남건\SM-69255_170321_204159.tag_brk
Path: D:\DAT\3_TAG\170322_김남건\SM-69255_170321_204159.tag_brk
--- 0.39 sec ---
Path: D:\DAT\2_DATA\170322_김남건\SM-69255_170322_080434.bin_au
Path: D:\DAT\3_TAG\170322_김남건\SM-69255_170322_080434.tag_brk
No file D:\DAT\3_TAG\170322_김남건\SM-69255_170322_080434.tag_brk
Path: D:\DAT\3_TAG\170322_김남건\SM-69255_170322_080434.tag_brk
Total tag count: 411, found 387 (94.16%)
C:\Users\wooni\src\tsensdat>
```

```
C:\Windows\system32\cmd.exe
C:\Users\wooni\src\tsensdat\libsvm-3.22\windows>svm-train feature_vector.training
.....
WARNING: using -h 0 may be faster
*.....*
optimization finished, #iter = 15652
nu = 0.353624
obj = -5209.198632, rho = 0.948976
nSV = 6166, nBSV = 5142
Total nSV = 6166
C:\Users\wooni\src\tsensdat\libsvm-3.22\windows>svm-predict feature_vector.test feature_vector.training.model out.txt
Accuracy = 83.7327% (5451/6510) (classification)
C:\Users\wooni\src\tsensdat\libsvm-3.22\windows>
```

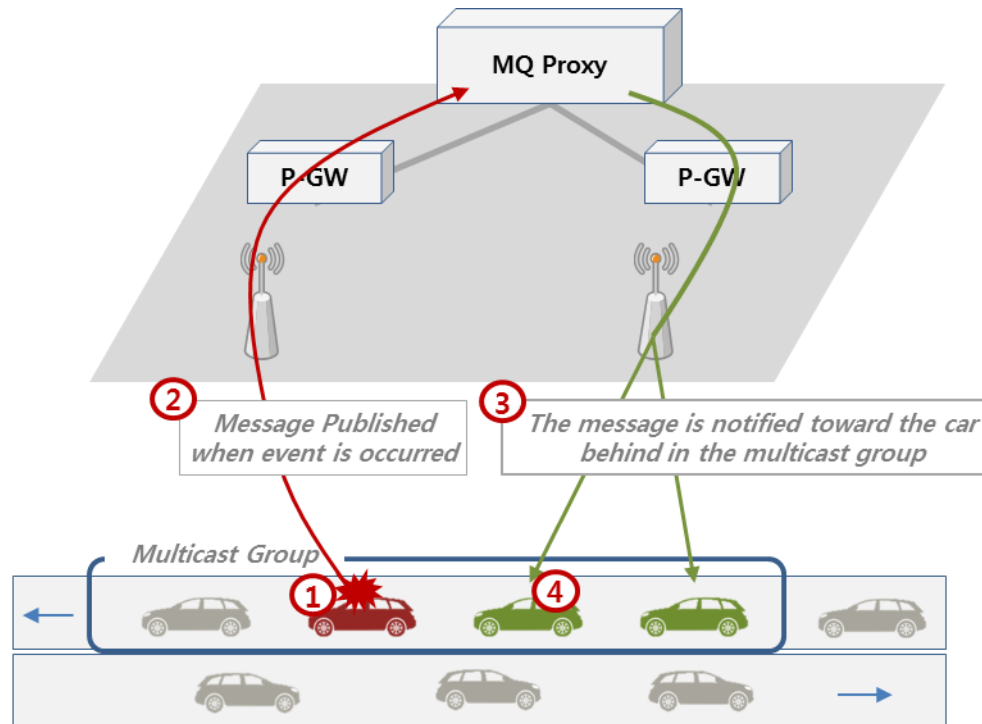
Propagation

- **Challenge**

- Latency – should be minimal, compared with ADAS-based approach

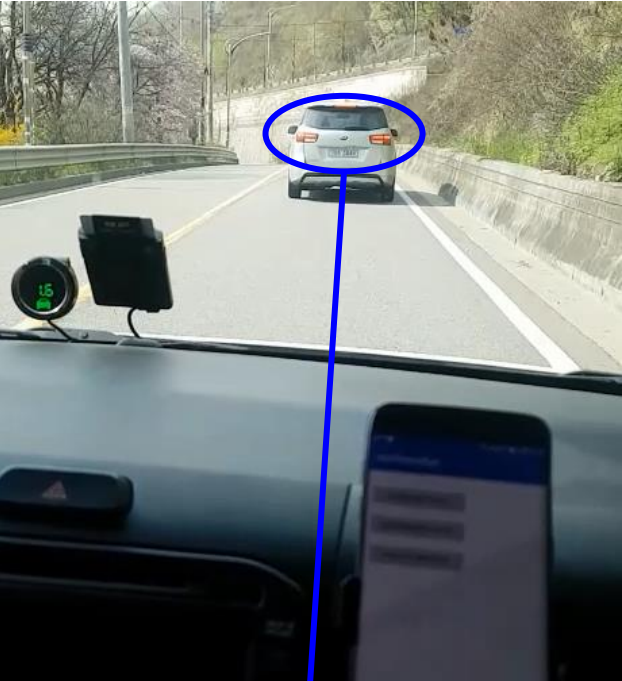
- **Solution**

- Customizing MQTT Protocol is developed for the multicasting communication
- MQ Proxy (Broker) is located behind the LTE core network to minimize latency



Preliminary Result

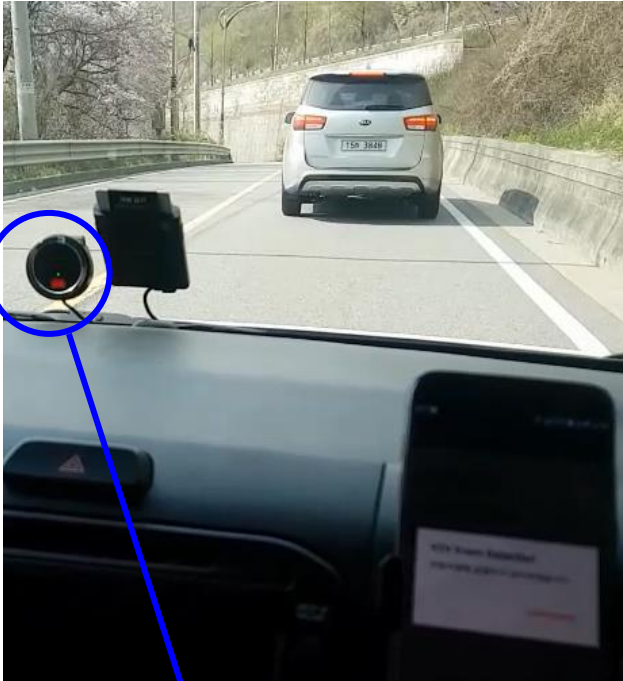
Comparable or better than vision-based ADAS solution



Sudden stop happens



Event is received



After that, ADAS detects the stop

617ms

601ms

Future Work

- Lowering the possibility of errors
 - Ex. false positive due to device mounting/unmounting
- SVM model improvement
 - Training-set generation
 - Algorithm visualization for analytics
- Commercialization
 - Crowd sourcing
 - Android: reliability, battery, OS compatibility
 - iOS support