mHealth Smartphone Application to Measure Risky Driving Behavior and Predict Crashes

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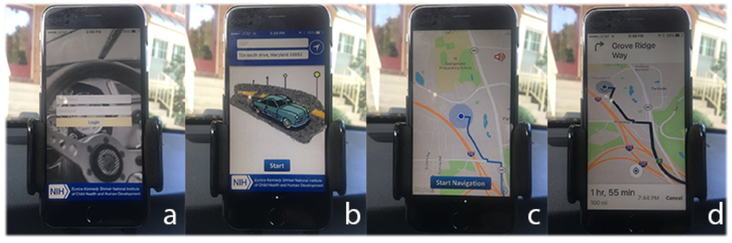
Introduction

Teenage drivers have the highest risk of getting into a fatal motor vehicle accident when compared to that of other age groups. The crash rate for 16 to 19-year-olds is 2.7 times higher than drivers of other age groups. To study driving behavior, naturalistic driving studies (NDS) are conducted to give insight into improving driving behavior and skill. However, most of the current devices and applications for conducting such studies are expensive, proprietary, and do not provide comprehensive raw data to researchers. Events with elevated gravitational forces (g-force), which can occur through driving events such as hard braking, rapid acceleration, and sharp turning (erratic and risky driving behavior), have previously been found to increase a driver's risk of getting into an accident. The goal of this work is to evaluate the feasibility of using our in-house developed iPhone application (gForce) as a research tool for NDS studies by comparing to an Android app and the Virginia Tech Transportation Institute's Nextgen Data Acquisition System (DAS) device. Subsequently, we would like to make gForce available to a wide range of researchers for NDS and related studies.

gForce iPhone Application

- Continuously records linear acceleration, rotation along the X, Y, and Z axes, and GPS location
- Calculates g-forces from acceleration data
- Acquires video from inside the vehicle (front camera) and a single image outside the vehicle (back camera), triggered by g-force event
- Fully integrated navigation system

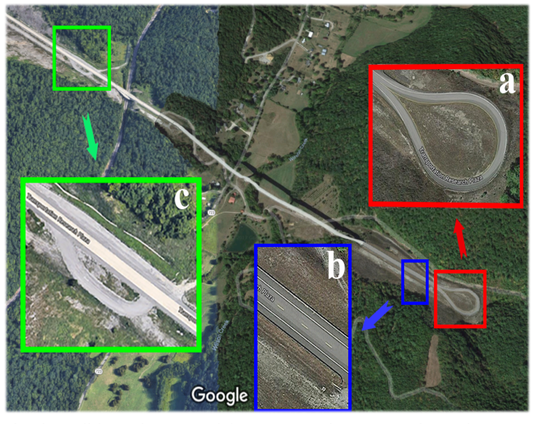


The gForce app's login screen (a), start screen (b), and navigation features (c & d).

Goal

Evaluate the feasibility of using the iPhone for naturalistic driving studies by comparing gForce linear acceleration with acceleration measurements acquired with:

1. Android application developed by Booz Allen Hamilton
2. In-vehicle Nextgen Data Acquisition System (DAS) developed by the Virginia Tech Transportation Institute (VTTI)



Cornering (a), braking (b), and turning (c) maneuver locations along the VTTI Smart Road.

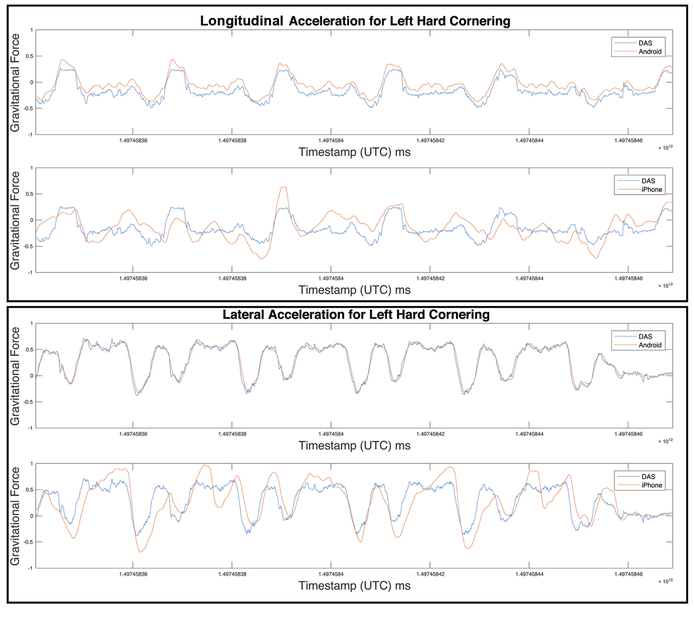
Results

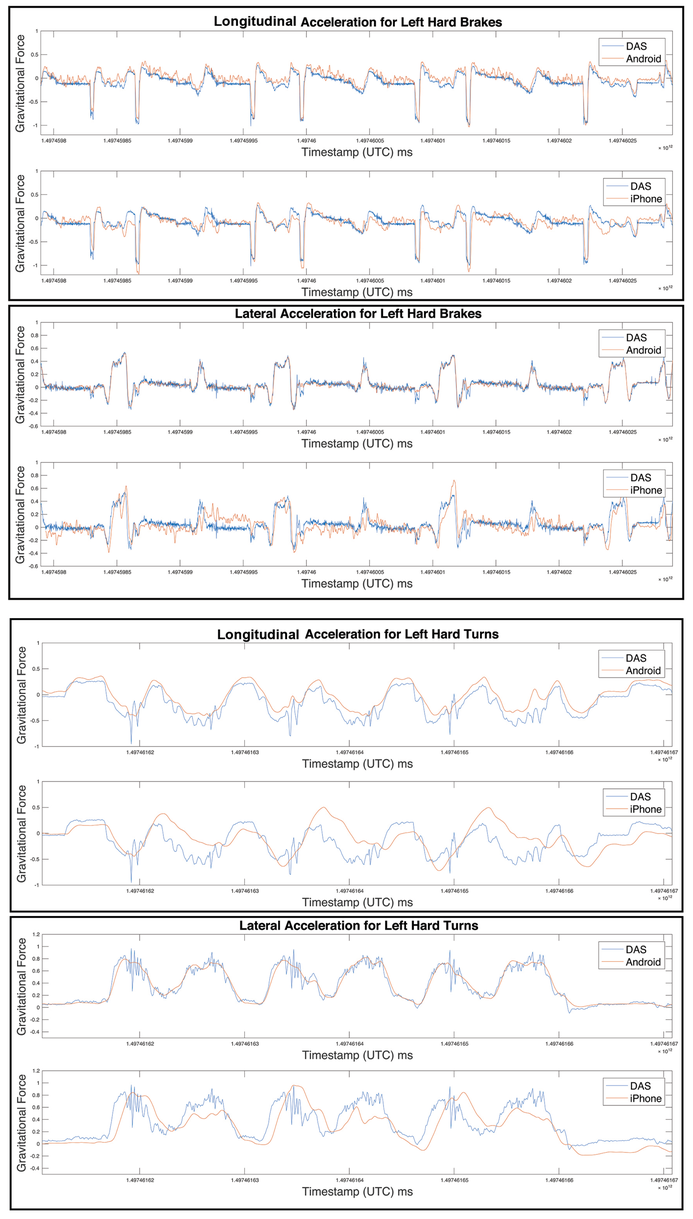
The Android app was run on the Samsung Galaxy S5 (Devices #1, 4, and 5), while the iPhone app was run on the iPhone 6 (Devices #2 and 3). Device #6 is the DAS.

Correlation between DAS and iPhone / Android Devices

Driving Maneuver	Lateral Acceleration	Longitudinal Acceleration
Cornering	0.4581 / 0.3982	0.2094 / 0.2311
Left Hard (> 0.45 G's)	0.7519 / 0.9344	0.5952 / 0.9446
Left	0.0516 / 0.0846	0.1538 / 0.3492
Right Hard (> 0.45 G's)	0.7836 / 0.9864	0.6930 / 0.9641
Right	0.1644 / 0.2117	0.3701 / 0.2029
Braking	0.6828 / 0.6382	0.7734 / 0.4788
Turns	0.7752 / 0.9617	0.4765 / 0.8899
Left Hard (> 0.45 G's)	0.7425 / 0.9479	0.4753 / 0.9172
Left	0.7879 / 0.9113	0.6356 / 0.8722
Right Hard (> 0.45 G's)	0.6754 / 0.9756	0.5823 / 0.9388
Right	0.7240 / 0.9060	0.5435 / 0.8458

The following plots compare the signals from the DAS and Android devices to the DAS and iPhone devices along both the longitudinal and lateral axes for each of the three maneuvers.





Future Work

- Repeat study using all gravity corrected devices
- Test gForce iPhone app with the latest iOS 8 iPhones
- Pilot study with 100 participants
- Improve detection of false positive elevated g-force events (i.e., potholes and speedbumps)
- Pilot study with Johns Hopkins and NICHD

Acknowledgements

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