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Drive Now, Text Later Nonintrusive Texting-While-Driving Detection using Smartphone

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Abstract: Texting-while-driving (T&D) is one of the top dangerous behaviors for drivers. Many interesting systems and mobile phone applications have been designed to help to detect or combat T&D. However, for a T&D detection system to be practical, a key property is its capability to distinguish driver's mobile phone from passengers'. Existing solutions to this problem generally rely on user's manual input, or utilize specific localization devices to determine whether a mobile phone is at driver's location. In this paper, we propose a method which is able to detect T&D automatically without using any extra devices. The idea is very simple: when a user is composing messages, the smart phone embedded sensors (i.e. gyroscopes, accelerometers, and GPS) collect the associated information such as touch strokes, holding orientation and vehicle speed. This information will then be analyzed to see whether there exist some specific T&D patterns. Extensive experiments have been conducted by different persons and in different driving scenarios. The results show that our approach can achieve good detection accuracy with low false positive rate. Besides being infrastructure-free and with high accuracy, the method does not access the content of messages and therefore is privacy-preserving.

I. INTRODUTION

According to the U.S. Department of Transportation, in 2011, at least 23% of auto collisions involved cell phones, that is 1.3 million crashes [7]. Among all distracted driving activities associated with cell phones, texting-while-driving (T&D) has become the top one killer. Those who send text messages while driving are 23 times more likely to experience a crash [10], compared to 2.8 times more by dialing and 1.3 times more by talking or listening. Besides using laws and battles against T&D, many systems have been recently developed to help combat the desire to T&D. For example, Drive Mode [2] is a mobile phone app and once activated, blocks you from reading or typing anything. Text-STAR [4] and Textecution [5] utilize

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3) Shaojie Tang (e-mail:shaojie.tang@utdallas.edu) is with Jindal School of Management, University of Texas at Dallas, U.S.A.
4) Zongjian He (e-mail:hezongjian@tongji.edu.cn) is with School of Software Engineering, Tongji University, China. the GPS and Network Location services of Android mobile phones to estimate the speed that the cell phone is travelling at the time text messages are sent and disable texting when required. However, the major problem for these systems is that they either require users' manual activation (such as in DriveMode), or disable all the cell phones in a moving car(such as Text-STAR and Textecution), causing necessary inconvenience to the passengers. Therefore, the key challenge in detecting T&D is to find a way to determine whether the mobile phone being utilized belongs to the driver or to a passenger. For this purpose, some systems adopt cameras mounted in front of the driver to directly monitor the driver's activity associated with T&D [18]. With carefully designed activity recognition software, camera-based T&D detection systems can achieve high ac curacy but are infrastructure-heavy (requiring hardware for real-time video processing) and raise intrusive concerns. Recently, there are some interesting research works for detecting T&D based on localization. In this approach, the user's mobile phone and some extra devices installed in vehicles work collaboratively to determine the mobile phone's location (i.e. whether at the driver's seat or a passenger's seat). For example in [17], beeps are emitted from in-vehicles speakers, and the smartphone records the beeps through its microphone and then performs time-difference-of-arrival localization. [15] determines a smartphone's location by comparing its centripetal acceleration, measured via its embedded accelerometers, to a reference one when the vehicle is making turns. Considering that a fine-grained localization result is required to distinguish driver from passengers, special devices, such as the Bluetooth hands-free system in [17] and a specially mounted accelerometer in [15], are generally needed. These successfully applications do enlighten us to a further step: is it possible to perform T&D detection without using any extra devices except the user's smartphone? This infrastructure-free T&D detection is much more intriguing since it incurs no cost and is more convenient. To answer the question, we seek a different approach from using camera vision or localization. We

believe that when a driver is composing messages, he will show some special patterns which distinguish him from a texting passenger. Furthermore, if these patterns can be collected and extracted via his smartphone, then infrastructure-free T&D

A. Modules
1) T&D system
2) Touchstroke Detection
3) Correlating
4) Touchstrokes with Information From Vehicles

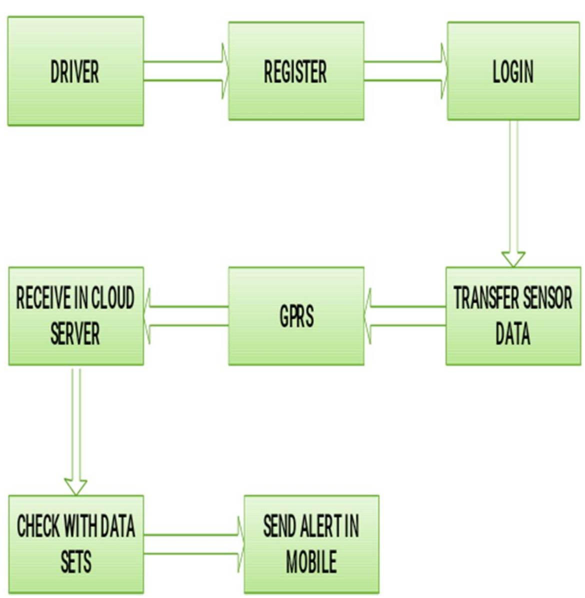
II. MODULES DESCREPTION

A. T&D System
In this paper, we investigate a new avenue for user's input detection: we utilize smart phone embedded sensors to infer touch strokes, which are directly associated with user's input. We have carried out extensive experiments which show that each touch stroke will cause a tiny, but discernable and distinctive rotation change of the smart phone, which can be captured by its gyroscope sensors. In this way, the time of occurrence of each input of mobile users can then be identified. In addition, using touch stroke-induced rotation to infer touch screen input does not need to access contents of the messages, thus the privacy of smart phone users can be preserved.

B. Touch Stroke Detection
We first construct a touch stroke template using the training data set. Then we utilize the template as the wavelet basis and carry out the wavelet transform (WT) on the collected gyroscope data. From the obtained WT coefficients, we select significant peaks and the locations of peaks correspond to the time of occurrence of touch strokes.

C. Correlating Touch Strokes With Information From Vehicles
We describe how to correlate touch strokes with the information of vehicle to test the first two patterns of T&D. In particular, the decrease of vehicle speed before and during touch strokes will be utilized to test pattern
1) A driver prefers to compose messages after the car speed is decreased, and the change of vehicle direction will be used to test pattern.
2) A driver usually stops editing messages when the car is taking turns.

III. ARCHITECTURE DIAGRAM



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A. System Requirements

1) Hardware Requirements

Processor	: Dual-core 1 GHz Krait
Speed	: 1.1 GHz
RAM	: 512 MB (min)
Internal Memory	: 4 GB
Device	: Android Smart phone.

2) Software Requirements

Operating System	: Android OS.
Technology Used	: Android 4.1
Front End	: Java.
IDE	: Eclipse.

IV. CONCLUSION

In this paper, we propose a novel method which is able to detect T&D. Instead of using any extra devices, the method leverages some patterns associated with how smart phones are used in moving vehicles. In particular, some build-in sensors in smart phones collect the associated information and analyze, through hypothesis testing to see whether these T&D patterns exist. Extensive experiments have been conducted by different persons and in different driving scenarios. The results show that our approach can achieve good detection accuracy with a small false positive rate. We believe the proposed T&D method could be utilized for usage-based insurance and provide support for many anti- T&D mobile phone applications.

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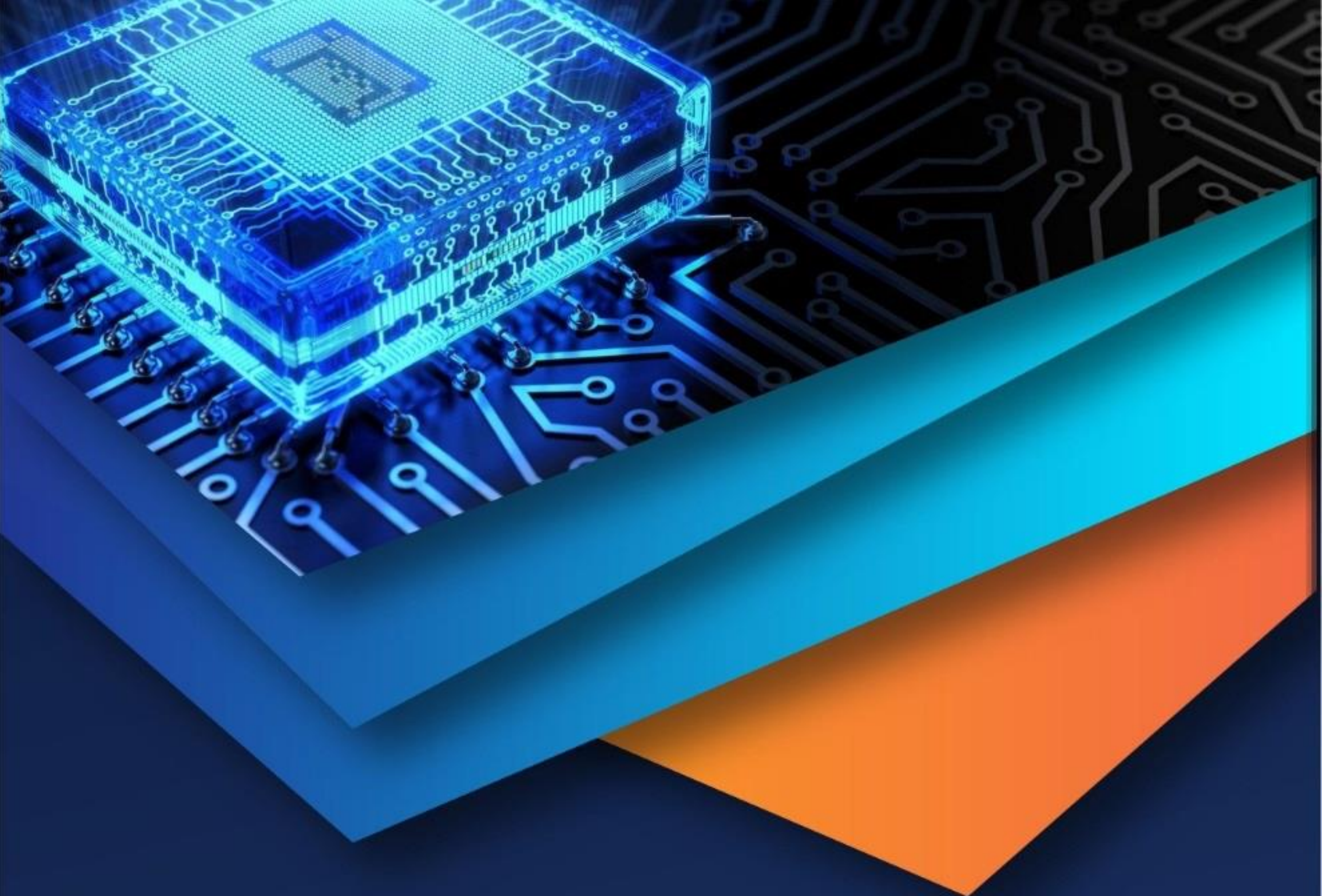

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