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A Public Safety Application of GPS-Enabled Smartphones and the Android Operating System

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***Abstract*— While the Apple iPhone single handedly redefined the term "smartphone" during its first two years of release, Google's Android platform for mobile devices has quickly developed into a serious open source alternative. We explored the Android Operating System (OS) and software development environment and evaluated several of its capabilities by constructing a working application. This application collected speed and location information from the Global Positioning System (GPS) receiver, used the Google Maps Application Programming Interface (API) to determine the location of nearby schools, and sounded an alarm if a person drove over the speed limit in a school zone. The platform proved capable of supporting a melding of different services, and we believe such smartphones have broad applicability to public safety problems.**

Keywords—Android, Smartphone, GPS, Public Safety

I. INTRODUCTION

Smartphones have become ubiquitous as newer, less expensive models with greater feature sets have been released. While much attention has been given to the danger posed by drivers distracted by talking on the phone or sending text messages, responsible application of smartphone technology could have a net positive effect on public safety.

In our exploration of smartphone technology, we developed a proof-of-concept system that addressed traffic safety in school zones. Our system addresses the need for drivers to be able to pay full visual attention to the road while still being alerted to the speed of the car. The system integrated several of the features that are becoming more commonplace on smartphones as well as information retrieved from Internet services.

The rest of the paper is structured as follows. We review the relevant technology in Section II. In Section III, we discuss a proof-of-concept system to increase public safety and its implementation. Section IV is the conclusion including a discussion of our future direction.

II. BACKGROUND

A. GPS Technology

The Global Positioning System (GPS) is a global navigation satellite system deployed by the US Department of Defense and maintained by the US Air Force. GPS is a space-based radio navigation system that provides accurate location and timing services to anyone with a GPS receiver. This service, made available to civilians in 1996 for navigation purposes, is free of charge, can support an unlimited number of users, and functions anywhere in the world [1]. Starting in 2004, the mobile phone industry began successful tests to incorporate GPS receivers into mobile phone devices to support 911 emergency location [2]. Most of today's smartphones are equipped with fully functional GPS receivers and supporting applications.

B. Android Software

The Apple iPhone has transformed the smartphone's image from a corporate-level personal organizer to a device that could potentially benefit every consumer. Recently, Google released an alternative Operating System (OS) and Application Programming Interface (API) for mobile phones called Android. Android joins iPhone OS and other smartphone platforms including Symbian OS, Blackberry, and Windows Mobile. Android is backed by the Open Handset Alliance (OHA), whose members include Sony, Samsung, Motorola, and Nvidia [3]. Though these companies are relatively new to the consumer-level smartphone market, they have already shown that by melding multiple technologies together in an open manner some unique applications can result.

On a basic level, Android is a distribution of Linux that includes a Java Virtual Machine (JVM), with Java being the preferred programming language for most Android applications. The Android Software Development Kit (SDK) includes a debugger, libraries, a handset emulator, documentation, sample code, and tutorials. Android's official integrated development environment is Eclipse using the Android Development Tools (ADT) plug-in. SQLite database support is integrated into the Android platform. The ADT plug-in includes an Android emulator that allows for the simulation of GPS and Wi-Fi [4]. The Android emulator is depicted in Fig. 1 displaying the Android desktop.

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Figure 1. The Android desktop.

Previously, mobile phone OSs have been proprietary, leading applications to be tied to a specific carrier and phone. The iPhone, for instance, has restrictive licensing terms that allow only applications approved by Apple to be distributed publicly [5]. Android's open nature is intended to set a new standard for mobile phone OSs. Applications can be written once and then run on a variety of phones and carriers. As such, Android is available as open source software under the Apache License [6].

As an open source platform, one of the goals of Android is to enable developers to create applications that utilize the features the mobile device has to offer and to tailor its features to the needs of the consumer. Android allows for the combination of information from the web with core features of the phone such as the camera function and text messaging.

C. *Android Capable Hardware*

T-Mobile released the G1 phone, running the Android platform, in October 2008 (see Fig. 2). Subsequently, Google began selling an unlocked version of the G1 as the Android Dev Phone 1 to developers. The Android Dev Phone 1 is not limited to the use of T-Mobile SIM cards and applications may exploit some features that are limited in the consumer version of the phone [7].

Figure 2. T-Mobile G1.

The G1 has a dual core ARM11 processor running at 528 MHz and 192 MB RAM. It features a touch screen, QWERTY keyboard, trackball, GPS receiver, Wi-fi, accelerometer, compass, 3G, and Bluetooth.

III. PROOF-OF-CONCEPT SYSTEM

Most school zones in the US have a speed limit of 20 MPH. Hurried drivers will try to go as fast as possible while staying under the 20 MPH mark; therefore, focusing on the 20 MPH mark on their speedometer when they really should be keeping their eyes on the road. Some drivers are not even aware when they enter a school zone area and make no attempt to reduce their speed. We attempted to write an application that used Android's GPS functionality to help solve this problem by sounding an alarm if the device was in a school zone and the vehicle was traveling over the posted speed limit.

Using the phone's Internet capability and its GPS coordinates, Google searches were performed to find schools that were closest to the phone's current location. The application ran silently in the background and required no configuration to use. An optional graphical user interface was developed to visualize the school zones as well as the user's current location. Fig. 3 depicts the application's output as the user drove at a normal speed outside of a school zone. The application's output when the driver was speeding in a school zone is depicted in Fig. 4. An audible alarm was also played under these conditions.

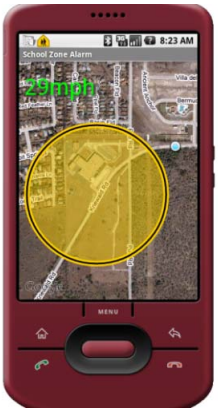

Figure 3. Driving at a normal speed.

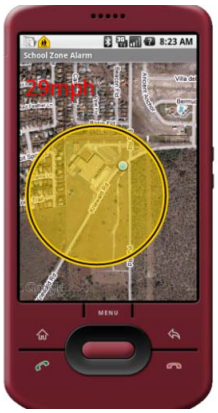

Figure 4. Driving too fast in a school zone.

In a school zone, the intensity of the audible alarm increased as the driver drove faster and faster over the speed

limit. As the driver slowed, the intensity of the alarm decreased until the all-clear sound was played. This sound signified that the vehicle was traveling at an acceptable speed. This fusion of sensor data and locale data allowed the driver to watch the road while adhering to the lawful speed limit. Testing the application through the emulator as well as on an actual Android device showed that the GPS and Internet searches worked as expected.

IV. Conclusion and Future Work

The Android platform proved to be capable of supporting a melding of different services. Our sample application showed how GPS data and Google search services could be combined to keep school children safe. Only one type of sensor and one online service was used. Many more novel applications are possible when taking into account Android's extensive sensor capability and Internet access. The open nature of Android forms the foundation of a hitherto untapped reservoir of mobile applications.

Future development is planned to integrate additional communication capabilities to give the smartphone the ability to allow it to communicate with an automobile's on-board diagnostic system to gain more information about driving conditions. This system would use current road conditions and real-time traffic information from the Internet to assist in the determination of the best route given the conditions. Such a system could be used to provide drivers an evacuation route in emergencies.

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