

# Triple-Mode Location-Aware Android Portable System for Field Operations

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*Abstract*— The goal of this research project is to create a portable system that makes use of easy-to-find and affordable Android devices for field operations where current positions of the operators are essential. A system that can be deployed virtually anywhere consists of location-aware Android application, Android mobile device(s), and a microcontroller module. By utilizing the Global Positioning System hardware on the mobile device and the spatial database and algorithms, the mobile application can send alerts to the users based on their current locations and the criteria of their missions. This portable system can be used in online mode where an active Internet connection is available, semi-online mode where a Local Area Network is deployed, or offline mode where it is completely self-contained. Using a microcontroller module instead of a computer server gives the system the flexibility and ease of setting up that are much needed in the field. Our experiments in the field showed that the system is suitable for field uses such as ground survey missions. The Location-Based Services along with the spatial algorithm yielded the correct and acceptable results for real use.

*Keywords*— Location Base Services; Android Location Alert; Point in Polygon Algorithm

## I. INTRODUCTION

In recent years, applications involving location-based alerts on smart phone platform have been widely implemented for variety of use cases [1][2]. A smart phone is one of the most common platforms for mobile application development for many reasons. For example, the hardware of a smart phone provides many sensors that can be utilized by application developers, in a compact and light weight form factor with affordable price. One of those sensors is a Global Positioning System with Assisted-GPS technology that can be used to acquire the location data of the device. Assisted-GPS or A-GPS is a relatively new, and still evolving, technology for smart phones that combines positioning from the mobile network with the positioning from GPS satellites to give a better accuracy of approximately 5 to 10 meters. With A-GPS technology, the location of the device can be acquired and locked on within seconds, has better coverage, consumes less battery power, requires fewer satellites, and can be used indoor in some cases.

Location-Based Services or LBS are services for locating geographic location of mobile devices. LBS usually consist of these components: mobile devices, communication network,

positioning component, service and application provider, and data and content provider. With the ability to locate the location of the mobile device in real-time, LBS can be used in many applications such as emergency service, navigation, location-based information service, and tracking system [3][4][5].

The LBS has been widely accepted and applied to various communities in recent years so that fear occurs as distrusted LBS providers may lead to major privacy breaches. To preserve user location privacy, spatial cloaking was demonstrated to enhance privacy in LBS [6]. This founded the principles of establishing the special investigation organization in Thailand. A conceptual model and a LBS test environment were presented in [7] to study the behavior and interaction between environments, individuals and mobile devices. The research illustrated how the test environment was used for LBS applications and how the data collected was analyzed. The research is closely followed in system design and test of this research report.

This research proposes a method of LBS for detection of restricted areas using predefined geographic polygon boundaries stored in the database. When a user who carries an Android smart phone gets inside the perimeter of a restricted area, the application on the device will alert the user. The proposed system uses A-GPS for location detection, an algorithm for determining the distance between the device and the restricted areas, and a small microcontroller module for operating in offline, WiFi station, and mobile network modes.

The system design in both hardware and software aspects including how the three operating modes work will be described in the next section.

## II. SYSTEM DESIGN

The design of this location-based alerting system was aimed for field uses. For this reason, instead of operating everything on the smart phone alone, a microcontroller module was added to the system to provide convenience and flexibility in setting up and deploying the system in the field. The system can be operated in three modes: offline mode, WiFi station mode, and mobile network mode as shown in Fig. 1. The offline mode is suitable for when there is only one mobile device operating in the field. The WiFi module of the Microcontroller Unit (MCU) is connected directly to the WiFi adapter of the smart phone. The WiFi station mode is for deploying in the area where there