Location - Aware Mobile Crime Information Framework for Fast Tracking Response to Accidents and Crimes in Big Cities.

Teddy Mantoro[1,2], Feriadi[2], Nazori Agani [2], Media A. Ayu[1], Dwiki Jatikusumo[2]
[1]Faculty Science and Technology, Universitas Siswa Bangsa International, Jakarta, Indonesia
[2]Graduate Programme of Information Technology, FTI, Budi Luhur University, Jakarta, Indonesia
teddy.mantoro@usbi.ac.id*, feriadi@budiluhur.ac.id, nazori@budiluhur.ac.id, media.ayu@usbi.ac.id, dwiki@budiluhur.ac.id

***Abstract*— Recently the number of accidents and crimes are arising in many big cities. Mobile applications with location aware systems can be utilized in providing location information of the crime. The problem is that location information provided by mobile phones has not been fully utilized. Mostly mobile phones used for its main functions which are for calling and messaging. This paper argues that location information can be used for reporting accident and crime, so that a quick and fast response can be achieved. This study proposes a framework of mobile crime information assistance to help the users (victim) from locus delicti (location where accident or crime happened) with location aware capabilities. Using this framework, mobile app can send and receive location of crimes including the scenes (images) to the nearest police station or central police station. The system can offer a facility to track the location of the nearest police station by accessing a built-in database with a combination of Google map APIs and send the scene/image of the crime location as one complete set of report to the police station. This will allow the police to find the location of the accident right away and increase the safety of the resident in big cities.**

Keywords- Location awareness, locus delicti, tracking crime, mobile crime assistance.

I. INTRODUCTION

Mobile phones today are not just used for calling and sending messages, but also as a means of entertainment and finding information quickly.

Figure 1. Mobile Crime Clients.

Given today's mobile phone, it is easy to get information, including the location of an accident and its surroundings.

As the number of accidents including traffic accidents and victims of crime were increased from time to time, the mobile crime assistance application may help the city inhabitants and the police to decrease the number of accidents and crimes.

The theory of the crime scene analysis is very dependent on the time of the accident The police can quickly identify an event based on the locus and tempus. The following are the four ideas used to determine the locus delicti (location where accident or crime happened) [7] i.e.:

1) de leer van de lichamelijke daad
   Doctrine based on the physical act. That is why this doctrine asserts that which is regarded as the scene of the crime / locus delicti is the place where it was committed.
2) de leer van het instrument
   Doctrine based on the functioning of a tool used in crime. So this doctrine asserts that which is regarded as the scene of the crime is the place where the tools used in committing a crime are.
3) de leer van het gevolg
   This doctrine is based on the result of a crime. According to this doctrine, what is regarded as the locus delicti is the place where the offense is a result rather than a cause.
4) de leer van de meervoudige pleets
   Confirms that which is regarded as the scene of the crime is the place where the act physically happened, the place where the tools used are located, and the place where the result of the crime emerges.

Benefits of knowing Tempus delicti doctrine [7]:

1) Age of the perpetrator (Article 47 KUHP) and age of the victim for moral offenses (Article 287 paragraph 2 and Article 290 and 291)
2) Mental state of the perpetrator (Article 44 of the Criminal Code)
3) Expired in the prosecution and undergo a criminal (Article 78-85 of the Criminal Code)
4) Legality of article 1, paragraph 1 of the Criminal Code
5) Change a law criminal section 1, paragraph 2 of the Criminal Code
6) As a condition absolute validity indictment.

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By utilizing mobile phone technology as a means of detection of the crime scene that can be read by the central police station, the information that comes into the office can be forwarded to the police station nearest to the scene of the crime.

This study proposed a Mobile Crime Assistance Architecture (MCIAA) for mobile devices which is constructed with servers using public IP addresses and the police databases that exist around the server environment. The application prototype was developed using android (Figure 1). This application reads the longitude and latitude coordinates and the position will be listed on the site and it will also get the location of existing police stations that are around. When there is a crime, a set of accident/crime information will be sent to the police station closest to the accident by executing the application from the mobile phone.

The next section presents the related work on location awareness and is followed by the model on crime information assistance in Section 3, and Section 4 discussed the LBS on Android framework. The results based on simulations of the proposed approach and the search position model are discussed in Section 5. Section 6 presents the conclusion of this study.

II. Related Work

Many posts have discussed location awareness by using the signal strength and signal quality from the simple ones to the following algorithm discussed in connection with some of the writings and activities of this article.

The implementation estimating the location of a mobile device or a robot from wireless signal strength has become an area of highly active research. The key problem in this context stems from the complexity of how signals propagate through space, especially in the presence of obstacles such as buildings, walls or people [1]. This study show how Gaussian processes can be used to generate a likelihood model for signal strength measurements.

The implementation of context-aware location and time on a normal basis with the minimum requirements of having a mobile phone that has Bluetooth, internet access, supports java ME, and a simple browser which illustrates the circumstances surrounding the user [2].

This development followed by the building of an artificial application of mobile and web-intelligence services in twitter that provides intelligent and personalized queries that result in tourists visiting places like historic sites, dining, shopping using a web interface for user application [3].

During each iteration cycle, the message with reliable information is passed efficiently with an adaptive weighted technique and the error propagation law, and then the message-passing approach based on prediction-correction recursion is to simplify the implementation of the Bayesian filtering approach for location-estimation and tracking systems [4].

Location-based services (LBSs), such as location-specific contents-providing services, presence services, and E-911 locating services, have recently been drawing much attention in the wireless network community. Since LBSs rely on the location information in providing services and enhancing their service quality, we need to devise a framework of directly using the location information to provide a different level of service [5].

Received signal strength (RSS) can be used in sensor networks as a ranging measurement for positioning and localization applications. This contribution studies the realistic situation where neither the emitted power nor the power law decay exponent is assumed to be known. The application in mind is a rapidly deployed network consisting of a number of sensor nodes with low-bandwidth communication, each node measuring RSS of signals traveled through air (microphones) and ground (geophones). The first contribution concerns validation of a model in logarithmic scale, that is, linear in the unknown nuisance parameters (emitted power and power loss constant) [6].

III. Mobile Crime Information Assistance Architecture

This section discusses the Mobile Crime Assistance architecture (MCIAA) based on a Location model for mobile client user and the police mobile station. The Architecture is be shown in Figure 2, provide mobile phone users instantly the position information when there is either a crime against themselves or others. The framework was built especially for the android system in reading the crime location based on LBS. Android mobile crime client will keep record of the individual user, and it will be synch with the Mobile server as the middle tier which connects to a crime database repository. Figure 3 shows the generic mobile crime in application level.

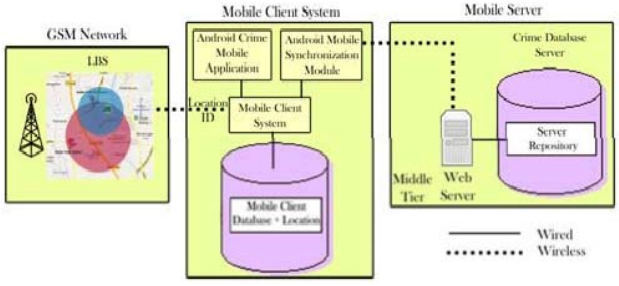

Figure 2. Mobile Crime Assistance Architecture based on Location.

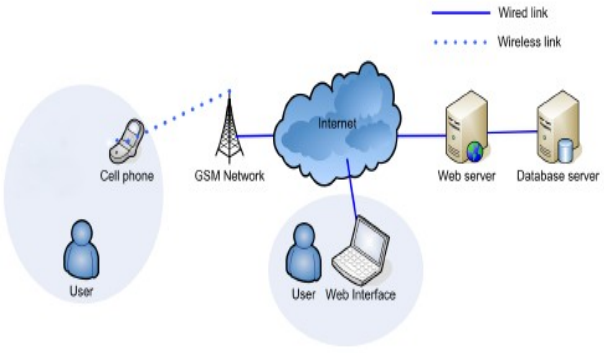

Figure 3. Generic Mobile Crime Application [2].

IV. LBS ON ANDROID

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Android is the operating system for mobile phones based on Linux. Android provides an open platform to developers for creating their own applications for use with a variety of mobile devices. Initially, Google Inc. bought Android Inc., newcomers who make software for mobile phones. Then to develop Android, they formed the Open Handset Alliance, a consortium of 34 companies for hardware, software, and telecommunications, including Google, HTC, Intel, Motorola, Qualcomm, T-Mobile, and Nvidia [8].

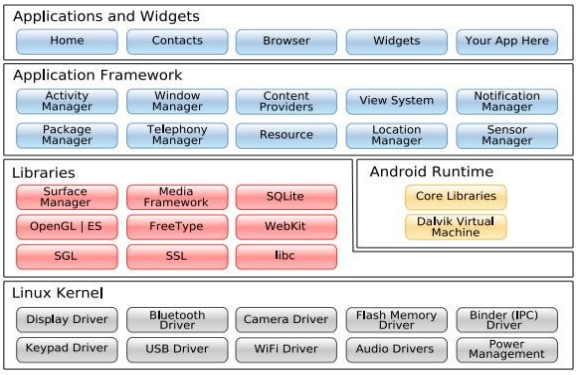

Figure 4. Android Architecture [9].

Android has been widely used by major vendors of smart phones and smart phone prices are very affordable, and documentation for developers is very easy to find.

Google APIs Add-On is an extension to the Android SDK development environment that lets the programmer develops application for devices that include Google's set of custom applications, libraries, and services. A central feature of the add-on is the Maps external library, which lets you add powerful mapping capabilities to the Android application as shown in Android architecture in Figure 4.

This study also capitalize on location based services [6], location based services (location based services) is an information service that can be accessed via mobile devices using the mobile network, which has the ability to take advantage of the location of the mobile device.

LBS (location based services) provide the possibility of two-way communication and interaction. Therefore, the user tells the service provider to get the information he needs, with reference to the user's position. Location-based services can be described as a service that is at the confluence of three technologies, namely: Geographic Information System, Internet Service, and Mobile Devices. LBS (location based services) is a meeting of the three technologies.

In Figure 1, 2 and 11, LBS as an intersection of three technologies that can also be divided into two, namely:

1) Pull Service: Services are provided on request from the customer. This may be analogous to the type of service such as a web access on the Internet.

2) Push Service: This service is provided directly by the service provider without waiting for requests from the customer, of course, the information provided relates to customer needs.

Mobile application, in this case using Android, can interact between a victim to report his/her accident to a police anywhere either in a police station or the police on duty in a street.

Figure 5. . The client opening menu of crime information assistance

The prototype was developed based on structured menu from the opening menu (Figure 5) as the top menu to the min functionality of the crime information assistance menu (Figure 6). In this menu, we provide the menu of traffic accidents, robberies and terrorist act. A menu button, which transmits signal to the central police station, is included in this mobile application. Users can use only one crime location information which can be directly sent to the central police station.

Figure 6. The client menu display prototype

The crime information assistance prototype was developed by using Google Maps API which allows the longitude and latitude of the position obtained from the GSM signal strength and signal quality, and it translates to a location on a map. Figure 7 shows the crime scene location on Google maps.

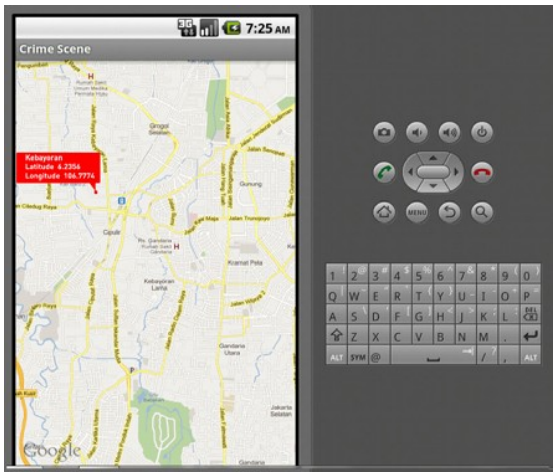

Figure 7. The police station menu display

At the central station, the location of the complaint can be seen, based on the coordinates of the location that is sent over the GSM network to the central police station to analyze the position of the victim or complaint to the police station nearest to the victim or the complaint as Figure 8

Figure 8. The Location of crime scene at the central station

After that, the system of mobile phone users retrieves the longitude and latitude. Then, the application will send to the police station the data and displays the area around the user. If the application is executed, then the last user's location coordinates will be sent to the police station nearest to the user of the data based on GSM's signals, which translates to the coordinates.

In GSM network, reference signal receive power (RSRP) is the most basic of the UE physical layer measurements and is the linear average (in watts) of the downlink reference signals (RS) across the channel bandwidth. Since the RS exists only for one symbol at a time, the measurement is made only on those resource elements (RE) that contain cell-specific RS. It is not mandated for the UE to measure every RS symbol on the relevant subcarriers. Instead, accuracy requirements have to be met. There are requirements for both absolute and relative RSRP. The absolute requirements range from ±6 to ±11 dB depending on the noise level and environmental conditions. Measuring the difference in RSRP between two cells on the same frequency (intra-frequency measurement) is a more accurate operation for which the requirements vary from ±2 to ±3 dB. The requirements widen again to ±6 dB when the cells are on different frequencies (inter-frequency measurement).

Knowledge of absolute RSRP provides the UE with essential information about the strength of cells from which path loss can be calculated and used in the algorithms for determining the optimum power settings for operating the network. Reference signal receive power is used both in idle and connected states. The relative RSRP is used as a parameter in multi-cell scenarios.

Although RSRP is an important measure, on its own it gives no indication of signal quality. RSRQ provides this measure and is defined as the ratio of RSRP to the E-UTRA carrier received signal strength indicator (RSSI). The RSSI parameter represents the entire received power including the required power from the serving cell as well as all channel power and other sources of noise. Measuring RSRQ becomes particularly important near the cell edge when decisions need to be made, regardless of absolute RSRP, to perform a handover to the next cell. Figure 9 presents the procedure for cell search. Reference signal receive quality is used only during connected states. Intra- and inter-frequency absolute RSRQ accuracy varies from ±2.5 to ±4 dB, which is similar to the inter-frequency relative RSRQ accuracy of ±3 to ±4 dB.

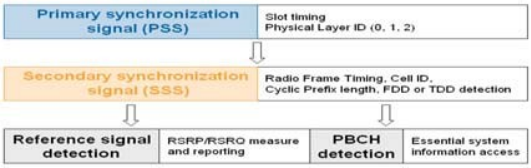

Figure 9. Cell search procedure [10]

RSRP is comparable to the CPICH RSCP measurement in WCDMA. This measurement of the signal strength of an LTE cell helps to rank between the different cells as input for handover and cell reselection decisions. The RSRP is an average of the power of all resource elements which carries cell-specific reference signals over the entire bandwidth. It can, therefore, only be measured in the OFDM symbols carrying reference symbols.

The RSRQ measurement provides additional information when RSRP is not sufficient to make a reliable handover or cell reselection decision. RSRQ is the ratio between the RSRP and the Received Signal Strength Indicator (RSSI), and depending on the measurement bandwidth,

means the number of resource blocks as the formulas is shown in Figure 10. RSSI is the total received wideband power including all interference and thermal noise. As RSRQ combines signal strength as well as interference level, this measurement value provides additional help for mobility decisions.

$$RSRQ = N\frac{RSRP}{RSSI} \qquad [dB]$$

N: Number of Resource Blocks

Figure 10. Formula reference signal receive quality [13]

Assume that only reference signals are transmitted in a resource block, and that data and noise and interference are not considered. In this case, RSRQ is equal to -3 dB. If reference signals and subcarriers carrying data are equally powered, the ratio corresponds to 1/12 or -10.79 dB.

V. Discussion on Search Position Method

Accurately estimating the location of a Mobile Station is a key requirement to effectively provide a wide range of Location Based Services over mobile networks [12]. Hence, developing cellular positioning techniques has been a key research problem, with numerous localization solutions being proposed. These include technologies such as Cell ID, angle and time of arrival methods, statistical methods and fingerprinting methods. This study used fingerprinting based positioning techniques.

Basic Positioning Methods based on Cell Identification (Cell ID) is a generic method to determine the current position of a mobile phone using GSM network as shown in Table I, II and III. To further enhance the accuracy of search results, the Cell ID method is often combined with other methods such as the Timing Advance (TA) method. By using the TA method, the method of Cell ID will be added to a functionality to calculate the Round Trip Time (RTT), i. e. the transmission of a frame (from base station to handset) and time of receipt of a mobile phone (from handset to Base Station).

TABLE I. GSM Cell ID

Technology	Rural	Suburban	Urban	Indoor
Cell ID	Range of 1 km - 35 km is generally 15 km maximum of ~ 100 km	Range of 1 km - 10 km generally 5 km	Macrocell: Range of 500 m-5 km generally 2 km Microcell: Range of 50 m - 500 m generally 200 m	If using a picocell is usually up to 10 m - 50 m
Cell ID + TA	TA does not provide a marked improvement in terms of accuracy, but the good is used as a good parameter to check if a handset is connected to the nearest cell			

Enhanced Positioning methods are commonly used approaches to Observe Time Difference or OTD. In a GSM network Enhanced-OTD (E-OTD) is often used (Table II).

TABLE II. E-OTD

Technology	Rural	Suburban	Urban	Indoor
E-OTD	50 m - 150 m	50 m - 150 m	50 m - 150 m	Good
	Lower the performance for the base stations with low-density environments such as inland			

Advanced Positioning methods are commonly used in Assisted Global Positioning System (A-GPS), the estimated accuracy can found in the Table III.

TABLE III. A-GPS

Technology	Rural	Suburban	Urban	Indoor
A-GPS	10 m	10 m - 20 m	10 m - 100 m	Variable
	Less accuracy in the room scale			

The general architecture for provisioning LBS GSM-based wireless is presented in the following figure:

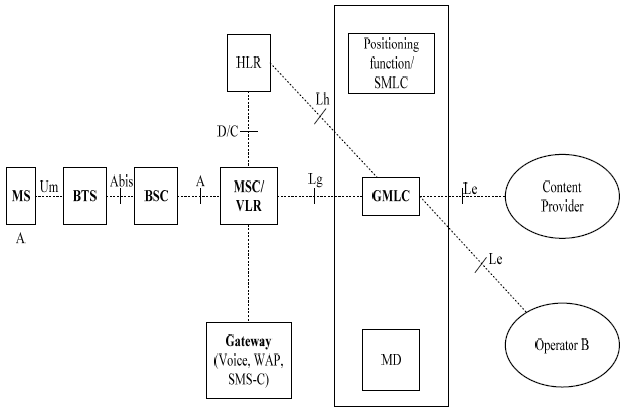

Figure 11. The general architecture of LBS GSM Network [11]

This study implemented several servers that use linux and MySql database servers. The database has been populated with data of latitude and longitude of the stations.

The crime information assistance system is easily accessible from anywhere by the mobile user and the data used can be accurate and precise. This application depends on the availability of a connection to the mobile network.

During testing, the server was down many times because of lots of users accessed it simultaneously. The accuracy of the LBS with GSM systems in some cases is not precise enough, possibly because of the shadowing and fading from the mobile client.

VI. Conclusion

This study presents a framework of mobile crime information system assistance to help users (victim) from locus delicti (location where accident or crime happened) with location aware capabilities. The mobile crime assistance prototype, based on the proposed architecture, was capable to send and receive location of crimes including the scenes (images) to the nearest police station or central police

station. This also will allow the police to find the location of the accidentstraight away.

By using signal strength and signal quality that is read by an application, this application provides a convenient approach to the user by allowing the provision of location information of longitude and latitude coordinates of the crimes to the police station without having to spend time to find the location of a police station.

LBS system works indoors and outdoors in different precision depending on the signal strength, area, etc. This is a very useful tool of spatial data to identify the location a crime/incident.

The system can track the location of the nearest police station by accessing the built-in database with a combination of Google map APIs and send the scene/image of the crime location as one complete set of report to the police station.

REFERENCES

[1] G Brian Ferris, Dirk Hähnel, Dieter Fox, Gaussian Processes for Signal Strength-Based Location Estimation, Proceding of 2nd Robotics Science and Systems Conference, pp. 303–310, 2006

[2] Martijn Pannevis, Maarten Marx. Using web-sources for location based systems on mobile phones. In Proceedings of the SIGIR 2008I. S. Jacobs and C. P. Bean, "Fine particles, thin films and exchange anisotropy," in Magnetism, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.

[3] Thiti Vacharasintopchai, Jesdabodi, C. ; Tu Ngoc Nguyen, An Intellegent Agent for Ubiquitous Travel Information Assistance with Location awareness. The 6th International Conference on Wireless Communications Networking and Mobile Computing (WiCOM), 2010, pp. 1-4.

[4] Yih-Shyh Chiou, Fuan Tsai, Chin-Liang Wang and Chin-Tseng Huang A reduced-complexity scheme using message passing for location tracking, EURASIP Journal on Advances in Signal Processing 2012.

[5] Hwangnam Kim, Hyun Soon Kim, Suk Kyu Lee, Eun-Chan Park and Kyung-Joon Park, Enabling location-aware quality-controlled access in wireless network, EURASIP Journal on Wireless Communications and Networking 2011.

[6] Fredrik Gustafsson, Fredrik Gunnarsson and David Lindgren, Sensor models and localization algorithms for sensor networks based on received signal strength, Gustafsson et al. EURASIP Journal on Wireless Communications and Networking 2012.

[7] Suraban, Locus dan tempus delicti (place and time of the criminal offence), available at http://suraban-kuliahfakultashukum.blogspot.com /2011/05/locus-dan-tempus-delicti-tempat-dan.html, on 14 May 2011. Accessed on 1 September 2014.

[8] http://www.androidpit.com/en/android/blog/397844/Google-Maps-Update-Lets-You-Create-a-Map-of-Your-Favorite-Places

[9] Kebomix, Android System Architecture, available at http://kebomix.wordpress.com/2010/08/17/android-system-architecture on 17 August 2011. Accessed on 1 September 2014.

[10] Rohde & Schwarz, Cell search and cell reselection procedure in UMTS LTE, available at http://www2.rohde-schwarz.com, 2009. Accessed on 1 September 2014.

[11] 3GPP TS 36.104 V8.6.0; Base station (BS) radio transmission and reception (Release 8), 2009.

[12] Lakmali B, Dileeka Dias, Database Correlation for GSM Location in Outdoor and Indoor Environment, the 4th International Conference on Information and Automation for Sustainability, ICIAFS 2008, pp. 42–47.