UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF LOCATION BASED SERVICES FOR GEOCODING AND RECORDING ROAD ACCIDENTS DATA

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DEVELOPMENT OF LOCATION BASED SERVICES FOR GEOCODING AND RECORDING ROAD ACCIDENTS DATA

BY

MOHAMMED MUSTAFA AL-HABSHI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Partially Fulfilment of the Requirement for the Degree of Master of Science

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ABSTRACT

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

DEVELOPMENT OF LOCATION BASED SERVICES FOR GEOCODING AND RECORDING ROAD ACCIDENTS DATA

By

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This thesis explores and reviews both conceptual and technological issues associated with integrating mobile Geographic Information System (GIS) and Location Based Services (LBS); within the context of the study, road accident geocoding data collection as subject of the problem.

The development approaches are discussed in this thesis from conceptual system modelling to integrating mobile-GIS and LBS middleware with the deployed map service, the developed geocoding service and data collections service. The developed system is partially based on open source software to reduce total cost of ownership for developing countries' governments and to follow Malaysia government policy for year 2007 in adapting and developing open source solutions. The testing of the system and geocoding was carried out within the campus of Universiti Putra Malaysia.

The conclusion of this research shows the LBS and mobile-GIS geocoding method have achieved improvement compared conventional method of geocoding and data collection; where each of positional errors and effort of data transferring have been reduced using these new technologies.

ABSTRAK

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PEMBANGUNAN PERKHIDMATAN BERASASKAN LOKASI UNTUK DAN RAKAMAN KEMALANGAN JALANRAYA

Oleh

MOHAMMED MUSTAFA AL-HABSHI

Pengerusi: Profesor Madya Ahmad Rodzi Mahmmud, PhD
Fakulti: Fakulti Kejuruteraan

Tesis ini meneroka dan mengkaji isu-isu konsep dan teknologi yang berkaitan dengan pengintegrasian sistem GIS (*Geographic Information System*) dan LBS (*Location Based Services*); masalah dalam konteks kajian ini ialah pengkodan pengumpulan data geokod bagi merekod kemalangan jalan raya.

Pendekatan pemajuan projek yang dibincangkan dalam tesis ini, daripada pemodelan konsepsi system sehingga mengintegrasi *middleware mobile-GIS* dan LBS beserta khidmat peta (*map service*), geokod dan khidmat pengumpulan data. Sistem yang dikembangkan ini sebahagiannya didasarkan perisian *open source* untuk mengurangkan kos pemilikan bagi kerajaan negara-negara membangun dan menurut polisi kerajaan Malaysia (2007) bagi penggunaan dan pemajuan penyelesaian *open source*. Pengujian system serta geokod telah dijalankan di dalam persekitaran kampus UPM.

Hasil kajian ini menunjukkan bahawa kaedah geokod *mobile-GIS* dan LBS telah mencapai kemajuan berbanding kaedah biasa bagi geokod dan pengumpulan data, di mana setiap ralat kedudukan dan kepayahan dalam pemindahan data telah dikurangkan menggunakan teknologi- teknologi yang baru tersebut.

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APPROVAL

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DECLRATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

MOHAMMED MUSTAFA AL-HABSHI

Date: August 23, 2008

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LIST OF ABBREVIATIONS

Abbreviations	Description
1NF	First Normal Form
2NF	Second Normal Form
3G	Third Generation of Mobile communication System
9MP	Ninth Malaysia Plan
Ad-HOC	A wireless network that transmits from computer to computer
A-GPS	Assisted Global Positioning System
AKA	As Known As
AP	Access Point
API	Application Programmable Interface
ArcIMS	ESRI Internet Mapping Server
ArcXML	ESRI Property XML format
BPP	Bit Per Pixel
BSD	Berkeley System Distribution
CAD	Computer Aided Design
CARS	Computerized Accident Recording System
CBS	Context-Based Services
CE	Compact Edition
CF	Compact Flash interface
CGI	Common Gateway Interface
DBF	Database File, used by ESRI for storing attributes attached with ShapeFile
DGPS	Differencial GPS
DHCP	Dynamic Host Configuration Protocol
DPI	Dot Per Inch
E-OTD	Enhanced Observed Time Difference
EPSG	(European Petroleum Survey Group) standards for coordinate reference system
ESRI	Environmental Studies Research Institute
EDR	Event Data Recorder
FTP	File transfer Protocol
G2C	Government Service To Citizen
GCI	Geocode Certainty Indicator
GeoDBI	geocoding database interface
GIF	Graphics Interchange Format
GIS	Geographical Information System
GIX	An open source ArcView GIS Import and eXport extension from/to other open source standard GIS software
GPL	General Public License
GPRS	General Packet Radio Service
GPS	Global Positioning System
GRASS	Geographic Resource Analysis
GSM	Global System for Mobile Communications
GUI	Graphical User Interface
HDOP	Horizontal Dilution Of Precision
HTTP	Hyper Text Transfer Protocol
HSDPA	High Speed Downlink Packet Access
ICT	Information and Communication Technology

IEEE	Institute of Electrical and Electronics Engineers
IMSEMU	ArcIMS EMUlator
IP	Internet Protocol
IPAQ	Brand of PDA devices, Product of Compaq/HP company
ITS	Intelligent Transportation System
J2ME	Java 2 Mobile Edition
JPEG	(Joint Photographic Experts Group) standard for compressing image
JPG	Joint Photographer Graphics , three letter abbreviation for JPEG
LAN	Location Area Network
LAP	LAN Access Profile
LBS	Location Based Service(s)
LCBS	Location and Context-Based Services
LGPL	Lesser General Public License
LOC	Line Of Code
MAAP	Microcomputer Accident Analysis Package
MAMPU	Modernisation and Management Planning Unit
MIT	Massachusetts Institute of Technology
MOSS4G	Mobile Open Source Software for Geoinformatics
MRDB	Multi Representation database
NCSA	National Centre for Supercomputing Applications
NRRI	Natural Resources Research Institute
ODBC	Open DataBase Connectivity
OGC	Open Geospatial Consortium
OMA	Open Mobile Alliance
ORDBMS	Object Relational Database Management System
OS	Operating Systems
OSGeo	Open Source Geospatial Foundation
OSS	Open Source Software
OTDoA	Observed Time Difference of Arrival
OWA	Ordered Weighted Averaging
PAN	Personal Area Network
PDA	Personal Digital Assistant
PDE	Positioning Determination Equipment
PHP	Hyper text Pre-processor (a web programming Language)
PNG	Portable Network Graphic
POI	Point Of Interest
POL27	POLice form No. 27 for Road Accident data collection
PPP	Point to Point Protocol
RAS	Remote Access Services
RDBMS	Relational Database Management System
RSO	Rectified Skewed Orthomorphic coordinate system
RSRC	Road Safety Research Centre
SDIO	Secure Digit interface
SMS	Short Message System
SPP	Serial Port Profile
SQL	Structured Query Language
SSCE	Microsoft SQL server 2005 Compact Edition
SSID	Service Set IDentifier
TBS	Traffic Broadcasting System

TCO	Total Cost of Ownership
TCP/IP	Transfer Control Protocol / Internet Protocol
TRAP	Traffic Road Accident Program
UMN	University Minnesota
URI	Unified Resource Identifier
URL	Unified Resource Locator
USB	Universal Serial Bus
U-TDoA	Uplink Time Difference of Arrival
UTM	Universal Transverse Mercator coordinate system
VBScript	Visual Basic Script
VII	Vehicle-Infrastructure Integration
WAMP	Windows, Apache, MySQL and PHP. A Package of Open source programs for running dynamic web application on Microsoft Windows
WAN	Wide Area Network
WGS84	World Geodetic System 1984 coordinate system
WHO	World Health Organization
Wi-Fi	Wireless Fidelity trademark for the certification of wireless devices that meet IEEE 802.11 wireless Ethernet standards
WLAN	Wireless Local Area Network
XML	EXtensible Markup Language
$\forall$	for all; for any; for each
$\in$	is an element of
$\cap$	intersected with; intersect
$\cup$	Union with; union
$\Rightarrow$	implies

CHAPTER 1

INTRODUCTION

1.1 Background

The development of urban civilization had accelerated modern transportation and made it more convenient to road vehicles. However, this is disrupted by the phenomenon of road accidents. The causes of road accidents are due to many factors such as weather condition, vehicle design, safety measurements, driver's physical fitness, and many others.

Although, the safety measurements were implemented, the number of road accidents keeps on rising yearly. With the never-ending increase in population, the need for transportation will increase as well and as a result road accidents increases in number. The World Health Organization (WHO) (2004) warns that road accidents will jump from the ninth to the third rank in the most threatening health problem by 2020.

In understanding the source of road accidents, data needs to be studied and analyzed in a proper manner. In turn, data accuracy plays a vital role in making road accident data analysis a success.

One of the elements that affect data accuracy is the method of data collection at location and methods of archiving records. A more specific term used is geocoding, which describe method of data collection regarding location particulars. The implementation of technologies and standards has enhanced geocoding process. However, geocoding is still prone to errors and inaccuracy.

Based on this problem and with modern technological development, it is advised to facilitate the policeman (*the accident data collector and geocoder*) to send the collected data from his current location (*the road accident site*). The new integration of positioning systems and Geographic Information Systems (GIS) with wireless internet has emerged new type of information services defined as Location Based Services (LBS). Thus, the technology would be helpful to policeman and police headquarter to improve data handling from the accident location to central database.

LBS have many terms; according to Kupper (2005), it is referred to as location-aware service, location-related services, and location services. LBS have been considered disciplined concept of information system (Pick, 2005). However, GIS professionals consider it a new suite of GIS; a proper term 'mobile geographic services' would be wider definition and focus on geography and GIS (Maguire, 2001).

The LBS applications for accessing geospatial database remotely according to its user's location make it feasible to assist government officials in working site, like policemen. However, the cost of implementing a LBS solution comes expensive in the long term due the licensing and maintenances issues.

In the era of ICT, technological solutions of hardware and software are available to serve the information system age. Most of these solutions are commercial and costly. In addition, the licensing and the unknown Total Cost of Ownership (TCO) and misunderstanding may result in a costly system. Consequently, the government of Malaysia were encouraged to use, develop and implement open source software (EPU and MOF, 2006; MAMPU, 2005).

1.2 The Problem

In Malaysia, the duty of investigating and obtaining data from an accident scene is usually assigned to the policeman on patrol duties. Field information such as the locality of the scene, the cause and other scene related parameters which are related to the accident are then forwarded to the central police headquarters for filing and further analysis. Such methods of geocoding are inaccurate due to the high amount of subjectivity, which results in under-reporting of the accident scene.

In addition, the recent move by the Malaysian government to encourage the deployment of ICT infrastructure and open source software (OSS) in all its agencies is seen as a step towards modernisation of the public sector. However, one major drawback such as that experienced by the police is that the present ICT infrastructure in the country has not approach the provision level of technological solutions such as LBS, mobile GIS and OSS that may enhance the accuracy, reliability and productivity of the organisation.

1.3 Justification

The importance of road accidents data collection is to assist different benefited parties in making decision to improve life style and development; such as health agencies to determine the required type and cost of medication, consumer protection organizations to take actions agienst low standards of manufactures, insurers to determine insurance cost's cover, economists to determine the countries lost of the profits due to road accidents, politicians to enforce law counter measurement, automobiles' industries to undertake new standard measurement of safety, and transportation engineers to asure road safety design extent.

Archived records in Road Safety Research Centre (RSRC) shown inconsistency in coordinates and described location. In addition, some of the records are duplicated with differences of coordinates, date and time. These types of records are normally deleted from analysis (especially in GIS) as they may cause errors and misleading results. Methods of geocoding must leverage with the current trends of technologies to assist analyzers (especially GIS experts) in delivering much accurate data as much as possible. Thus, this sort of issues had motivated this research more.

The Malaysian government plans toward implementing technological solution based on open source solutions, shows interest of developing its internal resource to be more technologically independent from the monopoly of software vendors (refer to chapter 2 section 2.4 and 2.11). The situation and experience of Malaysia as developing country to improve their technological independent may be reflected on other developing countries to improve their own situation.

1.4 Research Objectives

The general aim of this research is to improve the efficiency the policeman in geocoding road accident more accurately through the development of mobile GIS application using LBS and open source software. The specific objectives are as follows:

i) To investigate and design a road accident geocoding and data recording system using location based services and open source software to be used as a platform for development the mobile and server.

ii) To establish map service for assisting the policeman to identify his location of the accident scene.

iii) To develop geocoding service through wireless infrastructure and to maintain of

record's validation entry based on geospatial temporal identifier.

iv) To develop a field entry form in digital format for recording road accident based on the capability of the mobile device and LBS consideration.

v) To evaluate, validate and analyse the LBS application portability based on Internet/intranet protocol.

1.5 Research Scope

The research were confined to the current available hardware and systems (Mobile Devices-PDA PocketPC based, GPS, Bluetooth, Wi-Fi and a laptop computer as portable server) due to the administrative process, cost and time constraints, the development, implementation and testing of the LBS for this study. This confination issued challenges of technological development.

The study site and duration of testing system was confined to Universiti Putra Malaysia (UPM) as it also provides some of the urban facilities locations as well as open areas that are available for testing as minimum set of the real world general situations. Date and time of testing is done on random based because the actual occurrences of road accidents are unknown as it is a phenomenon. The actual time date of recording, even though it is after the occurrences of the accident, is on random timing basis.

1.6 Thesis Layout

Chapter 1 introduces the subject of research, problem statement, research motivation and the aim and objectives to achieve. The second chapter reviews on road accidents in Malaysia, methods of recording road accidents, the roll of information and communication technology issuing mobility and wirelessly; focusing on wireless

networks, Personal Digital Assistant (PDA), location awareness, GIS, geocoding, LBS and open source development.

The third chapter will explains methodology of research and development from the scenario of the system solution and defining the required services to the system architecture. Details of the LBS components setup such as wireless network, middleware, geospatial database model, designing and programming PDA interface for the user and middleware interaction more elaborated.

The fourth chapter presents the result of map service and discusses performance in wireless environment and its role in identifying the location. The chapter also discusses on the method of geocoding using ArcPad and the integrity of data collection.

The fifth chapter concludes the efficiency of using LBS and open source software. Recommendation to improve the LBS and the standards to follow for developing open source LBS software solution were also included. Finally, future work needed to improve the system to work in different wireless environment and using different positioning techniques conclude the thesis.

CHAPTER 2

LITRATURE REVIEW

2.1 Introduction

The history of road accident phenomena have begun after the invention of ground vehicles. According to World Health Organization (WHO, 2004) report on road traffic injury prevention summary, the severity in South Asia comes in second after East Asia and Pacific. This chapter provides a review of literature in aspects related to road accidents, with main focus on Malaysia. The topics include current situation of road accidents in Malaysia and factual information about it, methods of recording road accidents, means of data collection, the means of mobility and wirelessly, the technical equipment needed like mobile devices, mobile GIS, open source development and LBS fundamentals and applications.

2.2 Road Accidents in Malaysia

WHO (2004) reported that there is a constant increase in road accidents throughout the world. In 1990, death toll on road accidents remained in 9th rank; and by 2020 road accidents is expected to be the third leading cause of death worldwide, (Kareem, 2003).

In Malaysia, road accidents among the ten causes of death (Azmani et al., 2005), from 1975 to 1998, road traffic fatality rates rose by 44% in Malaysia (WHO, 2004). In the year 2001, the total number of road accidents was 265,175 with fatalities of 5230, seriously injured 6942, and slightly injured 30,684.