Mobile GIS for Military Services: Tracking & Navigating Soldier Using Personal Digital Assistant (PDA)

by

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Dissertation submitted in partial fulfillment of
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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
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Approved by:

(Mr. Justin Dinesh Devaraj)

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TRONOH, PERAK

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

SARI KARTIKA SUPARNOTO

ABSTRACT

Mobile Geographical Information System (GIS) for Military Services: Tracking & Navigating Soldier Using Personal Digital Assistant (PDA) (MGMS) is a system for tracking and monitoring troop's movement in defense area. The system provides the exact location of the troop based on latitude or longitude coordinates on a digital map. The digital map is attached to PDA with a Global Positioning System (GPS) connection and a server (laptop/desktop) as the monitoring center. This system provides users with the opportunity to experience a wireless communication system using either Global System for Communication (GSM) modem or Wireless Fidelity (Wi-Fi) that enables monitoring center to track the exact location or movement of object with the connection of GPS in real-time environment. This system will also enable communication between the troops (through the PDA) and their monitoring center (through laptop/desktop) by sending text messages using the windows socket as a medium. The GSM modem or Wi-Fi is used to establish a wireless connection between the PDA and laptop/desktop (monitoring center). This project has been successfully completed and focuses only on the tracking of a single object. However, the concepts explored can be expanded to tracking multiple objects. In addition, several recommendations have been proposed to improve the current system to be more reliable and presentable.

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LIST OF ABBREVIATIONS

MGMS	Mobile GIS for Military Services: Tracking & Navigating Soldier Using Personal Digital Assistant
PDA	Personal Digital Assistant
GPS	Global Positioning System
GSM	Global System for Communication
GIS	Geographic Information System
MTS	Mobile Tracking System
IT	Information Technology
Wi-Fi	Wireless Fidelity
AP	Access Point
SSID	Short for Service Set Identifier
ID	Identifier
MTS	Mobile Tracking System
KB	Knowledge Based
Lat	Latitude
Long	Longitude
FYP	Final Year Project
BMP	Bit Map
DOD	Department of Defense
C42I	Command Control Communication Coordination, Information & Interoperability
C4I	Command, Control, Communication, Coordination and Information
KB	Knowledge Based
SDLC	System Development Life Cycle
UML	Unified Modeling Language

CHAPTER 1
INTRODUCTION

1.1 BACKGROUND OF STUDY

Mobile mapping nowadays with its incorporation of handled PDA devices for field data collection is a rapidly expanding field of GIS. While the wireless technology is increasing through time, the usage of mobile GIS is very useful in any organization and companies especially for defense area. The importance of implementing the location technologies is obviously useful in certain working environment, especially in defense area, when the soldiers struggle against their opponent and meanwhile the placement of the troop separately in large geographic area as a strategy as for example, the tourism field, the educational field and others.

From research there are huge interest in this emerging technology which comes from many different fields including Surveillance and target acquisition, Health, Supplier of Weapons, Land Information, Tracking, Surveying, Business and Urban GIS, Geology, Biology, Disaster Management, Hydrology and so on. GIS Mobile mapping is not just concentrate on one area field, but open widely to other field to used the technology to fully utilized the benefits that it provide.

One of the fast-growing GPS applications is tracking and monitoring system. The role of GPS in the project is to determine the actual position of the symbol (latitude and longitude) and monitoring the movement with the ability to track troop in real-time manner. Main purpose of Mobile GIS for Military Service: Tracking & Navigating Soldier System Using PDA (MGMS) development is to trace the actual position (latitude and longitude) of specific object. Besides that the system is also will be an impulsive stage for enhancement of the features in the future. The benefits of the system are listed below:

i. To detect, locate and track symbol information.

Mobile GIS for Military Service: Tracking & Navigating Soldier System Using PDA (MGMS) can detect, locate and track point information easily as soon as connection of GPS (Global Positioning System) is enabling. As a result, by using this system, point information can be enabled identified.

ii. To give clear, accurate and real-time information.

MGMS displays information and instructions in a clear, accurate and real-time manner way. As a result, information and instructions that are received by the user are interpreted correctly and action can be taken immediately.

iii. To operate in-door or outdoor environment

Instead of using desktop computer, the application can be used with a PDA in which it allows more mobility to the user. The system can be operated in-door or outdoor environment where wireless connectivity is available

The presence of GIS and GPS technology drives the professionals to look towards mobile platform in order to increase the productivity and better efficient handling which result in cost reduction, well informed workforce and faster information delivery

Furthermore, the users of the client PDA interface required either little or no training as the data entry tools provide simple and intuitive choices. The client PDA interface is easy and simple as for everyone to handle it.

Following the needs and after studying the potential utilization of transaction data from the server and client, location based technologies and also with the emerging of the mobile devices. This project is to develop a system to meet the demand of Mobile GIS for Military Service: Tracking & Navigating Soldier System Using PDA (MGMS).

1.2 PROBLEM STATEMENT

1.2.1 Problem Identification

In defense area, when the soldiers struggle against their opponents and meanwhile the placement of the troop separately as a strategy. Therefore, this system designated to track and communicate with the communication centre while in the jungle. The aim of the research is to track the actual position and to monitor the movement of the soldier, so that it would be easier to trace the actual position (latitude and longitude) of the troop or location of specific object in large geographic area. General reference map of Wangsa Maju, Kuala Lumpur region serve as a project base map for mapping purposes. Furthermore, Global Positioning System (GPS) attribute input and interactive GPS really become a major component of GIS and will be an essential input to the tracking and monitoring the actual position of the soldier. The reason of integrating Geographical Information System (GIS) and GPS is because GPS provide increasingly accurate data input for wider range of GIS applications in cost effective manner.

1.2.2 Significant of the Project

The significant of the project is to be able to develop a Mobile GIS for Military Service: Tracking & Navigating Soldier System Using PDA (MGMS). Mobile Positioning System is specially designed for future soldier application. This system integrates with multiple devices, which are desktop computer as a server and one mobile terminal (PDA) as a client. MGMS that incorporates several tools and techniques so that the overall system developed will have additional attributes such as the elements of reliability, maintainability and availability. With the successful development of the project, it is hoped that the system will be able to:

i Provide a communication centre with the system to track and monitor object information easily as soon as connection of GPS (Global Positioning System) is enabled.

ii Provide user with clearer, accurate and real-time information. As a result, information and instructions that are received by the user will be interpreted correctly and further action can be taken immediately.

iii Able to trace the actual position (latitude and longitude) of specific object in real-time manner.

1.3 OBJECTIVES AND SCOPE OF STUDY

1.3.1 Objective

The objectives to be achieved by the completion of this project are:

i. To provide user with a wireless communication system that enables to track the object exact location and movement easily as soon as connection of GPS (Global Positioning System) is enabled.

ii. Monitoring the actual coordinates location (latitude and longitude) of specific object in real-time environment.

iii. The system will be able to track the object movement on digital map by matching the coordinates transferred from GPS receiver to be displayed on mobile device such as PDA.

1.3.2 Scope of Study

The scope of this study is to develop a MGMS for military purposes in defense area. Besides that, it would covers the definition establishing connection between the client and the server, which is PDA, will act as client that sends data to the desktop or laptop

that act as a server. In sum, the servers will response to the request that had been made by the PDA and transmit the data request by the PDA through wireless connection. Furthermore, for connection of the system, GSM modem is used. It uses GPS information to track, detect and locate symbol information. However, there are few limitations in the system due to the accuracy of GPS reading (the accuracy is plus minus 10 or 15 meters radius). Besides, other limitation such as; there is a limit in handling multiple tasks. Due to the distance limitation, the system could be operated within 100 meters radius only. Moreover performance of the system will be decreased when wireless signal strength is decreased. In addition, the system also faced a constraint when handling large map of data.

1.3.3 Relevancy of the Project

The problem in defense area are when the communication centre having difficulties to track and monitor the object movement when their struggle against the opponents in the jungle. Since this kind of problem exists, the communication centre cannot take action immediately when there are any problems arise, such as missing soldiers in the jungle.

Besides that, the missing soldiers in the large geographic area need to be solved immediately by the military. Therefore, this real time tracking & navigating Soldier system research project is relevant to be conducted. In the other hand, location technologies nowadays are expanding it wings in the information technologies field. Furthermore the mobile computing is creating fundamental changes in the way in utilize geography with the ability to bring the work with the user and interact with the world.

1.3.4 Feasibility of the Project

The development of the project stretches for a period of 2 semesters which are FYP Part I in the first semester while FYP Part II is done in the second semester. The project is estimated to finish within the provided time frame as most of the analysis; planning and

designing are done in FYP Part I. It is estimated that within FYP Part I, the storyboard for the system to be completed and a rough design of the interface to be done. The other processes in the development of the system are to be done in FYP Part II. The processes involved in FYP Part II are transforming the design into workable codes, operation and maintenance and last but certainly not the least, unit and system testing.

CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION TO GIS (MAPINFO MAPX MOBILE) AND MOBILE ENVIRONMENT

MapInfo MapX® Mobile is the premier Windows-based software developer's tool for creating customized mapping applications on Personal Digital Assistant (PDA) devices [1]. With MapX® Mobile, developers can easily create custom-made applications that empower the mobile workforce with the ability to access, gather and analyse critical business information, resulting in increased productivity and enabling them to make faster, better-informed business decisions. The Pocket PC/handheld markets are growing exponentially and are rapidly becoming the de facto platform for mobile professionals. MapInfo MapX Mobile is the ideal tool for any organization with a mobile workforce looking to improve efficiency and productivity. MapInfo MapX Mobile allows for interoperability, enabling users to add mobile extensions to existing applications. Furthermore, the data collection with MapInfo MapX Mobile is fast and easy and significantly improved with immediate data validation and availability. MapInfo MapX Mobile is a part of the enterprise GIS solution.

MapInfo MapX Mobile support both image displays which is vector and raster map, and it links to their own database, which is the tab files as a data file. The MapInfo MapX Mobile also offers integration with an optimal GPS or differential global positioning system for real-time data capture.

There are many potential applications that can be implementing with the mapping system, such as [2]:

i. Different streams of planning

Urban planning, housing, transportation planning architectural conservation, urban design, landscape.

ii. Street Network Based Application

It is an addressed matched application, vehicle routing and scheduling location and site selection and disaster planning.

iii. Natural Resource Based Application

Management and environmental impact analysis of wild and scenic recreational resources, flood plain, wetlands, aquifers, forests,&wildlife.

iv. View Shed Analysis

Hazardous or toxic factories sitting and ground water modeling. Wild life habitat study and migrational route planning.

v. Land Parcel Based

Zoning, sub-division plans review, land acquisition, environment impact analysis, nature quality management and maintenance etc.

vi. Facilities Management

Locate underground pipes and cables for maintenance, planning, tracking energy use.

vii. Military fieldwork

Tracking and monitoring of troop and possible terrorist activity, surveillance and target acquisition, cartography, intelligence, battle field management, terrain analysis, remote sensing and military installation management [3].

MapInfo MapX Mobile normally used directly by an organization enterprise formats. MapInfo MapX Mobile uses vector data in industry-standard shape file format and it's also support the following raster image format:

i. JPEG

ii. Window bit map (BMP)

As for the purpose of developing project, the author used digital map as shown as in the Figure 2.3.2. The process of map digitizing is done layer by layer due to the land use. There are specific methods on digitizing the map. Digitizing process require software and hardware as a medium for digitizing.

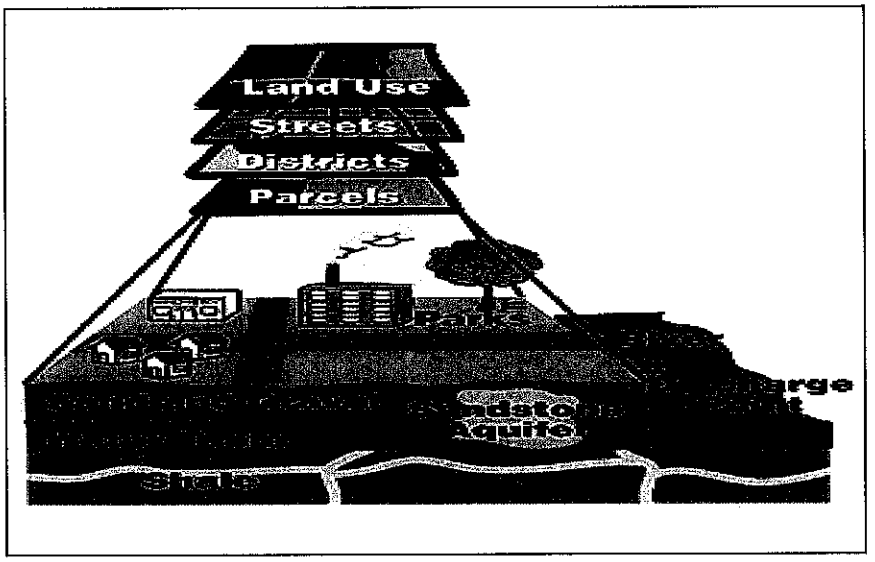

Figure 2.3.2: Digitize Map in Several Layers

A digital map is not much more difficult to use than a paper map. As on the paper map, there are dots or points that represent features on the map such as landmark, region that represent features such as cities and lines that represent as roads or rivers [5].

All this information, where the point is located, how long the road or river is, and even how many square miles a cities occupies, is stored as layer in digital format as a pattern of ones and zeroes in a computer. Moreover, GIS uses geographic locations and information about these locations. Think of this geographic data as layers of information underneath the computer screen. Each layer represents particular features on the map. One feature or theme could be made up of all the railroads in an area. Besides, another could represent all paddy field in the same region. Yet another could represent as another object. Each feature can be laid on top of one another, creating a stack of information about the same geographic area and region.

2.2 GEOGRAPHICAL INFORMATION SYSTEM (GIS)

Geographic Information System (GIS) is a computer based information system used to digitally represent and analyze the geographic features present on the Earth' surface and the events (non-spatial attributes linked to the geography under study) that taking place on it [2]. In other words, GIS is the automation of map-based information. This information is stored in number of ways, is usually displayed as a computer produced map [4]. One of the unique features of GIS is its ability to match coordinates (in form of latitude and longitude formats) on map with coordinates on earth.

2.3 MAP LAYERING

MAP is a representation on a medium of a selected material or abstract material in relation to the surface of the earth (defined by Cartographic association). Maps are originated from mathematics. Map Layering is used to divide a large map into manageable pieces. As shown as in the Figure 2.3.1, there are two categories of good layering standard, which are each layer, have their mnemonic name and hierarchical (have a structured classification scheme) [5].

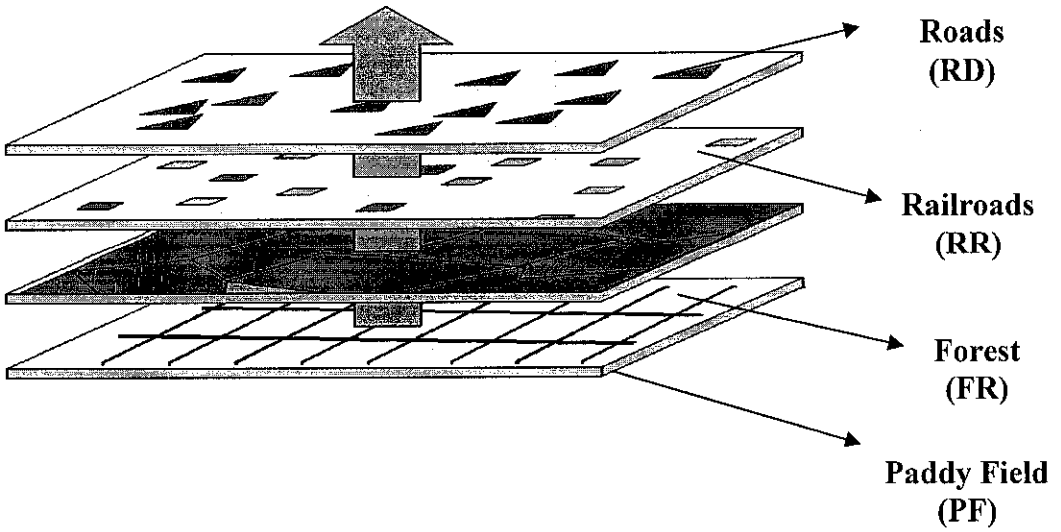

Figure 2.3.1: Map Layering Concept [5]

2.4 GLOBAL POSITIONING SYSTEM (GPS)

As a discussed before, GPS will be the method for tracking the troops and monitoring the movement of the specific objects. GPS is funded by and controlled by the U. S. Department of Defense (DOD) and is operated by the U. S. military. GPS provides specially coded satellite signals that can be processed in a GPS receiver, enabling the receiver to show the exact position and compute location on the Earth anytime, in any weather, anywhere [6]. The satellites transmit signals that can be detected by anyone with a GPS receiver. Four GPS satellite signals are used to compute positions in three dimensions and the time offset in the receiver clock. By combining GPS with current technology and future computer mapping techniques will be able to track and monitor the exact position of the specific objects and also their movement. GPS satellites transmit signals to equipment for the receiver on the ground. GPS receivers passively receive satellite signals; they do not transmit. GPS receivers require an unobstructed view of the sky, so GPS only used outdoors. They also have a limitation such as it often does not perform well near tall buildings area or inside the buildings.

2.4.1 GPS Component

GPS has 3 parts: the space segment, the user segment, and the control segment. The space segment consists of 24 satellites, each in its own orbit 11,000 nautical miles above the Earth. The user segment consists of receivers, which you can hold in your hand or mount in your car. The control segment consists of ground stations (five of them, located around the world) that make sure the satellites are working properly. The GPS satellites each take 12 hours to orbit the Earth. Satellites are equipped with very precise clocks that keep accurate time to within three nanoseconds - that 0.000000003, or three billionths, of a second. This precision timing is important because the receiver must determine exactly how long it takes for signals to travel from each GPS satellite.

2.5 GIS FOR DEFENSE

Geographic Information System (GIS) play a pivotal role in Military operations, as they are essentially spatial in nature. In the present digital era, GIS is an excellent tool for Military commanders in the operations. The use of GIS applications in defense forces has revolutionized the way in which these forces operate and function.

In military services, operations are largely dependent on the availability of accurate information in order to arrive at quick decisions for operational orders availability of accurate information in order to arrive at quick decisions for operational orders. Military forces use GIS in a variety of applications including cartography, intelligence, battle field management, terrain analysis, remote sensing, military installation management and monitoring of possible terrorist activity.
In the case of military, GIS mapping will help the army to have a clear cut idea about the terrain on which they have to move as well for the communication centre to keep track the movement of the troops in the large geographic area in the jungle.

2.6 MOBILE TRACKING SYSTEM FOR DEFENSE PURPOSES

Since the beginning of civilization on the planet earth, military forces have played a dominant role. In the military operation, all the information needs to be delivered in fast way. Simultaneously the concepts of C42I (Command Control Communication Coordination, Information & Interoperability) are largely dependent on the availability of accurate information in order to arrive at quick decision for operational orders. The Army is undergoing a revolution that will provide the technology and systems needed to support U.S. soldiers around the world. Older databases and redundant systems are being replaced with cutting-edge technologies that help the Army do its job faster and more effectively. It is increasing its efficiency by adopting improved business processes, and it is using technological advances to support operational concepts in a logistics revolution.

Innovations in technology have motivated the Army to find better ways to train, supply, and equip its soldiers. The revolution in communications technology in the 1980s and 1990s spurred the Army to improve its capabilities for tracking and communicating with soldiers in the field. Commercial technology was harnessed to suit the unique needs of the Army and develop a secure means of communicating. As part of this revolution, the Army is changing the way it transports and maintains equipment and personnel in an effort to improve its overall sustainability. One way the Army adapting technology to transform its logistics systems is by developing and installing the Mobile Tracking System (MTS) [11]. MTS is revolutionizing logistics on the move: the Movement Tracking System allows the Army to track and communicate with individual vehicles on the battlefield. Furthermore the existing of MTS is a low-cost solution designed for the Army and its vehicle operators for tracking vehicles and communicating while on and off the road during war or peacetime. MTS is a mobile satellite two-way messaging system that is totally wireless system from the MTS-equipped vehicles to the control station. The mobile component of the system is mounted on a unit's vehicles and the control station component monitors vehicle locations. Both components use the same basic communications software and hardware, although the control station uses a computer with a larger display and faster processor. Communication between the two is provided by a commercial satellite vendor that allows units to send and receive traffic over the horizon, anytime, anywhere.

MTS technology allows the transportation coordinator to "talk" to the driver of any truck, regardless of location, without having to put up antennas or involve more soldiers. MTS is currently being adapted to incorporate radio frequency technology, an upgraded military global positioning system (GPS) capability, automatic reporting of vehicle diagnostics (future), and other features that support in-transit visibility.

2.7 GIS ASSISTED KNOWLEDGE-BASED APPROACH FOR MILITARY OPERATIONS

An emergent situation means that the army has to move towards the border at a very short notice. The mobility of any armored column depends upon the terrain conditions over which it has to move. Ground conditions have always played an important role in all conflicts over the ages. The parameters like topography, soil type and land use land cover have a direct bearing to key activities like mobility of both men and machines, methods of crossing obstacles, selection of tactically important areas etc. Replenishment of ammunition, fuel and other supplies are required to reach the fighting troops in time. These require careful planning in terms of routes to be taken and movement of various types of vehicles to ensure success.

Fortunately, the IT tools can be sufficiently exploited for any challenging task such as planning of wars. Remote sensing, Geographical Information System (GIS) and artificial intelligence technologies are sitting on the top of these IT tools that can together be effectively utilized to develop intelligent systems for war planning. Command, Control, Communication, Coordination and Information (C4I) is one such system where these technologies can be effectively used. For example, satellite remote sensing data can be used to generate a wide range of products such as land use land cover maps, obstacle maps, slope maps, road mobility maps, line of sight plots etc. A GIS can receive process, create, store, retrieve, update, manipulate and compress digital terrain data to generate a number of products. Knowledge of experts is a key input for any C4I system. Knowledge Based (KB) systems are being developed for war planning that can process inputs from remotely sensed and GIS derived products and use the knowledge gained to aid the decision making process, thereby allowing the military commanders make better battle plans. GIS embedded C4I systems aim to give this KB to field commanders and their staff who despite having little knowledge of GIS, can work on such systems. Currently only a few C4I systems are in use with embedded GIS, but their numbers are likely to rise substantially soon as more and more systems are developed around the world.

The use of a GIS assisted knowledge-based approach for some military operations such as selection of sites for bridges and helipads, identification of tactically important roads and preparation of troops or vehicle mobility maps. Some common military operations:

i. Identification of Tactically Important Roads

In order to provide fast and safe movement of troops and equipment, identification of tactically important roads is essential. Roads and tracks that lead up to the likely bridge or ferry site are tactically important and need to be identified and suitably constructed so that these may be used as the axis of maintenance. Ideally these roads should not pass through any obstacles like the minefields.

ii. Preparation of Troops or Vehicle Mobility Maps

Military vehicles are generally classified into two broad categories, tracked and wheeled. Troops and vehicles like tanks have excellent cross country mobility due to the presence of tracks over its wheels. However vehicles having wheels but without tracks do need careful route planning before cross-country movement can be attempted. Vehicles carrying essential war stores like ammunition; fuel and other supplies are all wheeled vehicles.

The activities mentioned above are just a few undertaken by the defense forces while planning for a military operation. Most of these require good interpretation skills to understand the terrain. These skills may vary from person to person and hence the interpretation is also likely to vary. This may adversely affect the battle plan therefore, there is a need to standardize procedures and incorporate systems, which use the existing knowledge acquired by experts, intelligence agencies and other means. This knowledge base (KB) can be effectively used to make accurate decision making tools which can easily be used by military commanders at all levels. KB expert systems can be developed, which the experience and knowledge of terrain analysts and other experts to convert them into a set of rules, which can then be applied to digital data to derive a number of thematic maps that can in turn be used in war planning. The rules to be formed are based upon the spatial information about the terrain as desired by a

particular military operation. A number of spatial raster data layers are prepared. The data for the study area has primarily been collected from the topographical map as above. However, due to non-availability of certain information, some hypothetical data has also used for the preparation of layers. Following data layers have been prepared by on-screen digitizing the scanned topographic map.

Existing roads and tracks are an important aspect as it ensures the smooth movement of both fighting columns and logistical supplies. The area has a good network of roads and tracks both along the river and perpendicular to it. The roads and tracks are therefore the automatic choice for the categories in roads layer and are assigned a raster value of 1 and 2 respectively (Figure 2.7.1).

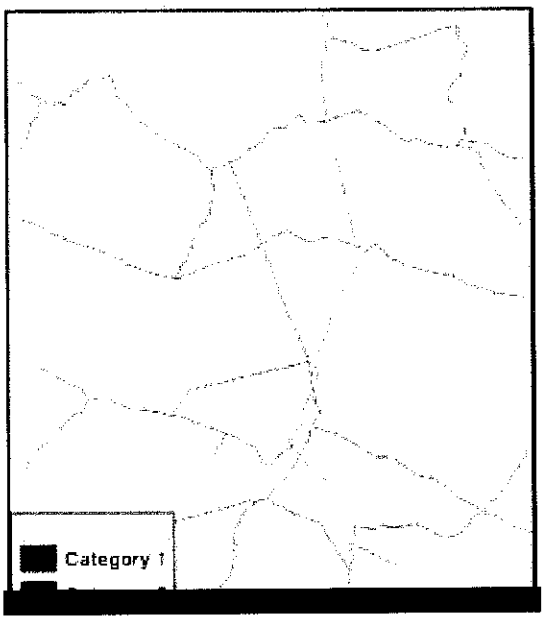

Figure 2.7.1: Thematic Layer of Road Network

2.8 GALILEO, GLONASS AND NAVSTAR

The GLONASS satellite system and NAVSTAR systems began operation in the early 1980's. both systems were designed to similar purposes, to allow for precise navigation and accurate positioning. The NAVSTAR GPS system is a satellite-based radio

navigation system developed and operated by the U.S. Department of Defense (DOD). The NAVSTAR system permits land, sea, and airborne users to determine their three-dimensional position, velocity, and time 24 hours a day, in all weather, anywhere in the world with a precision and accuracy far better than other radio navigation systems available today. The NAVSTAR system performs another function besides positioning and time transfer. NAVSTAR satellites carry nuclear explosion detection equipment.

Originally NAVSTAR had accuracy of ± 100 m @ 95% in the horizontal plane and ±186 m @ 95% in the vertical plane (x-coordinate) for civilian use. That was significantly improved with the recent abolishment of selective availability (SA) or time dithering of GPS signals that resulting in higher levels of errors. These errors are now 36 m @ 95% horizontal and 77 m @ 95% vertical respectively, though most users achieve much better accuracy often. The GALILEO system aims to provide similar or better levels of accuracy. GALILEO is designed to integrate both NAVSTAR and GLONASS to become a truly GNSS solution – or operate independently. There would be 30 satellites in the GALILEO constellation. In total combined, almost 80 satellites combining the 3 GPS systems would potentially be available to be tracked using a combined GNSS receiver. GALILEO would allow European providers of spatial services closer control over positioning services and be less affected by military needs of NAVSTAR, which at times results in the movement of satellites for military purposes. This system is being proposed by the 15 EU member states as well as the European Space Agency, which is a consortium of numerous companies involved in geo-science and scientific study for the European region. Perhaps one of the strongest reasons for envisioning GALILEO is that it becomes truly an international platform, designed to deal with interoperability issues arising from integration with NAVSTAR and GLONASS and is operated from a civilian standpoint – not a military one. Thought he European Parliament has recently indicated 'military peacekeeping' should be part of the mandate for GALILE.

The NAVSTAR and GLONASS systems use the principle of trilateration. That is, the user-receiver determines the distance from the user to each of several satellites. Since

the positions of the satellites are known, either through previous publication or as part of the satellite broadcast information, the user position can be calculated.

Display of the position of the object or vehicle can be taken on an instrument of a size of a mobile phone or palmtop. A central monitoring station or service providing central station can observe the position. The various services that can be provided by the central monitoring station can be as follows:

i. When emergency assistance is required, that can be in a stage of health problems, lost of way.

ii. In a search of facilities in a highway such as public conveniences.

iii. Search of a route that is short, less congested and that will touch the required places or facilities in need.

iv. List is very long and ends less. As long as technology helps, as the navigation facilities will reach to a point, at which when vehicles will become smart vehicle, which is self-driven vehicles. In which we have to give only the destination then sit a back, read newspaper or talk on a phone, vehicle will take us to our destination.

v. GPS integrated with VHF and HF radios are being offered to Army, Navy and Air force. It aids the soldier in navigating without the help of a map and automatic reporting of the position of the troop to control station.

2.9 ROLE GPS IN LOCATION BASED SERVICES

An object or vehicle tracking system can thus be defined as a part of a fleet management system, which enables the fleet operator to find out the location of the object or vehicle throughout the journey of the object or vehicle, against time.

Apart from utilizing the data generated by the object tracking system for enforcing the

schedule of the bus, this data also provides important inputs for decision-making. The system facilitates computation of exact distance traveled in a given time span, computation of the speed of the bus at a given location, analysis of the time taken by the vehicle to cover certain distance and so on. It becomes a very powerful tool in case the operating agencies.

To develop an object-tracking project for fleet management following steps is generally followed:

i. Digitizing the road map for the city.

ii. Developing the GPS receiver module.

iii. Development of software, which provides interface between the GIS and the GPS.

iv. Development of the error correction software.

v. Development of the analysis software

The GPS receiver module constituted the heart of the system. Each receiver has a facility to store the unique ID and was capable of recording the coordinates of its location every minute. A memory module was also added to the receiver, which was capable of storing the recordings of three days. In every record, the first entry represents the Latitude and the second entry indicate Longitude (both in degrees, minutes and seconds), followed by Time (in Hour, Minute and Second) and Date.

When the GPS coordinates were plotted on the GIS map of the city it was found that the recordings were not exactly sitting on the roads. There were several errors responsible for this. The resolution of the satellite map was only 20 meters, digitization has to be done by manually tracing the satellite image some errors crept in at that stage, selective availability of the GPS signals, and the signals are not 100% accurate. In order to overcome this problem software was developed which was capable of pulling these

coordinates onto the correct road thus facilitating further processing.

Generation of each schedule was a necessary output in order to find out whether the bus performed punctually as per the schedule. For this purpose the location of the bus was required periodically. The time interval could vary from a minute to half an hour. The GPS module throws up this data in terms of the latitude and the longitude, but for a traffic controller, it is very difficult to interpret. Therefore on the GIS road map of the city, landmarks were identified at every 200 meters length and a layer was created where the coordinates of all these landmarks were fed. Software was designed which would convert the latitude and the longitude given by the GPS into the nearest landmark and then generate a log-sheet giving the location of the bus at periodic intervals in terms of the landmarks.

CHAPTER 3
METHODOLOGY

3.1 PROJECT METHODOLOGY

Software engineering is the practice of using selected process techniques to improve the quality of a software development effort. A methodical approach to software development results in fewer defects and, therefore, ultimately provides shorter delivery times and better value. Availability of a number of software process models such as the waterfall model, evolutionary development, formal system development and reuse-based development [7] makes the process of selecting the appropriate model an important one. The reward of selecting the appropriate model is the deliverance of quality required in the system, while avoiding steps that waste time and other resources.

The author has applied a systematic approach throughout the development of project in order to keep the development phases of Mobile GIS for Military Services: Tracking & Navigating Soldier Using PDA (MGMS) in a more proper and structured manner. The author has used the System Development Life Cycle (SDLC) method, which was learned in the System Architecture and Design course as a guideline to develop the systems. Provided with ample time in the development of the system, the waterfall model was chosen as the software process model for the development the system. The waterfall provides an orderly sequence of development steps and helps ensure the adequacy of documentation and design reviews to ensure the quality, reliability, and maintainability of the developed software [8]. It follows a set of good software development principles which work are divided and done in stages, content review can be done at each stage and these reviews can represent quality gates and decision points for continuing. The development process only progresses into the next
stage when the previous stage is completed and satisfied. Below is a figure depicting the waterfall model:

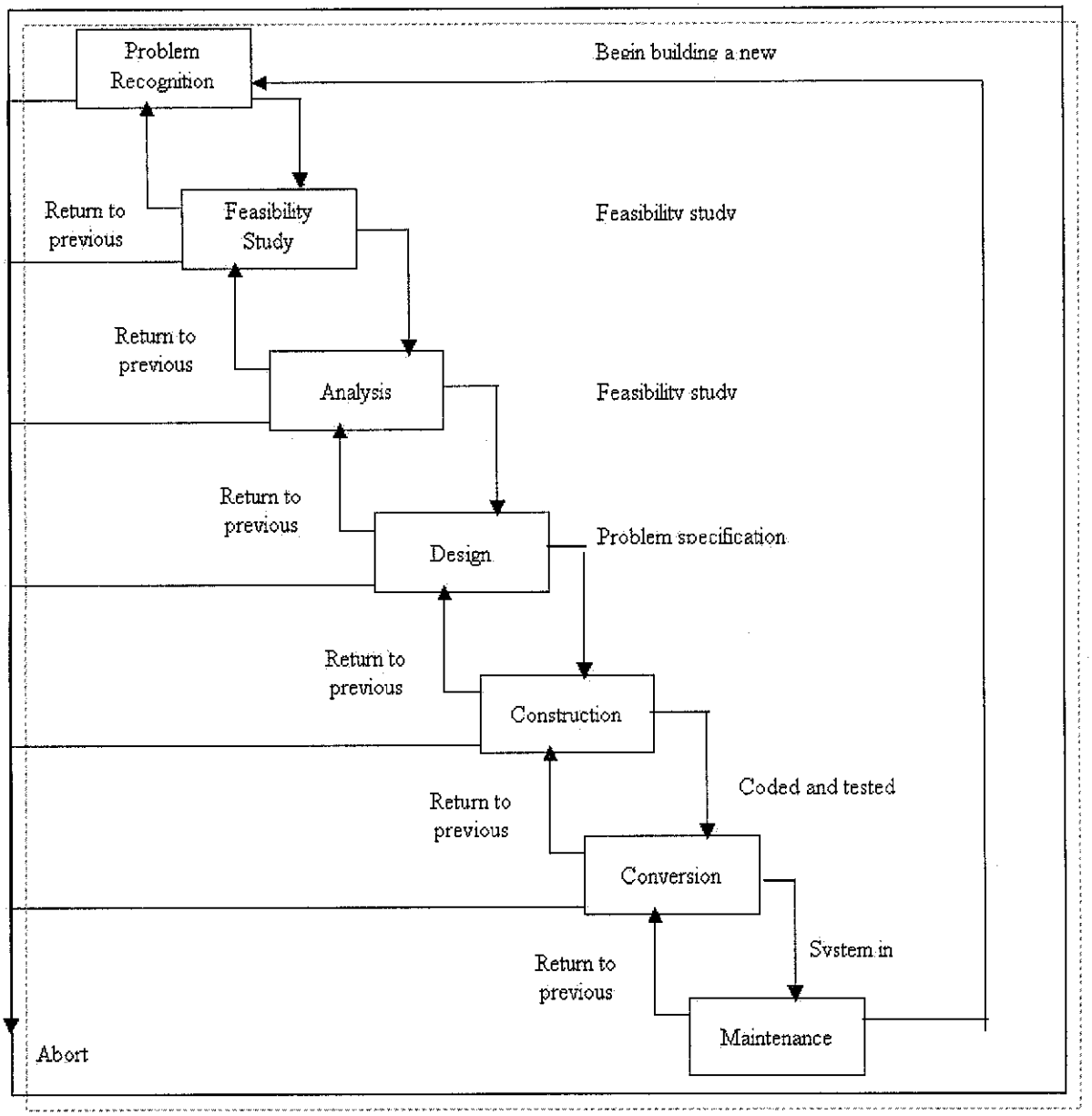

Figure 3.1.1: System Development Life Cycle (Waterfall Model)

Below are descriptions of the stages in the waterfall mode; generally, the system development life cycle consists of five stages. There are; the ***Planning, Analysis, Design, Implementation and Support*** phases. Author had started from the first to fourth cycle of SDLC, which are *Planning*, *Analysis, Design* and *Implementation* phases. For this time being, the author has been completed the *Implementation* and *Support* phase.

i. Planning

The purpose of this planning phase is to identify the objectives, scopes and boundary of the problem, and plan the development strategy and goals. In the first step, the author tried to identify the objectives, scopes and boundary of problem that will occur, and plan the development strategy and goals. Before continuing with the project, the author did a reading and research on GIS concept and analyzed MapInfo MapX Mobile manual. In addition, due to the project is fully developed by using Visual C++, the author spent some time in sharpening and refreshing her knowledge's and skills on Visual C++ programming language.

ii. Analysis

The purpose of this analysis phase is to study and analyze the system. In order to retrieve a successful solution the author had to identify and analyze the requirement. The author had analyzed on the flow of the system and its interactivity.

iii. Design

As for the design phase, the author has designed and developed Mobile GIS for Military Services: Tracking & Navigating Soldier Using PDA (MGMS) using Microsoft Embedded Visual C++ 4.0 for the client application (Pocket Pc application) and Microsoft Visual C++ 6.0 for the desktop application. In addition, the author was also involved in designing related Unified Modeling Language (UML) design for the Mobile GIS for Military Services: Tracking & Navigating Soldier Using PDA (MGMS). The Dia's Software is used for designing the Use Case Diagram of the system.

iv. Implementation

Implementation part is where the systems were demonstrated to the Supervisor to get his feedback for improvement. The Mobile GIS for Military Services: Tracking & Navigating Soldier Using PDA (MGMS) demonstration version simulates the actual position of the object within the real map area using GPS (Global Positioning System) receiver.

v. ***Integration and system testing***

The program units are integrated and tested to make sure that it meets the requirements that have been set.

vi. ***Operation and maintenance***

The system is installed and put into use. Maintenance involves correcting errors which were not discovered in earlier stages of the life cycle.

3.2 TECHNICAL REQUIREMENT

For this project, the following tools will be used in order to develop the project at the current time.

3.2.1 Hardware

In order to work on development of Mobile GIS for Military Services: Tracking & Navigating Soldier Using PDA (MGMS), there are several main hardware devices that need to be integrated with each other. The devices are PDA, laptop/desktop computer, GPS receiver and either GSM modem or Wi-Fi Technology with Access Point. The GSM modem or Wi-Fi connection produces a communication between PDA and desktop. As a result, wireless communication could be experienced by the user between both PDA and laptop/desktop.

To establish connection using GSM modem, SIM card is needed in both devices, which are one attached to the PDA, while another is attached to GSM modem that was plug-in to the USB port in the laptop/desktop. Whereas, when the user prefers to connect both devices using Wi-Fi Technology, the user will be attach to the nearer Access Point and at the same time the user should know the IP address of Access Point. GPS receiver as a source for location information is used to detect, track and locate symbol information. Table 3.2.1 shows the hardware requirement of the computer for the development of the

Mobile GIS for Military Services: Tracking & Navigating Soldier Using PDA (MGMS):

Device	Requirement
Operating System	Microsoft Windows XP
Processor	Intel® Pentium® 3 CPU1.7 GHz
Memory	128 MB of memory
Disk Space	20GB of free space
Other Peripherals	Monitor (1024 x 768), Keyboard, Mouse, CD-ROM drive

Table 3.2.1: Minimum Laptop/Desktop Computer Requirement

3.2.2 Software

In order to work on development of Mobile GIS for Military Services: Tracking & Navigating Soldier Using PDA (MGMS), as for the design phase, the author will be developed the system using Microsoft Embedded Visual C++ 4.0 for the client application (PDA application) and Microsoft Visual C++ 6.0 for the desktop application. In addition, for the purpose of designing the flow of the system, the author will be using a Dia's Software, which is used for designing the Use Case Diagram. In sum, in order Microsoft Developer Network will be using by the author as a reference when the author meet the problem in the future development. Windows Socket will be using too in order to establish connection between client and server. Table shows the software requirement for both PDA and Desktop application:

PDA	Desktop / Laptop
Microsoft embedded Visual C++	Microsoft Visual Studio C++ 6.0
Microsoft PPC SDK	Samba USB Modem / D-Link
Microsoft ActiveSync	Microsoft ActiveSync
MapX Mobile	MapInfo MapX
Microsoft Windows CE Platform Manager 4.0	Microsoft Developer Network

Table 3.2.2: Software Requirement for PDA and Laptop/Desktop

3.3 SYSTEM FRAMEWORK

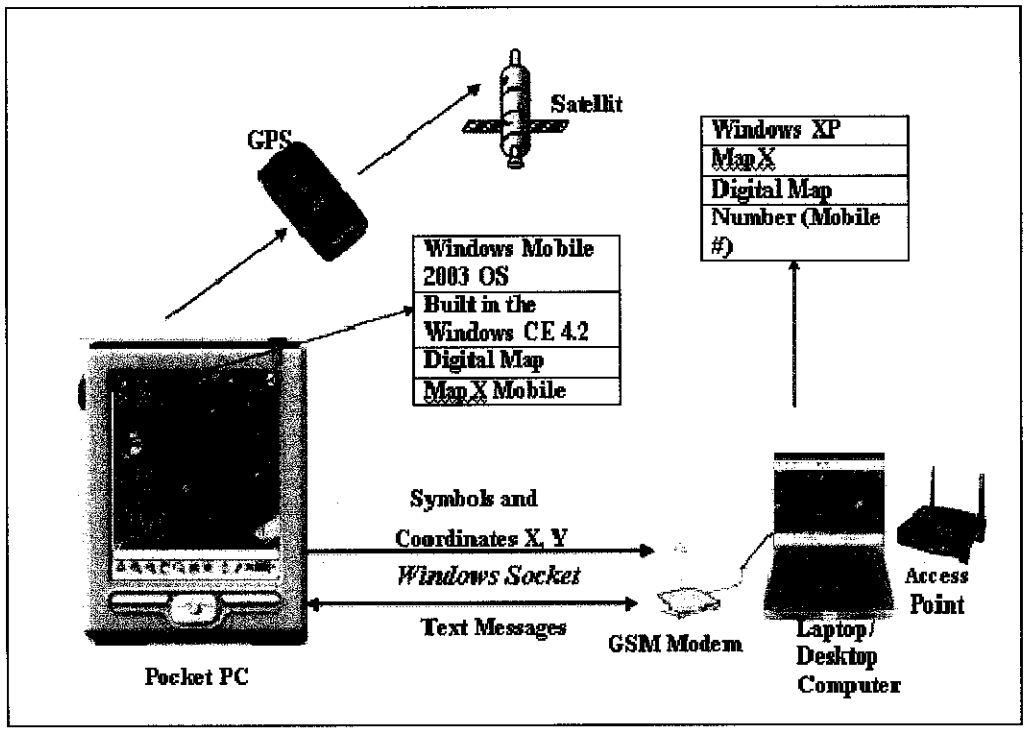

Figure 3.3.1: System Framework of MGMS

Basically, the principle of MGMS is schematically illustrated in the figure above. To further illustrate please refer to Figure 3.3.1. The digital map is attached to a client

(PDA) with a GPS connection and a server (laptop/desktop) as the monitoring center. Only PDA can send the actual position of the troop based on latitude or longitude coordinates on a digital map. The system is a two-way communication system, which both devices can communicate each other by sending text messages using the windows socket as a medium. In addition, either GSM modem or Wi-Fi is used to establish a wireless connection between the PDA and laptop/desktop that enables system to detect, track and locate the exact location or object movement with the connection of GPS in real-time manner.

CHAPTER 4
RESULT AND DISCUSSION

4.1 RESULTS

The expected results of this project are that the MGMS able to prove that the GPS tracking concept is right and able to track coordinates of particular object. The system should be able to match the coordinates in the digital map with the data transferred by the GPS receiver. In addition, GPS as a source for location information are also expected to deliver a very accurate position to the user in real time environment, which other positioning systems lack.

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4.1.1 Flow of the System

The results that have been gained through out the development of the system are shown in the Figure 4.1.1 below: diagram is used in order to explain the whole function of the system.

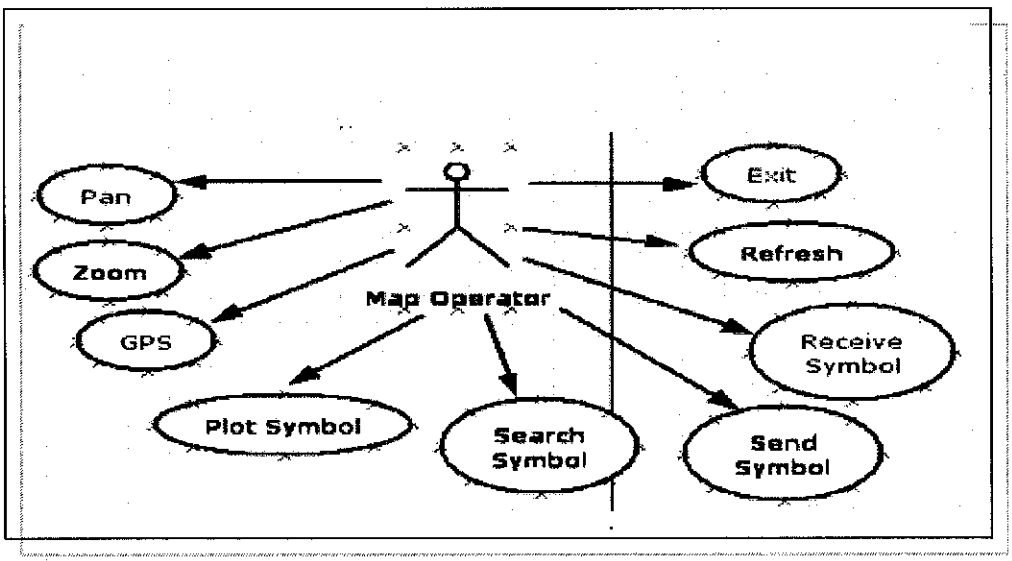

Figure 4.1.1: Function Diagram of MGMS

4.2 INTERFACE DESIGN

4.2.1 Main Menu Interfaces

The Interfaces Design for Mobile GIS for Military Services: Tracking & Navigating Soldier Using PDA (MGMS) is divided into two main menus. First main menu is developed for PDA application, while other interface is developed for laptop/desktop as a monitoring centre.

First section is the main menu for client of PDA application for Mobile GIS for Military Services: Tracking & Navigating Soldier Using PDA (MGMS). The digital map can be visible or invisible from the user view. It is depends whether the user is within the area covered by the digital map or not.

Figure 4.2.1.1: PDA Main Menu of MGMS

Bellow is the main menu of the Laptop/Desktop's main menu for Mobile GIS for Military Services: Tracking & Navigating Soldier Using PDA (MGMS).

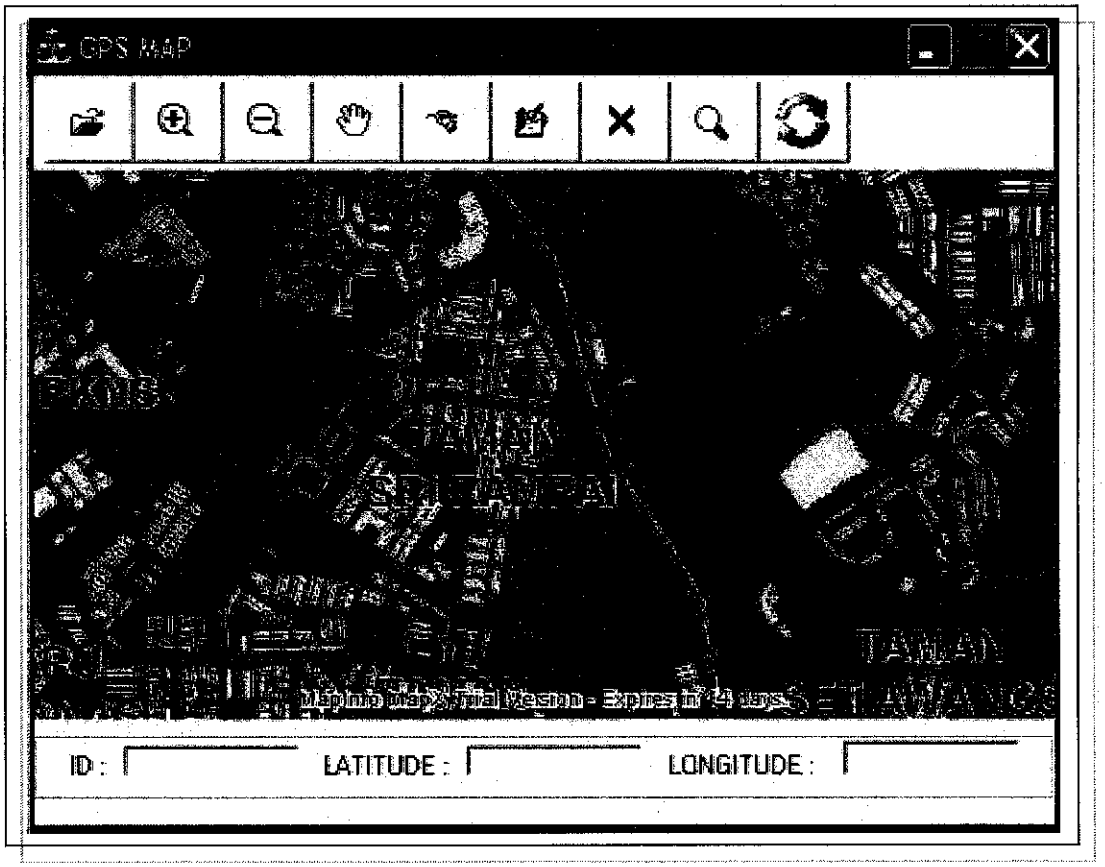

Figure 4.2.1.2: Laptop/ Desktop Main Menu of MGMS

4.2.2 GPS Tracking Interface

The diagrams below (Figure 4.2.2.1 and Figure 4.2.2.2) illustrate the system plotting the symbol into the digital map in both PDA and laptop/desktop application as soon as the GPS function was clicking by the user. Besides, the system also able to provide actual current position (based on latitude and longitude) of the troops in real-time manner and it is also able to monitor the movement of the object as the troop moves around the city, his position is updated in the map The map displayed bellow is viewed on the white screen only, it is due to the current object's location is out of the map study area. This

project using Wangsa Maju, Kuala Lumpur as a map studies area, while the current position of the object is in Tronoh, Perak.

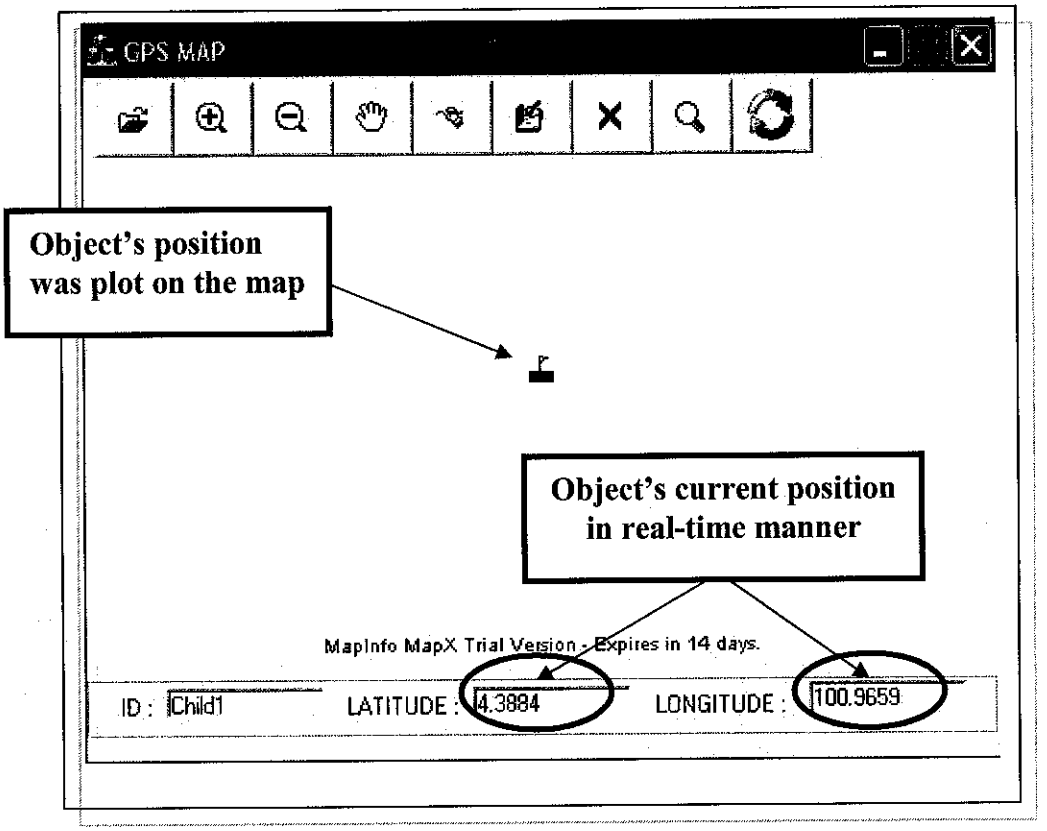

Figure 4.2.2.1: GPS Tracking Interface on Server Application

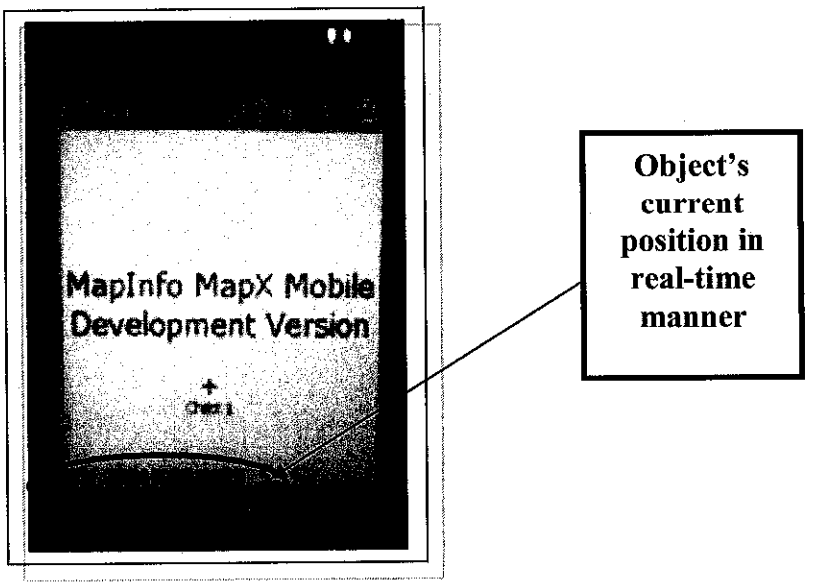

Figure 4.2.2.2: GPS Tracking Interface on PDA

4.2.3 Plotting Function Interfaces

This section provides with interfaces design of plotting function. Before plotting the symbol into the digital map, user in the PDA application inserts the symbol name, symbol color and symbol ID. After finished inserted the symbol information, user in the PDA will plot the symbol into the map based on the user current location. When the symbol is plot into the PDA, concurrently user in the monitoring center will receive the similar exact location as a plotted on the PDA.

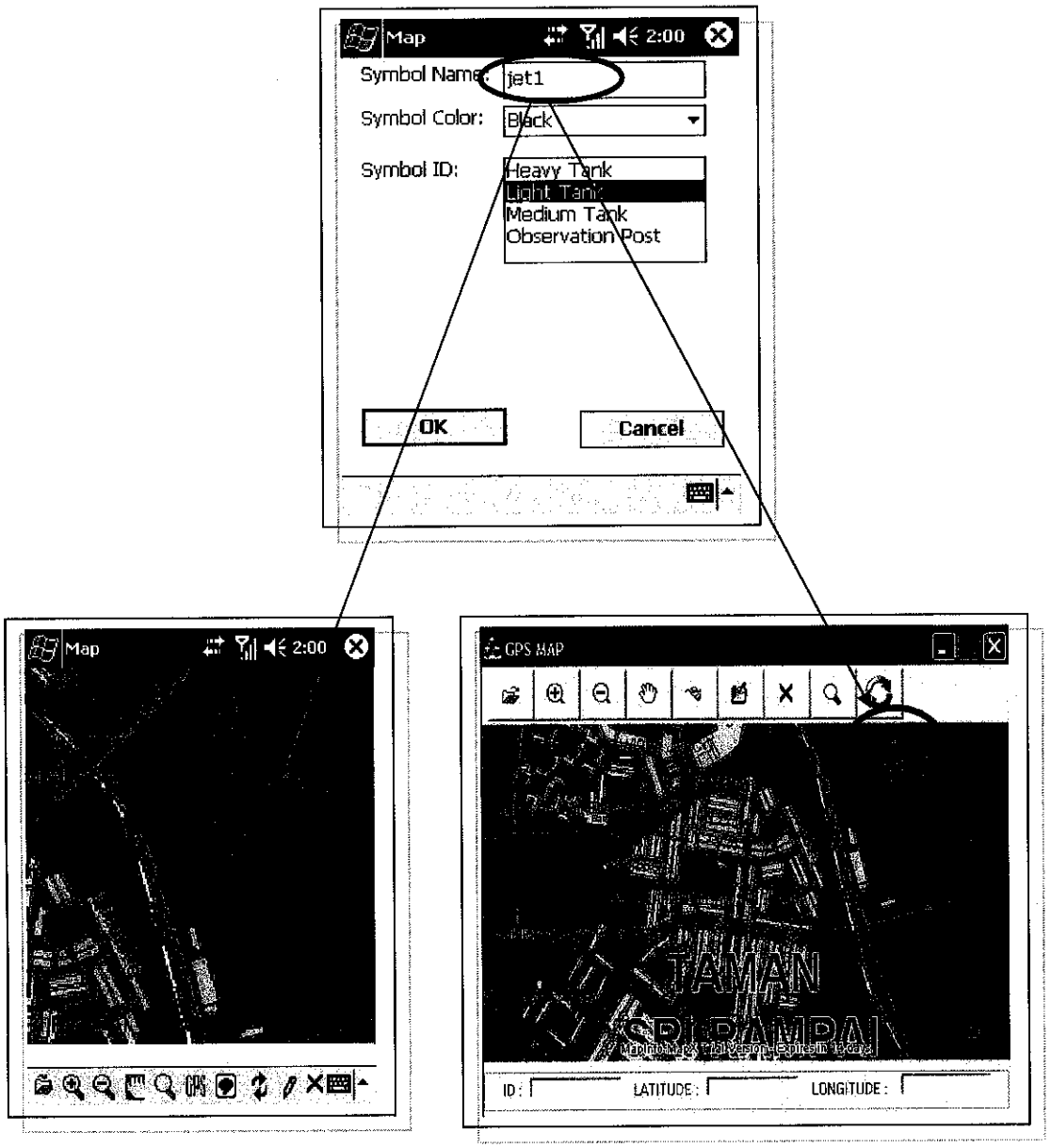

Figure 4.2.3.1: Plotting Symbol on PDA and Laptop/Desktop Application

4.2.4 Searching Function Interfaces

When the user enter the correct symbol name or symbol ID into the text box provided and click on the search button the system will execute the searching task. The matching process will be done automatically by the system through the coding behind the system.

When the searching process complete, the system is able to validate the symbol Id and will display error message instead as show in the Figure 4.2.4.1

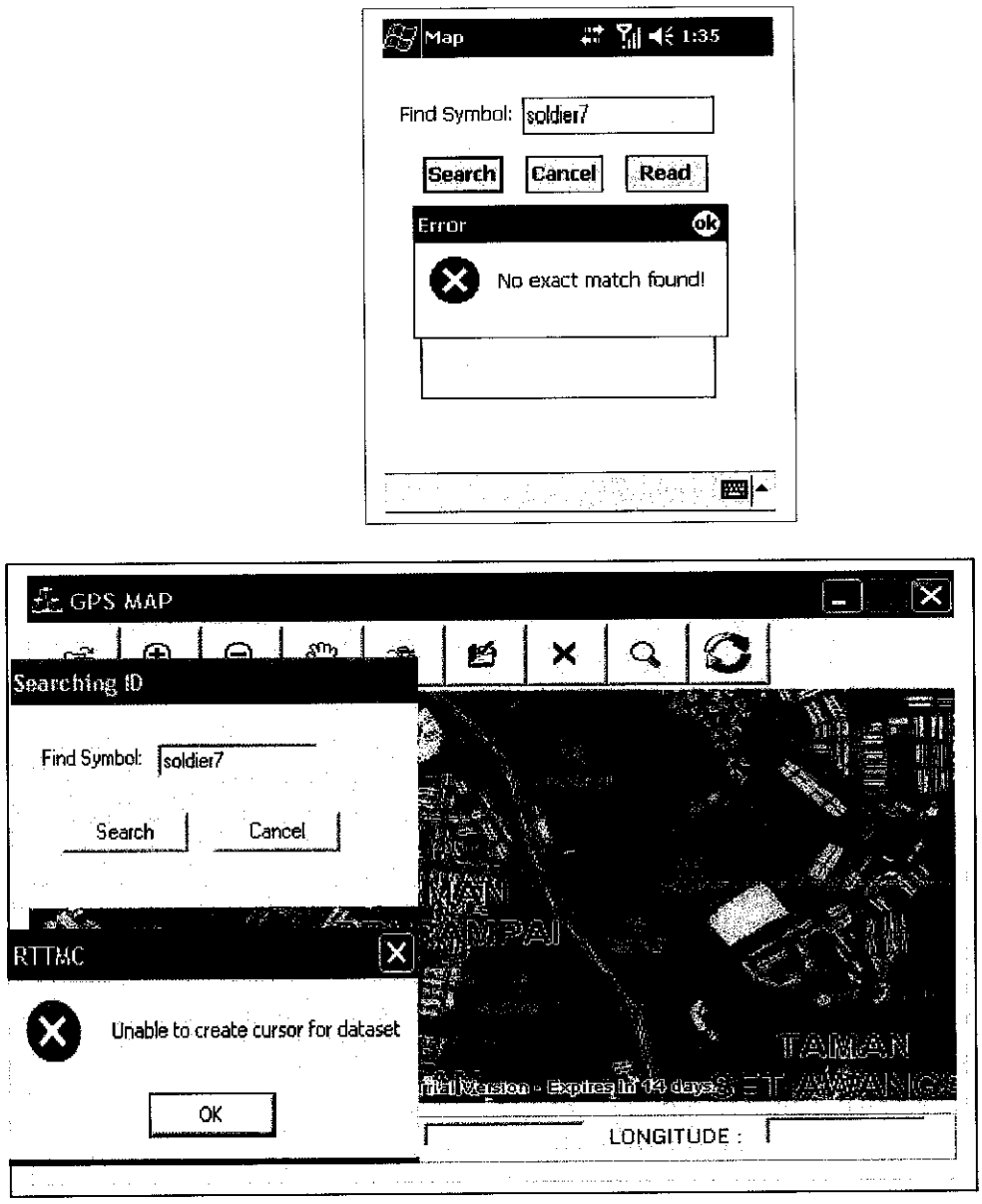

Figure 4.2.4.1: Searching error message on PDA and Laptop/Desktop application

The system also should be able to highlight and display the result of correct symbol ID and latitude and longitudes of the Id in the result section as shown in the Figure 4.2.4.2 below. Search function in this system is work based on two different layers, which are friend layer and enemy layer.

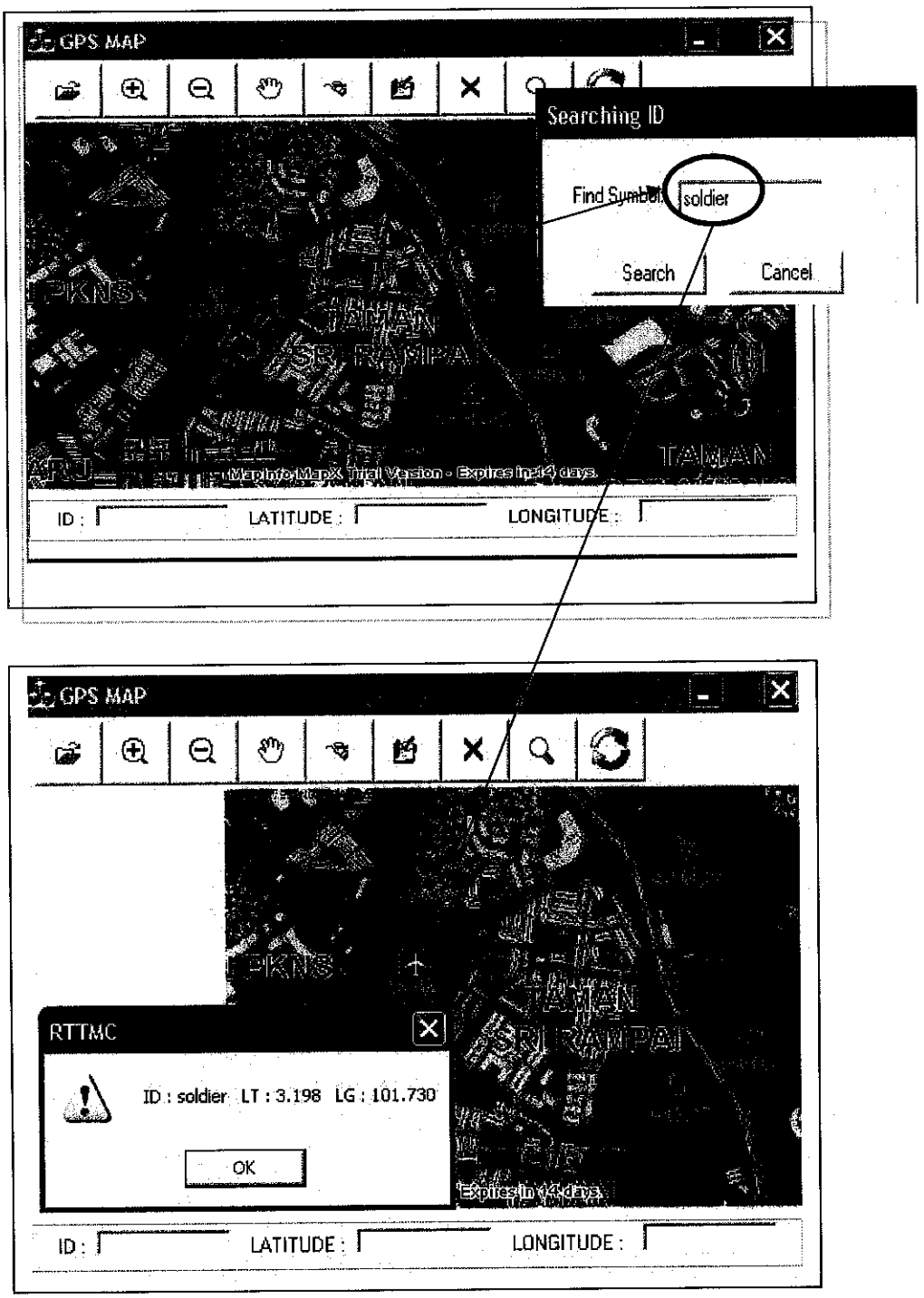

Figure 4.2.4.2: Searching Result on Laptop/Desktop application

4.2.5 Sending Text Messages to and fro PDA and Laptop/Desktop Application

Below are the application of sending Text Messages to and fro PDA and Laptop/Desktop application.

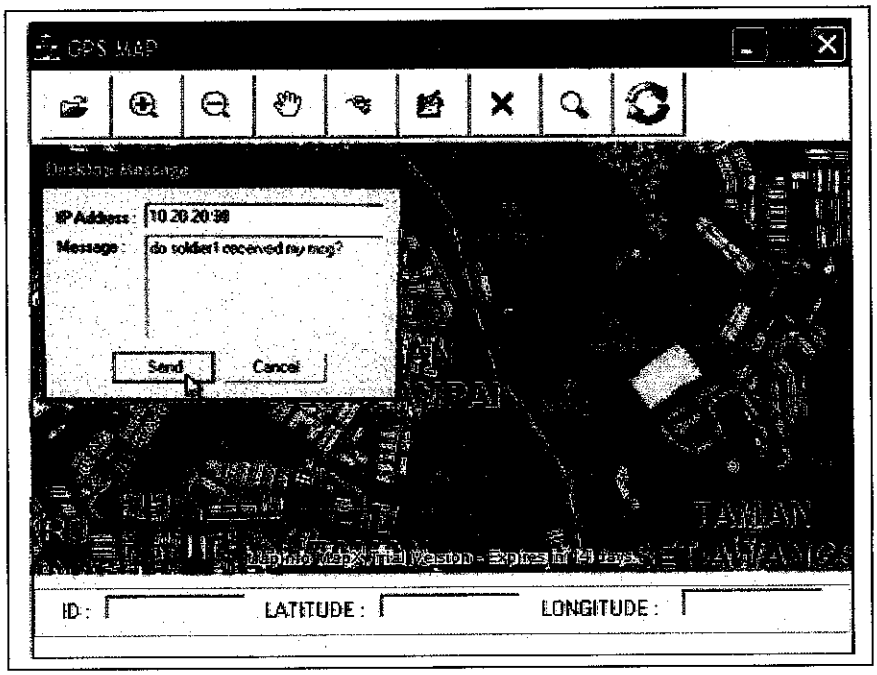

Figure 4.2.5.1: Sending Text Message from Server to PDA

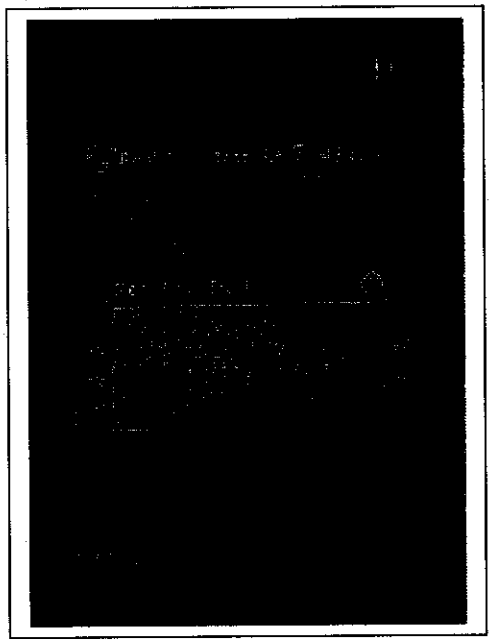

Figure 4.2.5.2: PDA Received Text Message from Server

The diagram below (Figure 4.2.5.3) illustrates the laptop/desktop application received the text messages sending by the PDA application.

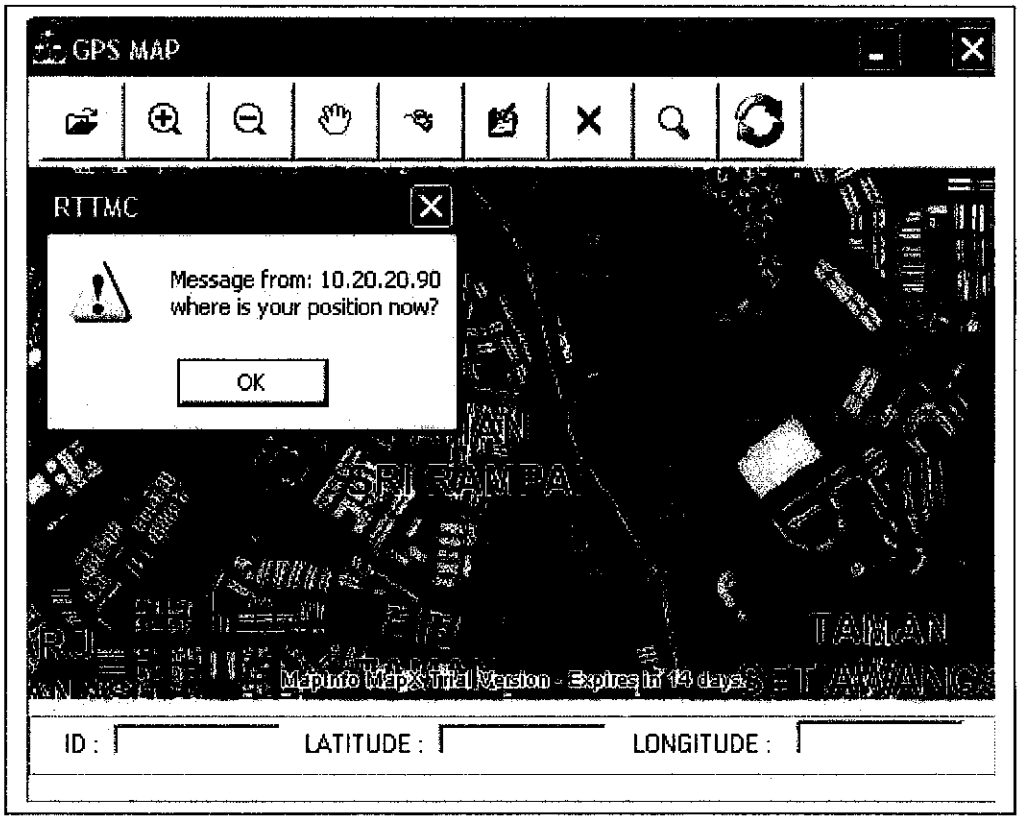

Figure 4.2.5.3: Server Received Text Message from PDA

4.3 MGMS FUNCTIONS

4.3.1 MGMS on PDA

The author has totally involved in the coding of MapInfo MapX Mobile control and function for Mobile GIS for Military Services: Tracking & Navigating Soldier Using PDA (MGMS). Bellow is the list of functions developed by the author:

- Open Map
  - ✓ To display digital map interface on the application.

- Zoom-in
  - ✓ To zoom in map in PDA and allow the user to have the desired level of enlargement.

- Zoom-out
  - ✓ To show the area that will be occupied by the map image then the image is reduced to that size, and more of the map is display in PDA.

- Pan
  - ✓ To move the map screen position in any direction.

- Messaging
  - ✓ To send and receive text message to and fro PDA and Desktop.

- Plot symbol
  - ✓ To plot symbol on map in PDA, then send that symbol to the desktop (in the same coordinate location as in the PDA).

- Search
  - ✓ To search symbol name (Symbol ID) on the digital map interface based at difference layers.
  - ✓ To display the symbol information; which are consisting of symbol name and location of the symbol (latitude and longitude) in PDA.
  - ✓ To automatically highlight the correct symbol on the map interface. The search function is case sensitive; the system will prompt the error message when the user inserts the wrong symbol name into the provided text box.

- Refrseh
  - ✓ To restore the entire layer of map in PDA.

- GPS
  - ✓ To detect, locate and track symbol information on digital map in PDA.

- Exit
  - ✓ To close the application on the PDA.

4.3.2 MGMS on the Laptop/Desktop

- Open Map
  - ✓ To display digital map interface on the application.

- Zoom-in
  - ✓ To zoom-in map in laptop/desktop and allow the user to have the desired level of enlargement.

- Zoom-out
  - ✓ To show the area that will be occupied by the map image then the image is reduced to that size, and more of the map is display in laptop/desktop.

- Pan
  - ✓ To move the map screen position in any direction.

- Messaging
  - ✓ To send and receive text message to and fro PDA and Desktop.

- Plot symbol
  - ✓ To plot symbol on map in laptop/desktop, then send that symbol to the PDA (in the same coordinate location as in the laptop/desktop).

- Search

- ✓ To search symbol name (symbol ID) on the digital map interface based at difference layers.
- ✓ To display the symbol information; which are consisting of symbol name and location of the symbol (latitude and longitude) in laptop/desktop.
- ✓ To automatically highlight the correct symbol on the map interface. The search function is case sensitive; the system will prompt the error message when the user inserts the wrong symbol name into the provided text box.

- Refrseh
  - ✓ To restore the entire layer of map in laptop/desktop.

- Exit
  - ✓ To close the application on the PDA.

4.4 DISCUSSION

From the result being discussed in the Chapter 4, the system has some limitation due to some reason such as GPS unit needs to have a clear view of the sky, that means that it cannot be used indoors, and therefore any mobile equipment that uses GPS for outdoor positioning must rely on a second positioning system for indoor use. Furthermore the accuracy of the position reported by the GPS is not always the same, due to Selective Availability. Selective Availability is what prevents the GPS system to be used by the "enemy" for tactical purposes, since it will change the range of accuracy from 20 to 100 meters.

The GPS tracking system of auto positioning and tracking using GPS signals through the use of satellites to get accurate positioning information has been applied for many years. For transmitting the position data it can be applied using either through GSM mobile network to receiving terminal and integrating the data with GIS information system or Wi-Fi standard technology.

In fact, there are many applications and related products in the market that claims to be able to support this integrated system with ease and synergy. However, all these applications have their inherent shortcomings and problems and therefore cannot meet application requirement in many cases. Some of them are too slow, far from real-time, while others are easily "congested" as they run through the "air-waves". On the other side of the spectrum, systems that can overcome the inadequacies of the lower-end system are too costly, complicated, and requires high costs in setups and maintenance by IT experts.

As seen from the limitation, the used GPS method for establishing the location of a user is only effective outdoors. The proposition for indoor positioning is very ineffective. Because of this, solutions for the system that will not only solve the positioning issue but would also enhance the functionality of the device. This solution is based on wireless networking or the known Wi-Fi standard. The proposed Wi-Fi solution uses SSIDs. SSID (short for service set identifier) a 32-character unique identifier attached to the header of packets sent over a WLAN that acts as a password when a mobile device tries to connect to the BSS [12].

The SSID is used to differentiate one WLAN from another, so all access points and all devices attempting to connect to a specific WLAN must use the same SSID. In the same matter, different SSID can be used to separate groups of access points located nearby. This is useful, as this property can help divide geographical regions based on the location of access points. A device will not be permitted to join the wireless network

unless it can provide the unique SSID. Because an SSID can be sniffed in plain text from a packet it does not supply any security to the network. Therefore, the use of access points can provide positioning system without compromising network security. Also wireless access points can be configured to broadcast the SSID, allowing any nearby client to connect to the wireless network without previously knowing the SSID. This feature of broadcasting the SSID can be very helpful for making an access point available to everyone with a wireless connection without any hassle.

Since many access points can be in reach at the same time, the server could grab the signal strength information of each access point to triangulate a more accurate location of the user. Once the location of the user has been established, it can be issued as the location input for systems. And since the SSIDs available and their signal strength get updated automatically as the user moves, the user can walk in and out of buildings without having to change positioning devices. Unlike the GSM Modem, a Wi-Fi's connection is more reliable and freely accessed by the user without spending any extra money to pay for the connection and requires low costs in setups by the users.

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The projects research and study will be conducted is concerned on Geographical Information System (GIS) and Global Positioning System (GPS) area. The project will be focusing on developing an application for defense area, named Mobile GIS for Military Service: Tracking & Navigating Soldier System Using PDA (MGMS).

The integration of a mobile field mapping system with a centralized GIS server and map-enabled, provide a powerful system for data management and strategic decision making. Mobile mapping with its incorporation of handheld PDA devices for field data collection is rapidly expanding field of GIS. While, wireless technology will increase the usefulness of mobile GIS in the future. However, as the technologies improve, wireless data transfer speeds are increasing to levels where real-time data integration and dissemination will be reality.

The project is able to demonstrate the power of GPS coupled up with a mobile device such as PDA. This project deliverable and functions are hope to be beneficial to the defense area as well as the public in order to keep track the object's actual position in certain area as well as to monitor the movement of the object in the large geographic area.

5.2 RECOMMENDATION

Here are several aspects have been identified as possible future expansions of the project. First is that suggested the system to have save function. The save function is to save all the former tracking information. Besides the system could also retrieve all the information stored in the data base for every former object tracking by the system. Archive information is crucial for the defense area especially information that relates to the enemy.

Widen the MGMS function such as providing with more user friendly function such as the Map Tips which provide the area name when the users point the mouse or stylus on the digital map without the user need to zoom-in the map. Also provide the function for user to choose the shortest path distance and calculate the distance between one location to another for better making decision by the user itself.

Furthermore the system could also be improved by searching the area name instead just searching the current latitude and longitude of the object.

Last but not least full understanding and research should be well acquire before official commencement of the project, so can avoid possibilities of lack resources and materials, lack of knowledge or expertise in certain area, causing the shortening of development time frame.

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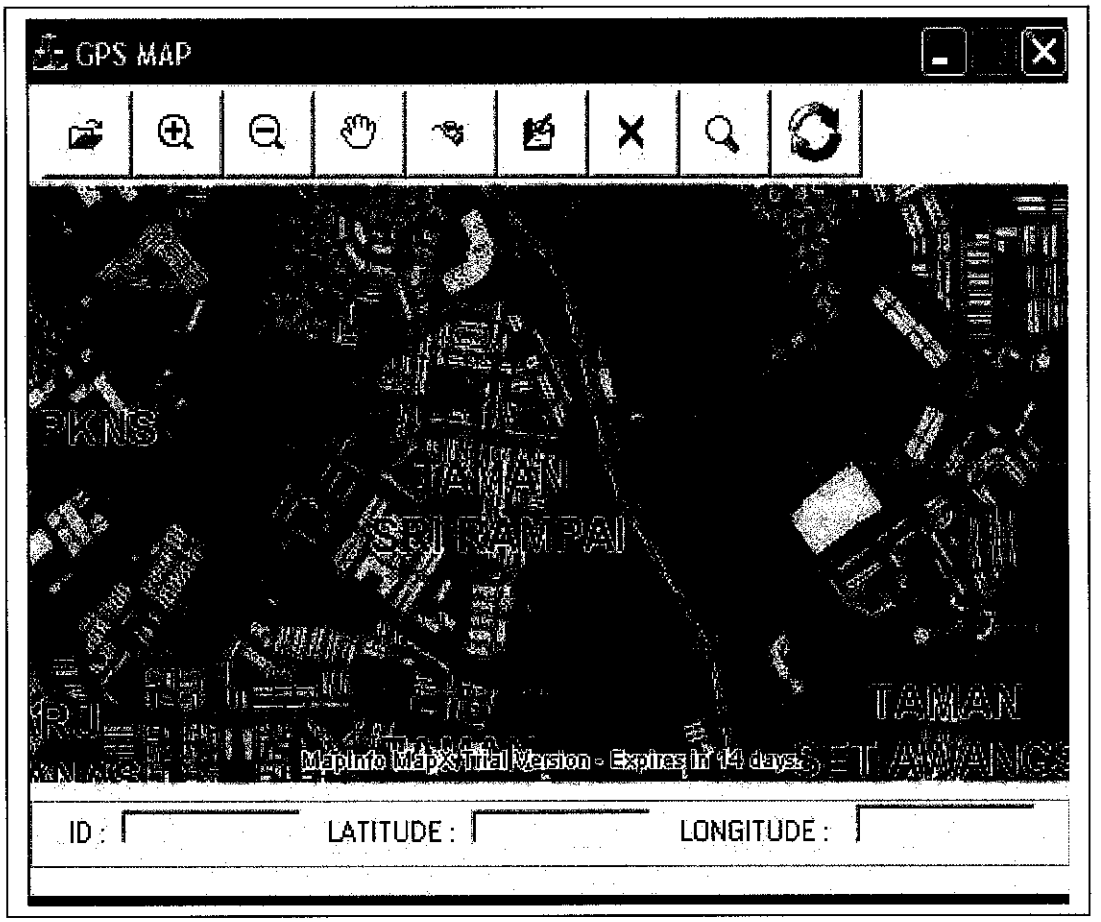
APPENDICES

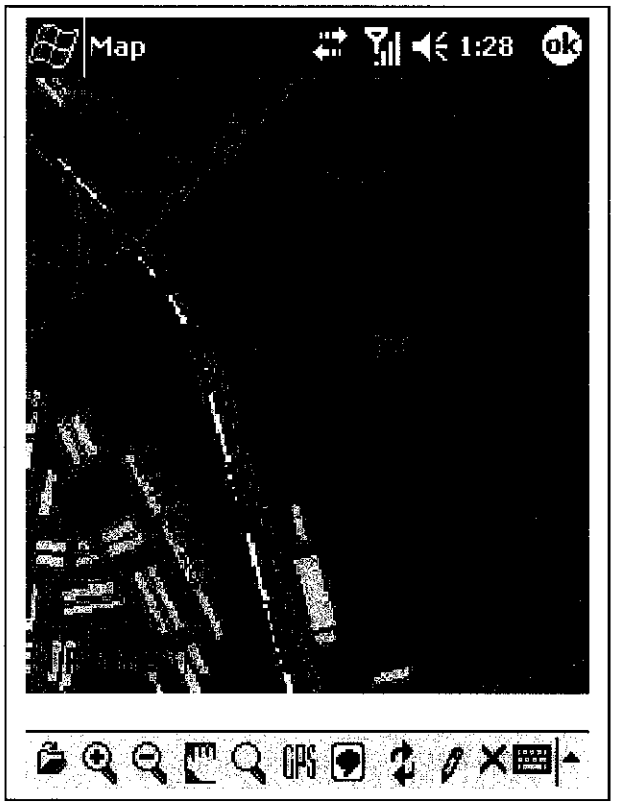
APPENDIX A

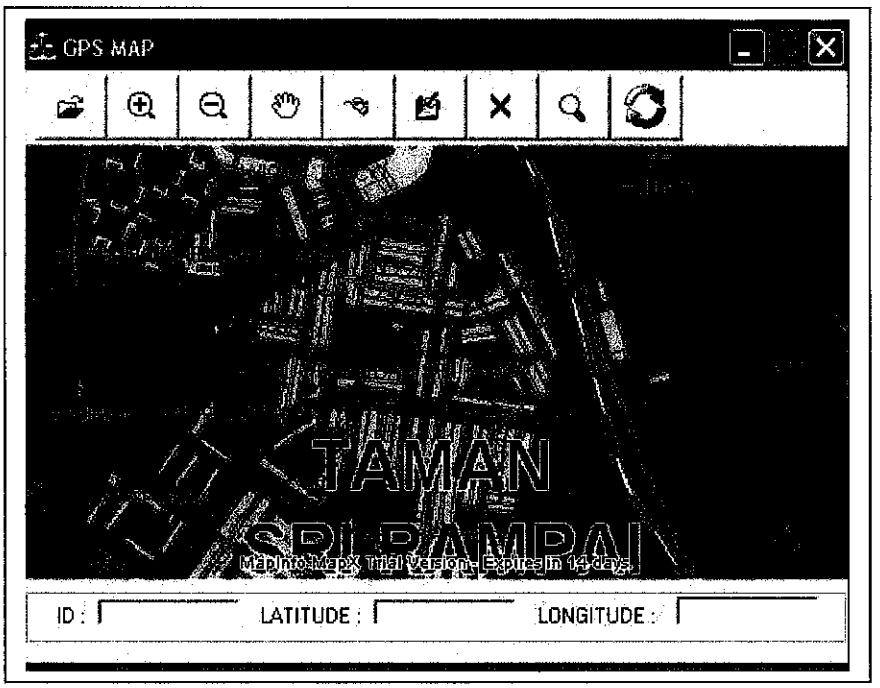
ZOOM-IN AND ZOOM-OUT FUNCTION

PDA Main Menu

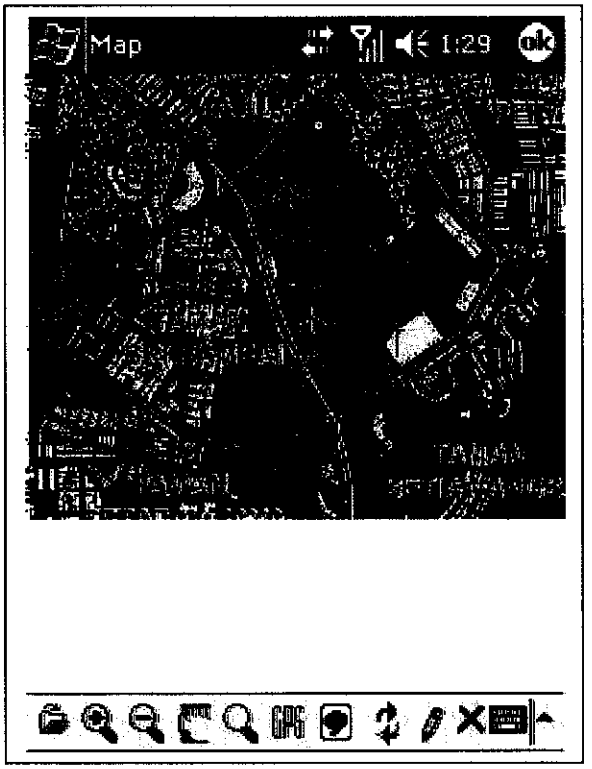


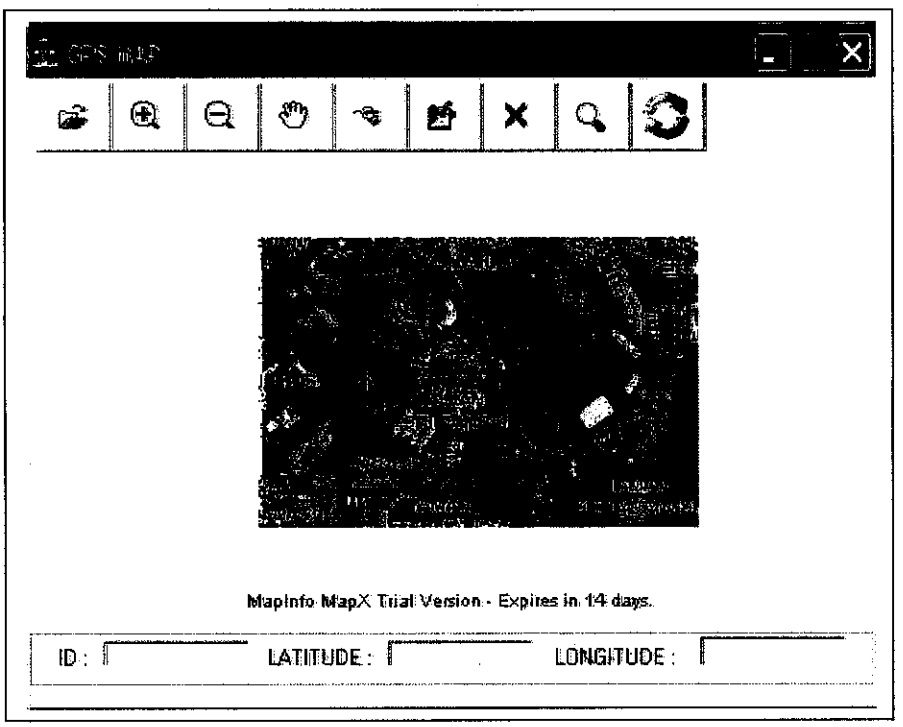
Desktop Main Menu


Map
1:28
ok
GPS


GPS MAP
TAMAN
SRI PAMPAI
MapInfo MapX Trial Version, Expires in 14 days
ID :
LATITUDE :
LONGITUDE :

Zoom-In


Map
1:29
ok

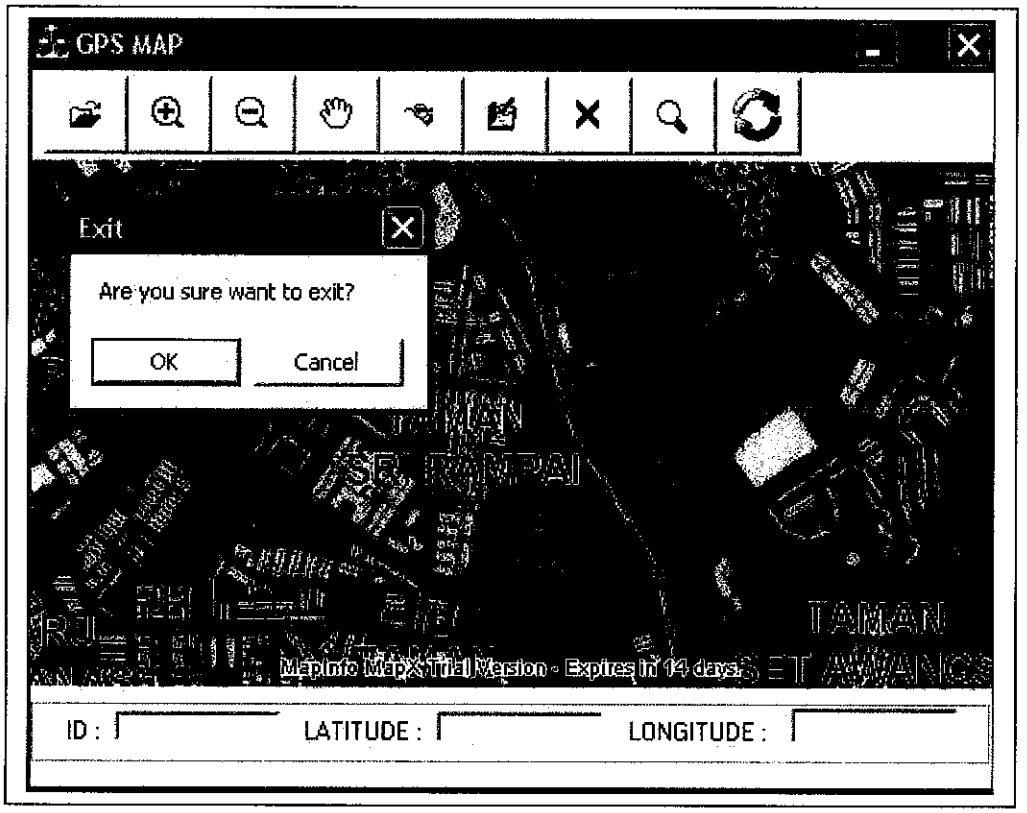

GPS MAP
MapInfo MapX Trial Version - Expires in 14 days.
ID :
LATITUDE :
LONGITUDE :

Zoom-Out

APPENDIX B

EXIT FUNCTION

PDA Application



Desktop Application