Integration of GIS & GPS Systems on Vehicle Monitoring

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Abstract. Continuous technological development of information systems provide an extensive range of services impacting on upgrading performance and diminishing expenses by utilizing GPS system on vehicle monitoring. Due to positive impact, GPS utilization has been widely applied into the many government departments and institutions, meanwhile used from private businesses, as well. Services derived from usage of information technology, bearing efficiency and beneficiaries of gadgets, resulted on solid increment of the interest and special focus towards multitasking utensils and IT systems in different areas. GIS provides monitoring functions via visual display of information on spatial data and precise geographical positioning of monitored vehicles, whilst GPS presents accurate, clear and precise information upon position and navigation of monitored or tracked vehicle just in time and exact location. Efficiency of GIS and GPS on vehicles monitoring and tracking have also been extensively used emphasizing law enforcements- police and military services.

Keywords: GIS, GPS, Monitoring, technology, information system, police, military.

1 Introduction

With enhancement of technology particularly of information systems, demand for such devices have been profoundly increased worldwide. Cause for increased demanded occurred due to the offer of miscellaneous gadgets thru which operations costs are massively diminished. Efficiency, accuracy, cut on spending, ease on communication, availability of immediate data collection, quick retrieve of information, reliability, and other immense benefits are among potent patterns shown to be provided from information technology devices which ignited wish of almost entire private and public entities inclinations towards and being keen on prompt implementation into their daily operations. Recent years government institution were not left behind on race for information technology neither, meanwhile they leaped towards trying hard to implement technology systems into their routine daily operation. So far, private firms and companies were slightly ahead as it comes in their restless searching for information technology innovations. Therefore, amidst information technology innovations GIS system emerged as a novelty of technology

back in late 1960s. Ever since system is updating on accuracy and massive data completeness, thus, demands for GIS system are persistently increasing

The term Geographic Information System (GIS) was introduced by Roger Tomlison and was used later promoted by professors at Harvard University in the 1970s, inspiring several geographic consulting companies to develop and expand GIS technology. Local government and businesses started deploying large GIS operation systems in the early 1990s and soon it became clear that the success of such distributed GIS operations was strongly connected with understanding of its performance and scalability in a distributed computer environment (Peters, 2008, 5).

Through the years, innovation and improvements on technology reached higher levels. Invention of wireless enhanced and pushed even further utilization of technology systems. Remote control of objects, pattern of wireless technology, penetrated deeply in today's life making communication easier, faster and cheaper at the same time. Wireless technology is in series of utensils and gadgets been used for GIS and GPS integration into operation systems, as well.

Knowing crucial functions of GIS as an system, it started being broadly implemented besides private firms and businesses, it has been also integrated into many government agencies, different institutions, police services and military forces, respectively.

Therefore, intention of this scientific paper is to provide range of function and operation features of GIS and GPS, it necessary application on monitoring and tracking of moving vehicles. For wide comprehensive understanding purposes qualitative methods has been used depicting facts and figures supported from carefully chosen literature about topic of the paper.

2 GIS & GPS Systems

Integration of GIS and GPS devices make available mobile communication easier using latest wireless technology. Both GIS and GPS devices have their own components which combined together provide high powered network which is mainly used for remote real time communication. GIS has the function to manage large amount of data and it is used to display geographically information on map that are massively accepted for digital maps. GPS enables collection information about the location of a vehicle or an object. GPS is the only system today that can show exact position on the Earth anytime, in any weather, no matter where the person, vehicle or any object is located. Prior to showing the attributes of utilization of integration of GIS and GPS systems, I'll briefly show components of systems having better picture of gadgets and their most important functions.

3 Components of GIS

GIS is defined as system of hardware, software, and procedures designed to support the capture, management, manipulation, analysis, modeling and display of

spatially referenced data solving complex planning and management problems (Cowen, 1988).

An operation of GIS has also series of components that combine to make the system work. GIS is consisted of five important components, computer hardware, sets of application software modules, required data, people who manage the system and develops plans, and a well designed implementation methods. Those critical components of GIS are:

1. Hardware - is computer system on which a GIS operates. A GIS relies on a computer for storage and processing data. GIS needs a personal computer to run on. In addition to computers, as variety of other devices can be used to capture and feed data into the system. Scanners and digitizing tables are used to scan existing paper maps, charts and drawings into the system. GPS receivers are used to create map features in the field and transmit the current location of moving vehicles.

2. Software - provides the functions and tools needed to store, analyze and display geographic information. The core of any GIS systems is based in the its own software providing the functionality to store, manage, link, query and analyze geographic data. In addition to the core, various other software components can be added to GIS software to provide access to additional sources of data and forms of functionality.

3. Data - A GIS can integrate spatial data with other existing data resources often stored in a corporate DBMS. Data for GIS comes in two forms: Geographical and spatial data and attribute of spatial data. Spatial data are data that contains explicit geographic location in the form of a set of coordinates. Attribute data are descriptive set of data that contain various information relevant to particular location, depth, height and sales figures, and can be linked to a particular location by means and identifier as for instance an address or a zip code.

4. People - the main objective of a GIS is to support its users with appropriate data and decision support tools. Thus, careful consideration of particular needs of the users must be given at the design stages of the system, so that each group of users will be given access to the data and functionality of the system in the most appropriate way. A system must be highly accessible and usable otherwise it may not be used efficiently or even it may not be used at all.

5. Methods - A successful GIS operates according to a well-designed implementation plan and business rules, which are models and operating practices unique to each organization. As in all organizations dealing with sophisticated technology, new tools can only be used effectively if they are properly integrated into the entire business strategy and operation, therefore it requires necessary investments in hardware and software meanwhile it requires hiring of personnel to utilize the new technology in the proper organizational context (Gopi, Sathikumar, Madhu, 2007).
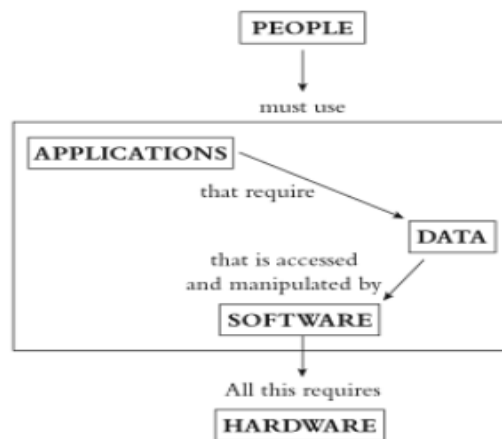
Fig. 1. Components of GIS. *Source: "The Design And Implementation Of Geographic Information Systems"*

4 Components of GPS

The Global Positing System is comprised of the three main components are followings:

1. The GPS tracking system satellites - GPS tracking system is an aerospace technology comprising of at least 24 operational satellites at all times. Each satellite is on a circulate orbit 20,000 kilometers above the Earth on a 12-hour period. In order to make sure that these satellites are detected from anywhere on the surface of the Earth, the satellites are divided into six groups four space vehicles each which are assigned a different path to follow. The orbit is such that GPS satellites recapitulate the same ground track and configuration at approximately over any point each in 24 hours.

2. The GPS Tracking System Equipment on the Ground - ground stations are used so that each satellite orbit is accurately tracked. The GPS tracking system has ground stations which is comprised of a receiver and antenna, as well as communication tools to transmit the data to the data center. When the GPS satellites supply specially coded signals, the Omni-directional antenna at each site picks up the signals and that is processes in a receiver. The receiver then separates the signals in various channels for particular satellite and frequency at a particular time. Once signals are isolated, the receiver now decodes them and splits them into individual frequencies to calculate position, velocity, direction and time anywhere on the Earth.

3. The GPS receivers - The GPS receiver is the endeavor of the complete system the receives the signal that is sent directly from the satellites to nail your location and get you pre-programmed direction. The device is usually mounted on the dashboard of the car or with a suction cup to the screen. It has a registering cover that

instrument present to the line to go and several GPS receivers verbalize phonation cues to get person, vehicle or any object along the path. (GPS made easy).
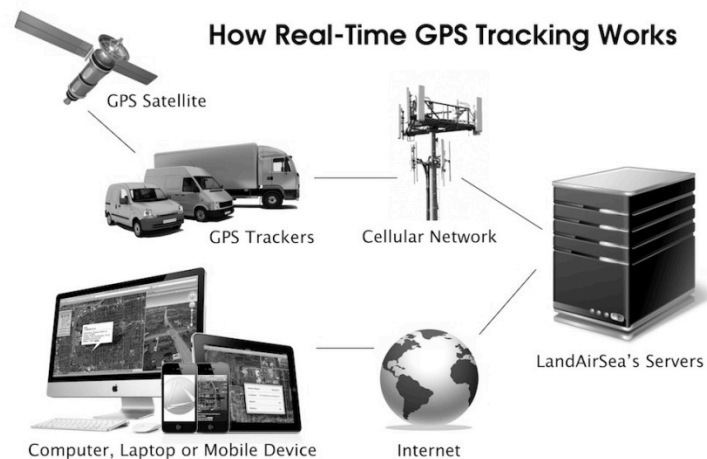

Fig. 2. How Real-time GPS tracking works. *Sources: LandAir Sea*

5   Features and Users of GIS & GPS Systems

Geographic Information systems (GIS) are "smart maps." They are smart because they are tied to databases and they know exactly where are on the face of the earth. They, GIS maps, can also perform feats such are values summation, neighborhood evaluation, and buffering (Hanna, Culpepper, 1998, 7). GIS is a highly specialized technology of interest to professional users and researches for specific applications. One the major driving force behind the recent popularization of spatial information is the increasing availability of spatial data from government and commercial sources, distributed via internet through such mechanisms as spatial data depots, digital geo-libraries and spatial data warehouses and clearinghouses. Another major driving force is the growing awareness of the importance of spatial information by all sectors of modern society.

The number of disciplines that that use GIS in some form or other has increased dramatically in recent years. GIS developed from analysis which is why the first and more traditional disciplines adopted GIS and many other disciplines are seen as potential users of the system including: geology, geophysics, oceanography, agriculture, biology, environment sciences, geography, sociology, political science and anthropology. Other examples within business include the transportation industry and the taxi trade. In recent years the local government sector has started to use web-based GIS services that citizens can use (Grinderud, Rasmussen, Nilsen, 2009, 38-39).

Along GIS amongst the mostly utilized technological devices we can firmly state that it's GPS. Although GPS was originally designed as military system, its civil application grown faster. On the surveying side, GPS has replaced the conventional methods in many applications. GPS positioning has been found to be a cost-effective process in which 50% cost reduction can be obtained whenever it is with conventional techniques. In terms of productivity and time savings it could provide more than 75% time saving whenever it is possible to use GPS methods. GPS has numerous applications in land, marine and air navigation, while in vehicle tracking and navigation are rapidly growing. Future of GPS users of GPS will include automatic machine guidance and control where hazardous areas can be mapped efficiently and safely using remotely controlled vehicles (El-Rabbnany, 2002, 10-11).

6   Integration of GIS/GPS systems for police vehicle monitoring

Recent development of technology made it possible spatial databases systems being used in relatively sophisticated ways in many private and public institutions including law enforcement departments such are police sector. Spatial data system or GIS could go beyond the simple management, by displaying and analyzing of geographically referenced information. A typical spatial database system is enhanced by capabilities to manipulate new data types and models, complex data structures including spatial indexes, sophisticated algorithms and operators for efficient data processing. The increase reliance of spatial database on the internet and related technologies has led to many innovative methods of communicating spatial information (Albert, Yeung, Hall, 2007, 6-7).

While role of GIS is to provides mapping of certain location and precise spatial information, GPS on the other hand provides many functions that helps monitoring and tracking police officers while outdoor. In general, main objective of integrating GPS is done due to multiple functions of device on assisting and easing daily police force operations. Monitoring or tracking of police cars provides better service to their local community. Via GPS can be identified cars are commuting closest to a crime scene and ensure that police officers stay within their assigned zone. Tracking of the police cars as also done for internal use. Among objectives of using GPS on monitoring police service vehicles are:

 - Recording of route and movement of police car - having in mind that police officers do have their own route to pass, in some cases it is necessary to monitor road the car paths since any emergency case can be better managed having accurate and precise vehicle position under monitoring,

 - Velocity of movement - depicts the way police officers behave under certain route conditions,

 - Fuel expenses - measurements of fuel expensed may lead to managing of main expense that police car make. this function of GPS helps police officers having knowledge about the car's engine conditions by providing evidence in circumstances of increased fuel expenses due to the engine problems, for instance.

- Number of people (passengers) sitting on car - GPS sensors are installed in order to identify number of people or passengers on car.

- Filling fuel - sensors identify amount or gallons poured into fuel tank, time and place is also recorded. By having this data police officers will have information about the particular car how much fuel remained just by looking into the records provided by GPS at the time they decide to take a car for a drive,

- Starting and stopping time of vehicle - 5 seconds after the car is turned on, signal is sent showing car is ready for use and assist on fuel expenses management. Information supplied shows time car has set and " idle" time meaning car stand on place with turned engine on but it was not driven.

- Parking of vehicle - place and time vehicle was parked. Trying to avoid shirking of police officers, monitoring will proof for reliability and time spent while on duty.

- Seeking for vehicle - in case of any accident or any "force majeure" disaster (earthquake or flood), GPS makes possible monitoring cars in such occasions by shortening time for rescuing police officers from disaster or accident.

- Speed limit - in many circumstances police officers are ought to speed up while driving aiming to catch wrongdoers. In rare cases monitoring can be used showing if any of officers "intentionally" disobeys rules,

- Plates - GPS automatically shows plates of car strolling. This information helps identifying which car is taking particular route.

- Car identification - name of driver and his/her colleagues is identified. In case of any emergency or any duty call, car identification depicts if officers are on proper route, driving meticulously, their location, any plenty additional information according certain vehicle.

7 Conclusion

GIS and GPS systems have been proven as highly efficient, ease to be handled, communication facilitators, reliable to be used. With such pattern shown, implementation of systems found to be utilized from private companies, enterprises, agencies, government agencies, and law enforcement as police services and military forces. Continues technological improvements triggered demand on gadgets to increase, as it does for GIS and GPS systems. Deployment of systems is persistently increasing by integrating them into government and law enforcements, particularly on police service sector. Implementation in police services is the proper and suitable since integration of both devices provides perfect combination needed on assisting police officers. Reason relies on that since GIS system provides monitoring functions via visual display of information on spatial data and precise geographical positioning of monitored vehicles and GPS presents accurate, clear and precise information upon position and navigation of monitored vehicle in exact time and location.

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