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Application of GPS on Disaster Management System

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Abstract: In the last few years, new GPS methods have been developed with higher productivity and good theoretical precision. The main objective of this paper is to ascertain the performance of GPS in Disaster Management. The main purpose of the course is to enhance the capabilities of professionals and technical staff working in disaster risk management by providing them with understanding of the use of GPS in disaster risk management. When infrastructure is wiped out after a disaster such as the recent Indian Ocean Tsunami, providing relief efforts effectively and efficiently can prove to be a challenge. For instance, the absence of a functioning communications infrastructure hampers effective disaster management precisely at the time when it is needed the most. Among the new built-in capabilities added include the ability to geographically track via GPS available resources in real time and enabling the creation of mini private networks that allow such resources to be deployed in a manner which maximizes efficiency and effectiveness and minimizes duplication. This paper also capture as how the existing technologies like GIS, RS, GPS, Data Information Exchange, Data Mining, Early Warning System and Knowledge Management etc. help in disaster management. Finally, it concludes that the decision-makers should put appropriate steps to work closely with scientists for implementation of the required policies. Sometimes, disasters have no boundaries; therefore, international collaboration and advancement of technology usage should be the first step.

Keywords: Global Positioning System, Disaster monitoring, Disaster Management System, etc.

I.INTRODUCTION

GPS is the most modern means of mapping and surveying and is immensely used in navigation, marine geodesy, disaster management, remote sensing, arial photography, geodesy, GIS and military operations. GPS is used in the field to update the topographic maps and monitoring the disaster and create the Disaster Management System (Figure.1). This can provide countermeasures for the decision makers to adjust the development strategy and accelerate the forest resource development toward stabilization and exuberant in natural disasters. In order to meet extraordinary accuracy requirements for displacement detection in recent deformation monitoring projects, research has been devoted to integrating Global Positioning System (GPS) as a monitoring sensor. Although GPS has been used for monitoring purposes worldwide, certain environments pose challenges where conventional processing techniques cannot provide the required accuracy with sufficient update frequency. Ethernet and/or serial port communication techniques are used to transfer data between GPS receivers at target points and a central processing computer. The data can be processed locally or remotely based upon client needs. Disasters such as landslides, avalanches and structural failures do not occur without warning. Through strategic monitoring of the deformable object, abnormal behaviour can be detected and used to warn of imminent failure. The increasing number of structural collapses, slope failures and other natural disasters has lead to a demand for new sensors, sensor integration techniques and data processing strategies for deformation monitoring systems. This paper focuses on GPS role in Disaster management providing fully automated, continuous, high precision position updates using one of the above mentioned geodetic technologies: the Global Positioning System (GPS). Although GPS has been used for monitoring purposes worldwide, certain environments pose challenges where conventional processing techniques cannot provide the required accuracy with sufficient update frequency. Discussed are the challenges encountered in using GPS in harsh environments and the innovations that have been introduced in order to successfully integrate this technology for deformation monitoring in such scenarios. GIS and Remote sensing is an integral tool of disaster management system (1,4).

II.GLOBAL POSITIONING SYSTEM (GPS)

The Global Positioning System (GPS) is a worldwide radio navigation system formed from a constellation of 24 satellites and their ground stations. It provides continuous three-dimensional positioning 24 hours a day throughout the world. The GPS technology has a tremendous amount of applications in GIS data collection, surveying, and mapping.

The GPS technology is useful to the map makers and surveyors mainly for three purposes:

(i) To obtain accurate data upto about one hundred meters for navigation,

(ii) Meter-level for mapping; and

(iii) Millimeter level for geodetic positioning.

The GPS is divided into three major segments (Figure.2).

(i) The Control Segment;

(ii) The Space Segment; and

(iii) The User Segment.

All of these three segments are required to perform positional determination.

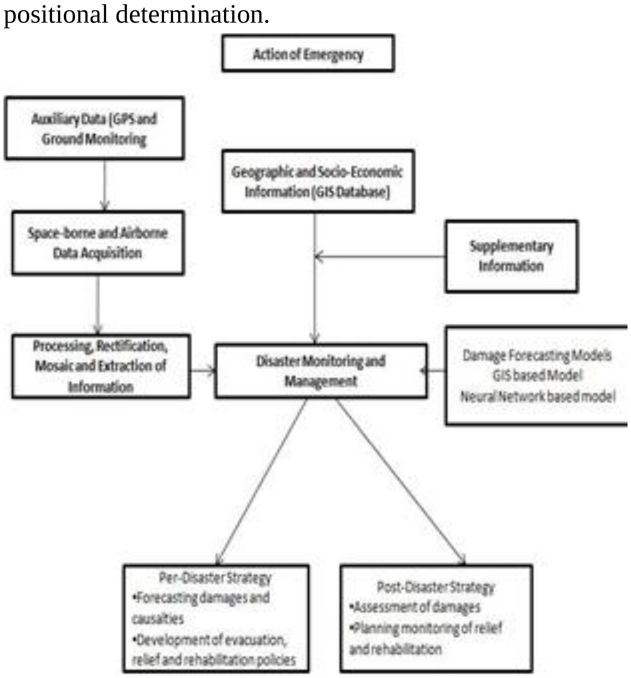

Figure.1 Flow Chart for Disaster Monitoring and Disaster Management System

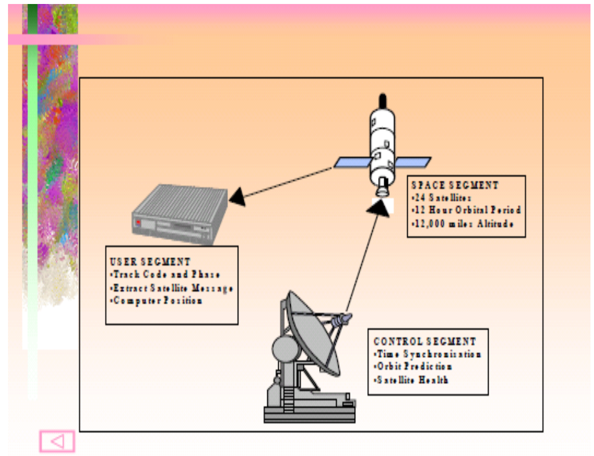

Figure.2 Three segments of GPS

A. *Functions of Control Segment*

The control segment performs three tasks:

(i) Monitor the Health of the Satellites;

(ii) Determine their orbits and the behavior of their atomic clocks;

(iii) Inject the broadcast message into the satellites.

B. *Functions of Space Segment*

The Space Segment consists of the GPS and the satellites. It transmits time and position from at least four satellites visible simultaneously at any time from any point on the earth's surface. The GPS satellite constellation is known as NAVSTAR (Figure.3). It consists of 21 operational satellites and 3 in-orbit spares, which arranged three in each of six orbital planes, inclined 55 to the equator. The satellites orbit the globe in every 12 hours from an altitude of 20,000 km.

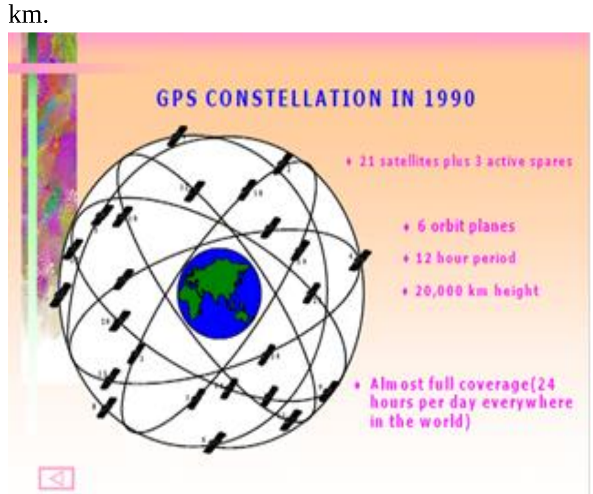

Figure. 3 GPS Satellite contellation

C. Functions of User Segments

The user segment consists of the users and all earth-based GPS receivers. A GPS receiver is a specialized radio receiver. Receivers vary greatly in size and complexity, though the basic design is rather simple.

The typical receiver is composed of

(i) Antenna;
(ii) Preamplifier;
(iii) Radio signal microprocessor;
(iv) Control and display device;
(v) Data recording unit; and
(vi) Power supply.

D. How GPS works

The GPS receivers collect the signals transmitted from system of 24 Satellites NAVASTAR. Five to eight GPS satellites always remains within the "field of view" of a user on the earth surface. The position on the earth surface is determined by measuring the distance from several satellites. The GPS satellite and the receiver each produce a precisely synchronized signal (a so-called pseudo-random code).

Synchronization is made possible by atomic clocks set in the satellite and also in the receiver. The receiver can measure the lag between the internal signal and the signal received from the satellite. That lag is the time it takes for the signal to travel from the satellite to the receiver. Since the signal travels at the speed of light, the lag time simply needs to be multiplied by the speed of light to obtain the distance. Once the distance from several satellite is known, position is determine in terms of latitude, longitude and altitude by triangulation method.

Thus GPS works under five conditions:

i) Satellite triangulation - set basis of the system
ii) Satellite ranging - measures distance from a satellite
iii) Satellite positioning - locate where a satellite is in space
iv) Satellites are receivers of signal and time keeper - generate same code & keeps same time
v) Correcting errors - does correction for ionospheric and tropospheric delays.

D. The major challenges involved in using GPS for deformation

GPS (and in general, Global Navigation Satellite Systems (GNSS) offers potential advantages over other geodetic technologies that allows for continuous and high accuracy displacement detection.

These include:

a) Line of sight is not required between stations;
b) Updates can be provided at frequencies of 1 Hz and higher;
c) 3 dimensional position information is provided; and
d) Millimetre level position information is possible for baselines potentially up to 10 km in length.

E. Using GPS for Deformation Monitoring in Harsh Environments

Monitoring in harsh deformation monitoring environments are:

a) The strength of the bias estimates, however, depends upon low elevation satellites which are generally not visible (5). In order to meet subcentimetre accuracy requirements in large open pit mines using GPS, a new methodology is required to mitigate this bias.

b) Providing continuous updates with limited satellite visibility: The steep pit walls of open pit mines obstruct satellite visibility. This limits the reliability of the solutions as well as the frequency at which updates can be provided. In order to meet sub-centimetre accuracy requirements with sufficient update frequency, new technologies must be integrated with GPS.

c) Connecting to stable reference points: As precise as the GPS software may be, the overall accuracy of the solution depends upon the validity of the assumption that each reference point is stable. Tremendous care must be taken in choosing suitable reference station locations. Additional sources of information regarding the properties of the rock mass must be utilized to make informed decisions.

d) Developing a fully automated GPS processor: A fully automated GPS processor is required to provide continuous updates in real-time. Ideally, the results from the processor can be used to provide 'on-time' warnings of impending danger. The processor must be designed to be robust so that false alarms do not occur. Additionally, the precision of the solutions must satisfy subcentimetre displacement detection requirements with 95% confidence. Communication links must also be built into the software to allow for data transfer between GPS receivers located on site at target points and a central processing computer.

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F. Monitoring System Infrastructure

Currently accepts two methods of data communication between GPS sensors and the central processing computer:

(1) Via Ethernet connection (either a Local Area Network (LAN) or

Wireless LAN (WLAN) and

(2) Via serial port (either directly or through radio modems).

A monitoring system may be designed to include all Ethernet connections, all serial port connections or a combination of both. The network infrastructure to support each method of communication is illustrated in Figure 4 and Figure 5 respectively.

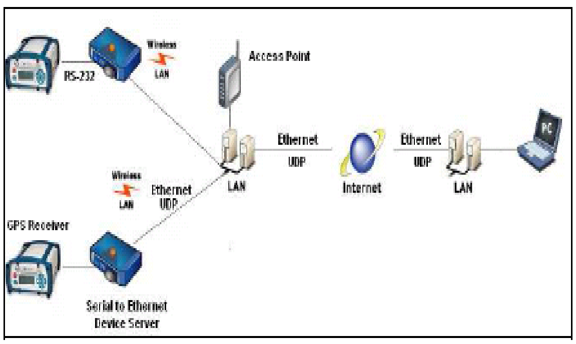

Figure.4 Ethernet based design for any management study

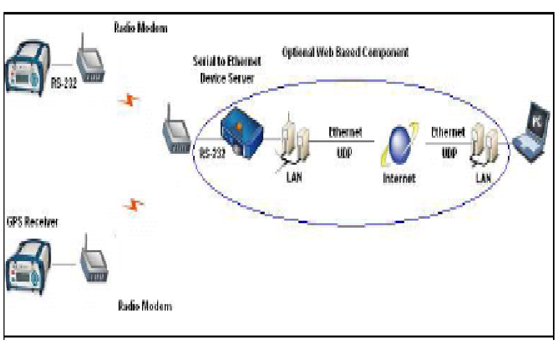

Figure. 5 Web based design for any management study

In the first method, a serial-to-Ethernet device server (e.g., Sollae Systems EZL-400S) is used. Although the maximum data rate is limited here by the serial communication between the receiver and serial-to-Ethernet device server, new model GPS receivers (e.g., Novatel DL-V3, Trimble NetR7) offer direct Ethernet connection. Thus, this first method offers potentially higher data rates than the next to be discussed. Either LAN or WLAN can be used to communicate between the serial-to-Ethernet device server and the destination PC which will process the data. Local conditions and available broadband infrastructure will dictate which method is the most suitable to connect the GPS receiver to a wired network.

The second method's design is similar to the first. An optional web based component is illustrated in Figure 5, which would allow for remote access of the data. A serial-to-Ethernet device server would be required to take advantage of this option so that the 'receive' radio modem could send its data online. Otherwise the data is directly streamed into the destination PC via serial port.

III.APPLICATION OF GPS IN DISASTER MANAGEMENT SYSTEM

GPS is an aeronavigation system based on radio positioning system, navigation system and timing system (6). Regarding the distance as basic observation unit, GPS can calculate the receptor position by measuring the fake distance of several satellites at the same time (8). Because this measurement can be finished in very short time, it is possible to realize the dynamic measurement. GPS technique originates from martial demand and has got rapid development in recent years. Presently, it is widely applied in the forest survey. Application of GPS in disaster management maintains in the following aspects:

(1) GPS has a widely application in field measurement. A new subject--GPS global geodesy has formulated. As a result of adopting the differential technique, the precision of DGPS (differential GPS) can reach one centimeter, which is enough to meet the requirement of disaster management.

(2) By using GPS, the forest surveyor can locate his azimuth exactly and on time during survey of forest resource.

(3) With assistance of GPS, the people can report the exact position and intensity of disaster to the commander in time.

(4) In disaster, according to the lmpact or intensity of disaster, position of source can be realized by using the

appropriate GIS software and GPS work at the same time.

GPS is a new marginal science that includes computer science, geography, topography, environment science, geoscience, spacing science, information science and management science. With combination of spatial distribution and computer techniques, by a series of spatial operation and analysis, it can provide useful information for enterprise operation, civic construction and country economic development. As tools of spatial management and analysis, GIS has important function in disaster management. Based on field data we can create the model in disaster management for awareness purpose in Table.1 (7).

IV.RECOMMENDATIONS

A fully automated, continuous, real-time monitoring system has been developed that employs GPS sensors. The system is capable of providing sub-centimeter precisions without having to solve for the integer ambiguity, making it suitable for monitoring the disaster in field.

Last, a fully automated system was needed for providing continuous GPS position updates and this has been developed. Two communication options are currently available between GPS receivers at target points and a central processing computer: Ethernet or serial port. Both approaches allow the data to be processed locally or remotely based upon field.

The increasing number of catastrophes in recent years has lead to a demand for new sensors, sensor integration techniques and data processing strategies for improved disaster monitoring systems. Further research is required to integrate this technology with other sensors to create more reliable and more adaptable monitoring systems in any disaster management system (2, 3).

Models	Input	Output
Human Causalities Model	1. Population 2. Wind speed, Height of Surge, Distance	1. Human Casualties
Livestock Casualty Model	1. Livestock 2. Wind Speed, Height of Surge, Distance	1. Livestock Casualties
House Damage Model	1. Number of Houses 2. Wind Speed, Height of Surge, Distance	1. Fully Damaged Houses 2. Partially Damaged Houses
Road Damage Model	1. Paved Roads 2. Unpaved Road 3. Wind Speed, Height of Surge, Distance	1. Paved Road Damaged 2. Unpaved Roads

Table.1 Example for some mode set up in Disaster Management System

V.CONCLUSION

This can provide countermeasures for the decision makers to adjust the development strategy and accelerate the disaster management toward stabilization and exuberant. To predict the disaster, firstly, we can build all kinds of prediction models in GIS, by inputting the data collected by RS and GPS simultaneously. Secondly, we can build a disaster prevention system by inputting distribution status of the rescuers and equipment in GIS, and it can provide the technique and methods for the leading section to arrange the rescuers and equipment. For instance, when disaster burst out, we can use GIS to select the best plan to put down the disaster, and assemble the prevention set up immediately in field. Thirdly, we can use GIS to delineate the suffering area and most prone disaster area to make the rescue and restoration plan.

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