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SURVEYING THE STATE-OF-THE ART

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ABSTRACT

Surveying has been a focal point of evolution in technology. It is developing day by day comprising both the science and techniques. It becomes an important tool of planning and decision making in human life; engineering, geology, agriculture, security and defense, health are a few of the many.

Surveying requires management and decision making in deciding the appropriate methods and instrumentation required to complete the task satisfactorily to the specified accuracy and within the time limits available.

The aim of this research work is to review the different specialization of surveying that immerged from the conventional definition, represent the relationship between different branches of surveying, and to review number of modern survey technologies available today.

It obviously found that in spite of the different branches of surveying, the base remains the same. Different sciences relay largely on survey information, so it becomes integrated science. Satellite technology becomes an important tool in surveying.

Moreover, the term of surveying itself become unable to cover all responsibilities. To overcome this short coming, the term of, geomatics, arises as a substitute term.

***Keywords**: Cartography, Geodesy, Geographic information system, Global positioning system, Mapping, Navigation, Photogrammetry, Positioning, Sensor, Scanner, Surveying, Remote sensing.*

I. INTRODUCTION

Surveying, has traditionally been defined as the science, art, and technology of determining the relative positions of points, on, above, or beneath the earth surface, and representing these points on a plane surface to a suitable scale, or establishing such points.

Relative positioning depends of making some sort of measurements such as distances, angles or bearings, and other measurable parameters lead to compute these measurements.

Distances can be measured directly using tapes, optical instruments, or electromagnetic instruments; or indirectly by triangulation. These distances can be measured in horizontal plane, vertical plane or inclined. Horizontal distances used to describe planimetric position of points while vertical distances describe the difference in height between points. From this point of view, surveying works in two board types of control (relative positioning); horizontal and vertical.

Horizontal control deals with all instruments and techniques used to find the position of points in horizontal plane. These techniques includes traversing, triangulation, trilatration and resection.

On the other hand, vertical control look for finding differences in height between points. This can be carried out using different levelling techniques such as barometric, ordinary, precise, trigonometric and others.

Relative positioning requires knowledge of bearing and direction. These values also need a reference. Therefore, grid, magnetic or true north may also be encompassed by surveying.

Besides positioning using relative direction and distance, it can also be described relative to a coordinate system. Therefore, coordinate systems represent an important tool in surveying that can be used to describe location of points. These coordinate systems can be polar, rectangular or other. Also, they can be planimetric or spherical.

The measured points in surveying are not always situated on the earth surface but they may be underground, in marine or even in space.

Point's representation on a plane surface to scale, stands for maps production. Map, by definition, is a graphical (symbolized) representation of geospatial data, that is refer to the location or the attributes of object or phenomena location on the earth.

Not all survey work cover large portion of the earth but sometimes small areas are required. Here, curvature of the earth can be ignored or earth assumed to be plane. This make surveying to work in two board branches; plane and geodetic.

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Geodetic surveying usually covers large areas therefore, the curvature of the earth has to be taken into a count. Instruments used should be very precise and equations applied are complicated. While, plane surveying used to cover small portion of the earth ignoring the earth curvature i.e. assuming plane surface of the earth. Therefore, Instruments used will be of a lower accuracy compared with those used in geodetic surveying and equations applied will become simple.

In many cases, after preparing maps a particular project need to be set out from map to ground. This is widely appeared in engineering surveying. It is also a part of surveying responsibilities.

II. SHAPE OF THE EARTH

The shape of the earth was assumed to be spherical for long time in the past. The operational approach to physical geodesy starts from the measurements and asks how they can be used in the best way to determine the earth's figure and gravitational field. Today, ellipsoid becomes the nearest mathematical shape that represent the earth. Survey observations can be reduced to one of the three geodetic reference surfaces; the earth surface, geoid, and the ellipsoid.

The earth's surface is the topographic surface of the earth. It is extremely irregular and not mathematically defined. It is approximately ellipsoidal in shape, the maximum departures from an ellipsoid being of the order of 8.5 km. The earth's surface is important because most of observations are made on it.

The equipotential surface of the earth's attraction and rotation defines geoid. Geoid coincides, on average, with the mean sea level. The shape of the geoid is approximately ellipsoidal. In fact, a best fitting ellipsoid could be placed in such a way that the maximum departures from that ellipsoid would be about 110m.
The geoid is of fundamental importance in geodesy because many geodetic observations are related to it. For example, all survey instruments are set up with their primary axis along the local direction of gravity, which is perpendicular to the local equipotential surface and almost perpendicular to the geoid.

Ellipsoid is simply an ellipse rotated about its minor axis. Mathematically the shape is an oblate spheroid. Ellipsoid is important in geodesy because it represent the nearest simple mathematical shape to the geoid so measurements can be reduced to it.

The world geodetic system (WGS-84) ellipsoid today becomes an important ellipsoid. This is so, because it is the surface on which Global Positioning System (GPS) observations are reduced to.

III. SATELLITE SURVEYING

In the past people utilize stars in determining directions. In field astronomy some sort of angle measurement are made for some astronomical heavenly, such as sun or polaris, to determine the directions (azimuth) as well as positions. Thus, positioning, tracking, mapping and navigation, depend largely on astronomical observations that consist of measuring position of the sun or particular stars. Therefore, orientation of any line or position (latitude, and longitude) of point can be determined. On the other hand, field observations of the relative positions of points can be plotted and oriented to produce a map. Map can also be produced directly by plotting referenced. Today, these techniques are no longer be used. This is so, because astronomical field procedures and computations are difficult and time consuming. Moreover, Global Positional System (GPS) make these operations simple and saving time.
Rather than to use natural heavenly, people think of making constellation of artificial satellite to replace the natural stars. This is the first generation of satellite positioning system. This early system, known as *Navy* Navigation satellite system (NNSS), more commonly called the TRANSIT system.
The success of the transit system lead to the development of the Navigation Satellite Timing and Ranging (NAVASTAR) Global Positioning System.
GPS was developed by the (USA) to determine coordinates of points. It consists of three components; these are space segment, control segment and user segment. Every component has its essential role in improving the positioning accuracy.

In this system, ground control receivers monitor the signals transmitted from a set of space segment (satellites). The received signals are used to solve for the coordinates of the position where the receivers are located. The GPS satellites are configured to provide the users with capability of positioning fixing.
Ground receiver equipment consist of two major units, antenna and units of analysis. The antenna is designed to receive the waves that come from satellites. Unit of analysis is linked to Antenna to analyze the data receiving by Antenna.
GPS provides number of advantages e.g. the comprehensive coverage during the 24-hour, comprehensive coverage of spatial locations of each hemisphere, does not need to monitor the use of direct and traditional methods, link all the points of the coordinates of a global uniform and provide a great deal of time in the work of the main connecting points of the major projects.
Because of it is high precision measurements, it is uses not confined to the process of identifying the exact locations of the vessels at sea and ground control point locations, but many geodetic applications and uses of the system became an active role to play effective applications in the areas of land surveying, civil engineering, aerial surveys, environmental engineering, navigation and tracking, geodetic, geophysical applications and modern systems such as geographic information systems (GIS) etc.

IV. INDIRECT MEASUREMENTS

Land surveying techniques are suitable for mapping small areas, but in large areas it may be not practicable. This is so, because it will become time consuming and cost effective. Here, indirect measurement from photographs may become suitable. Therefore, photogrammetry solved this problem.

Photogrammetry is the art science and technology of extracting useful quantitive and qualitive information about physical and man-made objects by measurements and observations on photos and/or images of these objects. Although of this photographic constrains, some of digital photogrammetric data acquisition has an ability to collect images with wave lengths beyond the range of photographic region. Photogrammetry can be divided into two areas; Metric and Interpretative.

The traditional, and largest, application of photogrammetry is to extract topographic information (e.g., topographic maps) from aerial images. However, photogrammetric techniques have also been applied to process satellite images and close range images in order to acquire topographic or nontopographic information of photographed objects.

Photogrammetry has passed through the phases of plane table photogrammetry, analog photogrammetry, analytical photogrammetry, and has now entered the phase of digital photogrammetry.

Digital photogrammetry (softcopy photogrammetry) is applied to digital images that are stored and processed on a computer. Digital images can be scanned from photographs or can be directly captured by digital cameras. Many photogrammetric tasks can be highly automated in digital photogrammetry. The output products are in digital form, such as digital maps, DEMs, and digital orthophotos saved on computer storage media. Therefore, they can be easily managed, and used.

The applications of photogrammetry are widely spread. Principally, it is utilized for object interpretation and object measurement. Aerial photogrammetry is mainly used to produce large scale topographical or thematical maps and digital terrain models (DTM), representing the terrain relief. Also photogrammetry used in architecture, engineering, manufacturing, quality control, police investigation, and geology, as well as by archaeologists to quickly produce plans of large or complex sites and by meteorologists as a way to determine the actual wind speed of a tornado where objective weather data cannot be obtained. It is also used to combine live action with computer - generated imagery in movie post-production.

V. SATELLITE IMAGARY

Development of satellite technology make it possible to take images from space then, data coverage is greatly improved by high altitude sensors so it provides a low cost means of environmental data collection. And frequent data can be collected. Moreover, data become accessible anywhere. Therefore, the science of remote sensing take place.

Remote sensing is the science of acquiring, processing, interpreting images and related data, obtained from satellites that record the interaction between matter and electromagnetic radiation.
Data analysis concentrates on the procedures that convert raw data into useful information through; Inspection of data using optical or digital tools, utilizing reference information such as old maps, tables or reports, producing quantitative or qualitative information in a suitable form and providing these information to the users to assist decision making.

The remote sensing system can be divided into two major categories; framing systems, and scanning systems. Faming systems instantaneously acquire an image of an area, or frame, on the terrain. Cameras and vidicons are common. A scanning system employs a single detector with a narrow field of view that is swept across the terrain to produce an image. The four common scanning modes are; Multi-spectral scanners provide images of the earth surface with different bands. Thermal infrared line scanner provide thermal imagery but now it becomes a part of the multi-spectral scanners. Radar is an active system that produces pulses of microwave energy. Passive microwave scanner detect and record radiant microwave energy.
Today, remote sensing affords a practical means of frequent and accurate monitoring of the earth's resources on literally a global basis.
Earth Thematic Mapper plus (ETM+) sensor on Landsat7 provides panchromatic band of 15m spatial resolution, co-registered with seven spectral bands 15m ground resolution and worldwide availability, information regarding land cover, soils, geology and infrastructure can be easily extracted and presented at up to 1:50,000 scale.
Operational Land Imager (OLI) in landsat8 provides 30m resolution in visible, NIR, and SWIR and 15m panchromatic.
Spot5 sensors provides 5m ground resolution in panchromatic mode and 2.5m in super mode and up to 5m in multispectral. Imagery can be presented at 1:10,000 scale or better.
Ikonos satellite sensors record data in 4 channels of multispectral 4m resolution and one panchromatic channel with 1m.
QuickBird is now acquiring 0.6m resolution in panchromatic and 2.44m multispectral.
GeoEye-1 and WordView-2 acquire images with resolution of about 0.4m panchromatic and 1.6m multispectral where, WordView-3 acquires 0.3m special resolution in panchromatic. Buildings, roads, bridges and other detailed infrastructure become visible. The imagery will be used for the assessment and management of land, infrastructure, and natural resources.
It is aiding in assessing the impact of human activities on our air, water and land. Data obtained from remote sensors have provided information necessary for making sound decisions and formulating policy in a host of resource-development and land use applications.

VI. MAPPING

Representing the earth surface or these geospatial data is not a trivial process but can be complicated. This is so because earth is a globe while paper is plane. Transforming the global surface of the earth to a planimetric surface, usually carried out using projection. Here, the science on map projection arise.

Map projection allows representing a portion of the 3-D curved surface of the earth on a flat (or 2-D) piece of paper. Projections can be divided into three types: Azimuthal (Zenithal) projections, Conical projections, and cylindrical projections.

Azimuthal or Zenithal Projections are made upon a plane tangent to the globe at any point. Usually the point is taken at one of the poles or at some place on the equator; it can, however, be taken at any other point.

A second type of projection can be made on a hollow cone set so as to touch the globe along any parallel of latitude between 0˚ and 90˚. The cone might also be tangent along any other small circle.

Cylindrical Projections like a cylinder of paper that wrapped round a globe so as to touch it along the equator. This cylinder could also touch the globe along any other great circle, but if so the lines of latitude and longitude will be curves difficult to define in simple terms.

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All these types of projection can be normal to the earth surface, transverse or oblique projections. Moreover, all these types can be divided into sub-type projection in order to satisfy a particular requirement such as preservation of area; preservation of shape (orthomorphism); preservation of scale; preservation of bearing, and ease of drawing.
Maps also need to use symbols, colours and letters. It needs some sort of design, generalization of features and other cartographic requirement. Therefore, cartography can leads the mapping process.

VII. HYDROGRAPHY

Hydrography is surveying of a water area, with depth measurement as the primary focus. However, the survey is not complete until there has been an analysis and scientific description of other physical conditions such as tides, currents, shoreline conditions, bottom composition, and determination of the physical and chemical properties of water, as well as positioning hazards and aids to navigation. A principal objective is to obtain information on water areas and adjacent coastal regions that will serve as source material for Navy and commercial fleet support; in addition, nautical charts, coastal engineering design studies, sailing directions and coastal pilots, and other nautical combinations will be of value to the user. Recent technological improvements in the area of surface and sub-surface data collection have given the hydrographer a number of sophisticated tools necessary to collect a wide range of data used in producing today's charts, as well as to provide a reliable database for electronic navigation of tomorrow.
Choosing the right equipment for a project in hand is essential to obtain high resolution hydrographic survey data ensuring maximum efficiency. The wide range of survey equipment allows users to select the best equipment exacting the specifications of the project.
Airborne LIDAR has become a fully operational tool for hydrographic surveying in recent years. Currently there are four Airborne Laser Bathymetry (ALB) systems operating worldwide. One system, the Scanning Hydrographic Operational Airborne Lidar Survey (SHOALS) simultaneously measures water depth and adjacent surface topography. Airborne hyperspectral imagery from the Compact Airborne Spectrographic Imager (CASI) has been proven to be a valuable tool for coastal measurements and analysis. CASI's spectral resolution of 288 bands for each spatial pixel allows for the extraction of a vast amount of information such as water clarity, water temperature, bottom type, bathymetry, as well as water quality (chlorophyll, dissolved organic carbon, and suspended minerals), soil types, and plant species. In order for ALB to achieve a comprehensive hydrographic capability, additional sensors would have to be integrated. Combining SHOALS and CASI would be a substantial step in accomplishing a full hydrographic survey capability for ALB. Surveys using this combination of sensors will provide valuable information for different agencies.

VIII. REPRESENTING AND ANALYSIS

In addition to collecting and representing geospatial data, surveying also concern with collecting and representing non special data i.e. descriptive data. This may started with statistical data and statistical maps or charts. Then cover all part of life. A new integrated system of data base system and digital mapping system arise; called Geographical Information System (GIS).
GIS is a system of hardware, software, and procedures designed to support the capture, management, manipulation, analysis, modeling and display of spatially referenced data for solving complex planning and management problems. GIS can be divided into five components: Hardware, Software, modules, Data and People.
Hardware; consists of the technical equipments needed to run a GIS including a computer system with enough power to run the software, enough memory to store large amounts of data, and input and output devices such as scanner, digitizers, GIS data logger's media disks, and printers.
There are many different GIS software packages available today. All packages must be capable of input, storage, retrieving analyzing, transforming, presentations, of data. Before this innovation, the geo-relational model was used. In this model, graphical and descriptive data sets were handled separately. The modern packages usually come with asset of tools that can be customized to the user needs.
Perhaps the most time consuming and costly aspect of initiating a GIS is creating a database. There are several things to consider before acquiring geographic data. It is crucial to check the quality of the data before obtaining it. Errors in the data set can add many unpleasant and costly hours to implement a GIS and the result and conclusions of the GIS analysis most likely will be wrong.
Procedures include how the data will be input to the system, stored, retrieved, managed, transformed, analyzed and finally presented in a final output. The procedures are the steps taken to answer the question need to be resolved .the ability of a GIS to perform spatial analysis and answer these questions in what differentiates this type of system

from any other information system. The transformation processes include tasks such as adjusting the coordinate system, setting, protection correcting any digitized error in a data set, and converting data from raster to vector or from vector to raster.

The people are the component who actually makes the GIS work. They include a plethora of positions including GIS managers, database administrations, application specialists, system analysts and programmers. They are responsible of maintenance of the geographic database and provide technical support. People also need to be educated to make decisions on what type of system to be used.

Today GIS become an important tool in different fields such as environment, agriculture, public utilities, real estate, health care, emergency, marketing and park management etc.

IX. CONCLUSION

Surveying can be regarded as that discipline which encompasses all methods for measuring and collecting information about the physical earth and our environment, processing that information, and disseminating a variety of resulting products to a wide range of clients.

In spite of the different branches of surveying, the base remains the same.

Because, the term of surveying is insufficient to represent its all responsibilities and activities, the term of geomatics becomes the modern term. Geomatics has been defined as the discipline of gathering, storing, processing, and delivering of geographic information, or spatially refereed information. This broad term applies both to science and technology, and integrates the following more specific discipline and technologies; surveying, navigation, positioning, global positioning system, remote sensing, photogrammetry, geodesy, geographic information system, mapping, cartography.

Because of its importance, surveying becomes an integrated science in many fields.

Satellite technology developed different branches of surveying such as land surveying, remote sensing and marine surveying.

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