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SOFT COPY MAPS ARE INDISPENSABLE IN THE DEVELOPMENT AND OPERATION OF MODERN LAND INFORMATION SYSTEM (LIS) AND GEOGRAPHIC INFORMATION SYSTEM (GIS)

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ABSTRACT: *Maps are visual expressions of positions of the earth's surface. Features are depicted using various combinations of points, lines and standard symbols. Maps have traditionally been produced in graphics or hard copy form. Today most mapping is then processed using computer aided drafting and design (CADD) system to develop softcopy maps which are stored within a computer. It can be analyzed, modified, enlarged or reduced in scale, and have their contour intervals changed while being viewed on the monitors of CADD systems. Different types or "layers" of information can also be extracted from digital maps to be represented and analyzed separately, and softcopy maps can be instantaneously transferred to other offices or remote locations electronically. They can be printed in hard copy if desired. Softcopy maps are indispensable in the development and operation of modern Land Information Systems (LIS) and Geographic Information Systems (GIS). This article addressed digital base mapping methods. It discussed the control survey, which is the spatial foundation of the base mapping, It also discussed digital mapping methods using graphic digitizing methods, followed by aerial photography and processes necessary to create a photo-geometric base map.*

KEYWORDS; Digital Maps, Geographic Information System, Survey Controls

INTRODUCTION

Map is one of the main products of scientific operations produced by surveyors. It has been long that production of these maps was done manually. All physical features of parts or whole of the earth's surface are represented on the map with the use of signs and symbols at a given or desired scale. But a lot of problems were associated with the maps so produced from manual method; either during the processing or after production or storage.

The manual operation process of maps production is error prone because not every feature can be plotted onto the map accurately; hence many of these features on map are generalized during plotting. This is not all, some data details may got lost during the transferring from one medium to another medium. It is not easy to revise or update maps after production because, attempts to revise or update the map, involves the repetition of the entire map and it gulps large amount of money. During the storage, stored maps do suffer dimensional distortion (expansion or shrinkage) thereby making them difficult to use after many years. Map sheet may got lost or misplaced during storage. It is also necessary to provide large space for the storage of maps because they occupy large spaces.

Maps are indispensable for all meaningful land based development and activities such as roads construction, enumeration and census mapping, urban and regional planning, communication network, mineral prospecting, location of industries and utilities, boundary

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demarcation, property delineation, erosion control, settling of land-in- dispute, and wild life conservation (Ndukwe, 2001)

Presently, maps are used for nearly every aspect of government and private sector activities. Maps are important to any developmental project, provided that those maps should have the following features:

(i) Revision or updating of existing maps should be easily carried out and at highly reduced cost.

(ii) Reduction or enlargement of maps should be easily carried out.

(iii) Stored maps should not suffer any dimensional distortion.

(iv) They should be able to solve the problem of large space storage facilities and be reliable after production.

(v) They should be able to be retrieved at any point in time.

In order to make maps so produced have above features, there should be a digital technology that will provide these features. To achieve these digital mapping should be employed in map production process.

There are a lot of developments that presently exist on our land. These developments cannot be found in analogue maps produced many years ago. This is due to the problem of non-availability of digital maps which provide easy way of updating. It is therefore necessary that all our analogue maps should be digitized so as to make production of digital maps easy.

This article deals generally on various methods of producing digital maps, from existing maps and fresh mapping of an area using photogrammetric methods. The significance of digital maps include the following:

(i) Subsequent revision and updating of maps can easily be carried out at reduced cost.

Relevant software can be used to create and generate various models such as profile, cross section, digital terrain model, etc.

Features of interest can be displayed or printed out since it can be produced in different layers.

Digital maps so produced will not suffer dimensional distortion, got lost or misplaced, and exposed to wear and tear.

Scale change can be effected easily in digital maps.

It will be useful for appropriate resources management and tackling of environmental problems of the area.

Digital Mapping

Digital mapping could be defined as all the processes involved n digital map production. According to Ndukwe (2001) digital mapping refers to a computerized compilation and production of maps or plans using information in a digital format (Onyeka, 2007) defined digital mapping as a most effective way of presenting digital data by computer processes.

Establishment of Geodetic Control Points

Control surveys are important for establishing a spatial reference framework for all mapping on the surface of the earth. Regardless of the method of compilation, be it aerial photography, coordinate geometry or Global Positioning System, geodetic control points are necessary as first step. The density and accuracy of the control survey network may be varied and the way in which it is used in mapping projects may vary, but is essential and present in all GIS and mapping projects.

A geodetic control is the wire-frame or the skeleton on which continuous and consistent mapping and surveys are based. To understand the function of geodetic control it is important to realize that a map or a plane survey is a first representation of the real curved world. If the maps are to become an authentic representation of the real world we have to be able to paste small pieces of the map contents into a curved world. Geodetic control is the mechanism that enables us to perform this "pasting" accurately and consistently.

Establishing geodetic control to be used as a geodetic base for mapping is not an easy task. It can be done with traditional surveying techniques but currently is done almost exclusively with differential global positioning system (DGPS). The following steps are applicable to any technology to establish a geodetic control network:

1. Determination of accuracy and density criteria.
2. Reconnaissance
3. Monumentation
4. Selection of techniques of observations
5. Field observations
6. Processing of field data
7. Documentation and reporting.

METHODOLOGY

Sources of Data

Sources of data for parcel mapping fall into one or two general categories: primary or secondary data. Primary data sources include data compiled directly from field measurements using traditional surveying methods or GPS. Secondary data sources include data compiled from a special product such as map. Digitized and scanned maps create secondary data sources because these data are compiled from a derived data source (the map) and not from direct field measurements. The quality of spatial data derived from maps depends not only on the accuracy of the original field measurements but also on the scale of the map, the drafting accuracy, the map medium (paper, mylar, etc), the digitizing accuracy and other accuracy factors. Most common methods of mapping parcels rely on secondary data sources of

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digitizing or electronic tracing of the property lines shown on graphics or maps. By contrast, the accuracy of a primary data source depends only on the accuracy of the field measurements used to obtain the data. If the field survey was performed with one meter or one-millimeter accuracy, the accuracy of the data will be one meter or one millimeter, respectively. Some of these methods are listed below:-

Ground survey method, Photogrammetry, Remote sensing, Graphic digitizing method and Integrated approach.

Graphic digitizing is most popular because it makes use of conversion of already existing analogue maps into digital data acceptable to the processing computer avoiding the task of expensive and tedious time of primary data capture.

Graphic Digitizing Methods

This includes three methods namely; manual digitizing, scan digitizing and on-screen digitizing. Manual digitizing requires manual tracing of all graphical elements with the help of a handheld cursor. Scan digitizing enables automatic conversion of graphic document into digital data. The on-screen digitizing method is very similar to manual digitizing, the main difference being that after the graphic documents has been scanned it is displayed on a screen and digitizing takes place in interactive graphic environments. These methods have their limitation in respect of time factor, labour consuming, error proof and expensive.

Digitization of graphics documents involves tracing of all the features on the map. For better efficiency scan digitizing method would be adopted. This is achieved using software known as High photo plus. On-screen digitizing method is employed for vectorization of the scanned image (Rasta data) using software known as AutoCAD etc. Other procedures between scanning process and vectorization are corrections such as scale, rotation and shift, and geo-referencing. Digital maps would be produced in different layers.

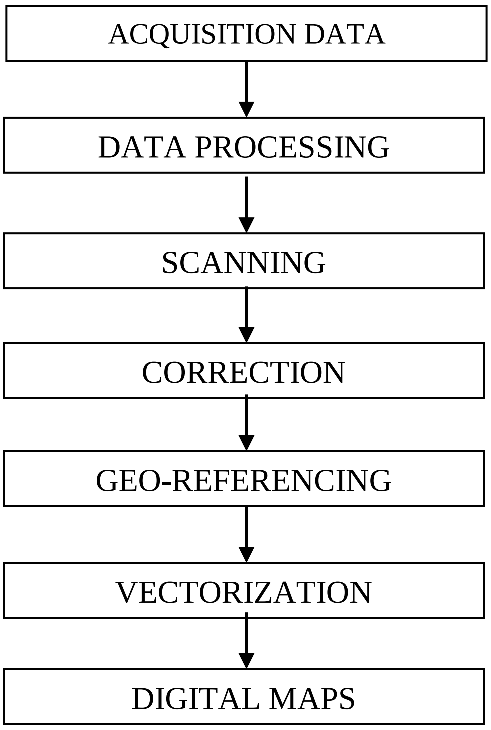

Fig. 1: Digitization process

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PHOTOGRAMMETRIC METHOD

Project Planning

In any photogrammetic mission, the goal of flight planning is to minimize time and exposures while still maintaining ground resolution and sufficient overlap. The pilot must maintain a constant speed and altitude, as well as being consistently 'online' in the flight management system. Unlike conventional missions, there is no time between exposures to adjust the position of the aircraft. Therefore, at the planning stage, flight lines are broken into smaller blocks.

The smaller blocks have additional benefits. The post processing of the data is much easier to address if they are split into smaller workable blocks. By breaking the flight plans into these blocks, we also ensure data acquisition over a given block in a shorter period of time, which helps with the radiometric processing. Enough target points or minor control points are distributed within the mapping area.

Aerial Photography

When there are no valid or reliable previous records of a place after an accurate geodetic control is established, aerial photography is the critical next link in the land base chain of events. The acquisition of aerial photography must be planned carefully. The map will be built from and referenced to features that are visible in the aerial photography. For a successful project, several factors must be taken into considerations for aerial photography planning, including overall project timing, size of the project area and scale.

As an airplane flies over the terrain, it snaps many exposures at specific intervals. Without control survey there would be no way of determining exactly where the aircraft was at the instant of exposure. To accomplish the tasks, targets are physically placed on the ground at specified locations within the project area. These targets are then surveyed to establish their location. For proper visibility, targets must be sized according to the photograph scale necessary

Digital Orthophotography

An orthophotography is an aerial photograph that has been ortho-rectified to remove displacement caused by aircraft movement, photographic tilt, curvature of the earth, and changes in topography. Each of these components is a source of error in the unprocessed photograph. Significant differences exist between the initial air photograph and its ortho-photograph counterpart. For example, changes in photography or elevation across the area being photographed impact substantial error to the unrectified photograph. Take the example of elevation differences. Suppose there are two hectare property lots located in one photograph. If these lots differed in elevation by several hundred meters, the lot at the higher elevation (that is closer to the camera) would appear to be larger on the original photograph than the lot at the lower elevation (that further from the camera). Photographic perspective also impacts the accuracy of the uncorrected aerial photographs. Ideally, in order to minimize distortion, aerial photographs should be taken from a vertical perspective straight beneath the plane. Actually, it is more likely that the plane will have a slight tilt, introducing displacement of features, or objects. These are just a few examples of how the original aerial photograph becomes distorted.

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Photogrammetry is able to use detailed elevation models (DEM). Digital terrain models (DTM), ground control locations, and analytical aerial-triangulation, together with recorded camera calibration and orientation parameters to nearly eliminate distortion and create an orthophotograph. Since orthophotography has such high degree of error correction, it is possible to use them to measure area, distance, and location of features accurately on the earth's surface. This is impossible with unprocessed aerial photographs. Orthophotography also can be used to overlay maps directly and delineate features (Wolf, 1987).

Stereo Digitizing

The third critical link in the chain of compiling a GIS land base is the stereo photogrammetric plotting instrument. At this point in the aerial photography process, the actual capturing of the land base occurs. To begin the digitizing process the following information are required:

(i) The camera calibration report for the aerial camera used to obtain the photography.

(ii) The survey control coordination

(iii) The aerial photography in the form of 23cm x 23cm film diapositives forming a stereo pair and

(v) The analytic aero-triangulation results.

These are physically located into the stereo photogrammetric plotting instrument. The instrument is then mathematically oriented to create a stereoscopic three-dimensional image of the earth's surface in its precise geometric proportion. The operator views the three-dimensional image and compiles or digitizes the features that can be viewed physically through the optics of the stereo plotting instrument. The actual point of digitizing occurs through a white or black dot of light that the stereo plotter operator moves through the three-dimensional stereo model. This dot is sometimes called a floating point since it appears to float in space in the three-dimensional model. Occupying their edge of roofline with the dot for example collects buildings for example collects buildings. Roads are collected by following the edge of pavement. Utility poles are collected by physically occupying the center of the pole with the dot, and so on.

Mapping data are collected in digital form and then processed using computer aided drafting and design (CADD) systems employing computers programmed with special software and interfaced with electronic plotting device. A softcopy manuscript is compiled in the computer and displayed on its screen as work progresses. CADD software provides instruction to the computer, which basically duplicates manual drafting function. A file containing coordinates of points as well as specific instructions on how to plot them must be input in preparation for mapping. An operator interactively designs and compiles the map by entering commands into the computer's keyboard or using a mouse to activate functions on a menu. Points, lines of various types, and a variety of symbols are available to the operator. Letters of different sizes and styles can be selected. When the manuscript is completely finished, simply simply activating the electronic plotter may draw the final map.

Elevations and Contours

The collection of contours is another matter. Contours can be collected by either of two methods: stream digitizing or electronically through a digital elevation model (DEM). In the

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stream-digitizing mode, the stereo plotter operator follows his or her interpretation of the physical elevation of the ground with the digitizing dot, thus creating an isoline (contour) of coordinates that exist at the same elevation. This is not a task that can be done quickly or without a great deal of care.

The second method for creating contours is by creating a DEM and employing a computer program known as a contour interpolation program. The DEM is created when the stereo plotter operator digitizes a network of spot elevations and compiles all break lines. Break lines are the lines at which contours would change directions abruptly, such as curves, ridgelines, valley bottoms, retaining walls and so forth. A digital terrain model (DTM) contains break lines and points of notable elevation. The difference between a DTM and a DEM is that a DTM does not have a regular grid of elevation points. Both are used to generate contour values.

A contour interpolation program is used in elevate the DEM or DTM to create the contours through computer. The DEM and DTM procedures are faster and require less computer space because far fewer elevation points need to be stored. Contours are generated rather than directly observed.

Cartographic Editing

Upon completion of the land base compilation, the data must be cartographically edited. This process occurs on a digital edit station, which consists of a computer, a digitizing surface and a digitizing puck. At this stage, any overprinting of data is corrected, contours are smoothened and street and place names are inserted. In general, the land base is given final cartographic quality and completeness. At this point in the process, the data are translated from the photogrammetric collection software to either the final GIS file format or general file format.

Field Editing

Personnel physically walking throughout the project area complete a filed edit. Survey crews use hardcopy of the land base and measurement tools, such as steel tape, a measuring wheel or even GPS, to compare the hardcopy of the land base to the ground, visually locating any missing detail. The missing items are positioned by measuring from features that have been properly located on the land base. The missing items are then scaled into their actual position and physically plotted unto the hardcopy land base. In the office, the printed map is electronically registered to the land base at a digital edit station and the detail obtained from the field edit is transferred into the digital land base via digitizing puck.

The field edit process is both time-consuming and costly. The need for and extent of field edits should be evaluated carefully. Some spot checks are important to establish the accuracy and completeness of the map.

Map Editing

Map manuscript must be edited carefully before or immediately after the stereo model compilation phase of the project is completed. The map editor should be someone other than the stereo plotter operator who compiled the original map manuscript.

(a) Each must be checked for:

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(i) Compile with the required map accuracy standards.

(ii) Completeness of plan metric and topographic detail, as called for in the contract specification.

(iii). Correction of symbolization and naming of features.

(iv). Agreement of edge-matched plan metric and topographic line work with adjacent maps.

(b) Preliminary digital maps may be plotted on bond paper for subsequent editing. Stereo plotters equipment with graphic superimposition in the viewing system can be used to assist the editor in checking the digital data.

Final map sheets can be prepared by computer driven plotter from a graphic database file. Final sheets should be on dimensionally stable. Final maps sheets should be produced utilizing plotter equipment that will meet the map class standard of accuracy required for the project. Digital data files shall meet the requirements for layers, symbols, line weight, attribution, etc, as specified for the project in the scope of work. Upon completion, each map sheet should be reviewed and edited to ensure completeness and uniformity of the maps.

DISCUSSION

The use of digital map has brought problem solving techniques in surveying and mapping. Production of digital map is easy and even easier to produce from existing analogue map than the start from primary data acquisition. The problems such as storage facilities, dimensional distortion, and wear and tear that are peculiar to the analogue map have been overcome. So also, time consuming, tedious work and cost implication of reproduction process (reversion) were reduced compared to revision of analogue map. It also maintains better accuracy than analogue map. Digital maps products are easier to use than the analogue map products because maps that depict different features of interest could be produced from composite map (topographical map) by the users.

Despite the problems that make analogue map different from digital map, they still have paper map in common as their end product. Analogue map has its end product as paper map while digital map are in soft copies, sometimes, also has its end product as paper map.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

The article described the procedure of conversion of analogue map to digital map. The process involved transformation of coordinates of selected control points, followed by scanning of map of the project area using High Photo Plus Software. The scanned image was saved into standard exchange format known as joint expert group (JPEG). Then corrections such as scale errors rotation error and shift errors were carried out. The coordinate of scanned image was properly geo-referenced; Vectorization of different features was carried out after

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the creation of layers for different features. Symbolization, annotation, and presentation of map followed vectorization.

Computer, scanner of A4 sizes, and printer were used to achieve digitalization of the analogue map. The digital maps were produced in three layers. These three layers were later superimposed on one another to form a composite map.

Photogrammetric methods of digital map production were fully discussed. The article discussed about project planning in Aerial Photography acquisition to stereo digitizing and final digital map production

Conclusion

The article shows the production of digital maps of the area, using available manpower and instruments within the reach, it also shows the advantages of digital maps over analogue paper maps. The article further stated that the vector data (model) that is good for graphics could be obtained from scanned image by further processing through on-screen digitizing method producing digital maps in different layers.

Recommendations

Due to the great advantages of digital maps over analogue paper maps, it is hereby recommended that digital maping should be carried out in all other subsequent map production in Nigeria. Combination of scan digitizing and on-screen digitizing should also be employed in production in layers so that it will be convenient to use by various users.

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