DATA ACQUISITION FOR LAND INFORMATION SYSTEMS BY PHOTOGRAMMETRY

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1. Introduction

The topic of "Land Information Systems" has internationally provoked a large interest during the past 5 years. Within the International Federation of Surveyors (F.I.G.) a special commission has been set up for this area of interest. In 1978 a special F.I.G. symposium on Land Information Systems has been organized in Darmstadt in the Fed.Rep.Germany.

Land Information has also been the topic of some Technical Cooperation Workshops held in the Federal Republic of Germany in cooperation with the United Nations (Hannover 1978, Berlin-West 1983) [1], [2]. At such meetings it usually becomes evident, that the term "land information system" is utilized by different groups in a different context:

2. Types of Land Information Systems

1) The group of geographers and regional planners consider as land information system a collection of geographic (land use) or planning data (land development potential). The information is either based on areas with geometrically defined boundaries or on grid points or other spatially distributed points between which the information may be interpolated.

2) The group of classically oriented surveyors from developing countries see as land information system the task of establishing a cadastre on the basis of monumented ground control, on photogrammetrically compiled line maps or (ortho-)photomaps in which land parcels have been graphically delineated, and a land register or a land title system with obligatory registration of land transfers.
A good example for such a system is the Atlantic Provinces Surveying and Mapping Program established in Eastern Canada since the 1960's [3], [4]. In developing countries there is frequently a social or political motivation to establish a system of this nature [2].

3) For the group of surveyors from developed countries, who have already an established cadastral system in operation, a land information system is an automated form of the multipurpose cadastre which is made accessible for users of other disciplines.

4) From rural reallotment and land consolidation comes the wish to create a land information system on the basis of the cadastre, which not only contains cadastral information, but opens the system for the systematic recording and the updating of all data relevant for planning purposes.

5) In urban and highly developed regions there is the wish to include into a land information system not only area related data, such as the cadastre, but also data referenced to points and lines, such as topography and the utilities. Such data are to be collected and kept up to date in a global information system containing all data of an urban area in integrated form.

Ultimately this last concept of a global information system can combine the advantages of all aforementioned system types, if it is possible to establish such a system.

3. Obstacles to Data Integration

While an integrated information system is generally considered as the ideal goal there are several obstacles against its introduction.

1) There is foremost an organizational problem. The administrations or enterprises which have the task to collect and to update land related data have not been established under the aspects of automation. They have no concern or jurisdiction for the data beyond their area of competence; therefore they only intend to automate their own data flow.

2) There is also a technical problem. Discipline oriented administrations have hierachies established beyond regions or states. The automation of their tasks favours the use of control large size computers with complicated data bank software and many decentralized terminals operated via the telephone network. Such a way of operation is severely limited by the data rate of transmission. This becomes particularly evident, if graphical data are to be administered.

3) A decentralized administration of graphic data, however, requires high investment costs, which are not sensible for local administrations charged with limited tasks only. This financial problem can only be overcome, if local data of several organizations can be maintained in an integrated manner.

4) Finally, there exists a research and development problem. Administrations and organisations involved in practical operations are according to their very nature not in the position to be able to afford extensive research and development activities. Such activities can be better pursued by research institutes or universities, who are often not given access to administrative problems on one hand, and who hesitate on the other to deal with aspects of a non-analytical nature. Yet, in the interest to more actively pursue to challenges of the profession a concentrated and coordinated effort of administrations, technical organizations and academic institutions becomes necessary to analyze the problem area in projects free from the limitations of specific organizational structures.

4. Pilot Project Neustadt am Rübenberge

For this reason the Institute for Photogrammetry and Engineering Surveys at the University of Hannover has embarked on a pilot project to study the methodology for data collection for an integrated urban land information system over a limited area (8 km²) in the city of Neustadt am Rübenberge, about 20 km northwest of Hannover.
The City of Neustadt possesses a densely monumented control network established and maintained by the State Survey Authorities. On the basis of this network numerical cadastral data are available in form of field notes and up to date cadastral records.
These data are supplemented by an up to date cadastral map 1:1000, which is only deficient in the display of certain topographic features.
It is possible to digitze the cadastral map with limited accuracy or to recalculate the cadastral data with survey precision to create the cadastral graphic data base.
In order to obtain all topographic features of interest, it has been decided to use aerial photography for the data collection.
Upon signalization of the control an aerial survey flight has been made of the area with a 30 cm focal length camera at an image scale 1:3300.
In cooperation with Kern, Switzerland the following equipment and software has been utilized to acquire digital topographic data, such as houses, vegetation, creeks, ditches, fences and walls, lampposts, signs and utility manholes:

1) the Kern DSR-1 analytical plotter for aerial triangulation and its adjustment by the BLUH program as well as for digital measurement of points and lines

2) the Kern Maps 200 System for the acquisition and recording of digital data in the DSR-1 in conjunction with the Kern GT 1 plotting table

3) the Kern digitizer for the input of graphic line connections of the utilities between manholes or from other records

4) the Kern electronic tacheometer for additionally required ground measurements

5) the Kern Maps 300 System for the off-line correction of the digital data acquired with the above instrumentation.

The experiences of this pilot project are reported in additional papers by K.Jacobsen, J.Leonhardt and U.Stampa-Wessel.
These papers demonstrate, in which way photogrammetry is capable of acquiring data for an integrated urban land information system.

5. KUDAMS-Project of Kuwait Municipality

A large size project, which integrates cadastral, topographic, utility and planning data over an urban area of 580 km² is the Kuwait Municipality KUDAMS-Project (Kuwait Utility Data Management System). The Institute of Photogrammetry and Engineering Surveys of the University of Hannover was involved in a study for this project during the years 1980 and 1981 [5]. Based upon the recommendations of this study Kuwait Municipality decided to implement the system within a 6 year period beginning in 1983. The main contract for this project went to the Mitsui-Asia Air Surveys Consortium of Tokyo, Japan.

The project is based on a sequence of stages:

1) A new control network for the entire state of Kuwait (17 800 km²) is established by monumentation of over 100 first order points and their survey by electrooptical distance and angular measurements; the orientation of the net is given by 6 simultaneously observed Doppler-points.
This net is densified by terrestrial surveys in the urban areas to a level required at which the monumented and signalized reference points at the street block level can be determined by analytical aerial triangulation and its bundle block adjustment.

2) The cadastral information is presently contained in field notes with numerical survey data based on boundary traverse points which are signalized either as existing reference points or as newly reestablished monuments.
Based on the photogrammetrically determined coordinates the cadastral boundary point coordinates are calculated and adjusted from the field notes.
The calculation of these coordinates is facilitated by interactive graphic systems using a special cadastral software.
For the Kuwait Project this is presently accomplished with 2 Intergraph graphic work stations linked to a VAX 11/750 computer operated by a specially designed Mitsui-Intergraph software.
Software has also been designed to update cadastral information on the work stations based on electronic tacheometer (total station) data, referenced to the control network.

The software furthermore permits to display or print attribute data, such as the parcel number or the ownership number for a particular owner identified in an Arabian name file.
For this reason a new parcel numbering scheme, also including roads and public parcels is being introduced.

3] The topographic information is collected by digital photogrammetric data acquisition in analytical stereoplotters equipped with graphic terminals. Asia Air Surveys is installing a digital photogrammetric data acquisition system at their premises in Tokyo. It consists of a VAX 11/730 computer linked with several Kern DSR 1 stereoplotters, a Kern GT1 plotting table, graphic terminals and magnetic tape units.

The topographic data, compiled from color aerial photographs taken with a normal angle (c = 30 cm), 23 x 23 cm format camera at the scale of 1:3300. In these the targetted control points, transfer points and utility manholes are visible. Their coordinates can be recorded and marked by an appropriate symbol in the data base. Topographic features, such as houses, road limitations, vegetation boundaries, water boundaries and contours are also acquired in digital form. In Kuwait a DSR 1 will be installed in 1985 for updating and checking of topographic information from new aerial photographs.

4] The utility information is compiled at 8 further Intergraph interactive graphic work stations linked to another VAX 11/750 computer to be installed in Kuwait by March 1985. The total computer configuration will then consist of 8 Mb main storage in the dual VAX 11/750 system and of disk storage facilities of 3000 Mb linked with 10 Intergraph work stations, a Kongsberg GT 5000 flatbed plotter and a rapid multicolor plotter.

The utility input is made from the following sources:

a] the coordinates of manholes, determined by a simultaneous photogrammetric bundle block adjustment in an analytical aerial triangulation.
b] terrestrial simple distance measurements to toopgraphic objects such as house corners, walls and street curbs. Such surveys are required, where electricity cables are to be detected by electric or magnetic cable locators.
c] utility reservations based on cadastral boundaries (e.g. for a 30 m wide road: high tension cables 0,5 m away from the boundary; sewer 1,0 m away; low tension cables 1,35 m away; drinking water pipes 1,8 m away, gas pipes 2,7 m away, irrigation pipes 3,2 m awa, telephone cables 4,65 m away.
d] graphical representation in the utility plans 1:2000, if necessary extracted by a digitizing table.

The system must be continuously updated on the basis of new survey records. Graphic map representations may be plotted at periodic intervals and distributed in microfilm form.
The generation and the upkeep of such a global information system creates a number of detailed questions, which can only be solved jointly with the user administrations in an interministerial committee, which is now already operating.
It is planned that each user ministry (Communications, Electricity and Water, Justice, Planning Dept. of Kuwait Municipality, Public Works) will eventually, after the establishment of the system in a 6 year period, have the possibility to update its own data base as far as geometry and especially the legal or descriptive attributes are concerned. This can be done by supplying each user service with additional work stations ooperated by a VAX 11/730 linked to the Kuwait Municipality Survey Department system. This will enable these administrations not only to utilize and to update the data, but also to develop their own dedicated task data management systems.
The KUDAMS-Project constitutes a model for the establishment of a global land information system in urban areas for the following reasons:

a] The system was conceived by the Survey Department, which has the expertise to geometrically integrate all data
b] the area of 580 km² is large enough to install the system; it is also small enough to handle the amount of data in an existing and serviceable hard- and software system, which only amounts to 15 % of the total project costs.
c] it has been made possible that this geometric information system is equally suitable for input and the updating with different data acquisition methods, such as simple tape measurements, digital tacheometry, analog or analytical photogrammetry and the digitization of maps, always maintaining and coding the original survey accuracy.

d) It was important to identify the required data linkages at the beginning, before the data structure was fixed in the software.

References

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