FROM PHOTOGRAMMETRY TO INCONIC INFORMATICS—ON THE HISTORICAL DEVELOPMENT OF PHOTOGRAMMETRY AND REMOTE SENSING

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Invited paper of Comm. VI, ISPRS Congress, Washington D. C.

Abstract

This paper gives a review about historical development of photogrammetry and remote sensing and the increasing combination and integration of photogrammetry, remote sensing with Geographic Information System (GIS). This development indicates that our discipline has being now in drastic changes from photogrammetry that belongs to classical geometry science to iconic informatics that belongs to modern information science.

1. Three Developoment Stages of Photogrammetry - Analog, Analytical and Digital Photogrammetry

If we count from the invention of photography in the year of 1839, the discipline of photogrammetry has had a 153 years long history. It can be devided into three development stages: analog photogrammetry (1856—1960's), analytical photogrammetry (from 1957 —) and digital photogrammetry (from 1964 —).

In the 1980's the general trend of the development of digital photogrammetry used nowadays can be interpreted either as a type of computer - aided or copmputer - controlled topographic data acquisition from a photogrammetric instrument, or as photrogrammetry with the use of digital or digitized images. The former is what the photogrammetric production units have now commonly adopted in their mapping process, while the latter still remains in the developing and experimental stage and is sometimes called " Fully Digital Photogrammetry" using digital photogrammetric systems. It is just the digital Photogrammetry that leads to the drastic changes in the development of photogrammetry. " Real - Time Photogrammetry" falls into this category of "Fully Digital Photogrammetry", and in the form of " Computer Vision" particularly, has made rapid progress mainly through investigation from experts in other fields outside photogrammetry.

For GIS data acquistion from digital photogrammetric systems there remain at least two main technical problems:

- automatic object reconstruction and location by using image matching techniques;
- automatic image interpretation and identification by using image understanding techniques.

2. The Development of Rmote Sensing and its Integration with Photogrammetry. —From "Photogrammetry" to "Photogrammetry and Remote Sensing".

During the 1960's there appeared the space aviation and the term " remote sensing" was then introduced for the first time by an American geographer who simply intended at that time to replace the traditionally used one, called " aerial photo - interpretation ". Afterwards the term " remote sensing" directed at the technology of detecting objects

without touching them . In this meaning the aerial photogrammetry falls into this definition and is called as "Airborne Remote Sensing". In the 1970's after the succesful launch of American Landsat satellite space - borne remote sensing received universal recognition owing to its efficiency in data acquisition and processing of the spatial information, especially in thematic information extraction for resource and environmental investigations.

The first contribution of remote sensing to photogrammetry is to extend the means of image data acquisition from day light photography by using frame cameras to whole electromagnetic spectrum sensing by using different sensor technologies. The space - borne images mostly adopted nowadays in the surverying, mapping and GIS community are from MSS and TM in Landsat, sensor HRV in SPOT, sensor AVHRR in NOAA and also the frame cameras carried by space shuttles as the American LFC, the Metric Camera RMK of ESA as well as the KFA - 1000 and MK - 4 Camera on the Cosmus spacecraft in USSR. All these sensors possess very high spatial or time resolution. In the 1990's the development of remote sensing is inclined to the multi - band scanner, represented by the imaging spectrometer and the new type of microwave represented by the multiparameter imaging radar.

Another contribution of remote sensing to photogrammetry is to extend the contents of data processing from purely geometric evaluations to physical analysis, and consequently the products are extended from topographic maps to different kinds of thematic maps.

At the same time photogrammetry is heading now towards digital photogrammetry, in which the modern technology in space aviation, in computer science and also in multi - spectral data are being more and more used. A lot of new techniques, such as GPS technique, CCD sensor, image processing and image understanding, as well as knowledge based systems are mutually used in photogrammetry and in remote sensing. In fact the history of photogrammetry including its constituent part "Image Interpretation" is exactly the history of remote sensing and remote sensing is the extension of photogrammetry. The word "photogrammetry" alone that has used for more than hundred years is unable to cover this development in its digital age. When a more appropriate name for our discipline was absent, the so called " Photogrammetry and Remote Sensing " has been used since 1980. At the KYOTO Congress of ISPRS in 1988 the definition of Photogrammetry an Remote Sensing was defined as following:

" Photogrammetry and Remote Sensing is the art, science and technology of obtaining reliable informations about physical objects and the environment through the process of recording, measuring and interpreting imagery and digital representation thereof derived from non - contact sensor systems. "

3. Integration of Photogrammetry and Remote Sensing with GIS

Since the output of analytical and digital photogrammetric systems is always at first in digital form, a data base or a certaim kind of spatial information system should be needed so that this output information can be stored, integrated with other non - graphic data and analyzed according to the user needs. It means photogrammetry and remote sensing is becoming more and more important as a basic data source for the acquistion and updating of the imformation in GIS.

On the other hand the data processing of digital photogrammetry and remote sensing is becoming more and more to use GIS support. These developments lead to a combination among photogrammetry , remote sensing and GIS.

In fact, this combination has already experienced several development stages. At the beginning, various kinds of thematic maps and topographic maps were completed through manual photogrammetric plotting and visual interpretation of image date and then were digitized to be input into GIS. Since the middle of the 70's the reseach has conducted to perform digital mapping analytically from computer - aided or computer - controlled system and to extract

thematic information automatically from digital photogrammetric system or/and remote sensing image processing system and then enter them (sometimes with orthophoto image) directly into GIS. Thus we have an unseparated, complete system composed of photogrammetry, remote sensing and GIS.

Considering the fact that the data structure of image processing is almost universal in the use of the raster format and the digital mapping and GIS Systems on the other hand typically use the vector format, the integration of photogrammetry, remote sensing and GIS will largely depend on the capability to perform a convenient data exchange between raster and vector formats. This gives rise to the necessity of finding a kind of unified data structure, as for example the linear quadtree structure where raster data can be treated like the stuctural vector data and vector data can be expressed with raster code numders/Li and Gong, 1991/. There is indeed a lot to be worked out in GIS theory in order to manage, query, process and display raster and vector data without the need of conversions.

From above discussion we can see that the Spatial Information System (SIS), which is a general term for Geographic Information System (GIS) Land Information System (LIS), Digital Object Model (DOM), Digital Surface Model (DSM) and many others, has been and will be becoming unseparable from photogrammetry and remote sensing.

In fact as early as in the 1960's when the term GIS was first used in the developmant of the Canaidan GIS, it was already closely associated with the government Surveying and Mapping Organization/ Tomlinson 1972/. As for LIS it was a product for the automation of cadastral surveying.

In 1974 during the 14th FIG Congress, a definition was first proposed for LIS. In consideration of this integration International Union of Surveying and Mapping (IUSM) has given a definition of Surveys and mapping in its 1990 statutes: "Surveys and mapping is the science, art, technology and ecnomic aspects of collection, measurement, processing, analysis, interpretation, portrayal, dissamination, utilization and evaluation of geographically and other spatially referenced data ".

The role of ISPRS has been investigated by John Trinder, chairman of an ad hoc committee/Trinder 1991/.

As we mentioned above the term GIS was first used by Tomlinson, who was a member of the American Society for Phtogrammetry. During 1970—1980 the theory of DEM and its application, which can be as a part of GIS data base, was a major studying topic in ISP. In 1980, the Bylaws of ISPRS included a change of name of commission IV to "Cartographic and Data Bank Application of Photogrammetry and Remote Sensing", while the terms of reference of this commission included the term " Geographic Information System". In the 1984—88 period, an Inter - Commission working group was chaired by Professor Roy Welch with the title " Computer Graphics, Digital Technology and Land Information System". Papers at Kyoto Congress in 1988 covered such topics as data acquisition, data structures, integration of raster and vector techniques, GIS design and creation, and data model for GIS. Resolutions of Kyoto Congress recommended significantly greater emphasis on GIS techniques in Comm. Ⅲ and Ⅳ.

During 1988 — 1992 our Comm. Ⅲ has the following working groups: Ⅲ/1, Geographic Information Theory, Ⅲ/2 Object Reconstruction and Location by image Analysis, Ⅲ/3 Thematic Information Extraction from Digital Images, Ⅲ/4 Knowledge Based System. These works are clearly beyond the data acquisition stage of GIS and to include the modelling of GIS data, data and database structure, knowledge representation, quality assessment of geographic data and dynamic modelling. In similar situation Comm. Ⅳ has six working groups which deal with the theory of GIS data acquisition, management and application of GIS. Also the seven WGs in Comm. Ⅶ are all related to the GIS application and indicate the integration of remote sensing with GIS.

4. Iconic Informatics-A new Branch of Infomation Science

As mentioned above, photogrammetry , remote sensing and spatial information system are very closely interrelated with one another and are gradually becoming unseparable in their respective development. Recently," Photogrammetry and Remote Sensing" has been heading towards its integration with the technology of spatial Information Systems. Some of the well - known photogrammetric analytical plotters have already changed their designs and developed databases or spatial information systems, such as P series with PHOCUS form Carl Zeiss, DSR series with INFOCAM from Kern and BC3 with SYSTEM 9 from Wild.

What is the right name of our discipline? We cannot use Photogrammetry and remote sensing and GIS Faced with such a situation, some scholars from different countries have proposed a few new names for it, and some of them have already been used officially in higher educational institutions. For example, the " Geoinformatics" is used by the International Insitute for Aerospace Survey and Earth Science (ITC) in Netherlands, the term " Geomatics" is used by Laval University in Canada as the name for their relevant speciality, the term " Image Informtion Engineering" is used in China as a new speciality of Department of Photogrammetry and Remote Sensing at WTUSM, among which the contents of photogrammetry, remote sensing and GIS and some others are included. Prof. Wang Zhizhuo has indicated (Wang, 1991): the terms " Iconometry" and " Geoiconics" with similar intentions as above have appeared in papers written by Berlyant of Moscow University. These two words all have the root from the Gerrk word " ikonics", meaning" images". The use of the term" Iconometry" can date back to the 18th century long before the invention of the photogrammetry, and it denoted at that time a method for reconstructing an object by the use of its perspective. Since the Wuhan symposium of Comm. III of ISPRS in 1990, Professor Wang suggested many times to use " Iconic Informatics" as a new name of our discipline which is defined somewhat as follows:

A discipline concerned with the recording, storage, measurement, processing, interpretation, analysis, administration, presentation and display of the image data. and informations of physical objects and their environments acquired by non - contact sensor systems.

Such a discipline may include the contents of photogrammetry, remote sensing, spatial information systems and possible some parts of cartography. According to above discussion the components and the flow chart of iconic informatics can be described in Fig. 1.

From Fig. 1 we can see that the data acquisition. processing analysis, display and application of iconic informatics are closely connected with each other, and build a circle loop and network. The conventional photogrammetry is just along the loop 1 —2—4—1 in Fig . 1. It means, that we take at first photographs from objects and measure them on analog instruments together with visual interpretation, and then produce visuable products for the user. In order to obtain reliable information about Earth and its environment and about other physical objects and processes the iconic informatics starts from the image data acquisition by non - contact sensors , then analyses and processes these different kinds of image data by using analytical, digital photogrammetry and image processing methods to build a spatial information system, and to provide both digital and visuable graphic products (Loop 1—2—3—4—1) in Fig . 1. As for a real - time photogrammetry, it is the loop 1—2—3—1 in Fig. 1. In this case all opertions and algorithms should be done in real - time. Then through a CAD/ CAM system the results will feed back to the physical objects. The digital products and visuable products can be of course transfered from one to another. The subjcts, with " * " in Fig. 1 indicate just the main contents of the discipline of informatics.

Summerized, iconic informtics is a new branch of information science, eg. image information engineering science and technology which combines and integrates photogrammetry and remote sensing

with GIS, computer science, digital image processing, computer vision , aerospace science and expert systems, it has an unlimited life and a very brilliant future.

References

Li. D. (1992): From Photogrammetry to Iconic Informatics, ZPF, 1/92 P5—9.

Li, D. and Gong J. (1991): A unified Data structure based on Linear Quadtrees, presented paper to ISPRS conference on Digital Photogrammetric Sytems, September 3—6, 1991 Munchen.

Tomlinson, R. F. (1972): 1972 Geograhical Data Handling (Symposium Edition). UNE - SCO/ IGU Second Symposium Geographical Information Systems, Ottawa.

Trinder, J. (1991): Position Paper on Current Status and Future Prospects of the Society, Presented to Baltimore Council Meeting of ISPRS, March, 1991 Baltimore.

Wang Zhizhuo (1991): Drastic Changes in the Devlopment of Photogrammetryand Remote Sensing. Address at the opening Ceremony of the international Symposium of the 58th FIG PC Meeting , May 21st, 1991, Beijing.

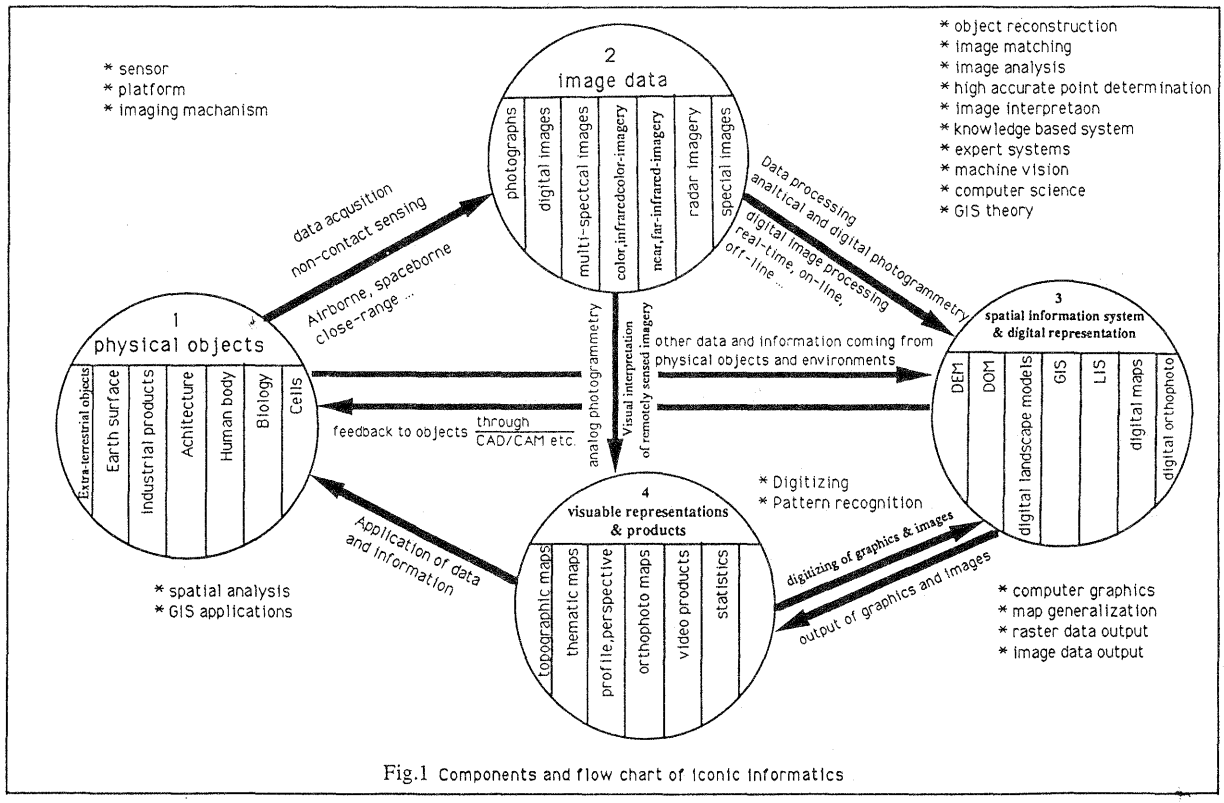

Fig.1 Components and flow chart of iconic informatics