UNCONVENTIONAL TECHNOLOGIES IN CLOSE-RANGE PHOTOGRAMMETRY

(Activity Report of ISPRS Working Group V-3)

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ABSTRACT

The rationales behind the formation of ISPRS Working Group V-3 (Unconventional technologies in close-range photogrammetry) are presented. The working group members along with their fields of interest are listed. The goals and achievements of the working group during the period 1984-1988 are elaborated. Brief descriptions of the various technologies considered by the working group are given along with their current status. Certain recommendations based on the experience of the working group are made.

SOMMAIRE

On y présente les raisonnements qui nous ont guidés pour constituer le groupe de travail V-3 de SIPT (sur les technologies non-conventionnelles en photogrammétrie à courte-distance). On y dresse aussi la liste des membres du groupe et leurs champs d'intérêt. Les buts et les accomplissements du groupe de travail sont élaborés. Des descriptions brèves des diverses technologies considérées par le groupe ainsi que leur état actuel sont présentés. Nos recommandations fondées sur l'expérience du groupe sont incluses.

INTRODUCTION - OBJECTIVE

According to the bylaw XIII-10 of the ISPRS statute and subsequent to the XV Congress held in 1984 at Rio-de-Janeiro, Brazil, the new President of Commission V (Dr. Vladimir Kratky) asked this author to form a Working Group (on Unconventional Technologies in Close-Range Photogrammetry) and act as its Chairman for the period 1984-1988. The assigned tasks of this working group (WG V-3) are:

Studies and assessments in individual subject areas in (including but not necessarily limited to) the following:

Electron micrography	Solid State imagery
Holography and speckle metrology	Tomography
Moiré contourgraphy	Ultrasonic imagery
Raster photogrammetry	X-ray photogrammetry

and others.

The working group was formed also in pursuance of Resolution 2, ISPRS Commission V, made at the Rio Congress, which reads as follows:

"The Congress, noting the rapidly increasing availability and improved performance of solid state and other unconventional sensing techniques, recognizing their potential for the immediate processing of acquired data and for the inclusion of a real time feedback loop in dynamic processing, recommends that the real time aspects of digital photogrammetric processing be given high priority in all relevant activities organized by Commission V, especially in the monitoring and control of processing in scientific, industrial and biomedical applications."

In view of the diversity of the fields/subject areas, the WG Chairman invited several international colleagues to form subgroups to look into problems in separate fields. The WG was composed of the following members:

Dr. Muzaffer Adiguzel, Switzerland	Electron micrography
Dr. M. Shawki El-Ghazali, Kuwait	Electron micrography
Dr. Hebbur Nagaraja, Sweden	Electron micrography
Dr. Taichi Oshima, Japan	Electron micrography
Dr. Guy Butcher, U.K.	Holography
Dr. Chandra P. Grover, Canada	Holography
Dr. R.J. Pryputniewicz, U.S.A.	Holography, Speckle metrology
Mr. George E. Karras, Greece	Moiré topography
Prof. H. Takasaki, Japan	Moiré contourgraphy
Mr. Gary Robertson, U.S.A.	Ultrasonic imagery
	Raster photogrammetry
	Solid-state imagery
Dr. Henrik Haggrén, Finland	Solid-state imagery
Dr. Manfred Stephani, F.R. Germany	Solid-state imagery
Dr. Mohamed Bougouss, Morocco	Tomography
Dr. Z. Wishahy, Egypt	Ultrasonic imagery
Dr. Michel Boulianne, Canada	X-ray photogrammetry
Mr. A.N. Charny, U.S.S.R.	X-ray photogrammetry
Dr. S.A. Veress, U.S.A.	X-ray photogrammetry
Dr. Takenori Takamoto, U.S.A.	Ocular Fundus photogrammetry
Dr. D.C. Williams, U.K.	Optical metrology
Dr. S.K. Ghosh, Canada	WG Chairman

The Working Group was represented in two sessions at the ISPRS Commission V Symposium held at Ottawa, Canada, in June 1986. There were, furthermore, several papers presented in other sessions that relate to the subject matters of this WG. A total of 12 papers were identified as being related to our WG. We had a business meeting during the same symposium where diverse matters were discussed.

A questionnaire, in the pattern although modified followed during the previous quadrennium and intended to collect updated information on the various techniques was finalized during the Ottawa Symposium business meeting and was distributed shortly thereafter among the WG members and several other colleagues known to be involved in these technologies.

UPTO DATE INFORMATION

Updated information derived from the various completed questionnaire and from papers presented by the WG members and other colleagues in the world as collected by the WG Chairman are given below:

Electron micrography (EM)

Both SEM (Scanning Electron Micrography) and TEM (Transmission Electron Micrography) systems have been studied and analyzed by photogrammetric procedures. Various distorsion patterns (viz., scale affinity, radial, spiral and tangential) have been identified and mathematical models have been developed for them. It is found that an EM system in use can be stabilized long enough to calibrate it and to apply the calibration results to the micrographs and their stereo-pairs for precision measurements. The near parallel projective imagery has been found to be compatible with analytical photogrammetric plotters. Magnification upto 500 000 x in TEM and upto 200 000 x in SEM have been reported, the limiting resolutions being, 0.3 nm in TEM and 3.0 nm in SEM. Applications include surface topography (SEM) and tissue and cell biological studies (TEM).

Holography and speckle metrology

The technique is based on electromagnetic wavefronts, scattered from an object, which are recorded on a photographic plate called a hologram. The derivation of 3-D information is based on double exposure holographic interferometry. The light must be coherent and monochromatic. Measurements of motions and deformations ranging from 1 µm to 1.5 mm with a potential accuracy of upto 0.3 nm have been reported. The advantage of unlimited depth of focus and the ability to look around an object makes it well suited to the study of small objects. It has applications in multiple image storage. A combination of holography and sonography appears feasible. One may see also holography as a great contributer in computer storage due to its enormous storage capacity.

Moiré contourgraphy

Moiré fringe topography is mainly used in biostereometrics to measure human body forms, volumes and deformations. Image resolution of 25 lines/mm and accuracies of upto 0.1 mm have been reported. As in various other fields, the potential exists here for real-time computer processing and analyses of Moiré images.

Raster photogrammetry

It involves the projection of a grid of known dimensions on the object. This permits obtaining of 3-D information on the object from a single image with simple and relatively inexpensive measuring instruments. The technique is adaptable to automated digitizing and real-time data processing. Accuracy of the order of 4 μm has been reported with the use of a metric (calibrated) camera and this technique. Its application potential exists in robotics and in computer vision.

Solid-state imagery

Solid state Charge Coupled Device (CCD) cameras of array sizes upto around 400 x 500 pixels are available commercially. The data can be easily processed by a computer in real-time and stereo-matching techniques have been developed to extract 3-D information. The technique has a great potential in not only monitoring but also in controlling dynamic processes of objects. Image resolution depends on the pixel array. Accuracies upto 0.2 pixel have been reported. Direct acquisition of digital data and on-the-job system calibration are two important possible aspects of this system.

Tomography

Tomodensitometry obtained through X-ray scanning at 360° around an object is extensively used in medical applications around the world. It gives a sectional view of the object (e.g., a human limb). By integrating data through several such tomographs, one can obtain 3-D information of the entire object (both internal and external detectable features in the system). On-the-job calibration and 3-D data generation are recently developed features in these regards. An accuracy better than 0.3 mm has been reported.

Ultrasonic imagery

Ultrasonic recording technique has been used in medical applications (biostereometrics). Image resolution of around 20 lines/mm has been reported. Photogrammetric calibration and data/image analyses methodologies have yet to be developed to perfection. Interesting researches are in progress.

X-ray photogrammetry

This is an area of extensive world wide application. In view of an Invited Paper by Dr. Veress on the state-of-the-art, further comments are avoided here.

Others

Only one center (Tufts - NEMCH, Boston, U.S.A.) reported the use of Ocular Fundas photogrammetry by using a stereofundas camera in ophtalmological studies. Graphical volume and shape determinations with 35 x 35 mm format image are reported. Image resolution of 120 lines and accuracy upto 7 µm are reported. Digital data are obtainable with photogrammetric stereo plotting instruments.

CONCLUSION

Only one technical session being assigned to this working group at this ISPRS Congress only certain selected papers could be presented here. A number of papers would be presented at the poster sessions. However all the prepared and submitted papers would be in the proceedings. Unconventional systems are growing and while they are offering significant solutions, they are posing considerable challenge to our profession. We are meeting the challenge without any doubt.

It is the generally acclaimed consensus that the activities of this working group be continued beyond this Congress. Unconventional technologies provide new dimensions of growth in photogrammetry and remote sensing. The recommendations are that the WG activities be not restricted to close-range photogrammetry. They provide newer challenges for research and development in the academic and industrial sectors.

I would like to express my sincere appreciation of the excellent cooperation I received from all Working Group members. On the other side, President Kratky and Secretary van Wijk of the ISPRS Commission V deserve my heartfelt thanks for their support and understanding.