

14th Congress of the
International Society for Photogrammetry
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Commission V
Working Group V - 3

Working Group Report

Application of Non-Conventional Imaging Systems

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Abstract

The Working Group finds that its field of study provides links with all other working groups in Commission V and in other Commissions. Its efforts have been directed towards exploring more widely the new optical measuring technologies of all kinds that arise, and towards the task of selecting the most important of these for review in greater depth in presentations to the ISP as a whole.

The resolutions approved at the 13th International Congress in Helsinki in 1976 confirmed the continuation of the work of the existing working group, and recommended that the scope of the group should be enlarged to include "hologrammetry, solid state imaging systems, underwater mapping, television, X-ray, scanning electron microscope systems and applications, and other close range sensors". Other resolutions strengthened the support for other working groups within Commission V, and many of these also carried implications for Working Group V-3. A close interaction with Working Group V-1 (Analytics of Close Range Photogrammetric Systems) is essential, in order to exploit new imaging potential to the full. Conversely, mathematical analysis of the measuring problem stimulates the search for methods of acquiring data in new ways. A very important extension in the use of photogrammetric methods is in the construction and production industries, for which the Working Group V-5 ("Industrial Photogrammetry") holds responsibility. In this area there already exists quite a diversity of optical measuring techniques that necessitates close liaison also with Working Group V-3. A similar situation exists in relation with Working Group V-6 ("Biostereometrics"). Thus a stimulating common interest runs through Commission V, in which joint activity broadens the contact of each working group. As a consequence, the Congress will include joint sessions between working groups and the contribution of papers across the demarcations between working groups. This should be regarded as a very healthy sign of outward-looking development in each working group, as an essential stage in defining the aspects of each working group's responsibility to the field of Commission 5 as a whole, and to the work of the whole ISP.

The Hamburg Congress will be an opportunity to extend the liaison with other bodies of international status in which non-conventional imaging systems are already a vital component in measuring schemes. The highly sophisticated imaging techniques developed so successfully for remote sensing could have even greater relevance for other purposes, including close range measurements. From a different quarter, another extension of liaison is offered by the International Federation of Surveyors (FIG), especially with Commission 6 of the FIG ("Engineering Surveying") whose Chairman, Dr John Van den Berg, has referred to the common ground in quite a number of similar non-conventional measuring tasks. He has given examples of alternative choices of measuring technology, such as that between camera and theodolite (and does not exclude the possibility in this case that both together might be more effective than either alone, perhaps in the accuracy achieved, or in the effort or cost entailed). He has suggested that our task should include the responsibility, with the surveyors, to look critically at the areas of tolerances, check methods, and quality control, and the possibility even that some kind of reversed photogrammetry, projecting a geometrical scheme on the actual site, might be conceivable. The basic processes of optical metrology set the limits for possible development of such new imaging and measuring systems, and provide for the ultimate reference to fundamental standards of measurement.

The organization of the Working Group was under the chairmanship of Colonel M.K.Kurtz until the end of 1977, and the first task of the present chairman was to join in the preparation for the Inter-Congress Commission V Symposium held in Stockholm in August 1978 under the title "Photogrammetry for Industry". The programme of papers included some examples of diverse

imaging systems. Several speakers described some aspects of photographic recording and measurement from the records. R.J.Pryputniewicz (Worcester Polytechnic Institute, USA) described holographic measurement of airfoil form, followed by L.Ek and K. Biedermann, from the neighbouring Institute of Optical Research, with a description of a holographic measuring system for distortion measurement. N. Abramson from the Department of Production Engineering (also on the Stockholm campus), gave in his lecture a most impressive practical demonstration of the simplicity and power of "Sandwich" hologram interferometry. Both these items were later available in the respective departments for visits of the Congress participants. The latter part of the working group's sessions of papers centred on a paper by S.Ghosh on measurements made from a combination of records from transmission and scanning electron microscopes and on a paper by P.A.E.Stewart (Rolls-Royce, Bristol, UK) on "Close range X-ray photogrammetry of gas turbine engines under test". References to published work by these authors are given in the bibliography at the end of this report. A very progressive meeting ensued, in which the main activity of Working Group V-3 was to explore the widening of interest set out in the Resolutions from Helsinki, even in some cases beyond the topics suggested, and to arrive at some consensus of opinion of those present to select topics for particular attention at the Hamburg Congress. In arriving at this consensus, an attempt was made to list the many processes of imaging likely to be relevant to our study, in comparison with the characteristics of the imaging process in conventional photogrammetry. A lively discussion produced the following comparisons:

<u>Conventional imaging</u>	<u>Departures from conventional imaging</u>
1 One-to-one object/image relation Conjugate points	Non image forming Moiré, speckle Optical transform relations
2 Illumination in visible wavelengths	X-ray, γ -ray, infrared, microwave, neutron beam, electron beam, lasers
3 Recording by photography	Video, xerography, holography, image scanning, image dissection solid-state linear and matrix arrays of detectors. Real time processing.
4 Records giving a two dimensional distribution of intensity modulation.	Phase recording, hologram, electro- optical, magnetic, or other computer storage.
5 Object approximates to a nearly flat surface	Range of other types of objects or arrays of objects. Inclusions in solids, fluids, or gases.
6 Objects in terrestrial (dry) environment at a visible scale	Immersed objects (eg in water) microscopic objects, or sub- microscopic.
7 Objects static or changing discretely	Continuous or periodic change of form. Time distribution required. Real-time measurement at a high rate for interactive systems.

- 8 Accuracy determined by the optical system involved Limitation by the other physical processes (eg wavelength of radiation, diffraction).

Any extension of conventional photogrammetric practice to incorporate only one of the many "departures" listed on the right above may involve a fundamental reconsidering of the basis of the measurement, and these cases we take to be our field for study. Members of the Inter Congress Symposium with a special interest in the non-conventional aspects were then invited to join the Working Group for a discussion on the selection of a limited number of these non conventional aspects for special attention at the Hamburg Congress. The conclusion was that the potential of further holo-graphic and related techniques should be reviewed, and a more systematic review of electron microscope imagery should be invited. Strong interest was evident also in the imaging processes being developed in the medical field (moire contouring, Xray tomography) and in the application in constructional and production engineering. It was suggested that if suitable papers were forthcoming, these subjects would link with Working Groups V-5 and V-6. The members of the informally-assembled working group on that occasion included

N Abramson	(Stockholm)
E Agnoletto-Baj	(Milan)
K Biedermann	(Stockholm)
O W Cheffins	(Maidenhead, UK)
M G Derrington	(Manchester)
L Ek	(Stockholm)
S K Ghosh	(Columbus, Ohio, USA)
J Hühle	(Heerbrug, Switzerland)
V Kratky	(Ottawa)
J Larsson	(Stockholm)
I Newton	(Newcastle-upon-Tyne)
T Oshima	(Tokyo)
H F L Pinkney	(Ottawa)
R J Pryputniewicz	(Worcester, Mass, USE)

with many others who have contributed at other times and by written contributions. Since the Stockholm meeting there have been a few meetings at which some aspects of the Working Group's interests have been further studied.

In May 1979, a meeting at Manchester University was organized by M.G. Derrington and J.T. Turner entitled "Complex and Sculptured Surfaces: their measurement, specification and formation in engineering and medicine" Amongst many interesting contributions were two that we hope may be presented more fully in Hamburg. J.P. Duncan described a development of the "shadow moire" technique to contour near cylindrical surfaces, and O.W. Cheffins gave a talk on the problems of applying photogrammetry to records made with a single nonmetric camera 100 m below the surface of the North Sea in surveying damage to an oil rig.

Later the same month a meeting at Imperial College, London, organized by B. Chiat, included papers on some unusual problems in engineering surveying, and in October 1979 the meeting in Stuttgart organized by Professor K. Linkwitz to review the field of "Industrial Photogrammetry"

provided an opportunity to link with the studies of Working Group V-5.

In conclusion, we look forward to the Hamburg Congress as the opportunity to concentrate our attention more on the topics that the several papers sessions will throw up, in the confident expectation that the task will be most enjoyable and worthwhile.

Bibliography

Pryputniewicz, R.J., and Bowley, W.W., 1978: "Techniques of holographic displacement measurement: an experimental comparison". Appl.Opt. 17, 1748.

Ek, L., and Biedermann, K., 1978: "Implementation of hologram interferometry with a continuously scanning reference beam" App.Opt. 17, 1727-1732.

Abramson, N., 1977: "Sandwich hologram interferometry: Holographic studies of two milling machines". Appl.Opt.16, 2521-2531.

Ghosh, S.K., and Nagaraja, H., 1976: "Scanning electron micrography and photogrammetry", Phot.Eng.Rem.Sens. 42 (5).

Stewart, P.A.E. "High energy X-ray TV of gas turbines on test"
Chartered Mechanical Engineer, 1978 (April): 25(4), 45-52.