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Report of Working Group III/5 on  
Mathematical Pattern Recognition and Image Analysis

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Abstract

Pattern recognition is a concept of computer science that is useful in the analysis of digital images and therefore of great relevance to remote sensing and photogrammetry. The paper presents a review of recent developments in the field, in particular regarding the Working Group. The core of the activities was a specialist workshop held on pattern recognition in photogrammetry in 1983.

1. Introduction

A separate Working Group III/5 was formed after the last Congress in Hamburg to address the still somewhat exotic concepts of digital picture analysis. It was well understood that one had to be careful in avoiding excessive overlaps with the more traditional subjects of the Working Group III/4 which was first formed in 1972 to deal with geometrical aspects of remote sensing data.

Working Group III/5 essentially served to represent the subject at the Commission Symposium, and now here at the Congress in Rio. The following will define some basic concepts, outline difficulties in dealing with pattern recognition, and describe work initiated by the Wh.

2. Some Concepts

"Pattern Recognition" has become a frequently used but little defined concept in many branches of engineering. Essentially it is an area of applied computer science with an active international representation in the form of the International Association for Pattern Recognition (IAPR). There are bi-annual congresses, the last one 1982 in Munich, the next one this fall in Montreal. About 800 to 1000 participants can be expected. There are several journals addressing the subject, such as:

Pattern Recognition  
Computer Graphics and Image Processing  
Pattern Analysis and Machine Intelligence  
Pattern Recognition Letters

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and there are numerous other journals that contain relevant publications, such as:

Artificial Intelligence  
IEEE Transactions on Medical Imaging  
IEEE Transactions on Man Systems, Man and Cybernetics.  
Communications of ACM  
and other computer science journals.

What is "pattern recognition?" Clear definitions are hard to find. "Pattern" is hardly ever defined. The least ambiguous definition that I know is one developed by Niemann (1983); however it takes about 10 pages. The author defines "patterns" as properties of objects or phenomena which can be represented by so-called "features." The features can be color, dimension, frequency of a tone, texture, brightness, temperature, etc. Features are combined to form feature vectors; these are classified in feature space. Classification may be followed by analysis.

Therefore, pattern recognition consists of feature classification followed by pattern analysis.

One can easily create confusion if one attempts to clarify the differences among some related concepts. We have

artificial intelligence  
machine or robot vision  
image processing  
image understanding  
computer graphics  
computer aided design.

It is not trivial to indicate where the differences lie. It should, however, be emphasized that quite an impressive industry is emerging around these concepts. Table 1 is a list of companies just offering machine vision systems. Longer lists can be compiled for image processing, etc.

Applied Intelligence	Machine Intelligence
Automatrix	Microtex
Cognex	Object Recognition
Control Automation	Octek
Diffacto	Penn. Video
Eibonix	Perception
Electro-Optical Information	Prothon
G2 Industries	Recognition Concepts
Grinnell	Robotic Vision
Ham Industries	Spectron Engineering
Hughes Aircraft	Technical Arts
Intergrated Automation	View Engineering
T2S	Vision Peripherals
LogE/Spatial Data System	Vuebotics

Table 1: Companies offering Machine vision systems from Computer Graphics World, June 1984

### 3. Activities of the WG III/5

A difficulty in addressing the task of the WG is the fact that pattern recognition is a separate field different from photogrammetry. Therefore, already existing scientific work and know-how must be brought into ISPRS if one does not want to simply "reinvent the wheel."

The WG raised little interest in the subject for the Symposium in Helsinki in 1982. To stimulate more interest, it was felt appropriate to organize a separate work shop that was held in Graz, Austria, 27-29 September 1983. Twenty-five papers were presented to nearly 100 participants.

The work shop was a partial success: 14 papers came from authors more typically associated with pattern recognition, 11 papers from photogrammetrists. Participants were essentially from photogrammetry. Ample opportunity for discussion was helpful to clarify a common terminology.

Sessions addressed image pointing accuracy, image understanding, image sequence processing, height generation, line drawings, digital orthophotography, thematic information extraction, image simulation, and image-map correspondence. A list of presented papers is enclosed; they appear in PHOTOGRAMMETRIA during 1984.

An important WG task is the solicitation of Congress papers and the arrangement of Congress sessions. The latter depends on availability of relevant papers. Two main topics are being treated upon invitation by the WG: targeting in digital images, and image understanding, both addressed through invited papers.

#### 4. Conclusion

There is no doubt that work with digital images is quickly becoming a central issue also of photogrammetrists; in the past it was limited to remote sensing concerns and emphasized image pre-processing. The surge in interest leads to a recognition of the importance of various existing computer science fields such as pattern recognition, image understanding and artificial intelligence.

The period 1980-84 has not yet shown a great number of studies in photogrammetric pattern recognition; however, one must well expect that the upcoming period 1984-88 will see the development of a major thrust in this area.

Papers presented at WG III/5 Workshop, 27-29 Sept. 1984

H. H. Baker, Stanford University, USA  
"Surfaces from Mono and Stereo Images."

M. Beer, SysScan, Munich, FR Germany  
"Interactive Editing of Cartographic Raster Images."

M. Benard, Ecole Nationale Supérieure des Mines, Valbonne, France  
"Automatic Stereophotogrammetry: A Method Based on Feature Detection and Dynamic Programming."

B. M. Chatterji, Indian Inst. of Technology, Khargpur, India  
"Use of Fuzzy Set Theory and Spline Techniques for Pattern Recognition and Scene Analysis." Read by title only.

M. Claus, University of Karlsruhe, FR Germany  
"Digital Terrain Models through Digital Stereo Correlation."

I. Dowman, University College London, U. K.  
"Problems and Some Solutions in Digital Correlation for Photogrammetric Profiling."

A. Ernst, B. Bargel, A. Ebert, FIM Karlsruhe, FR Germany  
"Comparing Images of Image Sequences using Segments."

M. B. Faintich, Defense Mapping Agency, St. Louis, USA  
"Interactive Analysis of Digital Terrain Elevation and Surface Feature Data Bases."

W. D. Groch, R. Lubkowitz, FIM Karlsruhe, FR Germany  
"Automating the Process of Digital Map Generation."

R. Haralick, J. Campbell, S. Wang, Virginia Polytechnic Institute, Blacksburg, USA  
"Relative Elevation Determination from Landsat Imagery."

P. L. Isaacson, Oregon State University, USA  
"Digital Image Interpretation by Analysis of Image-Image Correspondence."

W. Kestner, C. Rumpler, FIM Karlsruhe, FR Germany  
"Integration of Methods for the Segmentation of Aerial Photographs."

J. Kittler, J. Foeglein, Rutherford Appleton Laboratory, Chilton, U. K.  
"On Compatibility Functions in Probabilistic Relaxation."

H. Kuhn, University of Karlsruhe, FR Germany  
"Perspective Terrain Presentations for Planning Using Digital Image Processing."

- G. Maderlechner, P. Kuner, J. Schleibinger, Siemens-Munich, FR Germany  
"Segmentation and Description of Line Drawings by Spline Approximations."
- D. M. McKeown, Carnegie-Mellon University, Pittsburgh, USA  
"Toward Expert Systems for Photo-Interpretation."
- E. M. Mikhail, M. Akey, O. Mitchell, Purdue University, W. Lafayette, USA  
"Detection and Sup-Pixel Location of Photogrammetric Targets in Digital Images."
- N. Mulder, International Institute for Aerial Surveys and Earth Sciences, The Netherlands  
"Decision Making and Classification."
- N. M. Nasrabadi, R. A. King, Imperial College London, U. K.  
"Interframe Coding of Moving Image Sequences."
- H. Oswald, Technical University Graz, Austria  
"Simulating Perspective Images of Three-Dimensional Scenes."
- J. Peterle, University of Karlsruhe, FR Germany  
"A Concept for Topographic Map Updating Using Digital Orthophotos."
- H. Ranzinger, Graz Research Center, Austria  
"Map Guided Feature Detection in Aerial and Satellite Images."
- G. Schwinfurth, University of Karlsruhe, FR Germany  
"Orthophotomaps from Digital Orthophotos."
- J. Wiesel, University of Karlsruhe, FR Germany  
"Digital Image Processing for Orthophoto Generation."
- Sh. S. C. Wu, United States Geological Survey, Flagstaff, USA  
"Digital Image Transformation and Rectification of Spacecraft and Radar Images."