INTEGRATED PHOTOGRAMMETRIC SYSTEMS:

STATUS AND OUTLOOK

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ABSTRACT:

Growing impact of digital techniques on the photogrammetric systems and production procedures is accompanied by increasing integration of the components and subsystems into larger entities, and into a broader context. During the last decade of the development in photogrammetry, automation and system integration have been dominant. They address a broad scope of problems pertaining to both, the system design and development as well as to information collection and its handling.

The rapid evolution of the supporting fields, in particular of micro-electronics and of computer technology, call for frequent review of the status in photogrammetry and for reassessment of the developmental trends. The extent and the complexity of the knowledge in the area of integrated systems does not permit a comprehensive review within the confines of a paper. Hence, the contents are condensed, by giving consideration to the background knowledge and to a differentiated review of the common features of the present integrated photogrammetric systems (IPS). A differentiation is made between the high-performance and the low-cost systems, and between digital and analytical techniques.

Development trends can be extracted from the existing problem areas involving a number of factors, which influence the evolution. Such trends are mostly fragmentary, partly unrelated and partly overlapping.

A look forward in the system area can be gained from a critical analysis of the present state of the art and of the corresponding trends. Some general prospects are:
* Future systems will be determined by the optimum balance of digital and analytical techniques;
* Production economics of digital systems will strongly depend on the progress in real-time handling of very high resolution digital images;
* Further automation of the production processes will mainly depend on the progress in automatic image analysis and terrain feature (object) extraction;
* Integration will increasingly expand to the system external area (the users) and imply the concept of "open systems";
* Photogrammetric systems and techniques will gain in importance, because they are time-and cost-effective, and societal needs for detailed information are growing.

KEY WORDS: Context, digital versus analytical, system integration

1. BACKGROUND

Prior to the status review of the integrated photogrammetric systems (IPS) we address their context and their place in the GIS domain. Then we present a brief outline of the evolution of IPS, followed by their classification and indication of some concepts for the system integration.

1.1. Context

A prerequisite for system integration is survey of the knowledge about the context of the intended system. The context can be defined by identifying the societal (information users') needs, the background knowledge of the supplying fields (basic and related), and the expert knowledge of the specific system area.

The societal needs and benefits determine the desirability for a system. They provide the broadest scope for solving societal problems via information to be produced by the IPS. These problems can be differentiated according to several information users categories, each of which needs a similar type of information (Makarovic, 1988a).

Between the sources of raw information and the ultimate accomplishment of certain projects or programs, several professional fields are usually involved. Therefore the information specifications should be considered throughout the entire flow from the sources to the final results. Thus an iterative inference in forward-backward sequence seems to be most effective to attain rational specifications.

Another important contextual sub-domain represent the supplying fields (basic and related); they define the feasibility of a system in a broad sense. These supplying fields provide the general knowledge for system design and development, for its extension and upgrading, for internal and external interfacing, and for the overall system optimization. Several of these supplying fields are rapidly evolving, which makes the context dynamic.

The core of the context represents the available knowledge about the specific system area, in our case photogrammetry and the closely related (GI-)fields. Fast evolution of these system internal (and related) fields enhances the dynamics of the context.

The complexity and dynamics of the context tend to limit the optimization of system integration. Therefore integrated systems should be open and flexible.

1.2 Integrated Photogrammetric System in GIS

In a broad sense a GIS comprises three segments: an input segment, a GI handling segment, and an output segment (figure 1).

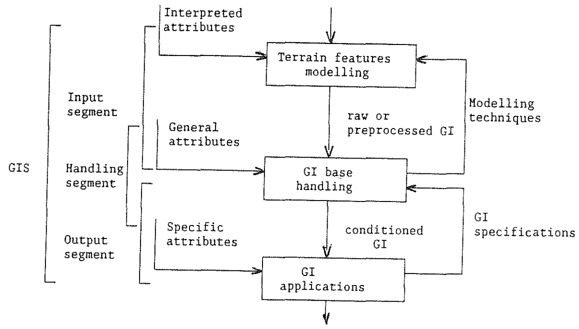

Figure 1: GIS domain and its segments

The input segment can comprise different subsystems for the supply and conditioning of raw information into a GI base. Such subsystems can be geodetic and surveying, photogrammetric, remote sensing, cartographic, etc.

Integrated photogrammetric systems are most potential in the input segment. An IPS should therefore be optimized in the context of the corresponding GIS. Hence, photogrammetric procedures and the GI structure need to be mutually adjusted (figure 2).

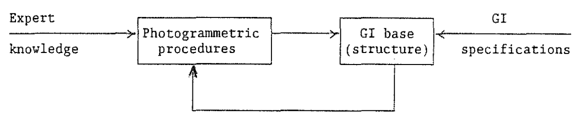

Figure 2: Interrelationship between procedures and GI structure

The photogrammetric procedures can be differentiated according the common and the production specific operations. The common procedures serve for the calibrations, orientations, geometric transformations, and the correction routines. The specific procedures support the different production lines, i.e., control network densification, terrain relief modelling, image transformations, and terrain features modelling (other than relief; Makarovic, 1988a).

A GI structure contains two main parts: a knowledge base and an image base. The knowledge base is usually structured hierarchically, and it is supplemented by a structure of the relationships. The information content can be differentiated according to the semantic and geometric items, and further according to the key-items and their attributes.

The content of a GI base should match the users' specifications which reflect their needs. These in turn affect the design of the GI production techniques and procedures, and thus determine the capabilities of the IPS.

Optimization of the techniques for terrain features modelling addresses two basic issues:
* Implementation of the latest state of the art;
* Balance of the triangle: image quality, geometric accuracy and production economics (Makarovic, 1988a).

Integration can proceed in forward sequence, i.e., from the production techniques to the users' needs, or vice versa. Both sequences can be connected in a feedback loop, permitting an iterative optimization.

1.3 Evolution

The evolution of integrated systems is signified by two interrelated, parallel developments:
- Integration of components and subsystems into larger systems, and these into a broader context;
- Transition from analytical to digital techniques, accompanied by increasing functionality and automation.

First steps towards integration were made already in the 1950's by the Wild and Zeiss companies with their analogue instruments. The different items of equipment were made compatible, and the production processes were streamlined.

The roots of digital photogrammetry stem from the mid 50's. In the early 60's, the first partly analytical and partly digital system (Bertram, 1964) and the first all-digital system (Sharp et al, 1964) were introduced by Bunker Ramo and IBM, USA. Both were autonomous systems with a limited degree of internal integration.

A significant advancement represents the design of the Digital Stereo Comparator Compiler DSCC of DMA in the early 80's (Case, 1982), which was followed by a vigorous development of several experimental digital systems at various levels of complexity (Albertz, 1984; Gruen, 1986; Murai, 1986; Dugan, 1986; Helava, 1988, 1991a, b; Konecny, 1988; Cogan, 1988a, b; Lohman, 1990; etc.).

In the 80's a new type of integrated digital system emerged, using digital images from electronic solid-state linear array CCD cameras (Hofmann, 1982).

Another milestone represents the Photogrammetric Open System, introduced by NOAA, USA in the 80's (Elassal, 1990). Because the software is largely hardware independent, it permits integration of current and of future analytical and digital stereo-plotters.

Since the mid of 80's several dedicated close-range photogrammetric systems have been developed. Some are real-time systems including two or more solid state video cameras.

1.4 Classification

Classification depends on the choice of the criteria and on their priority ranking. The criteria should reflect both, the purpose of the classification and the properties of the system area under consideration.

For classification of the IPS there are several possible entries, such as: the techniques for imaging and image handling, location of the imaging system (camera, sensors), system versatility-performance-cost, degree (level) of system integration, and the domain of information use (user category).

The technique and thus the IPS can be digital, analytical or open (analogue technique is by-passed here). The system hardware components can be fully or partly connected to a local communication network, or they can be disconnected for off-line, parallel or time delayed operation.

Imaging systems can be used from space, air, on ground or in water. The IPS can be classified accordingly, although some versatile IPS can handle images of different imaging systems and made at different locations.

A classification of the IPS according to system versatility, performance, and cost is indicated in table 1.

PERFORMANCE	VERSATILITY		COST OF			
			SYSTEM		PRODUCTION	
	LOW	HIGH	LOW	HIGH	LOW	HIGH
LOW		X	X		X	
HIGH	X	(X)		X		X

Table 1: Classification according to versatility-performance-cost

The degree of system integration can vary widely; it affects the versatility, performance and the system cost. The type and degree of integration depend predominantly on the product specifications, the type and location of the imaging system(s), and on the technique applied (table 2).

TECHNIQUE	LOCATION		
	SPACE	AIR	GROUND
Digital	very high	very high	very high
Analytical	high	high	medium
Open	-	medium	low

Table 2: Potential degree of integration

A higher level of integration does not necessarily result in a better performance; off-line systems which can operate in parallel, may perform better.

The information user domains are interrelated with the locations and types of the imaging systems. Actually the imaging missions should reflect the information needs. We distinguish between two basically different user domains: the GI domain and the close-range domain. The IPS can be classified accordingly, and each of these main classes can be further subdivided.

For the purpose of this paper a simple classification is adopted, and it is restricted to the GI domain. It differentiates only between the high-performance and the low-cost systems, and further between digital, analytical and open systems.

1.5 Concepts

Integration of parts into a system comprises a number of concepts from different disciplines. They pertain to information systems engineering, computer vision, CAD and GIS techniques, distributed networks of workstations, user interfaces, quality control, dynamic optimization, etc. A review of these concepts is beyond the scope of this paper.

2. PRESENT STATUS

2.1 General

The following review is restricted to the IPS using images from the air and partly from space, applying analytical and/or digital techniques (table 2). Computer-aided analogue techniques have become outdated. Remote sensing from space provides low resolution images over large areas. Although the functionality of the IPS can be extended for handling such images, special integrated systems for RS are more adequate. Such systems, and those for close-range images, are also beyond the scope of this paper.

The present status represents an instance in a fast evolution between the past and the future. Hence, the following considerations are restricted to the significant achievements and features in the area of IPS.

Development of the IPS is no more the exclusive domain of established manufacturers of photogrammetric instrumentation, although they still have an important role. Some information production ("mapping") organizations, universities and institutes have become increasingly involved in system integration (Dowman, 1990). Systems are being optimized for different production lines and for different types of products. New systems are being developed and/or existing ones are being upgraded, both inside and outside information production organizations.

In section 1 the techniques of IPS are differentiated according to digital, analytical and open (mixed). These classes have some common and some specific features. The limits between these classes are unsharp, because some of the features can be easily changed or added. This in turn, makes the classification and thus the review of the status tentative.

The distinction between high-performance systems and low-cost systems is also unsharp, because there can be arbitrary intermediate levels of performance and/or of system cost. Nevertheless, the adopted classification reflects the present state, and it is convenient for the purpose of this review.

In table 3 the present IPS are classified according to these simplified criteria. Included are the commercially available and operational systems, with various degrees of integration. The systems developed locally for own production needs and/or those in the experimental stage are not listed.

SYSTEM TYPE	VENDOR	TECHNIQUE		
		Analytical	Digital	Open
High perfor-mance	GD-HAI		DSCC DMA-WS DIWS	
	Leica (Kern)		DSP 1	
	Matra		T10 Traster	
	Leica (Kern) (Wild)	Kern CAM System 9		
	C. Zeiss	PHOCUS		
	NOAA			IDPF
Low cost	GD-HAI HAI		DSPW HAI-500 HAI-750 DCCS	
	Autometric		PEGASUS-WINGS	
	Intergraph		Image Station	
	Leica		SD-2000 DVP	
	Topocon		PA-2000	
	Int. Imaging Systems I²S	ALPHA-2000	PRI² MS	
	Other?			

Table 3: List of present IPS

2.2 Common features

For reviewing the common features of the IPS in an orderly way their common functions need to be identified. Photogrammetric functions can be differentiated according to geometric, photometric/semantic, and mixed.

Geometric functions are involved in all types of IPS. They concern the geometric calibrations, orientations, geometric transformations and corrections (real-time or delayed), control network densification, modelling terrain geometry, and conditioning of geometric information for its further uses.

Photometric functions are specific for digital systems, although some of them can also be implemented by optical or analogue electronic means. The commonly applied functions are image restoration and enhancement, and low level image analysis.

Mixed geometric-photometric functions are dominant in digital IPS. They pertain to image resampling, graphics overlay, image tracking, image matching, image transformations, image analysis and feature (object) extraction.

- Image resampling for display can effect image rotation, zoom, epipolar reformatting (for stereoviewing) and fractional pixel pointing.
- Graphics overlay on (stereo-)images and on overview images permits near real-time verification and editing, and differential restitution for updating, upgrading or expansion of a GI base.
- Image tracking can be realized either by roaming the images with respect to the fixed cursors (measuring marks) in the centers of the image windows, or by moving the cursors inside the fixed image windows. In both cases tracking of stereo-images is synchronous, except for the differential parallaxes.
- Image matching can be applied to conjugate image segments of individual stereopairs or of multiple images. Matching strategies vary widely between simple and sophisticated, without or with inclusion of the prior knowledge, feature extraction, adaptive capability, and of the least squares fit.
- Image analysis applies geometric and photometric information, and some prior- and/or in-process derived semantic information. Analysis can support both, image matching and feature (object) extraction.
- Feature extraction tends to infer semantic information on some terrain features (objects). Such inference implies a synthesis of the evidence from (stereo-)images with the interpreter's expert knowledge.

The common features can be identified by examining the functions of the IPS. These functions are implemented partly be means of dedicated photogrammetric processors and partly by a main computer. Such a division of the functions is, obviously, unsharp; it varies to some extent from one system to another, and it changes in due time. Hence, the review in table 4 is rather tentative. The table contains general information; it does not differentiate among the different classes of IPS.

FUNCTION		TECHNIQUE	
MAIN COMPUTER	PHOTOGRAMMETRIC PROCESSORS	ANALYTICAL	DIGITAL
Overall system control and management (incl. communication)		Command (menu) system, GI management system, Query system	As "analytical", plus extensions for image base
Calibrations (geometric, photometric)		Photostages with measuring devices	Raster-scanner, CCD sensor array
Orientations and geometric corrections		Manual or semi-automatic	Semi-automatic or automatic
GI collection (primary or differential)		Aerial triangulation, Terrain relief modelling, (Image transforms,) Terrain features modelling	As "analytical", with greater flexibility
CAD, GIS and Computer Vision support (on-line, off-line)		Display and editing (of maps), DTM, Oblique or Perspective views, Tables, Reports, etc.	As "analytical", with extension for the image base
Off-line computations		Aerial triangulation, DTM conversions, Orthotransformation, Statistics, etc.	As "analytical", plus various image transformations and resampling
	Real-time (stereo) display of images	(analogue: optical or electronic)	Image decompression, Enhancement, (Tiling), Image transformations (rotation, zoom), Resampling
	Observation system control	Optical transformations (rotation, zoom)	Image alteration with shutter control (or other techniques)
	Real-time geometric transformations and corrections ("loop")	"Object" space to image space (or reverse)	As "analytical" (plus "pixel registration" in object space)
	Positioning (tracking) control (x,y image and parallax)	Electric-mechanical full and differential positioning of photo-stages or of measuring marks	Digital full and differential roam or cursor movement on screen
	Graphics (stereo) overlay (black and white or colour)	Transformation, display and injection of graphs into observation system	Transformation, display and overlay of graphs on (stereo)image monitor (and on overview monitor)
	Image enhancement (for matching, analysis)	(partly by analogue filtering)	Low level photometric processing
	Image matching	Different techniques (if CCD cameras are provided)	As "analytical", (with or without array processors)
	Image analysis	(supporting image matching)	Supporting image matching and Feature extraction
	Feature extraction	(manual)	Interactive via user interface

Table 4: Common functions and their implementation

2.3 High-performance versus low-cost systems

High-performance digital systems employ powerful (high performance) hardware and sophisticated, extensive software. Usually they are custom built and thus expensive; in application, however, such systems can be very cost-and time-effective. High performance addresses the resolution of digital images (small pixel size), the positioning accuracy (fraction of pixel), and the speed of processing, transfers, and displays. Most crucial are the real-time photometric and mixed processes required for display of colour stereo-images, including roam, zoom, rotation and image enhancement, for image matching, image analysis and the related image handling.

Low-cost digital systems use personal computers and some other off the shelf hardware, such as image processing cards and special processors, storage devices, display monitors, etc. The software packages are smaller and usually less sophisticated, and the resolution of digital images is low (large pixels). Hence, the system cost is low, but the production cost can be accordingly higher.

A crucial item is the real-time display of stereo-images for roaming. Commonly the image transfer is not fast enough and the power of the display processor is insufficient. Therefore, prior to display, digital images need to be resampled to epipolar geometry and tiled. The restricted power of the real-time processors demands more background processing. In most of the low-cost systems, image roam is fully or partly replaced by moving cursor.
Capabilities of the low-cost systems can be upgraded by incorporating optional photogrammetric processors and software modules, and/or by linking them with the existing GIS and CAD systems. Such upgrading also increases the system cost. A "low-cost" system can be converted to a high-performance system by replacing its components and extending its functionality. A conversion, however, may not be cost-effective and it may not lead to an optimum system.

Regardless of the system class, upgrading and extensions are inherent in any system evolution. The extensions concern the input, image handling, and the output. If original images are analogue, a raster scanner (or CCD cameras) are required, and additional storage devices should be provided. For image handling the memory of the main computer has to be extended, and on-line storage devices, file servers for multiple work stations, and very fast communication means are necessary. The common extensions for output are image printers, fast plotters, etc.

3. TRENDS

3.1 General

Evolution can be predicted from the past and present states in the system external and internal areas. Incidental sudden changes make predictions uncertain.

The trends can be assessed subjectively by intuition or structured. A simple approach to a structured assessment is indicated in figure 3.

Influencing factors
↓
Problem areas
↓
Trends

Figure 3: States in assessment of trends

The first state concerns identification of the factors influencing the evolution. These factors are involved in the present and arising new problem areas (external and internal). The trends can then be extracted from the problem areas and from the insight into the possible solutions.

3.2 Influencing factors

The fast changing, complex domain of the IPS involves a great number of the influencing factors. These factors can be attributed to two main classes, i.e., the societal desirability and the technical-economic feasibility.
The desirability is defined by the societal needs and benefits in a broad sense, whereas the feasibility addresses the technical state-of-the-art in the system external and internal areas, and the anticipated cost-effectiveness of the IPS.

The desirability concerns mainly the system external area, especially the GI users' fields. On the threshold of the era of information society, desirability of the IPS does not seem to be questionable. A growing need is anticipated for more diverse and more detailed (large scale) GI, and thus for flexible, fast responding, cost-effective and user friendly systems.

The feasibility factors stem predominantly from the system internal area and its interactions with the external area. They can be differentiated according to functionality, flexibility, compatibility, performance, operational ease, support, and institutional impact.

Desirability and feasibility factors are inherent in the current and emerging new problem areas. Hence, instead of considering these factors individually, we shall address them collectively in the context of the identifiable problem areas.

3.3 Problems

Problems arise from the lack of, or fuzzy knowledge of the system internal and external areas and/or from the contradictory (or irrational) system requirements. It seems obvious that it is virtually impossible to identify all potential problems. Nevertheless, a number of such problems can be stated straightforwardly.

Problems arising from lack of, or fuzzy knowledge are:
. Rapidly growing knowledge in the system external area (suppliers' and users' fields);
. Overall system optimization (dynamics in the system internal and external areas; balance of analytical and digital techniques, degree of automation; overall quality control, etc.);
. Cost-effective, real-time handling of high-resolution digital images;
. Automatic detailed (large-scale) modelling of terrain relief;
. Automatic detailed (large scale) transformations of high resolution images;
. Automatic selective extraction of terrain features (objects) from images;
. Co-operative automatic and human image interpretation;
. Potential impacts of the IPS on the institutional environments (in the GI collection and handling organizations);
. Utility of new GI product types in the user fields.

Problems emerging from contradictory requirements are:
. Open systems versus custom-built systems;
. Automatic versus manual processes;
. Real-time versus delayed processing;
. Standardization versus flexibility;
. System acquisition cost versus production cost.

Some of these problems are interdependent, which does not affect the assessment of the trends. The trends emerge from the insight into these and some further (not yet identified) potential problem areas.

3.4 Trends

Trends can be assessed for the techniques and the information products. The techniques pertain mainly to the system internal area. The products, however, involve also the fields of the various information users.

The techniques comprise methods, means and procedures. The trends in the techniques address external system integration, extended capabilities, and a dynamic optimization. They can be summarized as follows:

. Integration of photogrammetric components and subsystems into a broad context of the current CAD, GIS and computer vision techniques;
. Transition to:
  - open, flexible systems,
  - photometric and semantic information processing, and thus to increasingly automatic operation;
. Dynamic optimization of the:
  - balance of analytical and digital techniques,
  - overall information production processes,
  - human interfaces,
  - quality control (geometric, photometric, mixed).

The information products reflect the users' needs and the system capabilities. The corresponding trends are:

. Growing demand for:
  - diverse items of information,
  - more detailed (large scale) information,
  - differential information (for updating, upgrading, and for thematic GI-bases),
  - prompt availability of up-to-date information;
. New (raw) information to be:
  - collected and structured in an orderly way,
  - provided with quality estimates and other relevant attributes,
  - conditioned for GIS and/or for specific uses.

A review of the trends in the system external area (supplying fields, GI users) is beyond the scope here.

4. OUTLOOK

Outlook implies predictions emerging from analysis and assessment of a broad factual knowledge rather than from intuition. Such knowledge can be condensed in the trends in system external and internal areas.

The transition from trends to predictions implies subjective interpretation. In contrast to prophecy a prediction can not be better than the available fragmentary knowledge and the quality of its interpretation permit.

Outlook should be considered from the viewpoint of the changing societal environment, including the supplying fields. The environment imposes constraints and determines the priorities. New achievements, e.g., in microelectronics and computer technology, have a profound impact on the development of IPS.

Evolution implies major and minor changes. Major changes stem from the important new achievements or breakthroughs, especially in the supplying fields. Such changes may affect the:

. Availability of and possibility for real-time handling of very high resolution digital images;
. Automatic analysis of stereo-images and terrain features extraction.

Minor changes concern refinement and extensions of existing techniques, i.e., to improve performance, cost-effectiveness, etc.

Changes induced by new achievements in the system external area may influence the optimization of the overall system. The dynamics of the optimization concern the balance of analytical and digital techniques, overall production procedures, human interfaces, quality control, and the support.

One of the core issues of dynamic optimization is the transition from analytical to digital techniques. The aim is to exploit the potentials of both and to minimize their limitations. The major advantage of the analytical technique is its ability to handle very high quality analogue images, and thus give high cost- effectiveness in information production. Its disadvantage is, however, an inability for photometric and mixed (geometric-photometric) processing (without attached CCD cameras), and thus restricted functionality, and a more expensive facility for graphics (stereo-) overlays.

Digital technique is highly flexible, permits photometric and mixed processing and thus an extended functionality, and it provides inexpensive graphics overlays. The major disadvantage is relatively low resolution of digital images, and thus reduced production economics. For cost-effective production the ability to display and to handle very high resolution images in real-time, is essential.

The choice of the optimum technique should be considered for each production line or product type in the context of the overall system. Digital technique is feasible for automatic control network densification and for terrain relief modelling from images at small and medium scales. At larger scales these processes should be supported by automatic image analysis and feature extraction. Thus further development in the automation of control network densification and of terrain relief modelling, depends mainly on the progress in automatic feature extraction.

Image transformations, with or without pixel registration, can be fully digital. Digital technique is highly flexible for handling both, geometric and photometric information. It permits image enhancement, local fill-in from overlapping images, and perfect mosaicing. A disadvantage of digital technique is its cost-effectiveness, especially when applied to large regions. The production economics depend on the terrain area covered by an image frame, i.e., the format size and scale. To resolve the smallest terrain features (objects) of interest, low resolution digital images should be taken at a larger scale. This, in turn, increases the number of images accordingly, and consequently the cost and time of production.

Another problem is specific for the geometric transformation of large scale images. It concerns the objects above (or under) terrain surface such as buildings. Such objects need first to be identified and measured.

Hence, the effectiveness of digital image transformation technique depends on the ability to increase image resolution and accordingly the production speed, and to correct for the geometric displacements induced by the differential heights of the objects.

Modelling of terrain features (other than relief) represents the most common photogrammetric production line, which is often extended with formation of a GI base. The modelling comprises image interpretation and spatial positioning. Its cost-effectiveness depends on image quality in a similar way as image transformations. To discern the smallest objects from images, a reduced resolution of digital images has to be compensated by a larger imaging scale, which increases the cost and time of production.

From these considerations it follows that the main issue of promoting digital IPS is to improve the resolution of digital images to the level of analogue images. This should be accompanied by a corresponding increase in the system throughput, including digital images. To this end very powerful hardware is needed, such as high performance raster scanners, fast mass-storage devices, powerful processors, fast communication means, and high performance display monitors.

Another issue important for the further development of the IPS addresses the automation, in particular of image analysis and terrain cure extraction. These operations can support a.d partly replace manual image interpretation and measurements. The progress in automation of photogrammetric processes, using images at larger scales, strongly depends on the achievements in automatic image analysis and feature extraction.

Further important factors concern the system openness and flexibility, performance and quality insurance, and the vendor's support. Acceptance of the IPS in the production environment will largely depend on these factors.

The final issue of this projection addresses the expected impact of digital techniques on the IPS, and thus on the photogrammetric profession. This is to contribute to clarification of confusing statements in some recent papers.

The domain of any technical profession is defined by its problem oriented objectives (mission, terms of reference). These reflect specific societal needs rather than capabilities of the existing or anticipated techniques or system types; the latter concern the solution oriented objectives.

The value of a professional domain is mainly determined by the societal needs for its products and its effectiveness in meeting these needs.

The societal needs for more, better and up-to-date GI will continue to increase. Moreover, there is no potential alternative to photogrammetry for primary and differential collection of detailed GI from images. Techniques are evolving from analytical to digital; accordingly the IPS are being dynamically updated and optimized for the photogrammetric production processes. Hence, the digital facilities incorporated in IPS are not less "photogrammetric" than their analogue counterparts, i.e., optical, mechanical or electronic. Extended functionality and automation are outcomes of the evolution in the system internal and external areas, as in most other technical fields.

The current evolution of photogrammetry is faster than ever before. It leads to extended capabilities, improved performances, and thus to increased effectiveness.

These features together with the increasing need for GI, make photogrammetry compatible with the societal and technical environments of the 21st century.

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