NATIONAL REPORT OF SWITZERLAND FOR PHOTOGRAMMETRY AND REMOTE SENSING 1992 - 1996

Prepared for the Swiss Society
of Photogrammetry, Image Analysis and Remote Sensing
by
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1. SOCIETY AND INSTITUTIONS

1.1 Swiss Society of Photogrammetry, Image Analysis and Reomote Sensing (SSPIRS)

The Swiss Society of Photogrammetry, Image Analysis and Remote Sensing (SSPIRS) was founded in 1928 and currently has 204 members. Of these 14 are abroad and 26 are corporate members. The official publication is the „Zeitschrift für Vermessung, Photogrammetrie und Kulturtechnik" (VPK), a monthly journal supported by 5 professional associations in the field of surveying, photogrammetry and land management.

Since 1989 the Society supports six Working Groups:
(1) Landinformation systems and photogrammetry, (2) Cadastrial Surveying, (3) Digital close-range photogrammetry and machine vision, (4) Remote sensing, (5) Applied photogrammetry including training and continuing education, (6) History of photogrammetry. The last group is about to conclude its work and to fulfil its mission.
This year the SSPIRS will publish a new book on the history of photogrammetry in Switzerland from the very beginnings to the year 1980.

The SSPIRS is also linked to societies such as the Swiss Computer Graphics Association (SCGA) and is a member of the Swiss Organisation of Geographic Information (SOGI).

More information about the SSPIRS can be found via Homepage http://www.giub.unibe.ch/remsen/sgpbf/.

1.2 Federal Office of Topography

The Federal Office of Topography is an administrative unit of the Swiss military department which fulfils the task of producing maps for military and civilian uses. Additionally it is responsible for the geodetic reference system of Switzerland and increasingly also in charge of preparing topographical data for military and civil GIS applications.
One of the fundamental tasks of the Federal Office of Topography is that of national map revision. This is also the mainstay of all photogrammetric activity. Since nearly 30 years the backbone of map revision is provided by new survey flights covering the whole Swiss territory periodically at 6 year intervals. The subsequent detailed photogrammetric map revision is complemented by the extremely important field verification. We are now in the 5th revision cycle and the method has proven to be stable and economical and has only required small improvements over time. The large quantity of aerial photographs taken in this process are administered in a photo archive. They are exploited intensely by the most diverse users (ecology, forestry, statistics, etc.).

A new application is emerging with the demand for digital forms of the topographical data contained in our maps. These so-called map derived landscape models represent the basic data for diverse GIS applications as well as for simulation purposes.

All these tasks are taken care of predominantly by the topographical division. In the last four years this division was involved mainly in the following projects:
- acquisition of a new and modern aircraft for aerial surveys
- establishing the basis for a topographical information system
- transition from analogue to analytical photogrammetry

1.2.1 New aircraft for aerial surveys

In close co-operation with the responsible military procurement office an aircraft for aerial surveys with optimal specifications was evaluated and purchased. The following constraints and specifications for the aircraft were followed closely:
- platform for a modern dual aerial camera system
- service ceiling of 10'000 metres above mean sea level
- modern GPS supported navigation system
- apt for transport of personnel and material

The choice fell on a BEECHCRAFT Super King Air 350. The aircraft is equipped with the most modern avionics (EFIS, weather radar, IFR category 1, etc.) and a GPS supported flight navigation system UNS1.
The payload consists of two gyro-stabilised LEICA RC30 cameras with the corresponding lens cones (f=15, 21 and 30 cm). The cameras are controlled via a processor unit by the operator. The view of the ground is picked up by a CCD camera on the navigation sight and shown on a video monitor. The processor unit is connected to the navigation system from where it permanently receives all relevant control data (position, drift angle, etc.) for both cameras. The drift angle is corrected automatically and in real-time on the camera. Independent of the aircraft's navigation system

the payload is equipped with a second GPS receiver (TRIMBLE 4000SSE) with a special airborne antenna positioned exactly over the master camera. It serves the purpose of recording the raw phase measurements together with the exact mid-exposure pulses of the cameras for determination of the exact projection centres through post-processing.

The performance of the aerial photo service has practically been doubled through improved navigation in comparison with the previous aircraft. Moreover the working conditions for the pilots and the operator have improved significantly due to the pressurized cabin. Flight planning and navigation today are based exclusively on co-ordinates. The mean position accuracy of a photograph with respect to the flight plan is approximately 50 metres (even when degraded by selective availability of GPS satellites).

1.2.2 The topographical information system

We define the topographical information system (TIS) as that part of a GIS which contains the topographical data set of Switzerland. The information density corresponds approximately to that of map scales ranging from 1:10'000 to 1: 25'000.

Differential GPS navigation is developing rapidly into a tool which requires digital maps of equivalent accuracy. Independent of the map scale the GPS position of manmade objects today can be determined with an accuracy of around ± 1 meter. We therefore are ultimately aiming to provide digital maps of the same accuracy.

Today mainly the military sector is demanding digital data with great urgency. Therefore a two phase solution was chosen as a compromise. In a first step the contents of the map 1: 25'000 are being digitised with an object position accuracy ranging from 2.5 to 7.5 metres, corresponding to the achievable accuracy at this map scale (map derived landscape model). According to our planning this data collection should be finished by the year 2000.

In a second phase the position accuracy will be improved to approximately 1 metre by adjusting to precisely defined objects (roads and buildings) and at the same time 3-dimensional data acquisition of certain objects will be realised (landscape model derived from reality). Most probably this will be implemented within the scope of data revision. In this respect we are confident that further developments in image analysis will provide an appropriate set of tools (e.g. feature extraction) which will satisfy our practical needs.

Vector data set VECTOR25

To accomplish the first phase we have built up a task force of 7 specialists in the last year, who are digitising the contents of the 1:25'000 national maps to satisfy the specific military needs. The resulting data set is denominated VECTOR25. This is being realised on the background of our pixel maps (scanned national maps) with the line following software from LASERSCAN. For automatic extraction of buildings, characters and symbols we are planning to use the KAMU/AUTOVEC pattern recognition and vectorising software developed at the ETH Zurich.

Height model DHM25

The height model DHM25 which we have been working on since quite some time will be finished this year. In the framework of an R&D project the ETH Zurich has made important improvements to the software program on which the basic model of the DHM25 is based. The DHM25 consisting of digitised contour lines, bathymetric contours of the lakes and single height points (and in the future also the main alpine break-lines) has been converted into a height matrix with a 25 meter grid. Additional improvement will be brought to the height model through the photogrammetric processing of the main break-lines of the Alps.

The basic height model and the matrix model are now being managed with the program system SCOP.TDM which is based on the topograpical database TOPDB from the University of Vienna.

1.2.3 Transition from analogue to analytical photogrammetry

Contrary to all scientific and technical papers appearing everywhere which report about the blessings of digital photogrammetry our practical day to day restitution still seems to live in an old-fashioned world. The Federal Office of Topography has 6 analytical plotters of the type WILD BC3 working day in day out. The last A8 was sold in 1994. Map revision requires a high degree of qualified interpretation of what can be seen in the aerial photograph. For this the optical viewing system of an analytical instrument is far superior to the viewing system of digital workstations. A modern aerial camera system combined with the right film emulsion today delivers a resolution of approximately 100 Lp/mm. If the same resolution was to be achieved digitally a scanning resolution of 5 microns would have to be imposed which would lead to enormous image files of over 2 Gigabyte per black and white photograph. Even in the most advanced workstations this amount of data cannot be handled economically.

On the other hand digital systems can be put to work economically for aerotriangulation, for the production of geo-coded image mosaics (digital orthophotos) and for the automatic determination of height models (DTM) through image correlation. The Federal Office of Topography is currently evaluating such a system consisting of an image scanner, a high-performance computer with adequate storage capacity and a stereo workstation. Acquisition of the system will take place this year. High priority is being given to a customer oriented archiving concept for digital image data. Within the framework of a research program together with the Centre for High-Performance Computing at the ETH Zurich new solutions are in the making.

1.2.4 Satellite Remote Sensing

In the field of satellite images the Federal Office of Topography together with the ETH Zurich is maintaining a contact office (National Point of Contact) to consult and support buyers and users of images and image data. Most of the customers come from the universities and from the research environment. Consulting in this context is normally very time consuming and very seldom can the costs be recovered. With the exception of meteorology the use of

satellite images in Switzerland is limited to research projects. This could change if images of higher resolution were available. However one has to consider that in Switzerland very good aerial images are available since many years at relatively reasonable prices.

1.2.5 Digital Cartography

At the ISPRS Congress in Kyoto 1988 a paper was presented (Eidenbenz/Perret, Commission IV) concerning map revision by means of digital cartography. It describes a hybrid raster-vector method. In the meantime the positive results of this test have been proven by applying it to two more map sheets. Unfortunately the provider of the system which was used decided to reconsider his market orientation which made it necessary for us to re-evaluate the project. Now we stand shortly before the end of this phase which promises to be successful. However we estimate that the acquisition and implementation phase will last various years (map revision cycle), in which the conventional analogue and the new digital techniques will have to continue side by side. Therefore we do not foresee any immediate savings. We are also concerned by the breathtaking speed of developments and the short life cycles mainly of the hardware but also the software. It seems as though we will have to adapt ourselves to not only replacing our maps in one revision cycle but also the hard- and software systems.

1.3 Federal Directorate of Cadastral Survey

Already in 1978 a rough concept for a reform of the official cadastral survey was launched. Among other objectives it was postulated in the guiding principles that the official cadastral survey was to orient itself towards a spatial information system and that this reform should also lead to improved services to the industry, the utility companies, the government and to the citizen through an increased adaptation to the needs of these users and their economic possibilities.
When the decree for this new official cadastral survey and its technical ordinance was put into force the basis was created for the official cadastral survey to fulfil its original objective of securing all property rights and on the other hand the foundation was laid for the creation and operation of Land Information Systems (LIS).
An essential tool was created for this purpose: a uniform data model containing a structured basic data set with its own uniform descriptive language AVS/INTERLIS. Great importance was placed on the parameters which define data quality. Therefore the following values have been described explicitly in this data model: accuracy, reliability, timeliness, completeness and consistency.

Financing is carried mainly by the public entities such as the state, the cantons and the municipality. But new financial models are being studied to increase participation of LIS users.

Thanks to the comprehensively described data model it was possible to avoid detailed regulation of individual processes such as data collection, data processing and data management. In line with modern quality assurance the contractor is free to choose from an ever increasing array of innovative methods to fulfil his contractual obligations. On the other hand the contractor himself is responsible for quality assurance. Already in larger contracts which have been tendered on a submission basis it is discernible that those win the contract who have implemented efficient economical methods maintaining the required quality standards. Specifically for the information layers describing surface coverage, single objects and the digital terrain model (initial survey and periodic revisions) photogrammetric methods will assert themselves without doubt. Depending on land value also the orthophoto will impose itself as an economical source of additional information.

Increasingly GPS methods are being used in the official cadastral survey. These methods produce tension-free networks of ground control points in an efficient way. Simultaneously the Federal Office of Topography has established a basic geodetic reference network (LV95) with which the existing national survey has been thoroughly modernised. We are now evaluating the possibilities to adapt the whole official cadastral survey into this new reference frame in an optimal way and without loss of quality.

The Federal Directorate also maintains an aircraft with dual LEICA RC30 cameras combined with the ASCOT GPS aerial survey navigation system. Main applications are large scale photography for cadastral purposes and periodic coverage of all forested areas with false colour photography to establish a forest health inventory.

2. PHOTOGRAMMETRY

Based on a recent study photogrammetry in Switzerland is undergoing a rapid transition from analytical to digital photogrammetry. In 1992 some 50 analytical instruments were in use and only 15 analogue instruments which had been digitised. To date 15 fully digital photogrammetric stations and 5 scanners are in operation whilst the number of analytical instruments has diminished. Practice is showing that digital systems are economical when DTMs and orthophotos are required. However it is also evident that large scale mapping gives better results if details can be interpreted through high-quality optics of an analytical instrument.

2.1 Photogrammetric facilities

The government is represented in this field by the following institutions: the Federal Office of Topography, two Technical Universities (Zurich and Lausanne), two Technical Colleges in Muttenz and Yverdon-les-Bains and a Federal Research Institute in Birmensdorf. The private sector is represented by 23 private companies with 1 to 4 instruments each.

In the field of aerial surveys the Federal Office of Topography and the Federal Directorate of Cadastral Surveys each are using an aircraft with dual cameras. Both government institutions are using GPS for flight navigation. 7 private companies are using a total of 8 cameras. Mostly

these private companies rent the aircraft when need arises. Since there are few ideal flying days per year this explains why so many cameras are available in such a small country.

2.2 Activities of the Swiss private photogrammetrists

Private photogrammetric companies have contributed substantially to accomplish large projects based on aerial photography in the last four years. The collection of basic geographic data on a national and a cantonal level was one of the most important tasks. In conjunction with the establishment of land information systems the layers of surface coverage and digital terrain models were compiled to meet the requirements of the Official Cadastral Survey and of large construction projects.

One project worth mentioning is the determination of the perimeter of the AlpTransit trajectory for the Swiss federal railways. Also for the Swiss federal railways photogrammetry made it possible to establish along all the main railway lines a 3D model based on which a noise impact cadastre was created.

The digital orthophoto has proven to be a innovative product with a high potential for very diverse future applications. For this purpose large aerial surveys where carried out by various cities and cantons.

Photogrammetry has established itself firmly as the method for forest health inventories and for basic flood control mapping. The latter was carried out mainly by means of helicopter-borne aerial photography.

Swiss private photogrammetric companies have also been active abroad mainly to help establish cadastral information systems (partly based on digital orthophotos) and to help put into operation cartographic production lines.

3. PHOTOGRAMMETRIC INDUSTRY

3.1 Analytical and digital photogrammetry

Shortly before the ISPRS Congress in Kyoto 1988 a historic change in the photogrammetric industry in Switzerland took place: Wild Heerbrugg and Kern Aarau had been brought together and the first digital stereoplotter DSP1 was shown on the common booth.

In 1990 both companies were integrated into the LEICA holding company together with 5 other high-tech companies. A careful analysis of market and technology in the field of Digital Photogrammetry led to a partnership between Leica and Helava. The ISPRS Congress in Washington (1992) was the appropriate occasion to announce this partnership.

Between 1992 and 1996 Helava and Leica together have established themselves as a provider of leading edge technology in the field of digital photogrammetric workstations and scanners.

3.2 Photogrammetric developments within Leica

Intense efforts continue to be invested in Leica's complete range of photogrammetric product lines:

- RC30 / ASCOT aerial camera system
- SD2000 / 3000 line of analytical stereoplotters
- DVP entry level digital photogrammetric workstation
- HELAVA digital photogrammetric systems
- INFOCAM land information system
- Laser Tracker to digitise moving industrial objects
- Axyz a multi-sensor industrial 3D measuring SW
- V-STARS for digital industrial photogrammetry

The Helava line continues to evolve very rapidly. The DSW200 scanner and the DPW670/770 are now available on the Sun Ultra host workstation and not only on the SPARCstation. The new Creator 3D graphics offers first class stereoscopic viewing and many of the latest Indy and Indigo workstations from Silicon graphics are also available. The current release of SOCET SET, software for the DPWs includes all around improvements such as HATS (Helava Automated Triangulation System), image map production with PostScript output, feature extraction with semi-automated tools promising real advances in productivity. The popular ATLAS and PRO600/MicroStation packages for map compilation continue to improve and the latter is supplemented by a new optional module, TerraModeler from the Finnish company TerraSolid OY, for the manipulation of digital terrain models.

On the SD line of analytical instruments the ORIMA software is becoming established as the standard software under Windows and customers throughout the world are keen to upgrade earlier models of Kern, Wild and Leica analytical plotters in order to gain the advantages of the latest developments.

Version 6 of INFOCAM runs under the Solaris 2.x operating system on Sun workstations and thus shares this platform with the Helava line.

Aerial Visionics Systems

In 1993 Leica acquired Magnavox Navigation and Positioning Systems. The complete integration of GPS receivers into the aerial camera system allowed to reduce the amount of ground control needed for aerotriangulation even further. The first step was to incorporate GPS navigation into the Leica RC30 aerial camera system providing perfect flight planning and flight execution - the ASCOT aerial survey control tool was born. The second step was to integrate GPS phase measurements, GPS post processing, aerotriangulation and bundle block adjustment into a reliable data processing chain to determine precise perspective centre co-ordinates. This Combined Block Adjustment method (CBA) which only requires 2 single frequency GPS receivers, one in the air and one on the ground, gives the aircraft an unprecedented operating radius of 500 km with resulting decimetre accuracies for the perspective centres. Ground control can be reduced to four full control points in the corners of the block.

In 1993 the Leica RC30 aerial camera system has been further enhanced by a new generation of lens cones of which the 15/4 UAG-S offers an exceptionally high resolution of approximately 120 Lp/mm (AWAR).

In 1995 the PAV30 gyro-stabilised camera mount was introduced for angular motion compensation (AMC). Features like FMC, AMC, pin-point photography through GPS controlled flight management and the high resolution lens cone have made the Leica RC30 aerial camera system a most cost effective tool.

Industrial measuring systems

One decade after first introducing photogrammetric and geodetic 3D measuring techniques into the industrial environment, the systems from Leica are well established on the shop floors of a variety of industries. The main benefits are:

- measurement without physical contact
- mobile systems, measurements where best suitable
- objects to be measured can remain in position.
- objects to be measured can be sensitive, large or delicate
- minimal interference to the manufacturing process.
- replace expensive, time- and space- consuming physical gauges
- improve manufacturing accuracy and quality standards
- reduce time requirements up to 80%

Within the reporting period the following systems have been further developed:

- Industrial theodolite measuring systems
- Laser Tracker system
- Industrial software platform Axyz

The V-STARS digital photogrammetric industrial-measuring system uses Kodak still video cameras to survey the object. The processing of the digital images is largely automatic, with the support of high-performance digital image processing programs. If certain points of the object have to be determined the targetless method with a cable-free probe can be applied. V-STARS systems are now in use in aeronautics, aerospace, automotive industries, in shipbuilding and in nuclear installations

4. RESEARCH AND EDUCATION

Research and development in Switzerland in the academic area is primarily conducted at the Departement of Geodetic Sciences, ETH Zurich and the Departement de Genie Rurale, EPF Lausanne. There are however a number of other institutions which are selectively active in either satellite remote sensing, image analysis, computer vision, machine vision, robot vision and related areas. Among those are

- Institute of Geography, University of Zurich
- Institute of Geography, University of Bern
- Institute of Geography, University of Fribourg
- Institute of Geography, University of Basel
- Institute of Communication Technology, ETH Zurich
- Institute of Electronics, ETH Zurich
- Multi-Media Laboratory, University of Zurich
- Institute of Applied Physics, University of Bern
- Institute of Computer Science and Applied Mathematics, University of Bern
- Center of Computer Science, University of Genève
- Institute of Microtechnology, University of Neuchatel
- Institute of Mathematics and Computer Science, University of Neuchatel

In 1994 the group „Inter-University Partnership in Earth Observation and Geoinformatics" has been founded, which consists of several Institutes and individuals from the University of Zurich and ETH Zurich. The common aims of the group are to support and coordinate research and teaching activities in the areas of remote sensing and geoinformation systems. The current membership includes professors/scientists from

University of Zurich

- Institute of Geography
- Institute of Computer Science

ETH Zurich

- Institute of Geodesy and Photogrammetry
- Institute of Cartography
- Institute of Scientific Computing
- Institute of Communication Technology
- Institute of Information Systems
- Institute of Theoretical Computer Science

In November 1994 there was a first successful workshop of all members at Monte Verita, Ascona. The following research projects were presented and discussed at this occasion:

- Prof. K. Brassel, Prof. R. Weibel, Institute of Geography, University of Zurich
  - Modelling and visualization of topographic data
  - Generalization of spatial data; use of expert systems, artificial intelligence, neural networks
- Prof. A. Carosio, Institute of Geodesy and Photogrammetry, ETH Zurich
  - Development of a software system for automatic pattern recognition in topographic maps of small scale (1:25000 and smaller), based on template matching
  - 3-D Geographic Information Systems
  Modelling and Visualization of 3-D GIS data, based on topographic maps (raster data).
  - Database Management System for cartographic raster images
  - Query Language for geometry in raster-based GIS
  - International standardisation of geographic information exchange
  - Data transfer between GIS
- Prof. A. Gruen, Inst. of Geodesy and Photogrammetry, ETH Zurich
  - Automatic DTM Generation from digital images.
  The algorithm is based on multiphoto geometrically constrained matching, using strict geometric sensor models for aerial images and very good approximations for SPOT, TM, J-ERS OPS and MOMS-02 satellite images.
- Project „AMOBE"
  In this interdisciplinary project, the expertise of the IGP in Digital Photogrammetry and that of the IKT (Communications Technology Lab, Prof. O. Kuebler) in Computer Vision/Image Understanding is being combined to develop novel, reliable and geometrically precise image analysis methods towards the semi-

automatic extraction of man-made objects from large-scale aerial images.
- Semi-automatic road extraction from raster image data, based on dynamic programming
-Generation of generic house models from 3-D point clouds for 3-D city models
- Correction of house roofs in digital orthoimages such that they appear in a correct geometrical location

- Prof. H.-J. Schek, Institute of Information Systems, ETH Zurich
  - Database problems, conceptual aspects fo GIS, database systems
- Prof. E. Spiess, Institute of Cartography, ETH Zurich
- Combination of vector and raster data in cartographic applications
- Program development for thematic mapping, based on knowledge-based systems
- Computer-assisted compilation and production of thematic maps
- Digital production and update of the „Swiss World Atlas" with a CAD system
- Digital 3-D modelling of topographic and geologic maps
- Prof. P. Stucki, Institute of Computer Science, University of Zurich
  - Virtual Reality and GIS
- Prof. P. Widmayer, Institute of Theoretical Computer Science, ETH Zurich
- Data structure and algorithms to handle and manage geometric (geographic and cartographic) data
- Fast access to 3-D data for real-time fly-overs.

More details about the members of the group and their research projects can be found at the WWW Homepage http://nobi. ethz.ch/ipeg/ipeg.html.

Also in 1994, the SIRS (Chair for Spatial Information Systems, Prof. F. Golay) was established at EPF Lausanne. The research activities of the SIRS follow two main objectives:
- Development of a rational and efficient usability of spatial information systems (SIS for different land management purposes).
- Evaluation and development of methods for planning, conception and implementation of SIS.

More details about the SIRS can be found at the WWW Homepage http://dgrwww.epfl.ch/SIRS/index. html.

In the fields of responsibility of the various ISPRS Technical Commissions the following activities are reported.

Commission I:

Tests of 3-line cameras in aerial and space applications and recent developments in high resolution CCD sensor developments were among the major topics of the workshop „From Pixels to Sequences-Sensors, Algorithms and Systems", held in Zurich in March 22-24, 1995. Scanners as the main source of digital data in aerial applications are being examined and calibrated at the Institute of Geodesy and Photogrammetry (IGP), ETH Zurich. Practical tests concerning the use of high resolution stillvideo CCD cameras in aerial applications have been conducted at IGP.

Commission II:
- Several practical tests in digital aerotriangulation were performed on the experimental Digital Photogrammetric Station DIPSII of the Institute of Geodesy and Photogrammetry, ETH Zurich using both aerial image blocks with different resolution as well as high resolution still video images of the Kodak DCS200 which were acquired from a helicopter. For image point measurements least squares template resp. image matching techniques were used.
- Both the Institute of Geodesy and Photogrammetry, ETH Zurich and the Institute of Mensuration, EPF Lausanne took part in the OEEPE test „Aerotriangulation using digitized images". Image point measurements in digital aerial test images were performed on one experimental and on three commercial Digital Photogrammetric Stations: DIPS II (ETH Zurich), Intergraph Image Station, Helava/Leica DPW770 and DSW100 (EPF Lausanne).

Commission III:
- Semi-automatic monoplotting techniques, using feature extraction based on dynamic programming and LSB-Snakes as a data acquisition resource for GIS applications have been developed at IGP.
- Algorithms for automated, precise and reliable point and surface measurement involving multiple images and geometric constraints have been developed and tested at IGP. The techniques have been modified using different geometric constraints in order to be used for processing of satellite imagery and edge measurement and tracking. Extensive tests of the algorithms were performed with aerial, satellite and close-range imagery.
- At IGP commercial systems for automated DSM/DTM generation (Leica/Helava DPW770 and VirtuoZo) have been used with aerial imagery of different types and scales and compared to reference data (manually measured or DHM25).
- Generation of ortho-images, use of ortho-images for map updating, their combination with other raster and vector data and aspects of their integration in GIS have been studied at IGP.
- IGP and the Communications Technology Lab (IKT) of ETH Zurich have started a project in 1994 on Automated Man-Made Object Extraction from Aerial Images (AMOBE). The project aims at semi-automated, high quality reconstruction of buildings using multiple information (multiple images, DSMs, texture, straight edges, colour and infrared) and combining photogrammetric and computer vision techniques. A very successful workshop with participation of most major international groups active on the above topic was organised in April 1995 at Monte Verita, Ascona.
- Research at the Multi-Media Lab, University of Zurich on automatic shape measurement of free-form surfaces from multiple cues is performed.
- At IKT a general framework for model extraction from 2D and 3D data sets using only a dictionary of generic models is developed.

Commission IV:

Compare information under Chapters 1.2 and 1.3.
At the Institute of Geodesy and Photogrammetry, ETH Zurich a joint project on "Processing of geodata for CAAD-

supported analysis and design of urban development" was conducted since 1990 as a cooperative effort between the Chairs of Architecture and Design (Prof. F. Oswald), Architecture and CAAD (Prof. G. Schmitt), and Photogrammetry and Remote Sensing (Prof. A. Gruen) and in 1994 successfully completed. The aim was to computerize the task of urban development and to provide the students in architecture with the respective computer-based tools for analysis and design.

Commission V:

Research and development in close range photogrammetry in Switzerland covered a wide range of topics:

- Commercial digital photogrammetric systems for high precision 3-D coordinate measurements have been developed and are sold by the companies Imetric and Leica.

  Several pilot studies on the application of digital close range photogrammetry for precise 3-D coordinate measurement have been conducted at IGP (at a shipyard, deformation measurement of a dam, biomechanics and animation, etc.).
- At the Communications Technology Lab of ETH Zurich a research project on control feedback for a nano-robot system was started January 1994. This involves new techniques for the calibration of stereo microscopes, solving the stereo correspondence problem for microscope imagery and image analysis of dynamic scenes.
- Techniques for the measurement of dense 3-D velocity fields in flows (3-D Particle Tracking Velocimetry and 3-D Least Squares Matching) have been developed at IGP.
- Digital photogrammetry and CAD techniques have been combined into a semi-automatic system for architectural photogrammetry at IGP.
- The Pattern Recognition Group at the Institute for Micro-technology, University of Neuchatel works on the recognition of arbitrary 3-D objects in range sensor data.

Commission VI:

- Major curriculum revisions are underway at ETH Zurich, Faculty of Rural Engineering and Geodesy. Currently, the Faculty is responsible for the curricula in Environmental Engineering, Rural Engineering and Geodesy. It is planned to reunite Rural Engineering and Geodesy into a joint track „Geomatics Engineering". In parallel, a credit system from 5.-8. semester will be introduced together with a major revision of the subjects of study. This is supposed to prepare the students better for the requirements of modern science, technology and applications.

Commission VII:

- At IGP research is performed on modelling of SPOT, MOMS-02/D2 and KFA-1000 imagery. Different accuracy investigations have been performed, as well as automatic derivation of DTMs and ortho-images from these sensors.
- IGP together with other international partners have been awarded an EU project on processing and synergistic integration of optical and microwave imagery.
- IKT is performing research on scene understanding by model-based interpretation techniques, snowmelt runoff modelling and derivation of high resolution DTMs from satellite imagery (more details under http://www.vision.ee.ethz.ch/).
- The Institute of Geography, University of Zurich, has broad activities on remote sensing grouped unser Remote Sensing and Natural Resources, and Remote Sensing Applications. Topics of research include: SAR data processing and SAR interferometry, landscape visualisation, snow hydrology and hazard studies, natural resources studies, airborne imaging spectrometry, land use estimation, and spectroradiometry (more details under http://www.geo.unizh.ch/).

5. SOURCES OF INFORMATION

In Journals

- Department of Geodetic Sciences, ETH Zurich. Vermessung, Photogrammetrie, Kulturtechnik (VPK), Vol.93, April 1995, pp. 171-308
- Optics in Switzerland, Part 1, 2, 3. Optical Engineering, Vol. 34, Nos. 7, 8, 9, July, August, September 1995

Conference Proceedings

- Symposium on Artificial Intelligence and Robotics (edited by R. Bless). 2 volumes, 22 October 1993, Technopark Zurich, and 29 September 1994, EPF Lausanne, Swiss National Science Foundation
- From Pixels to Sequences; ISPRS Intercommission Workshop. Int. Arch. of Photogrammetry and Remote Sensing, Vol. 30, 5W1, ETH Zurich, 2-24 March 1995, 396 pages
- International Workshop on Automated Face- and Gesture-Recognition. MultiMedia Laboratory, University of Zurich, 26-28 June 1995, 379 pages

Books

- Optical 3-D Measurement Techniques II (edited by A.Gruen, H. Kahmen). Papers presented to the Conference at ETH Zurich, 4-7 October 1993, Wichmann Verlag, 624 pages
- Automatic Extraction of Man-Made Objects from Aerial and Space Images (edited by A. Gruen, O Kübler, P. Agouris). Proceedings of the Workshop at Monte Verita, Ascona, 24-28 April 1995, Birkhäuser Verlag, Basel, 321 pages

Some relevant Homepages

ISPRS: http://www.geod.ethz.ch/isprs/isprs.html

SSPIRS: http://www.giub.unibe.ch/remsen/sgpbf/

Interuniversity Partnership:

http://nobi.ethz.ch/ipeg/ipeg. html

Department of Geodetic Sciences, ETH Zurich:

http://www.geod.ethz.ch/

Institute of Communications, Image Science Group, ETH Zurich: http://www.vision.ee.ethz.ch/

Département de Génie Rural, EPF Lausanne:

http://dgrwww.epfl.ch/