GROWING with technology

The invention of the photographic process in the mid 19th century stimulated the formation of small, but dedicated, scientific and industrial groups. In the late 1850's, Aimé Laussedat carried out the first topographical survey of an area by means of a pair of photographs suitably distanced from each other. Concurrently, Ignazio Porro developed the "photogoniometer" and many other ingenious apparatuses. Laussedat named the method 'Metrical Photography', which after further development was later named 'Photogrammetry by Intersection'. By the end of 19th century, the development of binocular measuring methods using stereopairs of photographs, led by Carl Pulfrich, resulted in a new field of 'stereoscopic photogrammetry'.

With the invention of the airplane in 1903, and subsequently the development of aerial cameras, opportunities for applications of aerial photogrammetry expanded rapidly. The potential for photogrammetry to overcome the deficiencies in 'topographic knowledge', in the form of maps, had clearly been recognised by Doležal and others. The task was to develop instrumentation that would improve the efficiency and accuracy of photogrammetric methods for mapping worldwide. Early examples of these instruments were demonstrated in the 2nd ISP Congress in Berlin in 1926.

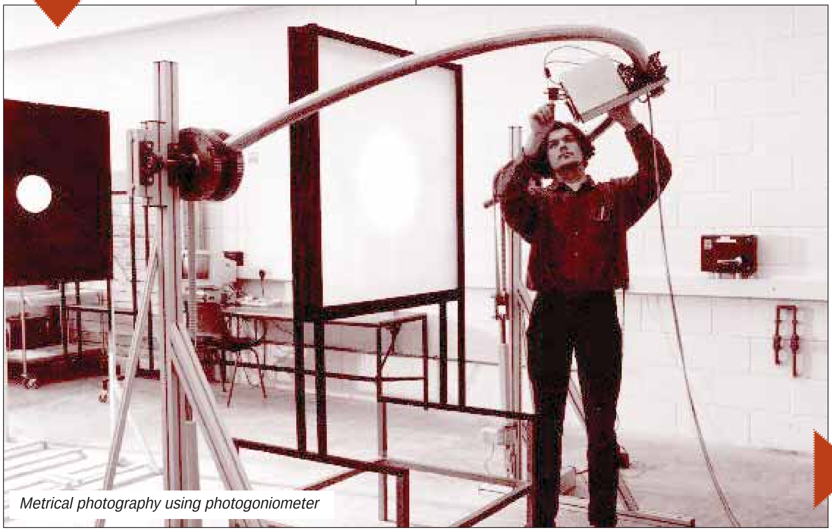
During the 3rd Congress in Zurich in 1930, interest continued in restitution of aerial photographs as well as aerial triangulation, which was an ongoing activity amongst practitioners. Seven areas of study were selected for the scientific commissions to address, based on the resolutions at the Congress. In 1934, except for the introduction of a commission on aerial triangulation, the commissions were unchanged from those determined in 1930. At the 5th Congress in Rome in 1938, the only significant change in the commissions was that medical applications replaced the topic of X-ray photogrammetry.

During the 6th Congress in The Hague in 1948, the commissions were reorganised by President Schermerhorn into the fundamental structure that lasted until the 20th Congress in Istanbul in 2004. That is, seven commissions based on the sequence of processes in photogrammetry.

The first aerial survey camera was developed in 1915. Initially aerial cameras were important for intelligence and mapping purposes in World War I. The early frame cameras had a narrow field angle, but the field angle was increased and both image and geometric quality were improved throughout the period 1930 to 1980. Preceding and during WW II, many unique cameras, some with multiple lens designs (up to 9 lens or more) enabling oblique imaging, were developed. A single wide-angle lens was developed by Carl Zeiss in Jena, Germany in the 1930s with nearly 100° field angle and a format of 18 cm square. Bausch and Lomb Optical Company in USA developed a wide-angle lens with approximately 90° field angle in 1938 for the US Corps of Engineers and a similar camera was built by Fairchild Camera and Instrument Company in 1940. Wild Heerbrugg introduced the RC5 wide-angle aerial camera in 1944.

Instrumentation continued to be based on an analogue solution of the restitution of images and aerial triangulation from 1930s into the 1960s. In 1957, the development of the concept of the analytical stereoplotter by Uki Helava brought about a major shift in the approach to the design of stereoplotters. In 1957, dedicated computers were necessary to perform the high speed computations that were required for the real-time operations of analytical stereoplotters. By the 13th Congress of ISP in Helsinki in 1976, almost all of the major instrument companies had abandoned development of analogue instrumentation and were marketing analytical stereoplotters. Attempts to automate height measurement in a photogrammetric stereoplotter by the process of stereo-correlation (now referred as 'image matching') was initially demonstrated by Gilbert Hobrough in 1957, and several prototype systems were demonstrated at the 10th ISP Congress in Lisbon, Portugal in 1964. Because of the limitations of digital image processing at that time, the stereo-correlation was based on analogue signal processing.

The potential of aerial triangulation to improve the economy of the mapping process by eliminating the need for large numbers of ground control points was recognised in the 1930s and hence became an ongoing topic of study within ISP for about 50 years. As computers became available in the 1950s and their power increased in the 1960s, aerial triangulation adjustments could be undertaken by analytical formulations (so-called bundle block adjustment) for almost unlimited photo block sizes, together with appropriate statistical analyses and self-calibration to correct for lens, film and atmospheric systematic errors. The origin of this approach was developed in the 1950s by Dr Helmut Schmid and Duane Brown in USA, and implemented by the US Coast & Geodetic Survey in the early 1960s.



Metrical photography using photogoniometer

Leica's Lidar System

While orthophotography had been discussed as early as the 1930s, development of equipment for their production gained momentum into the 1960s when it was apparent that manual methods of map production were unable to satisfy the demands for up-to-date maps throughout the world. Orthophotos, could be produced rapidly using specially designed analogue instrumentation in the 1960s and 1970s. Although the analogue approach was accepted for about 20 years, there were deficiencies in the orthophotos. Eventually the development of digital systems replaced the analogue approach.

Since its inception, ISPRS commissions have addressed a variety of close-range applications of photogrammetry. Each close-range application has its own characteristics and hence special processes usually have to be developed for each.

Photo-Interpretation (PI) had formally become a part of ISP activities in 1948 and was normally confined to black & white (B/W) aerial photographs. In the 1950s, colour and colour-IR films were developed and were adapted for PI applications such as for vegetation analysis. Radar images were also available at this time but they were very low resolution. It is agreed that remote sensing was born in July 1972 (during the 12th ISP Congress in Ottawa) when the first of the Landsat satellites was launched. At the 13th Congress in Helsinki, Finland in 1976, there were strong arguments by remote sensing specialists in ISP for the Society to embrace this technology more strongly in its activities. This stance was supported by the council which recommended to the GA at the Society's 14th Congress in Hamburg Germany in 1980 that the Society's name be changed to include remote sensing.

Expanding the horizons

The period 1980 to the present has seen the influence of the rapid developments in electronic digital technologies, including faster computing and virtually unlimited data storage capacities at continually reducing costs; faster computer graphics technologies; advanced digital imaging techniques and digital image processing; very high resolution commercial satellite imaging; satellite positioning based on Global Navigation Satellite Systems (GNSS); terrain laser scanning also referred to as LiDAR (Light Detection And Ranging); Synthetic Aperture Radar (SAR) and Interferometric SAR (IfSAR or InSAR) imaging; small satellite technologies; and growth of the Internet.

Data acquisition

The technologies of aerial frame cameras were advanced in the 1980s with the inclusion of forward motion compensation (FMC) to correct for the blurring effects caused by the forward movement of the aircraft during film exposure. With the introduction of GPS by USA in 1980s, it became possible to determine the position of the aircraft for each exposure during flight. This further advanced the ability of aerial triangulation to reduce the number of ground control points as was demonstrated at the 16th ISPRS Congress in Kyoto, Japan in 1988.

Although the principles of automatic photogrammetric systems were demonstrated as early as 1950s, it was not until 1988 that a prototype commercial system based on digital image processing was demonstrated at the 16th ISPRS Congress in Kyoto, Japan. Digital Photogrammetric Workstations (DPW or Softcopy Workstations) for undertaking photogrammetric operations on digital images, became commercially available in the early 1990s, based on digital images produced by digital cameras.

With the first commercially available high resolution images from space by Space Imaging Co. in 2000, and the first digital aerial camera demonstrated at the 19th ISPRS Congress in Amsterdam, and available commercially in 2001, came the new era of purely digital photogrammetry. While DPWs were commercially available in the early 1990s, it took another 10 years for the technologies to develop.

The commercial licensing in 1993 of space imaging technologies, which had been developed in the USA for military applications, led to a race by numerous international companies to produce high resolution cameras and systems for the acquisition and processing of high resolution satellite images for commercial applications.

Airborne laser scanning (ALS) or LiDAR has been growing in importance in ISPRS over the past 10-15 years. LiDAR scans the terrain


DEM from Lidar data

surface with a laser beam at right angles to the flight direction of an aircraft. The equipment includes a GPS receiver to determine the location of the aircraft and an IMU to continuously determine the tilts of the aircraft. A dense point cloud is determined at a separation typically of about 1m that represents a digital surface model (DSM) of the visible terrain surface. There are many applications of LiDAR data such as DEMs of the bare earth surface, beach erosion studies, infrastructure analysis, flood risk analysis and many more.

Remote sensing is based on the acquisition of satellite images, and to a lesser extent aerial images, in the visible wavelengths. Earth observation satellites launched since 1972 for remote sensing applications have resolutions (GSD) ranging from 0.4m to >1km and detect radiation in the various parts of the electro-magnetic spectrum.

Data Extraction for digital mapping and GIS

The typical applications of aerial photogrammetry prior to 1980 were for orthophotography and line mapping originally based on manual plotting and later on digitisation of features. Line mapping was partly automated using online computers in the semi-analytical and the analytical stereoplotters, but the process was still time consuming. However by the 1980s, spatial information systems, referred to also as GIS were being developed in many countries. There was a need for production of geocoded digital spatial data that could be input into a local GIS with an appropriate structure.

Close-range photogrammetry

In the late 1970s and 1980s, a new approach to close-range photogrammetry was possible due to the availability of digital imaging. This led to a much broader range of applications, including high precision industrial and engineering applications, referred to as 'Vision Metrology'. This approach is based on specially designed cameras made from off-the-shelf components, calibrated to achieve high precision measurements.

Remote sensing applications

Although remote sensing is a relatively new field, developments and applications of the technologies have grown rapidly in a very broad range of areas, from vegetation studies, geological applications, surface subsidence, transportation, meteorology, anthropogenic effects, environmental monitoring, sea surface and ocean colour, disaster monitoring and many more. Electro-optical multispectral and hyperspectral aerial and satellite images with resolutions from less than 1m to >1km continue to be used for the extraction of terrain information and interpretation of features.

Conclusions

Over 100 years of history of ISPRS, its basic goals and structures have been retained, yet expanded. Similarly, there have been major developments in the sciences and technologies that have driven the methods and applications of the P&RS&SI sciences. In the early days of ISP, the processing of images was based on analogue methods to reduce the computations.

The development of efficient algorithms, electronic computers and digital technologies has transformed the methods used in ISPRS. It is virtually impossible to project successful developments in the next 10 years, but one can be confident that the activities of the Society will continue to expand. ■