Photogrammetry and Remote Sensing

Prepared by the Remote Sensing and Photogrammetry Panel

Information note

Photogrammetry
Photogrammetry is the technique of acquiring measurements from photographic images, generally stereoscopic. The term photogrammetry was first used by the Prussian architect Albrecht Meydenbauer in 1867 who produced some of the earliest topographic plans and elevation drawings. The use of photogrammetry in topographic mapping is well established but in recent years the technique has been widely applied in the fields of architecture, industry, engineering, forensic, underwater, medicine, geology and many others for the production of precise 3D survey data.
Data acquired by photogrammetric methods is an integral part of the data input to both geographical information systems (GIS) and computer aided design (CAD). Indeed it has a role in any area where accurate spatial data is required.

Remote Sensing
Remote Sensing is a closely aligned technology to photogrammetry in that it also collects information from imagery. The term is derived from the fact that information about objects and features is collected without coming into contact with them. Where remote sensing differs from photogrammetry is in the type of information collected, which tends to be based on differences in colour, so land use and land cover is a primary output of remote sensing processing. Remote sensing was originally developed to exploit the large number of colour bands in satellite imagery to create 2D data primarily for GIS. Nowadays remote sensing tools are used with all types of imagery to assist in 2D data collection and derivation, such as slope. Software tools today tend to embrace a much wider range of image technologies such as image mosaicing, 3D visualisation, GIS, radar as well as softcopy photogrammetry.

Photogrammetry and Remote Sensing Applications
Topographic Mapping
Photogrammetry is most commonly associated with the production of topographic mapping generally from conventional aerial stereo photography although digital and satellite imagery is increasingly being used. Photogrammetry using imagery obtained from fixed wing aircraft helicopters and from satellites is used to produce mapping at a variety of scales. Recent improvements in camera design and photogrammetric instrumentation have led to increases in accuracies enabling mapping at scales as large as 1:200 to be produced from conventional aerial photography. Photogrammetrically derived three dimensional information produced from analytical or digital stereo plotting instruments is used to produce maps and plans and provide the source data for ground modelling packages, orthophotos and geographical information systems. Photogrammetry is used to provide national mapping and map revision at small and medium scales. At larger scales, photogrammetric data form the basis for three-dimensional modelling in a wide variety of applications including highway design, floodplain studies and pipeline routing.

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Architectural Applications
As the term 'photogrammetry' was devised by an architect, it is not surprising that the greatest use of the technique, outside of mapping, has been in the arena of architectural recording. Photogrammetry is now established as a standard technique for the survey of building elevations and is employed by English Heritage, Cadw, and the National Trust to name but a few. The technique is applied in the recording of historic buildings and monuments to produce elevation drawings and sections normally at scales of 1:20, 1:50 and 1:100. Imagery can be obtained from a variety of cameras ranging from large format metric cameras, where high accuracy and archival value are important, to smaller format 35mm cameras which are useful where access is restricted. Use is often made of aerial platforms and scaffolding to obtain the most economic coverage of a façade. Architects are becoming increasingly aware of the benefits of accurate photogrammetric surveys particularly the advantage of using a totally remote measurement system with superb archival qualities. The products available range from rectified images, orthophotos or precise 3D data formatted for use in a CAD package.

Engineering Applications
Over the years photogrammetry has been used in a wide variety of engineering situations including ship building, aircraft manufacture, chemical plant surveys, 'as builts', tunnel profiling and many others.
The non-contact nature of photogrammetry and the relatively short time required on site are important advantages, particularly in areas of a hazardous nature. The accuracies attainable compare favourably with other systems that may require longer site time and more intensive use of manpower. As equipment and cameras develop, real and near real-time monitoring of components and structures is becoming a reality. The phrase "*if you can photograph it you can measure it*" sums this up succinctly.

Laser Scanning
A relatively new technique complementing photogrammetry and remote sensing is that of laser scanning. The core technology utilised in terrestrial laser scanning systems will be familiar to any engineering surveyor who has used a total station. Terrestrial scanners for use in engineering surveying applications generally calculate the range to a surface in one of two ways; by measuring the time between the emission of a pulse and the detection of the reflected energy or by measuring the phase difference of the returned signal relative to the emitted signal. The laser pulse is automatically scanned (generally horizontally and vertically) to create a fan shaped pattern over the surface. This is performed using a rotating mirror, or servo motors fitted to the ranging device, that physically redirects the laser. Using a known distance and a horizontal and vertical angle, a XYZ position in the scanners arbitrary coordinate system can be derived for the point illuminated on the surface. The result is a 'point cloud' of data that describes the shape of the object and can be manipulated by the user. If the location and orientation of the scanner is known then real world coordinates can be calculated. Airborne laser scanning systems can create a three dimensional model of the earth's surface in a similar fashion. The aircraft's heading defines one scan direction and the laser emitted from the ranging device onboard the aircraft is redirected perpendicular to this. Onboard GPS and inertial measurement instruments calculate the position and attitude of the aircraft and the range and angle measurements are then used to determine the precise position of the point on the ground.

Other Applications
The remote measurement aspect of photogrammetry makes it ideal for certain applications such as body modelling, road traffic accident and scene of crime recording where intrusion in the subject area should be kept to a minimum. In the case of body modelling the data acquired has been used for clothing design, the manufacturing of false limbs and for animal husbandry. Forensic applications have been developed extensively throughout Europe although less so here in the United Kingdom. Currently a number of UK police forces are employing photogrammetry both from the air and the ground to ensure that site time is kept to an absolute minimum.

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Photogrammetry and Remote Sensing Equipment

Since the early days of the anaglyph (red and green glasses) instruments, the manufacturers of photogrammetric equipment have continued to develop new systems, the latest resulting in the introduction of the 'soft copy' plotter. The instrument most commonly used throughout the developed world is the analytical plotter. This is a computer driven, optical instrument using hard copy photography from which the operator extracts 3D measurements. There are a number of manufactures of this type of instrument, first introduced in the early 70s. Over the last few years, a number of 'soft copy' workstations have been introduced. These systems use digital photography through a powerful PC and glasses for the operator. These systems are far more portable than the analytical plotters and are considerably cheaper. The ability to use these from home or a small office offers greater working flexibility. A number of software and camera manufactures have recently introduced ‘low cost’ digital packages, designed for the non-photogrammetrist, to work on a PC. These systems developed by renowned companies such as Rollei and Kodak work on the principle of multi image, not stereoscopy, and may provide satisfactory answers in certain situations. They should not however be confused with the product produced by a professional photogrammetric company.

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