ФОТОГРАММЕТРІЯ ТА ЦИФРОВА ОБРОБКА ЗОБРАЖЕНЬ

THE TRANSITION FROM ANALYTICAL TO DIGITAL PHOTOGRAMMETRY, WITH CONSIDERATION OF CADASTRAL APPLICATIONS

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A major transition has been in progress, from analytical to digital photogrammetry. Whereas digital photogrammetry is a concept dating back to the 1950s, the major boost came in the 1980s, when the first operational digital photogrammetric workstations were developed for US government agencies. In the early 1990s, photogrammetric suppliers began to offer scanners and workstations in the commercial market place. Today, customers purchasing new photogrammetric systems are more likely to purchase digital than analytical, though this varies from country to country.

Digital photogrammetry is dependent on good digital imagery. Some work is done using satellite data, with SPOT the most popular sensor and both JERS-1 and IRS-1C generating increasing interest, but the great majority is based on film aerial photography digitised on specialist photogrammetric scanners. These systems incorporate an XY motion, of similar geometric performance to one of the stages of an analytical plotter, and an electronic image capture device, typically a linear or rectangular CCD array. The array moves with respect to the imagery or *vice versa*. The scanner is controlled by a high performance host computer capable of handling the large images produced: most users select pixel sizes in the range 10-30 μm, giving file sizes of 56-504 MB for each 230 x 230 mm black and white aerial photograph. Sophisticated software is necessary to ensure that the scanned image faithfully reflects the radiometric characteristics of the film.

The imagery is processed in a digital photogrammetric workstation (DPW). Also based on a powerful computer, this workstation enables the imagery to be triangulated and viewed stereoscopically. For stereo compilation it incorporates corresponding operations to those in everyday use on analytical plotters - indeed, the software in use for this task looks similar on both types of system. The availability on every DPW of colour, stereo superimposition of the digital map or GIS database on the stereo imagery is a special advantage. But the DPW encompasses many other functions. The most important

is the automated generation of digital terrain models (DTMs), which in turn enable digital orthophotos and mosaics to be produced. Furthermore, there is considerable scope on the DPW for automating processes, which leads to enhanced productivity in many mapping operations. Finally, the ability of a DPW to handle colour and multispectral imagery means that image processing techniques for land use mapping and classification can be incorporated on the same platform as the other mapping tasks.

The use of photogrammetry for cadastral work is well established. The plotting of visible boundaries, whether natural or monumented, is a straightforward part of stereo compilation, to which both analytical and digital photogrammetric systems are well suited. Moreover, it is possible to use parameters from automated triangulation on the digital systems to speed up the set up of stereo models on analogue and analytical plotters. As the automation of feature extraction on the DPWs improves, the collection of boundaries which are building corners or linear features will become faster.

Secondly, there is a strong tradition in the cadastre of the use of orthophotos, both in the marking of boundaries in the field and their subsequent measurement in the office, and for the display of cadastral information in an easily comprehensible way in the form of image maps. These operations are easier in digital than analytical photogrammetry, because all stages, except perhaps the final hardcopy output, occur in the same workstation. In addition, the DTM used to generate the orthophoto may be displayed as a conventional contour map, superimposed upon the rectified imagery. Modern algorithms enable the user merely to specify the area of interest, irrespective of the individual aerial photographs, and an output image is generated from the block of photography without recourse to the explicit steps of generating and mosaicking individual orthophotos. With digital photogrammetry, too, there are several options for the compilation of map detail: the user can work on the stereo model, on a single photo (monoplotting) or on the orthophoto (sometimes called "head up" digitising).

Thus both analytical and digital photogrammetric systems are powerful, versatile tools for cadastral work. The extra functionality of the digital systems offers an easier route to image based, or raster, products in addition to conventional line mapping. The transition from one technology to the other is in full swing, but there are several important management issues. Photogrammetrists must be capable of understanding and managing sites containing a complex, networked mix of analogue, analytical and digital systems. They require more computer literacy than previously. And they will have to redesign workflows in order to extract the optimum performance from the combination of technologies. As appropriate experience accumulates, cadastral offices will benefit increasingly from the development of photogrammetry.