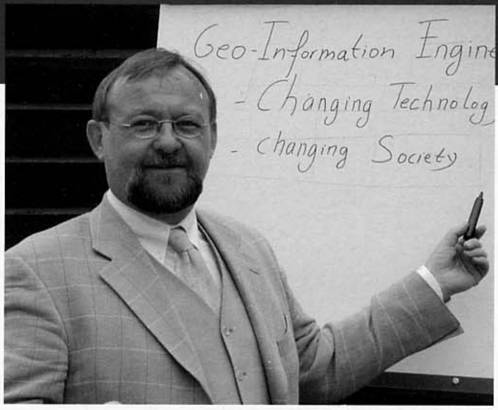

Maturing of INSAR

Two important articles, both from Canada, in the present issue of GIM International are on imaging radar. One article focuses on Canada's second SAR earth observation satellite: RADARSAT-2. This satellite under construction is due to be launched from Vandenberg Air Force Base in California (USA) in 2005. The other article treats quality management of interferometric synthetic aperture radar for producing Digital Elevation Models (DEM) and ortho-rectified radar imagery. Radar makes use of microwaves of which the wavelengths range from 8mm to 30cm. These wavelengths can penetrate clouds very well. They are also largely insensitive to haze and other weather conditions, which hinder so unpleasantly optical wavelengths. The all-weather capacity has been the main reason to use radar since the late 1960s for mapping tropical regions. Although already in operational use for nearly forty years, the maturing of this geo-data acquisition technique has gone along a rather flat time curve. One of the main reasons of slow development is that, after recording, radar data requires many complicated processing steps demanding high computational capacity.

Complementor

The first civilian applications of radar have been mapping of large tropical areas for exploration purposes. Today the application potential of radar reaches much further than just mapping and cartography. Indeed, applications concern a wide variety of geo-management activities, including management of disasters like floods and oil spills, determination of crop type and crop yield, and forest monitoring. In addition, radar is increasingly being used for the generation of DEMs. In particular, interferometric synthetic aperture radar - in the North Americas abbreviated to IFSAR, in Europe to INSAR - has proven to enable generation of high quality DEMs. However, INSAR is not a competitor of more conventional techniques like photogrammetry, or more rapidly evolving techniques like LIDAR. No, radar is more a complementor than a competitor to these techniques. By combining data stemming from different geo-data acquisition systems, the strengths of each can be used optimally whilst weaknesses of the individual systems can be balanced out. Certainly, data merging yields a most favourable DEM product in the sense of performance and quality.

Doppler

One of the most important quality parameters of a geo-data acquisition product is resolution. Resolution is the level of detail by which features and objects can be distinguished in the data. For example, the forthcoming RADARSAT-2 will be able to produce images with a resolution of 3m. This is no less than three times better compared to the present RADARSAT-1. Regarding resolution, let us go in somewhat greater theoretical detail. The resolution of imaging radar is directly proportional to the aperture of the antenna. The aperture is proportional to the ratio of the wavelength of the radar signal and the length of the antenna. In other words, the resolution is proportional to the wavelength but inversely proportional to the length of the antenna. Improvement of the resolution thus requires either the use of very small wavelengths or the use of a very long antenna. Lessening of wavelength faces absorption problems because the atmosphere blocks very short microwaves. Extension of the antenna meets physical and operational limitations. The solution to this deadlock has been found in the 1960s and reads: make use of the movement of the platform. The signals hitting the earth in front of a moving platform will be compressed, whilst the signals hitting the ground back of the platform, will be elongated. This effect on the frequency of signals, which are transmitted from a moving platform, is already known a very long time and has been described by Doppler in 1842. By registering along with signal strength and travel time the Doppler frequencies of the backscattered microwave signals the resolution and thus the aperture is considerably augmented in a synthetic way. Since the velocity of a platform is just in the order of 1 ppm (part per million) of the velocity of light, it does not take much imagination to recognise that the associated processing steps will be very complicated.

Slanting Time Curve

The complexity of the extensive and sensitive processing chain of INSAR data has for a long time impeded widespread practical application. Since the early nineties numerous software packages for processing INSAR data have been developed. In particular, Canada and Europe have carried out intensive radar research. However, most packages are products of stand-alone efforts from research institutes and are a result of lack of commercially available software. Today software, developed in the past in research environments, is increasingly adapted to market requirements as modules within commercial software like PCI's Geomatica products, Leica Geosystems' Erdas Imagine and within Intermap's STAR production chain. The emergence of high quality INSAR products should not only be attributed to the efforts of geomatics software developers but certainly also to the efforts of hard working hardware developers. Their hardware products make carrying out complex computations so cheap and so fast.

As a result of increasing availability of advanced software packages going in trace with the seemingly never ending growth in electronic computation power, the time curve of radar based geo-data products is turning to become slant.

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