CRC for Spatial Information Project 4.09

New Technologies for Radar Interferometry

Radar is a means of measuring the distance and orientation of a target with respect to a radar signal transmitter. The technique has been extended to operate also as an imaging system known as synthetic aperture radar, or SAR, able to observe the surface of the Earth from platforms of varying altitudes, e.g. aircraft, space shuttle and satellite. The wavelength of radar (e.g. 3cm for X-band, 6cm for C-band, 24cm for L-band, 70cm for P-band) is used as a "ruler" to measure the distance between radar transmitter/receiver and the imaged ground features, which is encoded as phase. The orientation of a ground target is recorded as the relative position of the relevant pixel in the SAR image.

"Radar interferometry" is a technique to combine two SAR images of the same area by matching precisely the pixels representing the same ground feature, and then calculating the phase or distance difference between the two images to produce the so-called interferogram. This interferogram can be used to generate a digital terrain model (DTM), and even detect subtle changes of the ground surface. For example, the Shuttle Radar Topography Mission in 2001 mapped 80% of the world land mass within only 11 days.

Project 4.09 is a follow-on of the CRCSI Project 4.2 on radar interferometry. In the new project, the first objective is to study to the means of producing an ultra-high resolution (~1m rather than 20-30m achieved in Project 4.2) DTM with state-of-the-art airborne radar systems and new generation radar satellite missions such as TerraSAR-X (launched in June 2007).

The second objective of this project is to develop innovative techniques of mapping small changes in the geometry of the earth's surface, down to cm-level in near real-time and over a very large area with a pair of radar images. These techniques include the use of radar satellite constellations and a new technology known as ScanSAR. A radar satellite constellation is a group of three or more satellites carrying identical SAR sensors. Several such constellations are currently under development. For example, the SAR Lupe by the German military is a five satellite constellation, with 3 satellites already launched. The COSMO-SkyMed by the Italian Space Agency is a four satellite constellation, with two satellites already launched. With these constellations the time required for the satellite to revisit the same area could be reduced to one day or less (compared to the conventional one month revisit time), so that near real-time applications such as monitoring of underground nuclear testing, battlefield damage, natural hazard effects, and ground subsidence due to mining. The ScanSAR, on the other hand, can drastically increase the spatial coverage to 500km x 500km areas (from the conventional 100km x 100km) so that large scale phenomena such as the impact of drought on the Gunnedah or Murray-Darling Basin can be monitored.

The final objective of this project is to develop robust techniques to map subtle changes on the earth's surface down to mm-level using a "stack" of radar images. The research aim is to decrease the number of images required for such techniques from 20-30 to around 10, without compromising accuracy, so as to make the technique applicable to both urban and rural environments. Outcomes of this research could find a range of applications, such as monitoring the stability of important infrastructure foundations.