RESEARCH AREAS

GEODESY

AHW Kearsley, C Rizos, C Roberts, J Wang

The traditional strength of the School has been in fundamental research into Physical and Satellite Geodesy. Geodesy deals with the shape and size of the Earth, its Gravity Field, and variations in Geometry and Gravity. These days the powerful observing systems of the Global Positioning System (GPS), Satellite Laser Ranging (SLR) and other space positioning techniques, absolute and relative gravimetry, airborne and space-borne gravity mapping, satellite altimetry, and interferometric Synthetic Aperture Radar (InSAR), provide the raw data for high precision (sub-centimetre) positioning of points on the Earth's surface and above it. Applications include: establishment and monitoring of reference networks, geodynamics and deformation monitoring, Geoid height determination, height datum unification, and the prediction of offshore gravity from bathymetry.

IMAGE ANALYSIS AND RADAR REMOTE SENSING

L Ge, JC Trinder

Photogrammetry and remote sensing offer a wide variety of research challenges. Some of the research is undertaken within the School, other research is carried out in collaboration with researchers in the Centre for Remote Sensing and GIS, and the School of Computer Science and Engineering. Research areas include: digital image analysis for photogrammetry and remote sensing applications; digital elevation model determination from images (airborne or spaceborne platforms) and InSAR; imaging radar and backscatter modelling; landuse and urban monitoring; and machine vision applications of digital photogrammetry.

MULTI-SENSOR NAVIGATION SYSTEMS

C Rizos, J Wang

GPS on its own cannot provide continuous availability, e.g. signals can be easily obstructed by foliage, buildings and walls. It is therefore necessary to integrate several navigation 'sensors' into a single package that can provide continuous, high precision position and attitude information for applications such as mobile mapping (using CCD cameras), LIDAR (airborne scanning) and various types of geophysical surveys. The 'classical' integration is GPS with Inertial Navigation Systems (INS). Research challenges include: development of algorithms for fusion of data from different sensors; MEMS-INS investigations, integrating GPS/INS with 'pseudolites'; quality control processes; and specific application challenges such as Augmented Reality.

NEW POSITIONING TECHNOLOGIES

J Barnes, C Rizos, J Wang

Over the last few years the School's research has broadened to include not only the space-based positioning technologies of GPS and Glonass (and by the end of the decade the EU's new Galileo system), but also INS, pseudolites (ground-based "pseudo-satellite" transmitters), WLAN signals/beacons, and mobilephone signals themselves. In addition, fundamental research and development has started on GPS (& other signal) receiver design and customisation using several Software Development Kits. One project, for example, involved the design of improved firmware for a GPS receiver to be installed on the UNSW BlueSat microsatellite. Such capabilities will open new research challenges in areas of indoor positioning, weak signal tracking, bistatic radar applications of GPS, integrated/new generation receivers, and consumer-level positioning devices.

OPTIMAL ESTIMATION THEORY

J Barnes, B Harvey, C Rizos, J Wang

To underpin all research within the School of Surveying and SIS, it is necessary to undertake fundamental research into data analysis tools. These tools allow high fidelity functional and stochastic modelling to be carried out, to aid GPS and other geodetic analyses. Estimation techniques based on Least Squares (LS) are used, in its various manifestations as Bayesian LS, Kalman filtering, digital signal processing, time series analysis, and so on.

PRECISE GPS NAVIGATION

J Barnes, C Rizos, J Wang

The School has been researching algorithms for centimetre-level positioning accuracy using space-based techniques such as since the mid-1990s. Fundamental contributions include: improved functional and stochastic models for carrier phase observations; dual-frequency and single-frequency ambiguity resolution and validation; mid-range (<100km) and long-range (>100km) baseline estimation of a moving platform; attitude determination using multiple antenna systems; multipath mitigation techniques; software issues related to real-time implementation; network-based positioning strategies; integrated GPS and Glonass modelling; and Galileo signal studies. The SNAP laboratory is well equipped to continue research in these areas.

SMALL-SCALE DEFORMATION MONITORING

L Ge, C Rizos, C Roberts

GPS is well suited for precise static applications such as the detection of changes in position of benchmarks located on a deforming body. Examples of applications include ground subsidence due to underground mining or fluid extraction; structural monitoring of buildings, bridges, and other manmade structures; steep slopes in opencut mines, etc.; volcanoes and fault rupture zones. This research has been carried out within the School over many years, and includes monitoring of a volcano in Indonesia, a tall building in Singapore, ground subsidence in the Appin coal mining area south of Sydney, and post-seismic fault motion measurement in the Burakin area of Western Australia. The techniques used are GPS and differential interferometric SAR, and the research includes the techniques themselves, as well as the interpretation of the deformation.

TELEGEOINFORMATICS APPLICATIONS

J Barnes, L Ge, S Lim, C Rizos, J Wang

The convergence of several crucial technologies is about to herald a new age of mobile devices and services. 'Mobility' cannot ignore position, hence the combination of wireless telecommunications, mobile IT platforms/devices and low-cost positioning (using GPS and other sensors) represents an opportunity to deliver Location Based Services (LBS). These include the ability to provide to users, on demand, guidance information, 'yellow pages' services, L-commerce transactions, and much more, to PDAs and mobile phones. To make LBS services possible, data warehouses (or spatial data servers) are used to provide the raw data to Geographic Information Systems, which deliver the requested information to users via a web-interface, or any of the wireless physical link technologies. This is an area of research that interfaces closely with Telecommunications Engineering, Electrical Engineering and Computer Science.

TERRESTRIAL LASER SCANNING

B Harvey, AHW Kearsley

In Australia there are two Laser Scanners available to academic researchers, one belonging to the School of Surveying and SIS. A new research area in characterisation of the data 'clouds' generated by a scanner has been launched. The research seeks to understand the quality (e.g. accuracy) of the scanner measurements, as well as how the geometry of such scans can be defined in an internal and external sense.

DESCRIPTION OF LABORATORY FACILITIES

The School of Surveying and Spatial Information Systems has a number of laboratories that are used for both teaching and research. The laboratory facilities include the Geographic Information Systems (GIS) Laboratory, the Image Analysis (IA) Laboratory, the Surveying Applications and Computing (SAC) Laboratory, and the Satellite Navigation and Positioning (SNAP) Laboratory. All laboratories are equipped with state-of-the-art computing facilities (PCs, workstations, printers, digitisers, scanners), reflecting the fact that the disciplines of Surveying and Spatial Information Systems are IT intensive. Each laboratory has its own specialist software and hardware systems.

Geographic Information Systems (GIS) Laboratory

The GIS Laboratory is equipped with the full suite of ESRI ArcGIS software.

Image Analysis (IA) Laboratory

The IA Laboratory facilities include two sophisticated LH Systems Digital Photogrammetric Workstations, two Adam MPS-2 analytical plotters, and a

Rollei 6006 semi-metric camera with reseau for close-range photogrammetric applications. The laboratory also has software for interferometric SAR (Synthetic Aperture Radar) data processing: Atlantis (ENVI, Canada) and PulSAR (Phoenix Systems, UK).

Satellite Navigation and Positioning (SNAP) Laboratory
The SNAP Laboratory principally undertakes research into the technology and applications of the Global Positioning System (GPS). It is home to the largest research group in the school, of approximately 15 PhD students, 6 senior researchers and a number of research assistants. The laboratory is well equipped with a wide variety of GPS equipment (more than 20 each of dual-frequency and single-frequency receivers), several Software Development Kits, inertial navigation sensors, pseudolites, wireless coms and UHF radio equipment, and a range of ancillary equipment to support research into GPS and other wireless location technologies. The laboratory also has a range of GPS software systems, many developed inhouse, as well as the GAMIT and Bernese software packages.

Surveying Applications and Computing (SAC) Laboratory
The SAC Laboratory is equipped with software packages to aid teaching and research for field-to-finish surveying systems: GEOCOMP, and CIVILCAD. It also contains a number of software packages such as MATLAB, SKI, and others.

The School also has a Store, containing a wide range of field portable equipment: a large number of electronic tacheometers, theodolites, levels (laser and digital), a Cyrax 2400 Laser Scanner, a reflectorless total station, and high precision industrial measurement equipment and accessories (e.g. electronic barometers and temperature/humidity probes).

The facilities of the Centre for Remote Sensing and GIS, jointly administered by the School of Surveying and SIS and the School of Biological, Earth and Environmental Sciences, are also available to researchers. The CRSGIS has a range of GIS and remote sensing/image analysis software, including ENVI, ArcGIS, GENAMAP, ERDAS, and others.

FOR FURTHER INFORMATION:

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