NATIONAL REPORT OF FINLAND FOR PHOTOGRAMMETRY, REMOTE SENSING, GIS AND DIGITAL MAPPING 2000-2004

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ABSTRACT:

The national report of Finland outlines education and research developments in photogrammetry, remote sensing, GIS during period 2000-2004. The national report is based on papers and reports submitted to The Finnish Society of Photogrammetry and Remote Sensing by institutes and organizations active in the field of photogrammetry, remote sensing and GIS.

1. INTRODUCTION

The photogrammetric scientific research in Finland is conducted in Helsinki University of Technology, Department of Photogrammery and Remote Sensing and Finnish Geodetic Institute, Department of Remote Sensing and Photogrammetry. Also some companies have made remarkable research for their commercial products. In addition research concerning remote sensing is conducted in Laboratory of Space Technology, Helsinki University of Technology. Application areas of remote sensing in Finland are for example forestry, geography, geology and ice monitoring. Research related to these is done in several laboratories and institutes.

National organizations, municipal surveying offices and private companies practice mapping in Finland. The national organizations concentrate on small-scale mapping covering the whole country. Municipal surveying offices and private companies make large-scale maps related to their projects.

Education of surveying at the university level is centred at the Helsinki University of Technology (HUT) at the Department of Surveying. Fundamentals of photogrammetry and remote sensing are given also at some other universities. Three Geoinformation professorships exist is Finland.

2. OVERVIEW TO DEVELOPMENT OF PHOTOGRAMMETRY

Major development in photogrammetry in Finland during the past four years has concentrated to following topics:

- Direct georeferencing in aerial image acquisition
- Airborne laser scanning
- Terrestrial laser scanning
- Testing digital aerial camera

Direct georeferencing refers here to determination of image orientations from GPS/INS data and calibration parameters. The Aerial Image Centre, National Land Survey of Finland, has two GPS/INS units. Several tests have been carried out and results have been promising. Technique is expected to become operational in the future.

Airborne laser scanning techniques have been taken into operational use by national and private mapping organizations. Typical application area is road planning and construction and digital terrain model acquisition. Research is carried out concerning laser scanning quality, change monitoring, mapping and laser scanning in forestry. Airborne laser scanning systems has been rented from abroad. Terrestrial laser scanning system is alternative and supporting system to close range photogrammerty. At least one system has been provided by Finnish company and services are offered for scanner calibration. Terrestrial laser scanning has been applied to industrial measurement.

3. OVERVIEW TO DEVELOPMENT OF REMOTE SENSING

The Finnish remote sensing activity concentrates in the following three fields: construction of airborne microwave sensors, retrieval of geophysical parameters from air- and spaceborne optical and microwave sensors, and development of operational applications. In all of these fields remote sensing has been developed during the reporting period. Most resources have been used for developing operational applications in crop yield estimation, snow mapping, sea ice monitoring, forest inventory, SAR interferometry for determining digital elevation models and monitoring the environmental impact of mining activities. In sensor construction the main emphasis has been in developing microwave radiometers (interferometric) and radiometer calibration systems. Modeling of spectral signatures of snow, sea ice, forest and soil has been carried out during the reporting period.

During the past four year period operational use of satellite images has tripled in environment monitoring. Application areas are crop yield estimation, snow mapping, sea ice monitoring, oil spill detection, forest inventory and topographic database updating. In private markets interest in satellite image usage is focused on change detection and digital terrain model creation.

4. OVERVIEW TO DEVELOPMENT OF GIS AND DIGITAL MAPPING

The National Land Survey of Finland (NLS) is responsible for Finland's general mapping assignments. It also promotes the shared use of geographic information. Besides the National Land Survey of Finland there are private surveying companies and municipal surveying organizations producing maps. They produce normally large-scale maps for purposes like land use planning and road building. GIS has increased the need and production of digital map-data in cities and other municipalities. Private companies add value to the existing digital databases and produce high-class products for customers.

Classical cartography has been transformed mostly into digital cartography, and more generally into GIS. Map making has become more like just a part of the GIS data visualization process. To be useful GIS databases must be updated continuously. For example the National Land Survey of Finland uses digital orthophotos to update their land information. Stereo blocks are produced by National Land Survey Aerial Image Centre and delivered to local district survey offices, where to stereo blocks are compared to digital map database. All map data that the National Land Survey of Finland produces is nowadays in digital format. Digital map data is used for example for planning, follow-up, documentation, navigation, positioning, optimization, and in newspapers.

The Finnish Maritime Administration produces naval charts in Finland. Digital naval charts are now covering northern parts of the Gulf of Finland and the lake Saimaa. These naval charts can be used with GPS devices for real-time navigation.

5. EDUCATION AND RESEARCH

5.1 Education in Finland

Education in surveying at the university level is centred to the Helsinki University of Technology (HUT) at the Department of Surveying. There are two separate degree programs: Geomatics and Property Economics. The Geomatics include Geodesy, Photogrammetry, Remote sensing and GIS. Total intake is 90 of which 40 will study geomatics and 50 property economics and law.

During the period in question two doctoral, three licentiate and ten M. Sc. thesis have been accepted at the Institute of Photogrammetry and Remote Sensing at the Helsinki University of Technology. The dissertations were:

- Niini, Ilkka: Photogrammetric Block Adjustment Based on Singular Correlation, Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series 120 2000
- Jokinen, Olli: Matching and Modelling of Multiple 3-D Disparity and Profile Maps, Acta Polytechnica Scandinavica, Mathematics and Computing Series 104 2000
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There are also a number of other institutions, which are selectively active in photogrammetry, remote sensing and GIS education. Laboratory of Space Technology at the Helsinki University of Technology has professorship in remote sensing, University of Helsinki has two professorships in geoinformatics, in Department of Geography and Department of Forest Resources Management. Department of Forestry at the University of Joensuu is also active in remote sensing. Courses in photogrammetry are available in University of Tampere.

5.2 Research activities

5.2.1 Finnish Institute of Marine Research (IMR)

The research areas at Finnish Institute of Marine Research (FIMR, http://www.fimr.fi) are remote sensing of the Baltic Sea ice using SAR data, remote sensing of oil slicks in the Baltic Sea, and remote sensing of clorophyll (algae blooms) from optical/IR data. The Finnish Ice Service (FIS), an operational part of FIMR, uses remote sensing data from multiple sources (e.g. NOAA AVHRR, Radarsat-1, Envisat ASAR) to produce the daily ice charts over the northern Baltic Sea during the ice season (typically from February until May). These ice charts are also available in digital form, and can thus easily be compared to SAR data, and be used in validation of the automated sea ice products.

FIMR has an automated operational sea ice thickness monitoring system based on Radarsat-1 ScanSAR wide mode data. The resulting ice thickness charts are automatically transmitted to end-users after a SAR image has been received and the processing. We have also developed a wavelet-based compression algorithm for the SAR images, such that the data can be transmitted to end-users in high resolution.

Remote sensing research at FIMR is concentrated on utilization of the Envisat ASAR and Radarsat-2 data in operational sea ice monitoring (projects: ESSI, EnviSat and Baltic Sea Ice conditions, funded by the National Technology Agency, Tekes, 2000-2001 (phase I), 2003-2005 (phase II); ICEMON, sea ice monitoring for climate research, environmental management, resource exploitation and marine operation safety in Polar Regions, funded by ESA under GMES/GSE Consolidation Phase, 2003-2004; IWICOS, Integrated weather, ice and ocean service system, funded by EU, 2000-2002), remote sensing of oil slicks from SAR images to develop an operational oil spill monitoring system (project: OILI, Oil spill detection information in the Baltic region, funded by Tekes, 2003-2005) and defining the ice ridging parameters from SAR images (project: IRIS, Ice Ridging Information for Decision Making in Shipping Operations, funded from the EU 5th framework programme, 2003-2005). These projects are performed in co-operation with several partners. The most important domestic partners are Helsinki University of Technology (HUT), Technical Research Centre of Finland (VTT) and Finnish Environment Institute (SYKE).

In ESSI the use of Envisat ASAR data have been studied for operational use in Baltic Sea ice monitoring, and the classification algorithms are developed based on both Radarsat-1 and Envisat ASAR data combined with field measurements. An improved operational sea ice classification algorithm for the Baltic Sea ice will be developed and adjusted for both Radarsat and Envisat ASAR data. Also the possibilities of dual polarization will be studied based on Envisat ASAR data.

In OILI the possibilities to use SAR data for oil spill monitoring are studied, the limits of the wave conditions in which oil spills can be detected from SAR images will be defined, and an algorithm for these conditions will be developed, to be integrated as part of an operational monitoring system.

The objectives of IRIS are to increase the resolution and accuracy of the traditional routine ice chart by adding new informative elements of in situ and forecasted ridging parameters, and to include ridging to ice information, and provide the forecasts of ridging resolving operative models as time series.

The objective of ICEMON is to design and implement an integrated monitoring service for sea ice and related atmospheric and ocean processes in Polar Regions using satellite earth observation data in combination with in situ observations and modelling methods.

The objective of IWICOS was to develop the marine information system prototype, where users could use the single point entry for the use of various users including weather offices, ice services and research institutes. At FIMR also SAR image classification algorithms were developed as part of the IWICOS project.

5.2.2 Finnish Environment Institute (FEI)

The Finnish Environment Institute (FEI) is both a research institute, and a centre for environmental expertise serving whole Finnish environmental administration, local authorities, general public and private industry. The Geoinformatics and Land Use Division (GEO) looks after the Finnish Environmental Administration geographical information systems and remote sensing data, while also maintaining and developing information systems related to land use in Finland. There are 30 people working at GEO, operational environmental monitoring. The number of acquired satellite images has increased from about 300 image in 2000 to about 850 image in 2004. Images are mainly low spatial resolution NOAA/AVHRR and MODIS-images, but higher resolution Landsat TM/ETM and Radarsat images are used when needed. The main operational tasks are snow-melt monitoring during spring-time and water temeprature and algae monitoring during summer.

All research projects are co-operation projects with national and international research organizations. Main research topics during 2000-2004 have been:

- Oil spill detection using EO data, near-real-time dissemination of information and combination with drifting models
- Database system for EO data
- Data assimilation between EO data, ground measurements and environmental models
- CORINE2000 land cover classification
- Water surface temperature and quality parameters (chlorophyll, turbidity, algae) for sea and lakes
- Snow melt monitoring covering whole Finland

5.2.3 Finnish Geodetic Institute (FGI)

Finnish Geodetic Institute, Department of Remote Sensing and Photogrammetry, concentrated in laser algorithms and applications, SAR data analysis, digital photogrammetry, and modelling and analysis of BRDF effects.

Photogrammetry (photogrammetry and laser scanning) at the Finnish Geodetic Institute:

- The FGI has carried out photogrammetric research in the following areas:
- Development of a quality control system for a countrywide orthophoto production project and functioning as a quality adviser
- Development of test fields for photogrammetry, laser scanning, remote sensing and mapping
- Development of quality indicators for digital aerial images
- Quality and calibration of direct georeferencing
- Coordinates EuroSDR project on Building Extraction to compare photogrammetric and laser scanning techniques in building extraction.
- Handbook on the quality of laser scanning
- Development of change detection methods for airborne laser scanners, i.e. the estimation of forest growth and monitoring of harvested trees.

Remote Sensing at the Finnish Geodetic Institute:

The FGI has carried out remote sensing research in the following areas:

- Automation of map updating using aerial images, photogrammetry and GIS
- The use of SAR images in mapping and map updating were investigated and methods for automatic interpretation of the images were developed. In 2002-2003, the research concentrated on land-use mapping using interferometric European Remote Sensing Satellite (ERS) data and high-resolution ESAR data.
- The use of SAR for crop monitoring
- The use of permanent scatterers to detect land subsidence
- The correction of BRDF effect in aerial images
- Development of field goniometers for BRDF measurements

5.2.4 Geological Survey of Finland (GTK), Remote Sensing Laboratory

Remote Sensing Laboratory at GTK is specialized in hyperspectral remote identification and mapping of geological and environmental objects. It offers a base for projects dealing with utilization of remote sensing. Currently, the laboratory is equipped with a portable spectrometer, electromagnetic radiation sources, a non-reflecting sample shelf and systems for controlled moving of imaging and portable spectrometers to scan the sets of objects on the shelf.

At GTK, hyperspectral remote sensing (electromagnetic wavelengths 400-2500 nm) is used to study environmental features, bedrock and soil geology, indications for ore deposits and industrial minerals and environmental contamination. Spectroradiometric measurements of samples and hyperspectral test imaging are carried out in laboratory from near distance. Imaging of field targets is done from airplane. Hyperspectral satellite imagery is being tested, too (for reports see: http://info.gsf.fi/eng/).

The latest completed European project studied ‘Assessing and monitoring the environmental impact of mining activities in Europe using advanced Earth Observation techniques’ (MINEO) This project developed key components of the decision-making tools to exploit Airborne and Earth Observation data and facilitate their use to locate and monitor

environmental risks related to mining sites and aid the decision processes. Such tools will give the sound basis for effective environmental management through a dialogue between industrialists and decision-makers, ensuring a sustainable development of the mineral industry, which faces increasing environmental pressure and regulatory controls. MINEO was funded and carried out within EU FP5 IST-Program by Geological Surveys of Finland, France, Denmark, Austria, Germany, Portugal and UK, Deutsche Steinkohle, Environmental Agencies of Denmark and France during years 2000-2003 (for reports see: http://www.brgm.fr/mineo/).

In near future, the emphasis of the activities at the Remote Sensing Laboratory will be on assessment of (geo-) environmental impact of mining and other industries and remote identification of mineral materials.

5.2.5 Helsinki University of Technology (HUT)

Institute of Photogrammetry and Remote Sensing

The emphasis of research has been analytical photogrammetry ever since the foundation of the Institute in 1960. In the 1960s and 1970s its methods were under strong development, and their practical applications have provided us favorable feedback indeed. The research in photogrammetric and measuring instruments was obligatory for the development of analytical photogrammetry.

In early 80ies the research concentrated on digital image processing, the objective being the automatization of photogrammetric processes. Moving from analytical methods into digital ones required, among other things, acquaintance with the geometric properties of digital images. Also the means to 3-D pattern recognition in photogrammetry needed, and still need, to be found.

During the last half of the 80ies, the research activities within the Institute have moved onto the extensive use of digital images in order to automatically derive 3-D geometric information of generally any kind of objects. Traditionally, the discipline of photogrammetry and remote sensing has become known as the mathematical and technical part of producing 3-D information, or topographic and thematic maps, from land. The images used for this information extraction have varied from airborne analog images to spaceborne digital images.

Currently photogrammetric procedures are utilized in the same manner for non-topographic applications, as well. The digital images are acquired by solid-state video cameras and these 'living' images, if processed in real-time, are used for the variety of both scientific and practical tasks, like geometric scene-analysis and manufacturing control measurement. Recursive methods of estimation, use of satellite images in the inventory of natural resources, and stability of analytical plotters have also been within the field of our research in the last years. The work commissioned to us has been applications of aerial as well as of terrestrial photogrammetry to both 3-D coordinate determination and mapping.

Laboratory of Space Technology

The main research areas in remote sensing at the Laboratory of Space Technology (LST), Helsinki University of Technology (http://www.space.hut.fi), are development of methods to retrieve geophysical parameters from the data of spaceborne sensors for various applications, operation of the LST research aircraft and construction of active and passive sensors. LST participates in several international research projects funded by the European Space Agency and European Union. The annual research output includes from 10 to 20 international journal articles and dozens of international conference reports. The total amount of person-years is around 30.

The main applications are forest (development of forest monitoring and management systems), snow and hydrology (operational optical/microwave snow extent and melt monitoring; retrieval of snow water equivalent; flood monitoring; soil moisture), sea ice (ice extent and deformation) and water quality (monitoring techniques for lakes and the Baltic Sea).

In sensor technology resarch the emphasis is on the development of interferometric microwave radiometry. This includes the construction and operation of airborne 2-dimensional interferometric (synthetic aperture) radiometer and design of on-board calibration systems, noise injection radiometers and ground support systems for the ESA SMOS satellite mission (1.4 GHz radiometer system that will produce global data on soil moisture and sea surface salinity). The airborne HUTRAD system (6.8 to 94 GHz) of LST has been in operation since 1998.

5.2.6 Tampere University of Technology, Department of Civil Engineering

The research in the field of photogrammetry is mainly focused to the general needs of civil and construction engineering.

5.2.7 University of Joensuu, Faculty of Forestry

The research at the University of Joensuu, Faculty of Forestry has concentrated on forestry applications of remote sensing, and GIS. These applications include forest inventory and monitoring of forest resources as well as detailed forest information. During recent years especially high resolution remote sensing data including satellites, digital photographs, video and laser scanning images has been utilised. The most important projects during recent years are described below.

- Forest Information Assessment and Updating' (1999-2002), funded by Finnish Ministry of Agriculture and Forestry, was a project where methods based on remote sensing were sought for stand-level inventories in private forests. The project participants were University of Joensuu, Finnish Forest Research Institute, Forestry Centre Pohjois-Savo and Forestry Development Centre Tapio.
- Earth Observation for Natura 2000+ (EON2000+)' is an RTD project co-funded by the European Commission as part of the 5th Framework Programme. The project is a partnership of 14 members from seven European countries working for a duration of three years (2001-2004). The other Finnish partner is the Finnish Environment Institute as an end-user. The aim of the EON2000+ project is to develop and demonstrate integrated indicators of environmental state and socio-economic pressures for environmental protection purposes in support of the conventions on Biodiversity and European Biodiversity Strategy. The suitability of the Very High Resolution satellite data for the environmental monitoring was tested in Joensuu.

- In the project 'The Usability of Single Tree Laser Scanning in Forest Planning' (2002-2004) funded by the Academy of Finland laser scanning data is used to produce height estimates of individual trees which can then be used as a basis for the prediction of forest stand estimates. The other participant of the project is Finnish Geodetic institute, Department of Remote sensing and Photogrammetry.
- Evaluation of the suitability of the ICP data set for forest biodiversity monitoring' (2002) was a project funded by European commission, Directorate general JRC, Joint research centre, Insitute for Environment and Sustainability, Management Support unit. In the project the ability of European level forest condition monitoring data to describe also forest biodiversity was tested.
- In the study 'The use of a superresolution method in interpretation of forests from multiple NOAA/AVHRR images' the objective was to clarify whether it is possible to recognize forested and non-forested areas from NOAA/AVHRR images more accurately using a superresolution method than when using the original images.

6. SCIENTIFIC ORGANIZATIONS

6.1 Education and scientific organizations

EVTEK, Espoo-Vantaa Institute of Technology
Leiritie 1, FIN-01600 Vantaa, Finland
http://www.evtek.fi

Finnish Environment Institute
PO Box 140, FIN-00251 Helsinki, Finland
http://www.vyh.fi/eng/welcome.html

Finnish Geodetic Institute
Geodeetinrinne 2, P.O.Box 15, FIN-02431 Masala, Finland
http://www.fgi.fi/index_eng.html

Finnish Meteorologigal Institute
P.O. BOX 503, FIN-00101 HELSINKI, Finland
http://www.fimr.fi/fi.html

Finnish Institute of Marine Research
P.O Box 33, FIN-00931 Helsinki, Finland
http://www.fimr.fi/fi.html

Geological Survey of Finland (GTK)
P.O.Box 96, FIN-02151 Espoo, Finland
http://www.gsf.fi/

Helsinki University of Technology, Institute of Photogrammetry and Remote Sensing
P.O Box 1200, FIN-02015 HUT, Finland
http://www.foto.hut.fi/

Helsinki University of Technology, Laboratory of Space Technology
P.O Box 3000, FIN-02015 HUT, Finland
http://www.space.hut.fi/

University of Tampere, Department of Civil Engineering, The Laboratory of Geoinformatics
P.O. Box 527, FIN-33101 Tampere, Finland
http://www.ce.tut.fi/index_e.html

University of Helsinki, Department of Geography
P.O. Box 64, FIN-00014 University of Helsinki, Finland
http://www.helsinki.fi/geography/

University of Helsinki, Department of Forest Resource Management
P.O. Box 27, FIN-00014 University of Helsinki, Finland
http://www.honeybee.helsinki.fi/mmvar/

University of Joensuu, Faculty of Forestry
P.O.Box 111, FIN-80101 Joensuu, Finland
http://www.forest.joensuu.fi/index.php

Technical Research Centre of Finland,VTT Automation, Remote Sensing Group
P.O. Box 1304, FIN-02044 VTT, Finland
http://www.vtt.fi/aut/rs

6.2 The Finnish Society of Photogrammetry and Remote Sensing

The Finnish Society of Photogrammetry and Remote Sensing (1931-) is devoted to the research and development of photogrammetry and remote sensing in Finland. The Society gives recommendations for aerial photogrammetry. Last recommendation has been Recommendations for the Use of Digital Aerial Images (issue 1/1998), in Finnish. This publication is also available in CDROM.The most notable part of the work of the Society is to publish The Photogrammetric Journal of Finland (http://foto.hut.fi/seura/pjf.html).

Finnish Society of Photogrammetry and Remote Sensing
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http://foto.hut.fi/seura/fsprs.html

7. ACTIVITIES IN INTERNATIONAL ORGANIZATIONS

7.1 International Society for Photogrammetry and Remote Sensing (ISPRS)

The Society is member of the International Society for Photogrammetry and Remote Sensing. Contact persons of the ISPRS are:

I:	Juha Vilhomaa
II:	Maarit Mikkelsson
III:	Eija Honkavaara
IV:	Lassi Lehto
V:	Petteri Pöntinen
VI:	Arzu Cöltekin
VII:	Markus Törmä
VIII:	Jenni Vepsäläinen

Mrs. Aino Savolainen is the honorary member of the ISPRS.

7.2 EuroSDR (EuroSDR is an acronym for European Spatial Data Research)

Prof. Dr. Risto Kuittinen is president of EurSDR Steering Committee.