RESEARCH ACTIVITY IN THE FIELD OF REMOTE SENSING

IN WESTERN AUSTRALIA

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ABSTRACT

The paper gives a review of the remote sensing research conducted in Western Australia. Details are given about the activities at Commonwealth Scientific and Industrial Research Organization (CSIRO), Murdoch University, Department of Lands and Survey and of the different departments at the Western Australian Institute of Technology (WAIT).

1. Commonweath Scientific and Industrial Research Organization (CSIRO)

Address: CSIRO
Underwood Street, FLOREAT PARK WA 6014.

CSIRO is an Australian Government research organization engaged principally on applied research into industrial, scientific and community problems.

The Division of Land Resources Management (LRM) is involved in research into management and environmental problems associated with or as consequences of conflicting land uses. Remote sensing plays an important role in these activities by providing inventories of resources and the environment, and to monitor changes and the effects of utilization of the resources.

The projects undertaken by the remote sensing group in LRM are divided into two main areas, research and application.

The research interests of the group are principally in the development of techniques, software and hardware for analysis of satellite data, mainly LANDSAT but with increasing work on other sources such as TIROS Advanced Very High Resolution Radiometer (AVHRR), NIMBUS Coastal Zone Colour Scanner (CZCS) and the Heat Capacity Mapping Mission (HCMM). Facilities include an image processing system based on an HP1000 (21MX-E) computer with 256 kbytes memory, a 50 Mbyte disc, dual density magnetic tape drive, a GRINNELL interactive colour display system, with 512 x 512 pixels and 4 bit planes per colour, and an OPTRONICS PHOTOWRITE (black and white) which is presently being modified using three lasers to a single pass colour film recorder.

Software for the system has and is being developed by the group. Current software includes destriping, contrast enhancement, ratioing, spatial filtering (high and low pass), cluster analysis and classification. The group is working on geometric rectification, merging and overlaying of different images and data types (for example geophysical and geochemical data), and integration of the data into data base systems.

A package of interactive programs for analysis of LANDSAT data on DEC system 10 computers (large, general purpose interactive machines) has been developed and released to several computing centres at Universities and Institutes of technology throughout Australia. Unfortunately these programs are not transportable to other machines than DEC 10. They provide a rapid inexpensive means for detailed analysis of LANDSAT data, and are suitable for routine application, or for educational purposes.

Complementary to this research is activity in aerial photography and radiometric measurement. The group has 2 Hasselblad cameras with 500 frame magazines and a variety of lenses and filters. Radiometric data is recorded using EXOTECH ground truth radiometers with LANDSAT equivalent bandpasses and a BARNES PRT-5 thermal radiometer with a bandpass of 10.5 - 12.5 micrometers. Other radiometers are being developed as precursors to the development of a modular airborne multispectral scanner.

The applications areas being investigated include forest condition and disease mapping, wetlands inventory and monitoring, range condition assessment and soil erosion monitoring, mineral exploration and management of mined areas, water resource assessment, bathymetric mapping, sea surface temperature and water movement, and animal habitat studies. As the group is small, active collaboration with outside "user" groups is essential.

The above summary has been prepared by Dr. F.R. Honey, CSIRO, WA Division.

2. Murdoch University.
Address: Murdoch, Western Australia 6150.
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At Murdoch University in the School of Environmental and Life Sciences intensive researches are being conducted in the field of the use of conventional photographic multispectral techniques in

(a) the mapping of vegetation

(b) the monitoring of plant diseases such as jarrah dieback and

(c) the determination of the spectral characteristics of the radiation reflected by various plants.

Although the approach tends to be conventional, its uniqueness consists in its application to arid zone vegetation, and in the use of hand-held 35 mm and 70 mm focal length cameras from light aircraft from low altitude.

Researcher: Professor Desmond O'Connor, Murdoch University, W.A.

3. Department of Lands and Survey, Western Australian Division.
Address: Cathedral Avenue, Perth WA 6000.

The Department of Lands and Survey WA Division is the designated co-ordinating Authority of State Government users of LANDSAT data. In 1979 approximately 150 usable LANDSAT images were recorded over

Western Australia mostly for the use of (a) pastoral appraisement, (b) rangelands management, (c) water resources, (d) geological survey, (e) forest resources and (f) environmental protection.

Pastoral appraisement and rangelands assessment studies using LANDSAT data continued in the Kimberley and Ashburton River regions of the State, while preliminary investigations were undertaken in the Nullabor region. The studies involving staff from the Department of Lands and Survey, Department of Agriculture and the CSIRO, Division of Land Resources Management are aimed at establishing applied procedures for monitoring degraded pastures and mapping vegetation patterns. The use of maps derived from LANDSAT data indicating an initial interpretation of degraded land and mapped vegetation patterns will be used as a primary basis for more detailed rangeland surveys. Analysis of digital data combined with field survey and sampling in the Ashburton catchment was directed at detecting trends in rangeland condition. This study will continue for another year in the Kimberley and at least two years in the Ashburton region.

The application of first generation LANDSAT imagery to regional geological surveys continued in the North West coastal regions and expanded to the Kimberley district. The Geological Survey section of the Department of Mines is in charge of this research.

The Soil Conservation Section, Department of Agriculture, attempted to assess LANDSAT's potential to delineate drought affected crop areas where top soil stripping has occurred. Subject to the availability of suitable data this study will continue.

Imagery covering the Southern region of the State (later 1979) is being analysed for water resource inventory purposes (Department of Fisheries and Wildlife, Public Works Department). Annual coverage was sought to aid conventional assessment procedures. No finalised report on this work is available, development of computer programmes capable of extracting water areas are in progress.

LANDSAT imagery covering remote parts of the State (Mitchell Plateau) have been provided to the Forests Department for reconaissance surveys. Inventory projects over hardwood and softwood forests depend on computer software development.

The Bush Fires Board and Fisheries and Wildlife Department have used LANDSAT images to provide a ready index of bushfires, including fireburn histories (where multi-temporal data was available), extent and burn intensity.

The Wetlands Advisory Committee, Department of Conservation and Environment was interested in developing a multi-level remote sensing approach to monitor wetlands. LANDSAT imagery has been used in a number of studies, undertaken by the Department of Conservation and Environment mainly as a base for map overlays.

Enquiries may be addressed to Mr. H. Houghton, Liaison Officer, Department of Lands & Survey, Surveyor General's Office.

4. Western Australian Institute of Technology
Address: Hayman Road, BENTLEY WA 6102

At the Western Australian Institute of Technology several research projects are in progress and accomplished including hardware and software developments. The staff and graduate student project are financed by the Institute or sponsored by different agencies.

4.1 Department of Electrical Engineering.

Two projects involve the design and construction of receivers capable of collecting and processing data from orbital satellites.

The first project uses the USA Navy Navigational Satellite System (NNSS). The principle of positioning used relies on accurate orbital details from any one of six satellites and a count of the doppler frequency change as that satellite passes through the field of view during precise time intervals. This enables the geometric distance between the satellite and the receiver (slant range) to be evaluated and thereby the position on the earth's surface to be established. Multiple-pass calculations yield accuracies of less than 10 metres for position fixing. The receiver consists of two main sections, a dual-frequency (400/150 MHz) narrow bandwidth, automatic frequency tracking, phase demodulator module and a digital processor module.

Development thus far has enabled manual tracking on the 400 MHz channel to be achieved and the phase-encoded data to be demodulated. The mass-storage module had been completed and initial software routines developed to process the digital data. Further work on completing the 150 MHz channel and automatic tracking together with software for generating the co-ordinate values are currently proceeding.

The second project uses the Japanese Geostationary Meteorological Satellite (GMS) and will be extended to incorporate the polar orbiting TIROS-N satellite. At this stage, low resolution visible and infrared cloud cover meteorological data is being collected and forms the basis of experimental work for final year undergraduate engineering students. Both GMS and TIROS-N transmit high resolution meteorological data from which additional information on sea surface temperatures, to within 1 ^{o}C, can be measured. This temperature information is of potential value in fisheries, oceanography and in aspects of meteorology.

Reception and extraction of the temperature information from GMS is the main project throughout 1980 with new work on TIROS-N to commence later the same year. Academic staff involved in these projects include Dr. W. Carroll and Mr. I. James.

4.2 Department of Mathematics and Computing Studies

The projects firstly are designated to display satellite data in graphical form and then to develop methods for classifying and measuring data corresponding to various ground features.

Preliminary work was done on data from NIMBUS satellite using the PASCAL language with a few FORTRAN sub-routines. In general PASCAL proved satisfactory for the large amount of data manipulation required and the facility for including FORTRAN routines enabled existing interpolation sub programs to be used.

Work on the LANDSAT data is an on-going project. The data analysis programs have been written in FORTRAN with the use of various non-standard extensions to the language and a very few library sub-routines, INDUS and ISHIFT, written in assembly language. This has allowed the work to be shared by various programmers and will allow easier access by other users.

Further enquiries may be addressed to Dr. P. Hodgson, WAIT.

4.3 Department of Physics

During the past two years research has been initiated into meteorological applications of satellite data. In the main the analysis has been concentrated on NIMBUS 6 microwave data (SCAMS). Specifically, multi-frequency microwave effective brightness temperature information at 22 GHz (water vapour line), 32 GHz (atmospheric window), 52.8, 53.8 and 55.4 GHz (oxygen band) have been processed to yield water vapour, cloud water content, precipitation estimates and surface wind speeds. Correlations with synoptic data have been undertaken. The investigations have been conducted both over-land and over-sea. Unfortunately the pixel size for SCAMS data is large ($\simeq$ 145 km), but with improved radiometers planned, the contribution to be made by microwave data holds excellent potential. Nimbus 6 data from an alternate microwave sensor (ESMR) is presently undergoing analysis and will be compared with infra-red data.

Without doubt there is considerable interest in improving the contribution that satellite retrieved data is making to oceanography. In that sea state is primarily linked through the sea-air interaction to the condition of the overlying atmosphere, the analysis of over-sea infra-red and microwave data has much to offer to the oceanographer. While extensive research remains to be done, particularly in developing and validating appropriate algorithms, the prospects for satellite determined ocean current measurements remain optimistic.

A review of the current state of the art for atmospheric remote sensing by Lhermitte (1979) and in satellite oceanography by Huang (1979) are worthy of note. A number of Internal Reports arising from research activities within the Department of Physics (Beall 1978, Beer 1978, Glasbergen 1979) are available.

REFERENCES

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3. Glasbergen, P.T. Satellite Microwave Data Analysis. Project Report, Department of Physics, Western Australian Institute of Technology, 1979.

4. Huang, N.E. New Developments in Satellite Oceanography and Current Measurement. Rev. Geoph. and Space Physics, 17, 1558-1568, 1979.

5. Lhermittee, R. Advances in Remote Sensing of the Atmosphere. Rev. Geoph. and Space Physics, 17, 1833-1840, 1979.

All enquiries may addressed to the researcher in charge, Dr. M.J. Lynch.

4.4 Department of Surveying and Mapping

(a) NAVSAT Doppler Fixing

A computer programme "Space Fit" has been developed which uses as input latitude, longitude and height as output by any satellite processor and converts this data into the national spheroid and datum for any country given three known stations. The programme is being used to investigate whether further densification of satellite control is better referred to local stations by least squares fit than by using the universally adopted transformation constants.

All enquiries may be addressed to the developer and programmer, Dr. L.A. White, Department of Surveying and Mapping.

(b) Bathymetric Mapping From LANDSAT Data

This is an on-going area of student research and programmes have already been developed to provide contours from LANDSAT imagery.

(c) The research is dealing with the dynamic systems applied to LANDSAT satellites and encompasses a detailed error analysis related to (a) object (earth), (b) sensor platform, (c) sensor related and (d) processing related errors. A program package has been developed to deal with the geometric correction of LANDSAT MSS data and nine images have been tested to prove the applicability of the suggested method.

(d) The Use of LANDSAT MSS Data For Regional Planning

Staff and students are carrying out project work in this area to demonstrate the feasibility of the technique.

Enquiries in connection with points (b), (c), and (d) may be addressed to Mr. J.A. Szorenyi, Department of Surveying and Mapping, WAIT.

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