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Final Report
January 10, 1999

Enhancement of Capabilities in Hyperspectral and Radar Remote Sensing for Environmental Assessment and Monitoring

(COE/97-0045)

Principal Investigator- George F. Hepner, Professor
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NASA Center of Excellence Program
NRA 97 MTPE-05
Dr. Ming-Ying Wei, NASA HQ Program Officer

Impact on the University and Community

The University of Utah, Department of Geography has maintained a research and instructional program in satellite remote sensing and image processing for almost 30 years. Our program is the primary department involved in remote sensing research and instruction at the University of Utah. Our Digitally Integrated Geographic Information Technologies Laboratory (DIGIT Lab) supports both instructional and research activities in the Department of Geography and several other departments across campus (http://www.geog.utah.edu /geography/geog.html). Laboratory research funds subsidize the staffing, training costs, hardware acquisition, and software support costs for our instructional programs in remote sensing, GIS, and cartography..

Our existing instructional and research programs in remote sensing and image processing are greatly expanded and enhanced by the NASA COE support to include new offerings in the integrative use of hyperspectral imagery for environmental analysis and modeling. The new software and hardware are being integrated into our existing curriculum as we make the transition from the quarter system to the semester system (1998-99).

Our NASA Center of Excellence proposal requested funds for the purchase of ENVI software licenses with Interactive Data Language (IDL) development tools, mass storage for handling the massive hyperspectral imagery data sets, upgrades for our central data server to handle the additional storage capacity, a spectroradiometer for field data collection, and faculty and staff training and support. We have accomplished acquisition of all of these items, in addition to providing outreach activities beyond the scope of the original proposal.

Hardware/Software Enhancements (SF 272-A – Attachment I)

Software

15 seat ENVI lab kit

1 UNIX IDL/ENVI development license

1 NT IDL/ENVI development license

Technical and License Support

Hardware

1 ASD Fieldspec VNIR Spectroradiometer
with high intensity reflect. probe/access.

SUN Storedge D1000 Disk Array 144GB with Veritas volume manager and file system

1 Gateway E4200-400 workstation (purchased with UofU matching funds)

1 SUN Ultra 10 workstation (purchased with UofU matching funds)

ENVI training (2 faculty- 1 staff)

George F. Hepner, Professor

Richard Forester, Assistant Professor

John Norton, Technical Support

Technology Transfer/Outreach Activities

"Hyperspectal Imagery Analysis" – departmental colloquium presentation May 26, 1998.

"Overview of Hyperspectral Remote Sensing of the Environment" single-day workshop for individuals from private sector, government and the university community. Participation of 22 persons on November, 17, 1998.

Seminar –Hyperspectral Imaging of the Environment, Geography 6960, Spring, 1999.

Discussion of Project Results

Enhancement of the University Infrastructure

The ENVI software provides an excellent mix of traditional and advanced (hyperspectral and radar) image processing features with a straightforward interface that allows users to focus on analysis rather than software commands. The Interactive Data Language (IDL) development tools provide graduate student and faculty researchers with the flexibility to create their own routines and applications. We purchased a 15 seat ENVI lab kit and two development licenses (one UNIX and one NT) to support a multi-disciplinary special topics course in advanced hyperspectral and radar image processing,

complement existing courses in remote sensing, and to support faculty/graduate student research endeavors.

George F. Hepner, PI, Richard Forester, new assistant professor in the Geography Department and John Norton, the technical support/programmer for the project completed a 3-day training course on the ENVI software. We have a knowledge base sufficient to meet the needs of our instructional and outreach activities for the future.

Since hyperspectral data sets are substantially larger than traditional multi-spectral imagery, additional mass storage was needed to store and serve both software and imagery data sets to users. The NASA funds were used to purchase additional storage capacity to allow the Department to store and serve imagery data sets to other researchers and regional environmental agencies increasing the availability of these resources to more users. In addition to the substantial storage requirements of hyperspectral data sets, their efficient processing require additional computation power, particularly in the research setting, where data sets are likely to be very large.

The University of Utah provided a $12,297.00 match to the NASA support. These funds were used to purchase two workstations which were used to run the ENVI/IDL full development software for the creation and testing of research and instructional materials.

A field spectroradiometer capable of recording data in the range of 400nm to 2500nm with at least 10nm spectral resolution was necessary to extend instruction and research involving the collection and classification of spectra. With this equipment and associated software, it is possible to collect and record field spectra and to perform basic spectral analysis procedures. The analysis of these data is to provide improved interpretation of data from airborne imaging spectrometers, (e.g., AVIRIS). We evaluated several devices and purchased an ASD VNIR Fieldspec device with several accessories to allow us to undertake field spectra collection and analysis.

John Norton was hired as the technical support person for the project. John provided assistance in software and hardware installation. John undertook IDL programming to develop software that would allow us to transfer data from the field spectrometer to ENVI. He was involved in the web page creation for the advertising and

registration for the community workshop held in November, 1998 and the seminar offered in Spring, 1999.

Technology Transfer/ Outreach

Educational activities included a departmental colloquium on presentation May 26, 1998 (Attachment II). This presentation was open to the University of Utah community. Approximately 30 persons attended the session.

A single day workshop for individuals from private sector, government and the university community was conducted on November 17, 1998. This workshop was attended by over 20 people from the US Forest Service, Barrick Gold Exploration, Kennecott Exploration, Bureau of Land Management, Utah State University and several other agencies and universities (Attachment III).

The COE project has led to the creation of a research seminar for the Spring Semester, 1999. Currently, 11 students are involved in the course from a variety of backgrounds (Attachment IV).

FEDERAL CASH TRANSACTIONS REPORT

(See instructions on the back. If report is for more than one grant or assistance agreement, attach completed Standard Form 272-A.)

Approved by Office of Management and Budget, No. 80-R0182

1. Federal Sponsoring agency and organizational element to which this report is submitted: NASA/GSFC

2. RECIPIENT ORGANIZATION

Name: University of Utah Research Accounting

Number and Street: 201 S Presidents CIR RM 406

City, State and ZIP Code: Salt Lake City, Utah 84112-9020

3. FEDERAL EMPLOYER IDENTIFICATION NO.: 87 6000525

4. Federal Grant or other identification number: NAG5-6646

5. Recipient's account number or identifying number: 56000045

6. Letter of credit number:

7. Last payment voucher number:

Give total number for this period

8. Payment Vouchers credited to your account:

9. Treasury checks received (whether or not deposited):

10. PERIOD COVERED BY THIS REPORT

FROM (month, day, year): 12/1/97-11/30/98

TO (month, day, year): FINAL

11. STATUS OF FEDERAL CASH *(See specific instructions on the back)*

a. Cash on hand beginning of reporting period	$0.00
b. Letter of credit withdrawals	$91,865.00
c. Treasury check payments	$0.00
d. Total receipts (Sum of lines b and c)	$91,865.00
e. Total cash available (Sum of lines a and d)	$91,865.00
f. Gross disbursements	$91,865.00
g. Federal share of program income	$0.00
h. Net disbursements (Line f minus line g)	$91,865.00
i. Adjustments of prior periods	$0.00
j. Cash on hand end of period	$0.00

12. THE AMOUNT SHOWN ON LINE 11j. ABOVE, REPRESENTS CASH REQUIREMENTS FOR THE ENSUING *Days*

13. OTHER INFORMATION

a. Interest income	
b. Advances to subgrantees or subcontractors	

14. REMARKS (Attach additional sheets of plain paper, if more space is required)

15. CERTIFICATION

I certify to the best of my knowledge and belief that this report is true in all respects and that all disbursements have been made for the purpose and conditions of the grant or agreement.

AUTHORIZED CERTIFYING OFFICIAL

SIGNATURE: Stacy G. Oliver for

TYPED OR PRINTED NAME AND TITLE: Gary Gledhill, Manager

DATE REPORT SUBMITTED: 12/30/98

TELEPHONE (Area Code, Number, Extension): (801) 581-7343

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STANDARD FORM 272 (7-76)
Prescribed by Office of Management and Budget
Cir. No. A-110

University of Utah
Department of Geography
Colloquium

Spring Quarter, 1998

Presenting:

"Integrative Use of Hyperspectral and Interferometric Radar Imagery"

Describing research using AVIRIS and IFSAR imagery and an overview of the NASA-supported Center of Excellence in the Department of Geography

Drs. George Hepner / Roger McCoy
Professors of Geography
The University of Utah

Tuesday, May 26th, 1998
12:00-1:00 p.m.
Geography Conference Room (215 OSH)

Everyone Welcome

Refreshments

Agenda

Links

Register

Overview of Hyperspectral Remote Sensing of the Environment
Applications in Environmental Resources Assessment

This workshop is an overview of the scientific concepts and technologies of hyperspectral sensing of the environment. It is designed to be of use to both the novice and expert in hyperspectral imaging and remote sensing. The morning sessions (see Agenda link) will feature presentations and case study applications on remotely-sensed imagery data and field spectroradiometer data collection and processing. The afternoon will feature a demonstration of software (ENVI) designed for the analysis of hyperspectral data integration and analysis.

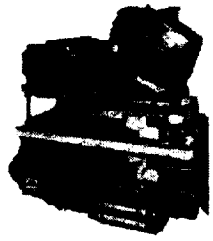
Host

NASA-sponsored Center of Excellence in Hyperspectral Imagery Analysis
for
Environmental Assessment and Monitoring
Department of Geography,
University of Utah

Sponsors

NASA

DIGIT Lab



Research Systems

American Society for Photogrammetry and Remote Sensing 1934

Home

Agenda

November 17, 1998
University of Utah
Orsen Spencer Hall, OSH Rm 215

Public Parking:
Olpin Union Lot
Click Links for Maps

Links

Register

8:30 - 8:45 refreshments & registration

8:45 - 9:15	Introduction to Hyperspectral Data Overview of differences in hyperspectral capabilities and analysis approaches relative to multispectral data	George Hepner
9:15 - 10:00	Field Data Analysis with ENVI	Roger McCoy John Norton
10:15 - 10:45	Application - Vegetation & Hydrocarbon Analysis	Roger McCoy
10:45 - 11:15	Application - Mineral Classification	Andrea Gallaghe
11:15 - 11:45	Application - Urban Analysis	George Hepner
11:45 - 12:45	Lunch - On your own	Student Union
1:00 - 1:15	Introduction to Digit Laboratory	Greg Gault
1:15 - 3:15	ENVI Demo & Hands on Exercises	Andrea Gallaghe
3:15 - 4:00	Discussions	

Workshop attendees are welcome to bring materials relating to their hyperspectal remote sen interests. Wall space and a small table will be available for you leave materials for other attendees to look at during breaks in the workshop.

Research Systems will be bringing ENVIware to give away to some lucky workshop atendee

Direct Questions to George Hepner or John Norton

Seminar
Hyperspectral Imaging of the Environment
Geography 6960 - 001
Wednesday 2:00-5:00pm

This research seminar is focused on one of the newest and most rapidly expanding areas of remote sensing. It will be a learning experience for both the instructor and the students in state-of-the-art research methods and analysis. Your responsibility is to read the materials assigned prior to class and fully engage in the class discussion. As this is a new and complex topic, careful reading, thought and additional investigation may be necessary to understand the material. However, by utilization of the best of the seminar investigation format, we can assist each other in advancing our collective knowledge.

Class Discussion Class will normally consist of a discussion of the assigned readings for that week. This will be followed by an overview lecture/discussion by me as an introduction to the topic for the next week. The last 15 minutes of each class will be devoted to discussion of class project ideas.

One or more students will serve as discussion leaders each week. It will be the responsibility of these students to lead (with the instructor's support) the seminar's discussion of the week's readings. This performance will be included as part of the class participation grade. I will ask for volunteers during the second class for each of the topics/weeks, so please review the topics.

Write-up Each student is to read the designated readings for the week and prepare a 1-2 page synopsis. This write-up must include a one page overview of the central points of the readings assigned. The second page should list questions, issues, needed research and ideas that will form the basis of his/her class discussion. This composition will be handed in after the class discussion. The student discussion leaders for the day should hand in the materials developed to lead the discussion as their write-up.

Term Project By midterm, each student will select a topic and prepare a 2-4 page proposal for a paper or project. The proposal should discuss the proposed topic, the methodology and the expected results/products to be delivered at the end of the term. A detailed outline indicating the logical flow of the project with specific headings and sub-headings should be part of the proposal. Upon approval of the proposal by me, the student will complete the paper/project and present their results to the class.

Papers/projects can involve library research, field spectroscopic research, IDL/ENVI programming, environmental application of an existing hyperspectral data set or any combination of these. I am open to most ideas. Projects are to be an individual, independent effort.

Possible Paper/Project Topical Areas

- Atmosphere: water vapor, clouds properties, aerosols, absorbing gases...
Ecology: chlorophyll, leaf water, lignin, cellulose, pigments, structure, vegetation species and community maps, nonphotosynthetic constituents...
- Geology and soils: mineralogy, soil type...

-Coastal and Inland waters: chlorophyll, plankton, dissolved organics, sediments, bottom composition, bathymetry...
- Environmental hazards: contaminants directly and indirectly, geological substrate...
- Calibration: aircraft and satellite sensors, sensor simulation, standard validation..
- Commercial: mineral exploration, agriculture and forest status...
- Algorithms: autonomous atmospheric correction, advanced spectra derivation...
- Human infrastructure, such as urban structures and surface materials.

The course is a seminar, not a lab oriented course, however, several concepts and analytical algorithms have been perfected for use with hyperspectral imagery, including spectral angle mapping, spectral feature fitting and matched filtering. These are implemented in ENVI. Thus, a latter portion of the class will examine the transfer of hyperspectral analysis concepts to algorithms to implementation in software.

Grades Grades are determined by class participation and weekly write-ups (approximately 20%), and the final projects. The final project will be evaluated on both the proposal (10%) and of the paper/project presentation and product(70%).

JPL Conference Details of participation in this conference (February 7-12, 1999) will be provided in class. It is not a requirement of the class, but should be a beneficial professional experience.