LARS Information Note 051975

Bringing Remote Sensing Technology to the User Community

by

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1975

LARS Information Note 051975
T-1039/4

BRINGING REMOTE SENSING TECHNOLOGY TO THE USER COMMUNITY[1]

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ABSTRACT

This paper discusses the procedures and services available for educating and training potential users of remote sensing technology and describes approaches for achieving an in-house capability for the analysis of remotely sensed data using numerical techniques based on pattern recognition principles. The hierarchy of educational steps includes self-study of the literature, attending conferences and symposia, participating in intensive short courses and in residence programs. Remote terminal computer networks and the implementation of analysis software are presented as ways to obtain an in-house capability for numerical analysis. Cost estimates are provided where appropriate.

INTRODUCTION

Historically, there has always been a time lag between technological breakthroughs and the widespread use of a new technology. The reason for this is that there are several steps which must be taken before this gap can be bridged; among them are a demonstration of the "usefulness" of the technology, education of the "user community," and making the technology available to the user community. The usefulness of remote sensing has been adequately demonstrated. This paper surveys the materials and services available for educating and training individuals in the principles and operational aspects of remote sensing and discusses two approaches for establishing an in-house capability for the numerical analysis of remotely sensed data.

In this survey emphasis is placed on sensor systems and analysis techniques that have developed within the past decade. These sensor systems, typified by the multispectral scanners aboard the LANDSAT satellites, are capable of supplying vast quantities of data, and computer-assisted analysis techniques have proved effective in handling this type and volume of data. Photo interpretation techniques are not stressed here; since this is a much more mature field, there is a relatively larger number of individuals trained in photo interpretation methods, and formal university courses have been in existence for many years.

The topics discussed here are structured in the order that an individual or organization might logically follow when learning about and applying remote sensing technology. These topics include studying available literature, attending remote sensing symposia and conferences, participating in intensive short courses and in residence programs, using remote terminal networks, and implementing the analysis software. This hierarchy begins at the introductory level and extends to establishing the capability for analyzing large amounts of remotely sensed data. Cost estimates are included in the discussion when they seem appropriate.

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[1] This report was prepared under the support of NASA Contract No. NAS 9-14016 and was presented at the Earth Resources Survey Symposium, June 1975, Houston, Texas.

[2] Professor of Electrical Engineering and Program Leader for Technology Transfer; Training Specialist; and Training Coordinator, respectively.

SELF-STUDY OF THE LITERATURE

An obvious first step in entering the field of remote sensing is to consult the literature which is available. Appendix A provides a list of books, journals, reports, conference proceedings and bibliographies dealing with remote sensing. To enhance the usefulness of the bibliography, addresses of publishers and professional societies have been included when available. Appendix A is not intended to be exhaustive but to serve as a reference to provide newcomers to the field with a logical starting point for selecting reading materials.

A search through the literature will reveal that there are only a few written pieces which present remote sensing in a tutorial way. One of the first to appear was a volume prepared in 1970 by the National Academy of Sciences, entitled Remote Sensing with Special Reference to Agriculture and Forestry.[1] Although somewhat dated now, this report from the Committee on Remote Sensing for Agricultural Purposes presents a substantial overview of remote sensing as related to two applications areas, forestry and agriculture. Its intent is to aid communication among physical scientists, data processing specialists, agricultural scientists and foresters, and, as such, attempts to establish basic working vocabularies and concepts. Another book dealing with the basics, but from a broader point of view, is The Surveillant Science: Remote Sensing of the Environment, edited by Robert Holz and published in 1973. This is a collection of 44 previously published papers selected to provide a comprehensive overview of a number of approaches to remote sensing. A third publication is actually a five volume report written at the tutorial level prepared for the European Space Research Organization (ESRO) in 1973, entitled Data Preprocessing Systems for Earth Resources Survey. It has as its objective "to provide information ... to the earth scientist community on data correction, processing and information extraction systems associated with the remote sensing systems and to indicate future trends."

Frequently, governmental units and other interest groups are faced with the need to inform a large number of people about remote sensing technology and its potential application in a specific field. Often this is accomplished through group meetings, and a few very helpful volumes have grown out of such meetings. One of these, a volume edited by Estes and Senger in 1973 and entitled Remote Sensing: Techniques for Environmental Analysis, is a collection of twelve papers initially presented to geographers and scientists from developing nations to give them a basic introduction to the field of remote sensing. Similarly, a tutorial seminar in 1972 resulted in a publication by the Iowa Geological Survey available under the title Seminar in Applied Remote Sensing. And a third worth mention here is the International Workshop on Earth Resources Survey Systems Proceedings published in 1971 and available through NASA. This workshop was designed to acquaint people from developing nations with the potentials of remote sensing.

Most people new to remote sensing approach the technology through a particular discipline area, whether it be engineering, earth sciences, hydrology, or agriculture. While there are very few journals devoted to remote sensing from an interdisciplinary point of view, there are

[1] References cited in this section are listed in Appendix A of this paper.

a number of journals related to specific disciplines which frequently carry articles on remote sensing. Several of these are listed in Appendix A. These journals provide subject specialists an opportunity to study remote sensing from the familiarity of their own discipline.

Once a person has passed the introductory steps in learning about remote sensing, he may wish to turn to the wealth of collected information on the subject, specifically the volumes prepared under NASA's sponsorship and the several sets of proceedings from remote sensing conferences. NASA's Annual Earth Resources Program Reviews from 1968 through 1972 are an excellent source of information, surveying the activities of remote sensing for earth resources during these critical formative years. The volumes published in 1972 and 1973 as a result of NASA-sponsored symposia on LANDSAT are also important collections for the person wishing to know about data collection methods as well as for those interested in analysis methods and possible applications of LANDSAT data. One of the monuments of remote sensing literature is the proceedings of the International Symposia on Remote Sensing of Environment sponsored by the Environmental Research Institute of Michigan (ERIM). Similarly, proceedings from the Laboratory for Applications of Remote Sensing (LARS) symposia on the Machine Processing of Remotely Sensed Data serve as collections of important papers dealing with the quantitative approach to remote sensing data analysis.

As the volume of remote sensing literature grows, it is not surprising to find that there are more bibliographic studies becoming available. Most significant among these is the Quarterly Literature Review of the Remote Sensing of Natural Resources, which is compiled and published by the Technology Applications Center of the University of New Mexico. This quarterly publication abstracts and gives the source for a very large quantity of technical literature related to remote sensing sensors and the sensing of natural resources. Editors of the review tap and index abstracted technical reports, conference papers, books, foreign publications and translations plus additional NASA governmental and engineering sources.

REMOTE SENSING SYMPOSIA AND CONFERENCES

The next activity that might be pursued in educating oneself on remote sensing would be attending one of the conferences or symposia devoted to remote sensing. Formal sessions at these conferences are designed to bring to the audience the newest techniques in remote sensing and to discuss ways the technology can be applied in various disciplines. Of equal importance, however, is the opportunity to mingle with members of the remote sensing community, to interchange ideas on an informal basis, and to identify individuals with common problems or interests. The cost of registration, conference proceedings, etc., usually ranges from around \$30.00 to \$60.00. Appendix B gives the name, sponsoring organization, frequency and contact person for some remote sensing conferences and symposia that have been held on a recurring basis. Information on proceedings is included in Appendix A.

The series of conferences with the longest history is the International Symposia on Remote Sensing of Environment sponsored by the Environmental Research Institute of Michigan (ERIM). Initiated in 1962, their tenth symposium is scheduled for October 6-10, 1975. Other regularly held conferences have been sponsored by the Tennessee Space Institute, the Laboratory for Applications of Remote Sensing (LARS) and the Canada Remote Sensing Society.

Conferences held by many technical societies also reflect a growing interest in remote sensing. Most notably, the American Society of Photogrammetry now has regular sessions on remote sensing. Significantly, they have recently changed the name of their journal to Photogrammetric Engineering and Remote Sensing. The Institute of Electrical and Electronics Engineers, Association of American Geographers and American Society of Agronomy are among other professional groups showing increasing interest in remote sensing.

Conferences and symposia, especially those devoted exclusively to remote sensing, offer an unusual educational opportunity to someone new to the field of remote sensing.

INTENSIVE SHORT COURSES

Surveying the literature and/or attending a symposium usually provides a person enough insight to determine whether or not remote sensing offers potential for a particular application and thus whether he wishes to pursue additional educational and training activities. If further education and training seems desirable, he should consider attending an intensive short course on remote sensing. Usually one week or less in duration, these courses provide the participant an opportunity to grasp the limitations as well as the capabilities of remote sensing technology. One advantage of these courses is that they are intensive. The participant is usually engaged in full-time study of the subject matter away from his home environment, away from the competition of other duties and interruptions. This environment provides an excellent opportunity to take full advantage of materials and presentations prepared by subject specialists. Participants in short courses often receive a collection of tutorial printed materials generally not otherwise available.

Short courses tend to follow one of two different formats. The first format emphasizes lecture presentation by research specialists. In effect, these lectures are an interpretation of the current literature in the field by an active research worker. Since organizers of these conferences tend to bring in expertise from various parts of the country, there is an excellent opportunity to obtain a broad overview of the field. A second way of organizing a short course is to use a smaller number of instructors, usually people from the same or nearby organizations who have worked together. This approach tends to result in a well-integrated course with a strong thread of continuity. The potential participant will want to pay attention to the manner in which the course is organized.

Appendix C lists names and addresses of organizations which have sponsored remote sensing short courses. Three organizations have come to our attention as offering or planning to offer courses on a regularly scheduled basis. They are the EROS Data Center, the Laboratory for Applications of Remote Sensing and Oregon State's Environmental Remote Sensing Applications Laboratory.

The EROS Data Center is planning to conduct annual spring and fall courses for international representatives on the general aspects of remote sensing. Quarterly offerings for general participation are in the planning stage. A publication by Reeves(1) describes EROS Data Center training programs.

LARS offered a two week course in the summer of 1972 and a one week course in June and again in September of 1974. The LARS courses have emphasized numerical analysis and pattern recognition techniques. Beginning in the summer of 1975, LARS intends to offer each month a one week course in Remote Sensing Technology and Applications to classes of eight to 15 members. Included will be a series of workshops that takes participants through a typical numerical analysis sequence using LANDSAT data.

Oregon State's Environmental Remote Sensing Applications Laboratory annually offers a two day course on Digital Processing of LANDSAT Data, and the Oregon State School of Forestry introduces participants in its annual Aerial Photography Remote Sensing short course to the broader aspects of remote sensing.

Costs for short courses usually range from $300 to $500 depending upon a number of factors, the duration of the course, the number of participants, and personnel resources for presenting the course.

RESIDENCE PROGRAMS

When an individual attends an intensive short course he probably does so either to get a broad overview of remote sensing technology in order to interact effectively with people working in the community or to determine whether he wishes to become a remote sensing expert himself. In the former case, the graduate of a short course is usually equipped to enter into meaningful research or contract discussions with people working in remote sensing. In the latter case a residence program may provide him the opportunity to increase his expertise by working at a particular organization or with a particular individual.

Within the university environment there are frequently semester-long courses and graduate student research positions available. Many university departments offer courses or series of courses in remote sensing. A survey published in 1972 by Eitel (2) lists 62 remote sensing courses in 39 institutions. More recently (1975) Morain (3) compiled a survey of remote sensing courses taught in geography departments alone which includes 45 courses in 33 institutions. While full-time university residency programs usually do not lend themselves very well to industrial or government agency employees, they should certainly be looked to as a source of future graduates with training in remote sensing.

More flexible residence programs aimed specifically at the practicing professional are encouraged by a number of remote sensing organizations within the United States. It usually takes initiative on the part of the person wishing to participate in such a program to write the organization, present his credentials, list the objectives of his visit, and negotiate an arrangement. At the Laboratory for Applications of Remote Sensing the Visiting Scientist program offers residency periods ranging from a few days upwards to a year or more.

Perhaps the best way to illustrate residence programs of the Visiting Scientist type is to give some examples. An ERTS Principal Investigator visited LARS for a period of eight days with the objective of comparing results of machine processing of ERTS data with classifications he had previously determined by photo interpretation techniques. Prior to his visit he had gained some background in machine processing by attending a LARS short course. Working closely with an experienced analyst, he accomplished his goal, successfully classifying portions of four ERTS scenes. His organization was charged about $3000 for computer services and $680 for personnel services incurred during his visit. Another researcher, interested in the identification of sub-resolution targets in remote sensing imagery, spent nine weeks at LARS and used about $300 of computer resources and $1000 for personnel and service resources. A one-year visit involving four to six weeks of intensive training followed by work associated with an on-going laboratory project could cost about $2200 plus $450 for computer time. These examples reveal the wide variation possible undef a visiting scientist arrangement.

The Visiting Scientist program at LARS can be characterized by stating that visits of a short duration resemble consulting service arrangements, whereas, long-term visits more nearly approach a post doctoral fellowship relationship between the visitor and his sponsor. Similar residence programs can be arranged at other remote sensing organizations. The EROS Data Center, the Environmental Research Institute of Michigan, the Tennessee Space Institute and the South Dakota Remote Sensing Institute have indicated that residence programs can also be arranged at their facilities. Because of the flexible and individual nature of these programs, similar arrangements can probably be made with other organizations as well. Costs associated with residence programs vary widely depending upon the duration of the visit, the resources used, and the basic charter of the host institution.

REMOTE TERMINAL NETWORKS

The next level in the hierarchy of mechanisms for bringing remote sensing technology to the user community is providing an in-house analysis capability. For the purpose of this discussion, "analysis capability" will be defined to include hardware, software and trained personnel. Initially, one might want to give serious consideration to providing hardware and software capability by means of a terminal connected to a data processing network capable of handling multi-image data. Advantages of this remote terminal approach include: full user access to both the data bank and the processing capability of a large earth resources data processing system, centralization and sharing of the expensive portions of the processing hardware, and centralization and cost sharing of software maintenance and updates. Perhaps of even greater importance to newcomers to the remote sensing community is the fact that usually within several months after an agreement is made, they can be on the network, can take advantage of the newest technological developments as they are implemented, and can write their contract to terminate the agreement at a definite time.

Although the authors are aware of a program to make remote sensing data analysis capabilities available on the GSA network (a computer network operated for federal agencies by the Government Services Administration) and that consideration has been given to installing multispectral data processing capability on commercial time-sharing networks, at the time of this writing there is only one operational earth resources data processing network. This is the Earth Resources Data Processing

System operated by Purdue University's Laboratory for Applications of Remote Sensing.[2]

The system provides remote access to LARSYS, a multispectral data bank, and a general purpose computer. LARSYS is a fully-documented multi-image data analysis software system designed to provide for advanced research, development, and applications of remote sensing concepts and systems. The multispectral data bank is available to all users of LARSYS and serves as its primary data base. LARSYS is implemented on a general purpose computer with time sharing and remote terminal capabilities.

It is significant that the word system is used instead of the word network in the title of the Earth Resources Data Processing System because considerable support above hardware/software capability is provided. The main thrust of this additional support is in providing education and training materials and services, extensive software documentation and personnel services. This support includes:

Educational materials and services

a) A two-week LARSYS Analysis for Instructors Course to train the designated remote site specialists to become qualified instructors prior to terminal installation.

b) The LARSYS Educational Package, a set of instructional materials developed to train people in the analysis of remotely sensed multispectral data using LARSYS. Site experts who have taken the LARSYS Analysis for Instructors Course serve as instructors at the remote sites.

c) An advanced LARSYS Analysis Workshop/Seminar offered at the remote site after users have received initial training by the remote site instructors and have gained some experience using LARSYS.

Software documentation

a) The LARSYS User's Manual contains a comprehensive description of the organization of the LARSYS system and the processing functions available.

Personnel Services

a) A Purdue/LARS employee designated to serve as an analysis specialist for remote terminal users.

b) A Purdue/LARS employee designated to serve as a system specialist to assure smooth operation of the terminal.

c) Specialized reformatting, preprocessing and LARSYS software programming instruction services.

A more extensive description of the Earth Resources Data Processing System has been prepared by Phillips and Schwingendorf (4). This

[2]Initial development of this system was supported by the National Aeronautics and Space Administration (NASA) under Grant Number NGL 15-005-112.

document also provides the basic parameters which would allow one to estimate the cost of installing and maintaining a remote terminal at a particular location. Data on seven such installations has shown that the average annual cost for maintaining and using a remote terminal has been $70,510; terminal installation costs have averaged $9,085.

IMPLEMENTATION OF ANALYSIS SOFTWARE

Other approaches to obtain an in-house capability for the analysis of remotely sensed data range from the purchase of specialized hardware and software to implementing software on a general purpose digital machine. It does not seem appropriate in this paper to try to summarize, critique or estimate the expense of the various kinds of specialized hardware available to the remote sensing user community. Some of these systems are described elsewhere in these proceedings and price information is readily available from manufacturers. It does seem appropriate, however, to discuss some aspects of implementing analysis software on your own general purpose digital machine. This discussion is motivated by the fact that many organizations already have access to general purpose computational facilities. Three factors will be considered: software availability, training and personnel requirements.

Computer algorithms proven to be effective for the analysis of remotely sensed multi-image data have been reported in the literature (see conference proceedings listed in Appendix A).[3] Copies of these programs may sometimes be obtained from the authors at nominal cost. Documentation varies, ranging from non-existent to good. A complete, well-documented software system, LARSYS, may be purchased by domestic organizations from the Laboratory for Applications of Remote Sensing for $1000. This price includes source tapes and over 3000 pages of documentation, consisting of the LARSYS User's Manual, LARSYS System Manual, LARSYS Test Procedures Manual and LARSYS Program Abstracts. Non-domestic organizations may obtain LARSYS through COSMIC, Barrow Hall, University of Georgia, Athens, Georgia 30601.

The Laboratory for Applications of Remote Sensing also offers, on a request basis, a LARSYS Programming Education Course. This course, which might be more adequately described as a consulting service, is designed to take participants as far as possible into understanding how LARSYS is programmed. Content and duration of the course are variable depending upon the background and objectives of the participants. The course fee is negotiated on an individual basis. Sample fees are: $2500 for a one-week course ($500 per day), $3200 for a two-week course ($320 per day) and $3900 for a three-week course ($260 per day). The thrust of the course is to prepare individuals to install LARSYS modules on their own computer.

Because it is easy to grossly underestimate the costs associated with the installation of analysis software, it seems appropriate to give some guidelines even though they may in themselves be subject to a considerable margin of error. Commentary will be restricted to estimating

[3] We do not mean to imply by this statement that existing algorithms are necessarily optimum or that continual research in data processing techniques should be curtailed. On the contrary, continued work in this area is essential to the future of remote sensing technology.

personnel costs only. No attempt will be made to account for computer time usage or prorated support of the computer facility. To provide a perspective, several levels of analysis capability will be discussed.

A single programmer could probably implement the algorithms commonly used in remote sensing analysis on a general purpose machine in six to twelve months. This implementation probably would not include user oriented input-output routines or other programming "frills." Furthermore, probably only one or two individuals who were very familiar with the programs would be able to use the algorithms for analysis purposes. The personnel cost required to achieve this capability, which might be described as a minimum capability, could range from $25,000 to $40,000 depending upon the individual's salary and supervisory and overhead charges. Since this level of capability would be highly dependent upon one or two individuals, the associated cost is perhaps more properly interpreted as an investment in the individual rather than in the software.

Providing convenient access to a larger group of analysts, say ten to twelve individuals, would require more careful implementation. User oriented input-output formats and careful documentation would be recommended. It is estimated that this intermediate level of analysis capability would require a personnel investment of $100,000 or more.

As a final example, consider establishing what might be called a "full service" remote sensing data analysis capability. Such a capability would include providing preprocessing services (such as geometric correction and multitemporal overlay) and specialized program adaptations. It is estimated that it would take at least two to three years to build up such a capability and would require building expertise in preprocessing operations, system programming capability, and routine service operations. One could anticipate a $300,000 to $500,000 investment to achieve "full service" capability with an accompanying $200,000 to $300,000 annual personnel budget.

While subject to considerable interpretation, the personnel costs quoted in these examples are felt to be realistic lower bounds. Naturally, justification of such expenditures would require large volumes of data analysis. Alternatives to such a large expenditure are the remote terminal approach, discussed in the last section, or outside contractors to analyze the data.

SUMMARY

This paper has presented a survey and discussion of the two components necessary for bringing the remote sensing technology which has developed over the past decade to the user community. These components are: education and training opportunities and the capability for analyzing the data available from today's sensors systems.

Education and training opportunities range from self-study of the literature, attending conferences and symposia, and participating in intensive short courses and residence programs. Options for establishing numerical analysis capability include purchasing specially designed hardware-software systems, accessing via a remote terminal the LARS Earth Resources Data Processing System, and implementing analysis software on one's own general purpose computer.

This paper, along with its appendicies, is intended to serve as a guide to potential members of the remote sensing community seeking a deeper understanding and involvement in remote sensing activities.

REFERENCES

1. Reeves, R.G., "Education and Training in Remote Sensing," Photogrammetric Engineering, Vol. 40, No. 6, June 1974, pp. 691-696.

2. Eitel, D.F., "Remote Sensing Education in the U.S.A.," Photogrammetric Engineering, Vol. 38, No. 9, Sept. 1972, pp. 900-906.

3. Morain, S.A., "Geographic Education in Remote Sensing at the University Level," compiled for the Association of American Geographers Committee on Remote Sensing, March 1975. 66pp.

4. Phillips, T.L. and Schwingendorf, S.K., "On the Access to an Earth Resources Data Processing System," LARS Information Note 031274, Laboratory for Applications of Remote Sensing, Purdue University.

APPENDIX A

REMOTE SENSING LITERATURE

The following list of published materials was compiled as an aid to persons new to numerical analysis of remote sensing data. The authors would appreciate knowing about other available tutorial and technical publications which might be of help to the newcomer.

Books

Alexander, Larry, Leo Eichen, et al. 1974
Remote Sensing - Environmental and Geotechnical Applications
Engineering Bulletin 45.
Dames and Moore, 445 S. Figueroa St., Los Angeles, CA

Colwell, R. N. (Ed.). 1960
Manual of Photographic Interpretation
American Society of Photogrammetry, 105 N. Virginia Ave., Falls Church, VA

Estes, John E. and Leslie W. Senger (Eds.). 1973
Remote Sensing - Techniques for Environmental Analysis
Hamilton Publishing Company, Santa Barbara, CA

Holz, Robert K. 1973
The Surveillant Science - Remote Sensing of the Environment
Houghton Mifflin, Boston, MA

Johnson, P.L. (Ed.). 1969
Remote Sensing in Ecology
University of Georgia Press, Athens, GA

National Research Council. 1970
Remote Sensing with Special Reference to Agriculture and Forestry
National Academy of Sciences, 2101 Constitution Ave., Washington, D.C.

Pouquet, Jean. 1971
Les Sciences de la Terra a L'heure des Satellites, Teledetection
Presses Universitaires de France, Paris
Translation (1974) - Earth's Resources from Satellite
D. Reidel Publishing Co., 306 Dartmouth St., Boston, MA

Reeves, R.G. (Ed.). 1975
Manual of Remote Sensing
American Society of Photogrammetry, 105 N. Virginia Ave., Falls Church, VA

Rudd, Robert. 1974
Remote Sensing - A Better View
Duxbury Press, 6 Bound Brook Ct., N. Scituate, MA

Wolff, Edward and Enrico P. Mercanti (Eds.). 1974
Geoscience Instrumentation
John Wiley and Sons, 605 Third Ave., New York, NY

APPENDIX A CONTINUED

Journals devoted to Remote Sensing

IEEE Transactions on Geoscience Electronics
Journal of the Geoscience Electronics Group of the Institute of Electrical and Electronics Engineers
345 East 47 St., New York, NY
Quarterly

ITC Journal
Journal of the International Institute for Aerial Survey and Earth Sciences
Enschede, The Netherlands
Five issues yearly

Photogrammetria
International Society for Photogrammetry
P.O. Box 1345, Amsterdam, The Netherlands
Bi-monthly

Photogrammetric Engineering and Remote Sensing
Journal of the American Society of Photogrammetry
105 N. Virginia Ave., Falls Church, VA
Monthly

Remote Sensing of Environment - An Interdisciplinary Journal
American Elsevier Publishing Co., 52 Vanderbilt Ave., New York, NY
Quarterly

Journals frequently carrying Articles on Remote Sensing

Agronomy Journal
Journal of the American Society of Agronomy
677 S. Segoe Rd., Madison, WI
Bi-monthly

Annals of the Association of American Geographers
Quarterly

Applied Optics
Journal of the Optical Society of America
2000 L St., N.W., Washington, D.C.
Monthly

Aviation Week and Space Technology
McGraw-Hill, 1221 Avenue of the Americas, New York, NY
Weekly

Crop Science
Journal of the Crop Science Society of America
677 S. Segoe Rd., Madison, WI
Bi-monthly

IEEE Transactions on Computers
Journal of the Computer Society of the Institute of Electrical and Electronics Engineers (IEEE)
345 East 47 St., New York, NY
Monthly

Proceedings of IEEE
Institute of Electrical and Electronics Engineers (IEEE)
345 East 47 St., New York, NY
Monthly

Journal of Forestry
Journal of the Society of American Foresters
1010 16th St., N.W., Washington, D.C.
Monthly

Journal of Soil and Water Conservation
Soil Conservation Society of America
7515 N.E. Ankeny Rd., Ankeny, IA
Bi-monthly

Optical Engineering
Journal of the Society of Photo-Optical Instrumentation Engineers
338 Tejon Place, Palos Verdes Estates, CA
Bi-monthly

Soil Science Society of America Proceedings
Journal of the Soil Science Society of America
American Society of Agronomy, 677 S. Segoe Rd., Madison, WI
Bi-monthly

<u>Reports</u>

Bressanin, G., J. Erickson, et al. 1973
Data Preprocessing Systems for Earth Resources Surveys
Prepared for European Space Research Organization (ESRO), 114 Avenue Charles de Gaulle, 92-Neuilly, France
Vol. 1 - Introduction to Preprocessing Techniques
Vol. 2 - Methods of Implementation
Vol. 3 - Technical Appendices
Vol. 4 - Summary
Vol. 5 - Bibliography

Laboratory for Applications of Remote Sensing. 1967-1970
Remote Multispectral Sensing in Agriculture
Agricultural Experiment Station, Purdue University, W. Lafayette, IN
Vol. 1 - 1967 Research Bulletin 831
Vol. 2 - 1967 Research Bulletin 832
Vol. 3 - 1968 Research Bulletin 844
Vol. 4 - 1970 Research Bulletin 873

NASA. 1968, 1969, 1970, 1972
Annual Earth Resources Program Review
1970 (3 vol) - MSC-03742
1972 (5 vol) - MSC-05937

APPENDIX A CONTINUED

NASA. 1972
Advanced Scanners and Imaging Systems for Earth Observations
NASA SP-335

Also check reports from Agricultural Experiment Stations and Technical Bulletins from the U.S. Geological Survey

Proceedings

American Society of Photogrammetry Symposia
105 N. Virginia Ave., Falls Church, VA
Annual, Semi-annual, and Special

Canadian Symposia on Remote Sensing
First Symposium Proceedings - Sept. 1972
Information Center, 171 Slater St., Ottawa, Ontario, Canada
Second Symposium Proceedings - March 1974
Canada Remote Sensing Society, c/o Canada Aeronautics and Space Institute, 77 Metcalf St., Ottawa, Ontario, Canada
Third Symposium - Scheduled for Sept. 1975

International Symposia on Remote Sensing of Environment
Environmental Research Institute of Michigan (ERIM), Ann Arbor, MI
Every 18 months since 1962

Machine Processing of Remotely Sensed Data
Laboratory for Applications of Remote Sensing (LARS), Purdue University, W. Lafayette, IN
1973 Conference - IEEE Catalog No. 73 CHO 834-2GE
1975 Conference - IEEE Catalog No. 75 CH 1009-0-C
IEEE, 445 Hoes Lane, Piscataway, NJ

NASA. 1971
International Workshop on Earth Resources Survey Systems (May 1971)
NASA SP-283

NASA. 1973
Earth Resources Technology Satellite-1 (Sept. 1972)
X-650-73-10

NASA. 1973
Symposium on Significant Results obtained from Earth Resources Technology Satellite-1 (March 1973)
Vol. 1 (A & B) - Technical Presentations. NASA SP-327
Vol. 2 - Summary of Results. X-650-73-127
Vol. 3 - Discipline Summary Reports X-650-73-155

NASA. 1974
Third Earth Resources Technology Satellite-1 Symposium (Dec. 1973)
Vol. 1 (A & B) - Technical Presentations. NASA SP-351
Vol. 2 - Summary of Results. NASA SP-356
Vol. 3 - Discipline Summary Reports. NASA SP-357

APPENDIX A CONTINUED

Seminar in Applied Remote Sensing (May 1972)
Iowa Remote Sensing Laboratory
Iowa Geological Survey, 16 W. Jefferson St., Iowa City, IA
Public Information Circular No. 3

Shahrokhi, F. (Ed.). 1972, 1973, 1974, 1975
Remote Sensing of Earth Resources
Space Institute, University of Tennessee, Tullahoma, TN

Thomson, Keith P.B., Robert Lane, Sandor C. Csallany (Eds.). 1973
Remote Sensing and Water Resources Management
American Water Resources Association, 206 East University Ave., Urbana, IL

<u>Bibliographies</u>

Nagy, George. 1972
Digital Image-Processing Activities in Remote Sensing for Earth Resources
Proceedings of the IEEE, Vol. 60, No. 10 (October 1972), pp. 1196-1200

NASA. 1970
Remote Sensing of Earth Resources - A Literature Survey with Indexes
NASA SP-7036

Technology Application Center.
Quarterly Literature Review of the Remote Sensing of Natural Resources
Institute for Social Research and Development, University of New Mexico, Albuquerque, NM

Telespazio. 1973
Data Preprocessing Systems for Earth Resources Surveys. Vol. 5-Bibliography
Prepared for European Space Research Organization (ESRO), 114, Avenue Charles de Gaulle, 92-Neuilly, France

APPENDIX B

SYMPOSIA AND CONFERENCES

Listed below are the names of organizations, contact persons and brief remarks on several remote sensing conferences and symposia that have been held on a regular basis. Information regarding proceedings of these conferences may be found in Appendix A.

Alberta Remote Sensing Center 205 100 Avenue Edmonton, Alberta T5JOZ6 CANADA	Cal B. Bricker, General Chairman. Symposia held every 18 months. Emphasis on Applications. Third Canadian Symposium on Remote Sensing scheduled for September 22-24, 1975.
Environmental Research Institute of Michigan, P.O. Box 618 Ann Arbor, Michigan 48107	Dr. Jerald J. Cook. 10th International Symposium on Remote Sensing of Environment scheduled for October 6-10, 1975. Remote sensing in general.
Laboratory for Applications of Remote Sensing, Purdue University 1220 Potter Drive West Lafayette, Indiana 47906	Dr. C.D. McGillem, Program Chairman. 2nd Symposium on Machine Processing of Remotely Sensed Data held June 3-5, 1975. Emphasis on machine processing.
University of Tennessee Space Institute Tullahoma, Tennessee 37388	Dr. F. Shahrokhi. 4th Annual Remote Sensing of Earth Resources Conference held in March 1975. Remote sensing in general.

APPENDIX C

REMOTE SENSING SHORT COURSES

The list of short courses which appears below is intended to be representative rather than exhaustive since many Remote Sensing Centers, while not offering short courses on a regular basis, have presented short courses in the past and are prepared to do so in the future when needed.

Location	Contact Person	Details and Emphasis
ERIM	Dr. Jerald J. Cook Willow Run Laboratories Environmental Research Institute of Michigan P.O. Box 618 Ann Arbor, MI 48107	Two courses on Infrared are offered frequently in summer in conjunction with summer school of University of Michigan.
EROS	Dr. Donald Lauer EROS Data Center Sioux Falls, SD 57198	Remote Sensing in general. Two courses for international representatives will be offered annually, spring and fall. Subsequently, a course will be offered quarterly for anyone interested.
KANSAS	Dr. Richard Moore Remote Sensing Laboratory University of Kansas Lawrence, KA 66044	Radar. Short courses have been offered in the past and will be in the future when need and demand dictate. Course notes are available for purchase.
LARS	D.B. Morrison LARS/Purdue University West Lafayette, IN 47907	Introductory course on fundamentals of remote sensing; offered first full week of every month; enrollment limited to 15/course. Workshops emphasize machine processing.
NSTL	Dr. Gary W. North National Space Technology Laboratory EROS Program Bay St. Louis, MS 39520	Various applications of remote sensing. 4-day courses are offered twice/month on a request basis. Limited to 12 participants.
OREGON	Dr. Barry Schrumpf Environmental Remote Sensing Applications Laboratory Oregon State University Corvallis, OR 97331	Digital Processing of LANDSAT Data. Offered yearly; 2-day course; participants limited to 30; cost $150/person; dates for '75: September 15th and 16th.
	Dr. David P. Paine School of Forestry & Extension Service Oregon State University Corvallis, OR 97331	Aerial Photography Remote Sensing Short Course. Offered annually in March; limit 40-50; cost $100/person; organizing aerial missions, photo mensuration and multisampling, introduction to broader aspects of remote sensing.

APPENDIX C CONTINUED

Location	Contact Person	Details and Emphasis
SOUTH DAKOTA	Dr. Donald Moore Remote Sensing Institute S. Dakota State University Brookings, SD 57007	Photointerpretation, but all aspects of remote sensing covered; will start next year initially for representatives of governmental agencies domestic and foreign; in conjunction with EROS Data Center. Training from one week to one year.
TENNESSEE	Dr. F. Shahrokhi The Univ. of Tennessee Space Institute Tullahoma, TN 37388	Remote Sensing in general. Courses have been offered on various aspects of remote sensing in the past and will be in the future upon demand.
WASHINGTON	Dr. Frank Westerlund Dept. of Urban Planning 410 Gould Hall University of Washington Seattle, Washington 98195	"Remote Sensing for Planners" Was offered May 30-31, 1975; attendance limited to 36.
WASHINGTON, D.C.	Ralph Bernstein c/o Director, Continuing Education George Washington University Washington, D.C. 20052	Digital image processing. 3-day course offered June 30-July 2, 1975. Emphasis on geometric and radiometric correction and computer configurations for image processing.