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DIGITAL PROCESSING SYSTEM FOR DEVELOPING COUNTRIES

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ABSTRACT

Digital data processing systems have, until
now, consisted either of expensive dedicated hard-
ware systems or complex software packages. An
effort was undertaken in Sri Lanka to perform
simple digital processing tasks using pre-existing
general purpose digital computers. An experimental
software package, LIGMALS, was obtained and modified
for this purpose. The resulting software permits
basic processing tasks to be performed including
level slicing, gray mapping and ratio processing.
The experience gained in this project indicates a
possible direction which may be used by other
developing countries to obtain digital processing
capabilities.

INTRODUCTION

As the field of remote sensing continues to advance, and major improvements
are made in analysis techniques, it is becoming increasingly obvious that
automated processing of digital data products is, for the most part, a necessary
component in a balanced program of remote sensing imagery interpretation and
utilization. When the user has available to him some of the expensive dedicated
hardware systems or complex analysis software that have been designed in recent
years, the processing of digital data products is a fairly straightforward task.
However, when no such hardware or software is available, and no major funding
can be obtained for the acquisition of these systems, the usual course of action
is to delete automated processing from the interpretation scheme. This is often
the case in developing countries. Very often when an attempt is made to develop
"home grown" processing systems using available computer components and local
scientists as the starting point, the lack of experience and the scarcity of
printed instructions on how to proceed in the development of such a system prove
an almost insurmountable stumbling block.

Such a problem was encountered in Sri Lanka, where a team from the Office of
the Surveyor General was attempting to implement digital processing techniques
for use with LANDSAT CCT's. This paper is a summary of the results of a project
undertaken jointly by Sri Lanka and ERIM which was funded, in part, under a
grant received from the U.S. Agency for International Development.

PROCEDURE

The major component of this project was to develop the capability of
Digital Processing of LANDSAT Data (on CCT) through computer facilities available
in Sri Lanka. Such available facilities were limited in computer capacity, to
48K of core memory. Other computer accessories were also limited to Card
Reader, Card Punch, Line-Printer, Mag Tape Drive and Disc Drive facilities.

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There were no facilities for interactive processing of data. We still do not have this facility. Hence we had to resort to the batch-mode execution of programs using a very small core memory capacity, available to the user.

This study commenced in the early part of May 1976. The computer facility used by the Survey Department up to this period was the ICL 1901, 24K capacity computer at the State Engineering Corporation. We had experience in executing programs for Geodetic computations and Photogrammetric Aero-triangulation at this facility. However, it was decided to conduct this investigation at the computer facility of the State Department of Census and Statistics, especially due to the great enthusiasm shown by the scientists there. Their computer facility consisted of an IBM 360, model 25, computer with 48K capacity. In the meantime, a study of the NASA publication "Generation and Physical Characteristics of the LANDSAT 1 and 2 MSS Computer Compatible tapes", was being conducted. No CCT was available at this stage. However, we wanted to obtain more information regarding the problem of reading and preprocessing a LANDSAT CCT. Up to this period a reference library on remote sensing was gradually developed. Reference to this literature revealed that none of the publications contained any information on such techniques. Though, all of them wrote at length on the significant achievements and results of tests etc., there were no descriptions of the actual techniques used. This was particularly lacking in the articles referring to computer processing.

A working group was formed within the Survey Department, consisting of personnel experienced in Photogrammetry, Scientific computer programming, Photo Laboratory Techniques and Photo-interpretation. We then wrote to various organizations and scientists involved in remote sensing and LANDSAT Digital Data Processing, seeking information on this subject. The replies received were not helpful. In fact, some expressed the opinion that LANDSAT CCT processing would not be possible on such small scale, general purpose computers of the type we have access to, in Sri Lanka. It was revealed that many organizations used special purpose, high capacity computers or extremely expensive general purpose computers of very high capacity with various display and inter-active capabilities.

The acquisition of such expensive hardware for our country could not be justified by any stretch of imagination, considering the limited number of frames required to cover the country, the limited frequency of coverage, the uncertainty of regular coverage due to cloud-cover and tape recorder capacity limitations on LANDSAT and our own foreign exchange limitations.

A further expansion of the working group was necessary to investigate this problem. Experts in computer systems analysis were co-opted into the group in a consultative capacity. During this period, we were informed by ERIM of the existance of an experimental digital processing package at the University of Michigan for use with LANDSAT CCT's on small scale computers. This processing package was named LIGMALS (Landsat Interactive Gray Map and Level Slicing system). Arrangements were made through ERIM to obtain a copy of this package.

We had the choice of only two LANDSAT frames which were suitable for investigation purposes. The first was frame ID 1234-04233 of North-East Sri Lanka acquired on 14 March 1973. The second was frame ID 2339-04151 of South-West Sri Lanka acquired on 27 December 1975. The first frame covered an area which has come under extensive development through the restoration of ancient irrigation works supplemented with additional irrigation through the diversion of Sri Lanka's largest river (Mahaweli) completed in January, 1976. The spatial distribution of large homogeneous tracts of rice cultivation and the irrigation pattern was clearly discernible in this LANDSAT image. But we were aware that from March 1973 onwards there were major changes in the development of this area mainaly due to the diversion of the Mahaweli River. The use of this frame, 3 years after acquisition, would have resulted in serious difficulties of correlating ground truth with the LANDSAT data because we did not even have aerial photography of this area taken around the same season. On the other hand the second frame was

acquired in December 1975 and was somewhat more suitable for ground truth correlation, through the use of aerial photography and short field visits from Colombo. However, we were aware of the major problem of a very complicated spatial distribution of the data within this frame. This area is highly developed with homesteads mixed with coconut, rubber, small forest reserves and very narrow and spatially complicated pattern of rice fields following the drainage pattern. Due to lack of anything better, we were compelled to take up this frame for digital processing. The CCT of this frame was received in July 1976.

We consulted local computer experts in the University, IBM and the Department of Census and Statistics on how to access the data from the CCT. The consensus of their opinion was that at some stage or the other, we had to go down to a lower level language. Two persons were, therefore, sent for a two-month training course in Assembler Language conducted by the Sri Lanka Branch of IBM. In the meantime we received from ERIM, the LIGMALS software package. We started to decode and document this program and at the same time converting parts of this program package to suit our local computer system as regards language and batch-mode operation. With this package, combined with additional information [1,2] it was possible to build up a viable program for batch-mode operation in our system.

Due to the lack of visual display facilities the sections of the LIGMALS program necessitating video display, were omitted or modified. The original LIGMALS package was divided into five different stand alone programs for batch mode operation. There are:

1) REFORM - a program to reformat LANDSAT CCT's into an IBM FORTRAN compatible format.

2) RSET - a program to locate and extract a desired area to be processed for further investigations.

3) ALSET - a program to automatically define level set boundaries for use with the gray mapping routine.

4) PMAP - a program to generate a line printer gray map of an area utilizing either automatically or manually derived gray-level boundaries.

5) RATIO - a program to apply a ratio processing algorithm to data to obtain a new imagery channel of an area after performing appropriate path radiance corrections.

Because the programs we received were optimized for use on the University of Michigan computer system, which is a large time sharing system using multiprocessing and virtual memory techniques, some sections of the program had to be extensively modified to be able to operate on the system in Sri Lanka. Additionally, an Assembler language input routine had to be written to accommodate EROS formatted CCT's which had been handled by system callable utility routines in the University of Michigan system environment.

DISCUSSION AND CONCLUSIONS

The work performed in this study has shown that it is possible for a developing country to obtain sufficient information to provide a starting point for a digital processing capability. Further, once the basic LIGMALS capabilities were implemented in Sri Lanka, local scentists had obtained sufficient experience with processing techniques to develop their own special purpose software without additional help from outside of their country.

Based on the experience gained in the Sri Lankan study, ERIM has produced LIGMALS/B which is a software system written totally in FORTRAN, and which is

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designed to function in a small to medium sized computer system environment. Also, extensive diagnostic procedures have been developed for use when the package is installed, a feature we believe is necessary since many times minor problems may go unnoticed by scientists who are not yet used to the behavior of digital image processing software. Further, compatibility with the large scale LIGMALS system used at the University of Michigan at at ERIM is maintained so that additional processing modules in use at these locations can be rapidly incorporated for use when needed in developing countries.

Aside from the results obtained with the LIGMALS system, it has been shown that effective low cost processing programs can be designed and implemented in a developing country. This can be accomplished without requiring a major commitment to specialized hardware systems or the use of major software packages which require local scientists to go abroad to be trained in their use and modification. It has also been found that technical assistance at the beginning of such a development project will greatly speed the rate of progress in a developing country.

It is hoped that the results presented in this paper will encourage other individuals to attempt to expand their capabilities to include basic digital processing of remote sensing data.

<div align="center">REFERENCES</div>

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