LARS CONTRACT REPORT 110984

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QUARTERLY PROGRESS REPORT

FOR

LANDSAT-4/5 IMAGE DATA QUALITY ANALYSIS

FOR THE PERIOD INCLUDING

AUGUST 10 - NOVEMBER 9, 1984

NASA CONTRACT NAS5-26859

TO: NATIONAL AERONAUTICS & SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT ROAD
GREENBELT, MD 20771

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NASA-CR-174131

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Introduction

This report covers work carried out on Landsat-4/5 data quality analysis under NASA Contract NAS5-26859 for the period August 10 through November 9, 1984. Focus was on estimation of two-dimensional point-spread function estimation. A brief description is included in the results section. Preparation began on the final report for the project.

Problems

Landsat-5 data needed for the final phase of the study were not received during the quarter, therefore no analyses could be done on evaluation of these data. Landsat-5 TM data were received for three sites on November 15, 1984. There is approximately one quarter of funding left in the project, so all work will be done within these remaining resources.

Publications

No publications were generated during the quarter.

Recommendations

No recommendations are made in this report.

Funds Expended

The funds expended in the project are reported periodically by the Purdue University Office of Contract and Grant Business Affairs to the sponsor on NASA Form 533M. Specific disclosure of funds expended in this report is not a policy of the University.

Significant Results

One of the system parameters estimated under this NASA-sponsored program has been the PSF or blurring function of the Landsat Thematic Mapper. The PSF is the result of the blurring effect of the atmosphere, electronics, optics, and data-processing operations that take place on the signal. With a good estimate of the blurring function on an imaging system, the next logical step is to use this information to restore the data radiometrically.

A signficant amount of work has been done on the area of image restoration. The classical approach that has mostly been followed is in the direction of the Wiener filter theory. There are major reasons against the usage of Wiener filters on Landsat data:

1. It is assumed that the image is a stationary random field, which is not a good assumption for agricultural fields.

2. The filter design requires statistics of the input signal.

3. A MMSE criterion is used, which has been shown not to be optimal for images whose final purpose is to be analyzed by a human observer.

Because of these limitations of the Wiener filter, a different approach was used which is based on minimizing a narrowness measure in the composite PSF (CPSF*), subject to constraints on the noise levels at the output of the filter (Chu, Stuller). Some of the advantages of this method are:

1. The resulting discrete filter is signal independent. The only a-priori information needed in the design is the PSF and the autocorrelation function of the noise.

2. The restoration filter is a FIR filter whose duration can be conveniently selected (within a certain range).

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* The composite point-spread function (CPSF) is defined as the convolution of PSF and the restoration filter.

We have been looking at new methods of introducing full control over the sidelobe levels present on the CPSF. The drawback of introducing constraints on the sidelobe levels is that an analytical solution for the filter coefficients cannot be obtained. But, by properly formulating the problem, this can easily be solved using nonlinear programming techniques. In particular, we are using a generalized reduced-gradient algorithm. For the case of space invariant PSF and stationary noise, the filter design has to be performed only once, making it very attractive for processing large volumes of data, as in the case of Landsat.

We are presently evaluating the performance of this image-restoration technique on Thematic Mapper data from the Iowa and Chicago sites. Also, we plan to combine the restoration filter with an interpolating function to simultaneously obtain improved radiometric and spatial resolution.

References

Chu, Nim-Yau, and C.D. McGillem. Methods and Performance Bounds for Constrained Image Restoration. Laboratory for Applications of Remote Sensing, Purdue University, 1291 Cumberland Ave., West Lafayette, IN 47906-1399. LARS Technical Report 061678.

Stuller, J.A. An Algebraic Approach to Image Restoration Filter Design. Computer Graphics and Image Processing I(2):107-122 (1972).