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INVESTIGATION OF 10.6 MICRON PROPAGATION PHENOMENA
(2880-8)

The Ohio State University

ElectroScience Laboratory

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This report summarizes the technical details of work performed at The Ohio State University ElectroScience Laboratory during the period 9 April, 1972 to 8 July, 1972.

The computer interface to the OSU data processing facility has been completed so that the output of the infrared scanner system installed at RADC can now be analyzed. Appropriate software has been written and tested for image reconstruction. With this step, the complete system is now operational.

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INVESTIGATION OF 10.6 MICRON PROPAGATION PHENOMENA

Edward K. Damon

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PUBLICATION REVIEW

This technical report has been reviewed and is approved.

Raymond P. Urtz Jr.

RADC Project Engineer

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CONTENTS

I. INTRODUCTION

This is the eighth technical report on Contract No. F30602-70-C-0003 entitled "Investigation of 10.6 Micron Propagation Phenomena." This report covers the period 9 April 1972 to 8 July 1972.

This program initially provided theoretical backup information to the RADC Atmospheric Optical Propagation Studies Program and is currently centered on the study of atmospheric imaging and the restoration of atmospherically degraded 10.6 micron images. The general aim is to provide initial attempts at image restoration, to determine potential problems, and to obtain data useful for preliminary systems design. For this purpose, a system has been completed, tested and delivered to RADC which will simultaneously sample with 40 x 40 resolution two 10.6 micron images at 200 frames per second and record these images in digital format on magnetic tape.

Primary effort during the past quarter has been devoted to completing and testing the hardware and software for decoding the special Miller Code tapes from the scanner system and interfacing this hardware with the data processing facility at The Ohio State University ElectroScience Laboratory. Test tapes recorded at RADC have been successfully converted to standard digital tapes and the images restored using the OSU FFT software.

II. DATA HANDLING

Installation of the interface between the modified Datacraft DC 6024-3 Data and Signal Processing System and the decoded output of the serial digital (Miller Code) recorder has been completed and the necessary assembly language software has been written that will generate the signals required by both the computer and the interface logic to transfer data into the computer. This interface gives the ElectroScience Laboratory Data Reduction Facility the capability of generating DC 6024-3 compatible tape to serve as bulk storage of input data for the existing image restoration software.

The signals that must be transmitted between the DC 6024-3 and the interface in order to transfer a 24 bit word, supplied by the OSU playback system, into the computer have been discussed in a previous report.[1] This section contains a description of the software required to transfer blocks of 1600 words, via an Automatic Block Controller (ABC), into the computer memory and then to generate a computer compatible tape containing this data. The ABC transfer feature allows a block of data (in our case 1600 words) to be transferred, without program intervention, between memory and a specified perpheral unit. Further, once the software program has initiated an ABC transfer over a given channel, the program can continue execution provided that subsequent program operations do not involve the channel on which the ABC transfer was initiated until

the transfer is completed. As will be seen later, this feature allows data to be read from the interface (Channel 3) while writing a previously stored block of data from memory onto the disc (Channel 5).

Figure 1 indicates the word format available from the interface unit.[1] Using this format, a frame from each channel and the associated code bits are packed into a single block of 1600 computer words. The interface unit has two image selector switches (CH 1 and CH 2) capable of gating either the A or B image, as scanned by the ElectroScience Laboratory Dual Channel Infrared Image Scanner,[2] to either or both channels. For the purposes of this report we will always assume Channel 1 carries image A while Channel 2 carries image B.

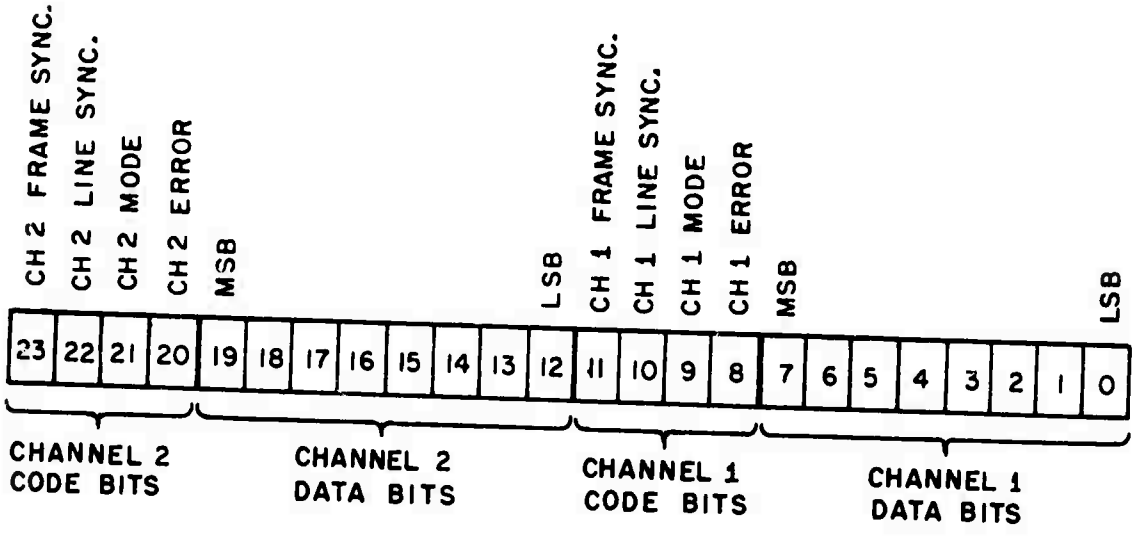

Fig. 1. Word format.

Because of the continuous rate at which data is being transmitted to the interface by the Miller Code decoder (12.5 Blocks or Frames/Sec or 20.8 K words/sec), data can not be written directly on the present computer tape units, which have a maximum writing rate of 12 K words/sec, without skipping every other frame. Thus, the interface software reads data into memory then transfers it onto disc storage, which has a read write capability of a nominal 100 K words/sec. The disc then acts as intermediate storage for the data. The important feature of the disc is that one has control over the frequency at which blocks are read off disc. This allows blocks to be read at a reduced rate permitting them to be preprocessed by the DC 6024-3 prior to being written on computer tape.

After a block is retrieved from the disc, it is read, word by word, into the A register of the computer where by using logical ANDing and shifting operations it is split into the A image frame (CH 1 frame), the B image frame (CH 2 frame) and the code bits (CH 1 and CH 2) are removed. The frames are then recorded in series (CH 1, CH 2, CH 1, ··· etc.) on computer tape.

The present available disc working storage will hold 2133 blocks of data or about 10.5 seconds of real time data (data recorded at 200 frames/sec in real time). This quantity of data fills one computer tape but represents only about 1% of the data recorded on a Miller Code tape. Hence, the Miller Code tape must be visually reviewed and sections of interest selected for conversion to computer tape and subsequent data analysis.

Figure 2 shows the flow of data from the time it is read into memory until the time when the two frames obtained from each block are written on tape. The key to flow is the ARC transfer which allows the computer to be reading data from the interface into a memory buffer while writing a previously filled buffer on disc.

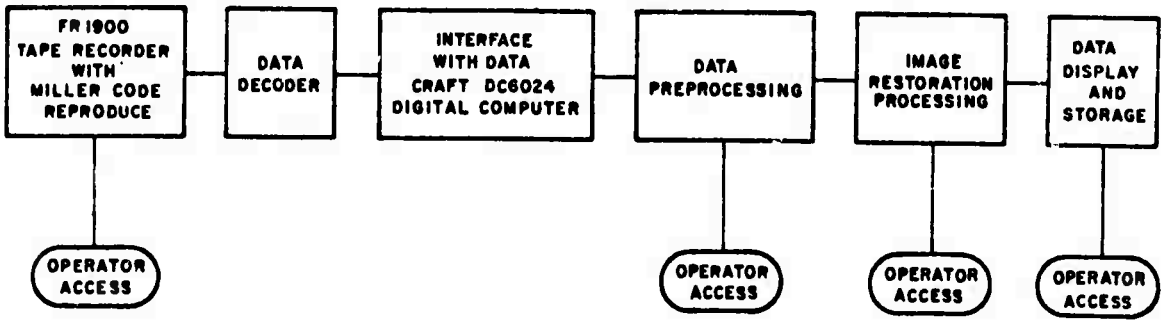

Fig. 2. Image processing flow diagram.

III. IMAGE RESTORATION

The ElectroScience Laboratory image processing software has been tested and documented previously.[3] However, the images processed at that time were obtained by digitizing filmed recordings of the images presented on the scanner display scope.[3] Now, with the completion of the digital recording and playback portions of the image scanning system and the completion of the interface between the playback system and the DC 6024-3 computer the restoration data will be the actual data sampled by the scanning disc.

A flow diagram reviewing the image processing software is included in Fig. 3. As stated previously, the two images (A and B) are recorded serially on the computer tape. The image processing program sees the first image and all succeeding odd numbered images as possible candidates for the system point spread function (psf) array while the second and all succeeding even images are seen as possible candidates for the degraded image array.

At present, only tapes with one point source have been tested and hence only a single channel of the dual channel scanning capability is being used. The second channel of data will be available in the future, since the dual transmitting optics have now been delivered. Channel 2 containing B images is the data channel while Channel 1 contains only system noise. Only slight software modifications are required to handle the single channel of data. First, the tape generated by the interface software will contain only Channel 2 (B images) recorded on it and secondly the first B image and all the succeeding odd images will be candidates for the psf while the second B image and all succeeding even images will be candidates for the degraded image in the restoration program.

IV. SUMMARY

All components and documentation for an imaging system for 10.6 microns have now been delivered and installed at the RADC PATS site. These include a dual channel infrared image scanner, digitizer, and serial digital (Miller Code) recorder for the receiving system. The transmitting system provides two point sources with adjustable separation and simultaneously transmits both 10.6 micron and 0.63 micron wavelengths.

Specialized equipment has been constructed, tested, and interfaced with a data processing facility at the ElectroScience Laboratory to read the Miller Code tapes and to analyze and restore the images. Fast Fourier Transform image restoration software has been written and tested.

The complete system is particularly capable of measurements of isoplanatic patch size and atmospheric optical transfer function in the infrared, where very little such information is now available to assist the designer of imaging or tracking systems which must operate in the turbulent atmosphere.

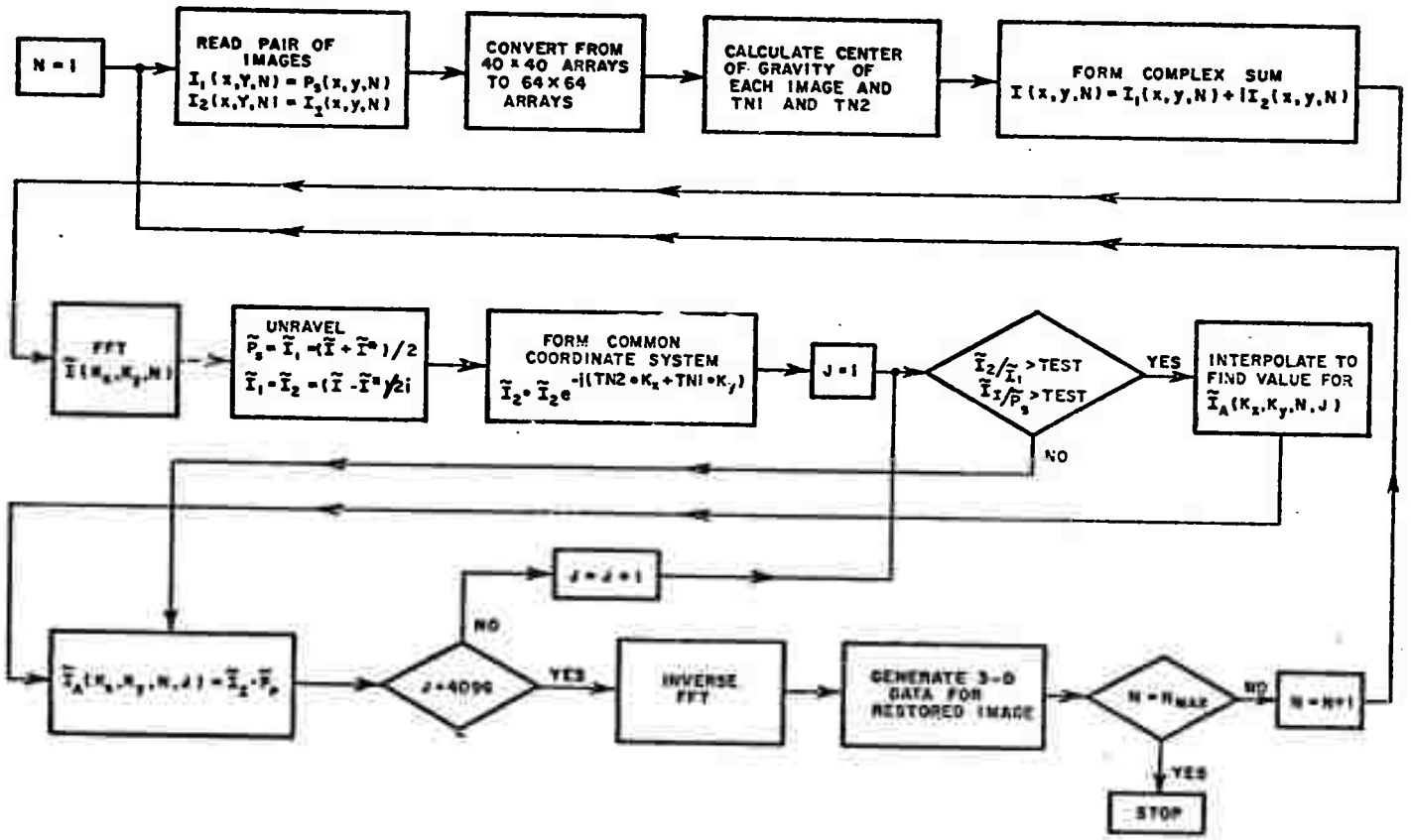

Fig. 3. Basic computer program for image restoration.

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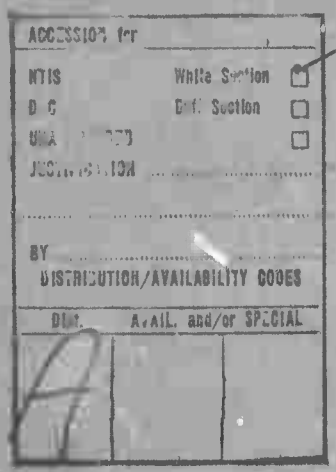
1. "Investigation of 10.6 Micron Propagation Phenomena," Report 2880-7, June 1972, The Ohio State University ElectroScience Laboratory; prepared under Contract F30602-70-C-0003 for Rome Air Development Center. (RADC-TR-72-158).

2. "Investigation of 10.6 Micron Propagation Phenomena," Report 2880-6, March 1972, The Ohio State University ElectroScience Laboratory; prepared under Contract F30602-70-C-0003 for Rome Air Development Center. (RADC-TR-72-157).

3. "Investigation of 10.6 Micron Propagation Phenomena," Report 2880-4, August 1971, The Ohio State University ElectroScience Laboratory; prepared under Contract F30602-70-C-0003 for Rome Air Development Center. (RADC-TR-71-202).



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