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National Radio Astronomy Observatory
Edgemont Road
Charlottesville, Virginia 22901

ATTN: Dr. L. Somers

SUBJECT: Monthly Report for July 1976
VLA Optical Processor
Contract: VLA-215
Reporting Period: 17 June through 31 July 1976

1.0 SUMMARY

The subject program was started in late June and this first letter report for the program covers the period from the program start through July.

Tasks required to carry out the program at ERIM were defined at the onset of the effort. A meeting was held at ERIM with NRAO personnel to discuss these tasks and to review the NRAO technical requirements for a VLA optical processor. Mutual agreement was reached on both of these topics.

Our efforts thus far have concentrated on the first of the three major tasks of the program, namely, the Initial Analysis. The accomplishments to date are reviewed below.

Data formatting and recording analyses have been started[1,2,3]. "Half plane" processing was considered and appears to be a possibility if some loss in signal-to-noise ratio over that realized with a full input data frame is permissable. An analysis describing real and imaginary parts of data at the Fourier plane was completed. Work is continuing in the area of a comparative assessment of encoding schemes.

The degradation of the Fourier transform of a signal which exhibits phase errors was analyzed[4] by performing the Fourier

transformations of such signals with our computer. Several adjustments to the computer program were incorporated to give the type of data desired. Graphical plots of the difference between the Fourier transform of the phase error corrupted signal and the uncorrupted signal were obtained. Plots for the difference of magnitudes, as well as the difference between real parts and the difference between imaginary parts were prepared. Thus far such deterministic error functions as the quadratic, cubic and quartic have been considered. Additional computer analysis is expected to be done next month. In addition, work was started on characterizing the phase errors of optical processor components.

A laboratory dedicated to this program was set up and a "beyond-the-lense input" optical Fourier transform channel, which uses a reference wave, was assembled. Preliminary testing directed toward minimizing path difference and atmospheric effects was successfully completed. Tests[5] of the Fourier plane output for the case of a clear 50 × 50 mm input data aperture were performed to evaluate the details of the main and sidelobe structure of the point-like sinc function output. This output is analogous to the VLA "dirty beam" although it is not, as we know, identical to it. The output was scanned with a scanning micro-photodetector for cases where the reference beam phase differed by π radians. The results were encouragingly good, both as to the detailed structure of the output and the expected difference between outputs having reference wave phases differing by π radians. Work in the optical processor laboratory is continuing in the area of individual component selection with the intent of arriving at a complete optical channel of usefully high quality for system type tests in the near future.

The commercial availability of high quality transmission gratings for use in testing of the breadboard optical processor appears to be non-existent. We are therefore considering preparation of the gratings[6] at ERIM since our personnel have considerable experience in this area.

Commercially available photodetectors were surveyed to assess[9] their comparative merits in sensitivity, noise, dynamic range and electronic scanning features. The Reticon and Fairchild units appeared promising. Both a Reticon RL1024C and a Fairchild CCD131 linear array consisting of 1024 individual detector elements have been ordered and are expected next month, at which time they will be evaluated experimentally. Requirements for interfacing the detector array output with the ERIM computer and display facility have been reviewed.

A linear model of the optical processing channel, including random noise sources has been prepared[7,8].

A review of the format of magnetic tape recordings of simulated VLA signals to be prepared by NRAO for use by ERIM was made. It appears that these tapes can be used for generation of CRT/film recordings of VLA test signals[10,11].

Copies of ERIM technical memoranda discussing the above efforts are enclosed*.

In addition to the ERIM activities on this program, it was agreed that the NRAO (Somers and Harrison) would contribute to

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* See separate reference list of these memoranda.

this effort in such areas as the detector array analysis, analysis of differences between exact and approximate characterizations of diffraction fields associated with the optical Fourier transformation, preparation of magnetic tapes (CCT) of simulated VLA data, and preparation of a numerical and graphical description of the expected VLA impulse response (dirty beam).

ERIM MEMORANDA

1. Circular Recording Formats, 7 June 1976, J. S. Zelenka
2. Detected Signal, 27 July 1976, James R. Fienup
3. Topics of Discussion with Dr. Lewis Somers on July 20, 1976, 3 August 1976, James R. Fienup
4. Phase Error Plots, 16 August 1976, C. Aleksoff
5. VLA Laboratory Measurement of Fourier Transform Using π Shift of Reference Beam, 16 August, 1976, A. Klooster
6. Proposal for Generating Precision Gratings, 27 July 1976, C. Leonard
7. Scanning Beam Model with Scan Position Errors, 19 July 1976, Ivan Cindrich
8. Linear Modeling of the VLA Optical Processor System, 3 August 1976, M. Carter
9. Recommendation for the Purchase of the Fairchild CCD as an Image Sensor, 23 June 1976, R. Dallaire
10. Generation of Simulated Data on a CRT/Film Recorder, 22 July 1976, R. J. Dallaire
11. Description of Simulated Data for VLA Processor Testing, 22 July 1976, R. J. Dallaire