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Final Report

on

Real-time Information-Processing Systems Research

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under

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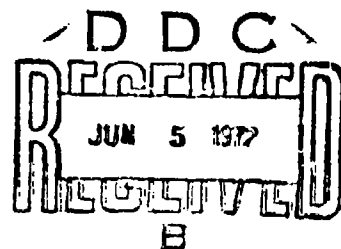
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Northwestern University  
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This final report on research conducted at Northwestern University under Contract Number N00014-67-A-0356-0023 covers the period from 1 April, 1971 through 31 March, 1972. The work conducted under this contract was in the areas of thin-film devices and computer graphics.

The results achieved are summarized on the following pages.

Thin-Film Field-Effect Transistor, Professor M. Epstein, F. C. Luo

The objective of this program was to prepare very thin films of InSb to be used in phonon amplifiers for acoustic surface waves on  $\text{LiNbO}_3$  and PZT substrates. High mobility films ( $20,000 \text{ cm}^2/\text{Volt-sec.}$ , 1 micron thick) were obtained by flush evaporation and recrystallization in very pure inert atmosphere. Also, very thin specimens of n-type InSb ( $300\text{-}400\text{\AA}$ ) were obtained with relatively high Hall mobilities ( $300 \text{ cm}^2/\text{Volt-sec}$ ) and majority carrier concentration of  $5 \times 10^{17}/\text{cm}^3$ . By employing the above films in a coplanar structure of a FET with indium source and drain electrodes, a  $350\text{\AA}$  SiO insulator, and aluminum gate electrode, successful transistor action, including pinch-off, was obtained. The transconductance of the TFT was about  $6000 \text{ }\mu\text{mhos}$ , the highest value ever reported. It was found that the InSb thin-film FET has high strain sensitivity ( $\approx 6,000$  volts per unit strain) and its application to the detection of surface acoustic waves is now being considered.

A paper, entitled "Coplanar Thin-Film InSb Transistor", by F. C. Luo and M. Epstein, has been submitted to the IEEE Proceedings. Another paper by the same authors is in preparation.

A patent disclosure, entitled "Stabilization and Control of Acoustic Surface-Wave Devices", has been submitted by M. Epstein.

Raster-Type Display with Interactive Graphics Capability, Professor B. W. Jordan, R. C. Barrett, S. Thieler, J. E. Allen, R. P. Cember, R. Langley

The possibility of designing a microprogram controlled character generator capable of refreshing the cell display in real time was investigated. The required functions were isolated, and the necessary primitive instructions were developed. Tradeoffs between vertical and horizontal microprogramming were investigated. Control store organization and requirements were defined. The execution facilities were described and performance was studied. A microprogram controlled character generator was shown to be feasible for real-time refresh of the cell display.

A design for the Display Output Buffer for the cell display was developed. The ability to repeat single characters as well as strings of characters was included in the design. A format for storing information pertaining to the repeat feature was developed, along with algorithms for its implementation, and the hardware design for the Display Output Buffer was completed and the buffer was constructed.

A capacitive read-only memory, of 1408 80-bit words with a cycle time of 80 nanoseconds, for use in the microprogram controlled character generator was designed, and a prototype of 12 8-bit words was constructed.

The Display Output Buffer was simulated in Fortran to verify its operation and determine its influence on the performance of the system. This led to several modifications in the design of the Display Output Buffer.

The number of primitives required to reproduce any figure drawn from straight lines in cell display with an arbitrary number of points and an arbitrary cell size was determined. It was found that 108 graphical primitives are required for a 512 by 512 display using 8 by 8 cells.

The instructions required to generate arbitrary figures on a cell display using the graphical primitives determined earlier and the available functional manipulations were determined. This instruction set is being used in the cell display simulation now under development.

Algorithms for the translation of picture information from xy format to the cell display format have been developed. A paper by B. W. Jordan and R. C. Barrett, entitled "A Scan Conversion Algorithm with Reduced Storage Requirements",\* on the translation from xy format to raster format has been submitted for publication.

A simulation of the entire cell display is now in progress. Many pictures of varying complexity are to be run through it to determine the choice of several important parameters as well as the limits of performance.

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\*A preliminary form of this paper entitled "A Display File Compiler for Raster Plotters", has been sent to ONR.