AD-A209 936

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

UNCLASSIFIED

(2)

1a. REPORT SECURITY CLASSIFICATION	UNCLASSIFIED
1b. RESTRICTIVE MARKINGS	N/A
2a. SECURITY CLASSIFICATION AUTHORITY	
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE	
3. DISTRIBUTION / AVAILABILITY OF REPORT	[redacted] Approved for public release, distribution unlimited
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	53 4502 0337
5. MONITORING ORGANIZATION REPORT NUMBER(S)	AFOSR-TR- 89-0910
6a. NAME OF PERFORMING ORGANIZATION	UNIVERSITY OF SO CALIFORNIA
6b. OFFICE SYMBOL (If applicable)	
7a. NAME OF MONITORING ORGANIZATION	AIR FORCE OFFICE OF SCIENTIFIC RESEARCH / NE
6c. ADDRESS (City, State, and ZIP Code)	UNIVERSITY PARK - SSC 502 LOS ANGELES, CA 90089-0483
7b. ADDRESS (City, State, and ZIP Code)	BUILDING 410 BOLLING AFB DC 20332
8a. NAME OF FUNDING / SPONSORING ORGANIZATION	AFOSR
8b. OFFICE SYMBOL (If applicable)	NE
9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	AFOSR 88-0211
8c. ADDRESS (City, State, and ZIP Code)	BOLLING AIR FORCE BASE WASHINGTON DC 20332

10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.
61102F	2305	B4	

11. TITLE (Include Security Classification)
INTEGRATED OPTO-ELECTRONIC COMPUTING

12. PERSONAL AUTHOR(S)
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13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
FINAL TECHNICAL	FROM 7/1/88 TO 1/31/89	4/15/89	2

16. SUPPLEMENTARY NOTATION

17. COSATI CODES

FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
OPTICAL INTERCONNECTION NETWORKS, INTEGRATED OPTOELECTRONIC TRANCEIVERS, LASER ARRAYS, ARRAY RECEIVERS, OPTICAL PROCESSORS IMAGE UNDERSTANDING,

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

RESEARCH ASSISTANTS SUPPORTED BY THIS GRANT HAVE WORKD IN A VARIETY OF OPTICAL COMPUTING PROJECTS. THESE PROJECTS ARE SUMMARIZED BRIEFLY IN THIS REPORT.

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	UNCLASSIFIED

22a. NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE (Include Area Code)	22c. OFFICE SYMBOL
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DD Form 1473, JUN 86 — Previous editions are obsolete. — SECURITY CLASSIFICATION OF THIS PAGE

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AFOSR-TR- 89-0910

Integrated Opto-Electronic Computing
Final Technical Report

This is the final report on Contract AFOSR-88-0211. The report covers the period from 7/1/88 to 1/31/89.

The research assistants supported by this research contract have worked in a variety of optical computing and optoelectronic computing projects. These projects have included:

Dynamic Optical Interconnection Networks with Integrated Optoelectronic Transceivers

A design has been developed for an optical multi-stage omega network suitable for interconnecting a 2-D plane of inputs to a 2-D plane of outputs. The network requires optical components to perform the shuffling and optoelectronic switching modules, which are dynamic, electrically controlled 4 x 4 crossbar networks that route any of four inputs to any of four outputs in the sense of a one-to-one permutation (no many-to-one [wire-or] or one-to-many [broadcasting] routings are needed). The output of the 4 x 4 switching modules are optical signals that are routed in 3-D by a set of interconnection optics and free-space propagation to succeeding stages containing switching modules.

Ultralow Threshold Laser Arrays

A low threshold laser design utilizing only a single growth step on an etched substrate to define a narrow active region has been developed. Stable, single mode operation with **threshold currents as low as 3.4mA (pulsed, room temperature) and 3.8mA cw** has been achieved in unoptimized devices grown in this manner by MOCVD. These devices, when coated to increase the reflectance of the mirror facets, should operate at threshold currents below 1mA.

Array Receivers for Optical Interconnections

During the last year, very low power receivers and logic circuits for high density interconnects have been emphasized. On the analytical side of the effort, a comprehensive model of InGaAs and InP JFETs has, for the first time, been developed.

Experimentally, fabrication technologies for both detectors and transistors needed for the array receivers have been investigated. In addressing the issue of crosstalk, the concept of remote, optoelectronic powering and switching of functional array pixels have been introduced. This concept relies on the ability to fabricate low power dissipation transceivers which minimize the use of inductive power supply and address interconnects via the use of integrated photovoltaic power cells.

Optical Interconnects using Waveguide Coupled Photodiode Arrays

During this reporting period, a high bandwidth organic-on-inorganic semiconductor photodetector for eventual integration into waveguide coupled arrays has been successfully demonstrated. The photodetectors consisted of a GaAs or Si substrate on which was deposited 2000Å of PTCDA followed by approximately 1500Å of ITO which formed a transparent ohmic contact to the PTCDA. The Si-based detector had an avalanche breakdown voltage (accompanied by photocurrent gain) of 55V, and a primary reverse current density of $0.9V_B$ of approximately 10^{-5}Å/cm^2. Also, the external quantum efficiency had a maximum of 85% at a >10V reverse bias, and at a wavelength of 0.8μm.

Optical Processors for Neural Computation of Image Understanding Algorithms

The central goals of this research are: 1) to develop efficient algorithms for several Computer Vision problems that can be implemented on artificial neural networks, and 2) to investigate optical implementation of these special purpose neural networks. Over the last 12 months, we have developed and experimented with an 1) algorithm for the extraction of 3-D information from two stereo images, and 2) algorithm for the computation of optical flow.

The algorithm for matching stereo images uses neural network for matching the estimated first derivatives under the epipolar, photometric and smoothness constraints. Derivatives are estimated using polynomial fits in a local window. The algorithm for computation of optical flow matches estimates of principal curvatures obtained from a local window. A neural network is employed to match the estimated principal curvatures under local rigidity and smoothness constraints.