Final Report on Electronics Research at The University of Texas at Austin

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This report summarizes scientific progress on "Basic Research in Electronics" which has been conducted under the auspices of the DoD Joint Services Electronics Program during the period 15 May 1992 - 31 July 1995. Progress on five solid-state, two information electronics, and two electromagnetic projects is described.
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ELECTRONICS RESEARCH CENTER

Bureau of Engineering Research
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OVERVIEW

Research carried out under the auspices of this contract consisted of five research units in Solid State Electronics, two in Electromagnetics, and two in Information Electronics.

In Solid State Electronics the objective is to develop new materials and devices for electronic and photonic applications, based on an enhanced underlying knowledge of those materials and devices. Techniques have been developed for MBE regrowth on wafers removed from the system for photolithographic processing, and then applied to the fabrication of advanced vertical-cavity surface-emitting laser (VCSEL) structures. Building on previous work on low-temperature grown AlGaAs, the semi-insulating AlGaAs material has been patterned for current tunneling and also as an etch-back layer to provide a GaAs shadow mask for selective growth and buried void structures. Oxidation of AlGaAs layers has been used to provide insulated regions in VCSEL structures having threshold currents of 225 μA. MBE growth of distributed Bragg reflectors has been utilized to make multiple-wavelength mirrors which exhibit great promise for photodiodes providing detection in multiple windows for multiplexing applications. Femtosecond-laser-induced second harmonic generation has been demonstrated to provide a quantitative diagnostic of angstrom-scale microroughness at the Si(100)/SiO₂ interface. Models for hot electron effects, avalanche mechanisms, and surface effects have been developed in support of the research previously described.

In electromagnetics, new extremely accurate and numerically efficient models of coplanar waveguide millimeterwave phase shifters, both voltage and optically controlled, have been developed. Furthermore, extremely high voltage quantum well diodes based on a depletion-edge modulated resonant tunneling diode have been characterized. Time-frequency space has been shown to be an attractive feature space for identifying target characteristics. Specifically, time-frequency information has been obtained using wavelet transforms, and most recently superresolution techniques. Such techniques appear to be excellent tools for understanding scattering phenomenology from computed or experimentally measured data.

In Information Electronics, work in multisensor signal processing involved the development of algorithms for analyzing signals from multiple sensors and multiple views. Accomplishments include a new methodology for an automatic interpretation system using multiple sensors, a new algorithm for detecting and interpreting linear features of a real scene as imaged by a single camera, and current development of an object recognition system which utilizes the Adaptive Resonance Theory (ART)-based ART-2 artificial neural network. In other work
involving applications of higher-order statistical signal processing and applications to nonlinear system identification, accomplishments include: the ability to model third-order (i.e., cubic) nonlinear systems and phenomena subject to nonGaussian random excitation, development of sparse third-order Volterra models with attendant savings in raw data, and new approaches to quantify and mitigate nonlinear distortion in telecommunication channels.
PRINCIPAL INVESTIGATORS

Professor Jake K. Aggarwal
Professor Joe C. Campbell
Professor Dennis G. Deppe
Professor Michael C. Downer
Professor Hao Ling
Professor Christine M. Maziar
Professor Dean P. Neikirk
Professor Edward J. Powers
Professor Ben G. Streetman
JSEP Supported Ph.D. Students

Choo, Heung Ro, Ph.D., "Rapid Scan Femtosecond Ellipsometry and its application to Optical Surface Diagnostics and Ultrafast Carrier Dynamics in Semiconductors," December 1992 (Downer)

Kim, Hyeongdong, Ph.D., "Interaction of Microwave Signal with an Arcjet Plasma Plume," May 1992 (Ling)

Kutchibhotla, Ravi, Ph.D., "New Photodetectors for Optical Communications: Physics, Fabrication, and Characterization," December 1992 (Campbell)

Moore, John, Ph.D., Boundary integral solution to the electromagnetic scattering from coated surfaces containing edges, gaps and periodic gratings," December 1992 (Ling)


Rogers, Thomas, J, Ph.D., "MBE Grown Microcavities for Optoelectronic Devices", December 1992 (Streetman)

Lebègue, Xavier, Ph.D., "Automated Modeling of Structured 3-D Scenes Using a Mobile Robot," December 1993 (Aggarwal)


Sabata, Bikash, Ph.D., "Feature Correspondence and Motion Estimation from a Sequency of Range Images, August 1993 (Aggarwal)

Sadra, Kayvan, Ph.D., "Lateral Modulation - Doped Diodes", August 1993 (Streetman)

Samani, Dariush, Ph.D., "Time Domain Analysis of Adaptive Polynomial Filters with General Random Input and with Applications to Nonlinear Physical Systems, May 1993 (Powers)

Tseng, Ching-Hsiang, Ph.D., "Advanced Nonlinear System Identification Techniques and Their Application to Engineering Problems, August 1993 (Powers)

Wang, Xiaoyi, Ph.D., Hydro- and electro-dynamics of solid targets under intense femtosecond laser excitation, September 1993 (Downer)

Ahn, H, Ph.D., "Femtosecond Dynamics of Condensed Matter Under Planetary Interior Conditions, May 1994 (Downer)

Chowdhury, Andalib Ahmed, Ph.D., "Modeling of Superlattice Surface States, December 1994 (Maziar)

Gullapalli, Kiran Kumar, Ph.D., "Heterostructure Device Simulation Using the Wigner Function, August 1994 (Neikirk)

Huffaker, Diana Lynn, Ph.D., "Vertical Cavity Devices Based on Buried Native-Oxide Layers," December 1994 (Deppe)
Islam, Saiful, Ph.D., "Modeling and Experimental Studies of Schottky-Contacted Coplanar Waveguide Transmission Lines on Semiconductor Substrates", August 1994 (Neikirk)

Reddy, Vijay, Ph.D., "Characterization of High Frequency Oscillators and Varactor Diodes Grown by Molecular Beam Epitaxy, May 1994 (Neikirk)

Im, Sungbin, Ph.D., "Frequency Domain Volterra Approach to Nonlinear Systems, December 1994 (Powers)


Shaheed, M. Reaz, Ph.D., "Modeling and Simulation of Si and SiGe-Base Bipolar Transistors Operating at a Wide Range of Temperatures, May 1995 (Maziar)

Srinivasan, Anand, Ph.D., "Growth and Characterization of Low-Temperature Grown GaAs and Resonant Cavity Structures, May 1995 (Streetman)

Tong, Abraham Shen, Ph.D., "The Monolithing Integration of Indium Allow Heterojunction Bipolar Transistors and Light Emitting Diodes, December 1995, (Maziar)

JSEP Supported MS Students


Wei, Guo, M.S., "Femtosecond Ellipsometric Analysis of Semiconductor Epilayers", May 1992 (Downer)


Bhalla, Rajan, M.S., "ISAR image formation using bistatic data from the shooting and bouncing ray technique," May 1993 (Ling)

Gaul, Erhard W., M.S., "Generation, Stabilization and Amplification of Ultra-Short Pulses", December 1993 (Downer)

Klimkowskii, Kenneth, M.S., "Two-dimensional electromagnetic scattering calculations by the moment method on an iPSC/860 parallel computer", May 1993 (Ling)

Rashed, Md. Mahbub Bin, M.S., "Development of a Particle Simulator for the Study of Electronics Emitted from Laser Irradiated Metal Semiconductor Surfaces", August 1993 (Maziar)

Camarena, Jose, M.S., "Sensitivity Analysis of Xpatch-based Range Profile Simulations Subjected to Model Uncertainties", August 1994 (Ling)


Frey, Alexander, M.S., "Repetition rate synchronization of a colliding-pulse mode-locked laser with an external oscillator", December 1994 (Downer)
Hansing, Chad, M.S., "Molecular-Beam Epitaxial Growth and Fabrication of Vertical-Cavity Surface-Emitting Laser Diodes", December 1994 (Streetman)


Turner, Nelson C., M.S., "Dual beam detection of frequency shifted ultrashort laser pulses", December 1994 (Downer)

A1. Publications in Reviewed Journals


Lu, H,Q, and Aggarwal, J.K, Applying Perceptual Organization to Detection of Man-made Objects in Non-Urban Scenes, Pattern Recognition, pp. 835-853, 1992


Murtaza, S,S, Campbell, J,C, Bean, J,C, and Peticolas, L, J, A High-Reflectivity GeSi/Si Asymmetric Bragg-Reflector at 0.8 \( \mu \)m, Electronics Letters, Vol 30, February 1994


Moore, J, and Ling, H, Time-frequency analysis of the scattering phenomenology in finite dielectric gratings, Microwave Optical Tech. Lett., Vol 6, pp 597-600, August 1993


A2. Conference Proceedings


Sabata, B, and Aggarwal, J.K, Correspondence of Surfaces in a Sequence of Range Images for Motion Estimation and Tracking, Proc. IAPR Workshop on Machine Vision Applications, (MVA '92), pp 385-388, Tokyo, December 7-9, 1992


Nair, Dinesh and Aggarwal, J.K, Detecting Unexpected Moving Obstacles that Appear in the Path of a Navigating Robot, Proceedings 1st International Conference on Image Processing, pp 311-315, Austin, Texas, November 13-16, 1994


Molecular Beam Epitaxy, North American Conference on Molecular Beam Epitaxy, Urbana, October 8-10, 1994


Moore, J, and Ling, H, Scattering by gaps in coated strips, National Radio Science Meeting, p 173, Boulder, CO, January 1993 (2nd Place, Student Paper Competition)

Moore, J, Ling, H, and Liang, C.S, Boundary integral solution to scattering from coated grooves at oblique incidence, National Radio Science Meeting, p 172, Boulder, CO, January 1993


Trintinalia, L.C, Ling, H, and Wang, T.M, Electromagnetic scattering from 3-D treated cavities via a connection scheme using triangular surface patches, URSI Radio Science Meeting, p 4, Ann Arbor, MI, June 1993

Wang, T.M, and Ling, H, Electromagnetic scattering from three-dimensional arbitrarily shaped cavities, 1993 Asia-Pacific Microwave Conference, Hsinchu, Taiwan, 1 page, October 1993

Bhalla, R, and Ling, H, Fast ISAR image formation of complex targets using the shooting and bouncing ray method, National Radio Science Meeting, p 114, Boulder, CO, January 1994


Ling, H, Moore, J, Kim, H, Bhalla, R, and Xu, G, Time-frequency processing of wideband radar echo--from fixed resolution to multiresolution to superresolution, Second International Conference on Ultra-Wideband, Short-Pulse Electromagnetics, 8 pages, Brooklyn, NY, April 1994 (Invited Talk)


Bhalla, R, and Ling, H, Fast inverse synthetic aperture radar image simulation of complex targets using ray shooting, IEEE International Conference on Image Processing, pp 461-465, Austin, TX, November 1994

Bhalla, R and Ling, H, Multi-aspect range profile interpolation for the shooting and bouncing ray technique, International IEEE AP-S Symposium, pp 1902-1905, Newport Beach, CA, June 1995

Bhalla, R and Ling, H, 3D scattering center extraction from Xpatch, International IEEE AP-S Symposium, pp 1906-1909, Newport, Beach, CA, June 1995


Shaheed, M,Reaz, and Maziar, C,M, Extension of Common-Emitter Breakdown Voltage for High Speed \( Si / Si_{1-x}Ge_x HBTs \), presented at IEEE Bipolar Technology Meeting, Minneapolis, MN, October 4-6, 1992


Miller, D,R, and Neikirk, D,P, Realistic Lattice Wigner simulations of double barrier resonant tunneling devices, 11th Annual Symposium on Electronic Materials, Processing, and Characterization, Richardson, Texas, June 1-2, 1992


Tsao, Alwin J, Islam, M,D, and Neikirk, D,P, Epitaxial liftoff of GaAs/AlGaAs thin film device structures for hybrid integration on silicon and quartz substrates, 11th Annual Symposium on Electronic Materials, Processing, and Characterization, Richardson, Texas, June 1-2, 1992 (Best Student Paper Award)


Reddy, V,K, and Neikirk, D,P, AlAs/InAs heterojunction barrier varactors, 17th International Conference on Infrared and Millimeter Waves, Richard J. Temkin, Editor, SPIE Vol 1929, pp 358-359, December 14-17, 1992

Tsao, A.J, Islam, M, Saiful, and Neikirk, D,P, Hybrid integration of millimeter wave devices using the epitaxial lift-off (ELO) technique, 17th International Conference on Infrared and Millimeter Waves, Richard J. Temkin, Editor, SPIE Vol 1929, pp 421-422, December 14-17, 1992


Hartin, O and Neikirk, D.P, Memory Switching in RTDs, AVS 14th Annual Symposium on Electronic Materials, Processing, and Characterization, Austin, Texas, June 6-7, 1995


Im, Sungbin, Kim, Sung, Bae, and Powers, Edward, J, Utilization of Orthogonal Higher-Order Coherence Functions for Cubic Volterra Identification, Proceedings of the IEEE Signal Processing Workshop on Higher-Order Statistics, pp 116-120, South Lake Tahoe, California, June 7-9, 1993


B. Books or Book Chapters


Chu, Chen-Chau, Ghosh, J and Aggarwal, J.K, On Supporting Rule-Based Image Interpretation Using a Distributed Memory Multicomputer in Parallel Processing for Artificial Intelligence, Kanal, Laveen, et. al, Editors, Published in Elsevier Science, B.V, pp 21-44, 1994

Sabata, Bikash and Aggarwal, J.K, Hypergraph Based Feature Matching in a Sequency of Range Images, V. Cappellini, Editor, pp 45-56, 1994


