



**CASE WESTERN RESERVE UNIVERSITY
CASE SCHOOL OF ENGINEERING**

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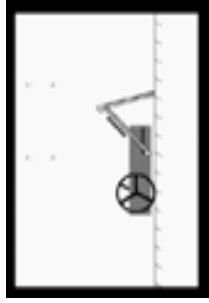
RESEARCH AREAS AND APPLICATIONS

- Evolution of dynamical neural networks
- Analysis of biological control systems
- Computational neuroethology
- Biorobotics

RECENT ACCOMPLISHMENTS

- Evolution of neural walking controllers for biologically-inspired legged robots (built by Prof. Roger Quinn)
- Analysis of a distributed model of leg coordination
- Analysis of an evolved neural circuit for object discrimination
- Evolution of learning neural circuits
- Analysis of the structure of neural fitness spaces

Model of a legged microrobot used for evolving neural controllers



APPROACH

- Continuous-time recurrent neural networks
- Genetic algorithms
- Dynamical systems theory
- Neuromechanical simulation

COLLABORATIONS

- DEPT OF BIOLOGY
- DEPT OF MECHANICAL AND AEROSPACE ENGINEERING
- CENTER FOR COMPUTATIONAL NEUROSCIENCE AND ROBOTICS AT THE UNIVERSITY OF SUSSEX

RESEARCH SPONSORS

- ONR
- NSF
- HFSP
- DARPA



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RESEARCH AREAS AND APPLICATIONS

- Hybrid Systems: those mixing continuous-time processes and digital logic
- Real-Time Control over Computer Networks
- Engineering Hybrid Systems: Robotic Assembly and Task Planning, Flexible Manufacturing, Flight Control, etc.
- Learning, Large-Scale Optimization, Analog Computing

RECENT ACCOMPLISHMENTS

- Developed a new means of programming robots to exploit the sense of touch during mechanical assembly
- Computed maximum delays preserving stability in a networked control system
- Invented an algorithm for optimal control of hybrid systems
- Predicted flexible parts feeder throughput via GSMP models
- Automated manufacturing assemblies previously only accomplished by humans [as part of a CWRU team]
- Patented a control algorithm for continuous-casting steel mills
- Proved the stability of a flight control law previously only validated by simulation

Automating "Peg-in-Maze" Robotic Assemblies



Class of assemblies, including clutch packs, gear meshing, etc.
-Uncertainty exceeds assembly clearance, sense of touch required
-Solution: Strategies (a switching between behaviors based upon continuous states, detected "events", progress of assembly itself)

APPROACH

- Mathematical analysis of "hybrid systems" (those mixing continuous-time processes and digital logic)
 - Computer modeling and optimization of such systems
- COLLABORATIONS (current and former)**
- NASA, Cleveland Clinic Foundation, Wright-Patterson AFB
 - Ford Motor Co. Advanced Technology Division
 - Eaton's Advanced Manufacturing Center
 - Siemens Corporate Research Center (Munich, Germany)
 - M.I.T., Lund Institute of Technology (Sweden), Duke, U. Md.
- RESEARCH SPONSORS**
- NSF, NASA
 - CAMP, Inc. (form. Cleveland Advanced Manufacturing Program)
 - Automotive, Manufacturing Firms



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RESEARCH AREAS AND APPLICATIONS

- Joint time-frequency signal analysis
- Wavelet Theory and applications
- Multiresolution signal decomposition
- Signal Processing for industrial applications
- Tornado detection using a 2-D wavelets on radar images

RECENT ACCOMPLISHMENTS

- Wavelet Filtering of noise corrupted audio signals
- Analysis of doppler radar images using wavelets



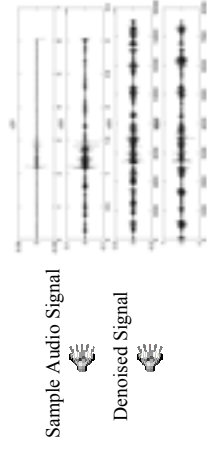
APPROACH

- Real-Time Discrete wavelet transforms
- De-noising using selective thresholding
- Ideal real-time signal reconstruction
- Internet based access for remote laboratory facilities

COLLABORATORS

- Prof. Kenneth Loparo - EECS (CWRU)

Discrete Wavelet Transform of Noisy Audio Signal



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RESEARCH AREAS AND APPLICATIONS

- Robotics: Medical Robotics, Haptics, and Teleoperation
- Computer Graphics / Virtual Environments: Surgical Simulation, Physical Modeling
- Systems and Control Theory: Modeling and Simulation of Biological Systems

RECENT ACCOMPLISHMENTS

- Proposed a novel Active Relative Motion Canceling algorithm for tracking heart motion
- Developed a task-based optimization framework for design of bilateral teleoperation controllers
- Proposed a new fidelity measure for telesurgical system design
- Developed and analyzed a novel multi-rate simulation scheme for haptic interaction with deformable objects in virtual environments

APPROACH

- Develop Intelligent Robotic Tools for Off-Pump (Beating Heart) Coronary Artery Bypass Graft Surgery
- Study Real-Time Finite Element Models of Deformable Objects for Surgical Training Simulators
- Develop an Open Source / Open Architecture Software Framework for Surgical Simulation
- Study Hierarchical Models for Organ Level Simulation in the Digital Human

COLLABORATIONS

- University of California, Berkeley
- University of California, San Francisco

RESEARCH SPONSORS

- National Science Foundation

UCB/UCSF Robotic Telesurgical Workstation for Laparoscopy





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RESEARCH AREAS AND APPLICATIONS

- Large Scale Optimization and Multi-objective Optimization
- Productivity and Quality Improvement Through Statistical Quality Control, Design of Experiments, Information Technology, and Smart Decision Support Systems
- Applications of Optimization and System Methodology to Production Planning and Control, Cell Design in Flexible Manufacturing, Magnetic Resonance Imaging (MRI), Power System Planning, Data Mining, and Gamma Knife Planning

RECENT ACCOMPLISHMENTS

- Decomposition Algorithm for Multi-criteria Design of Gradient Waveforms for MRI
- Cell Formation and Facility Layout Algorithms for Cellular Manufacturing
- Efficient Algorithm for Clustering Analysis
- Algorithm for Operations Assignment for Printed Circuit Board Production
- Algorithm for Unit Commitment in Power Generation Planning
- Algorithm for Aggregate Production Planning
- Algorithm for Operationally Constrained Quadratic Programming Problems with Applications to Design of Experiments and Response Surface Methodology
- Optimal Planner for Stereotactic Radiosurgery with Gamma Knife

APPROACH

- Specialized Decomposition Strategies and Custom Optimization Algorithms for Specific Large Scale Applications
- Integrated Production Planning and Control Software Systems with Decision Support (ERP, MRP II) for Custom Applications for Small to Medium Sized Enterprises (SMEs) (Productivity Improvement)
- Statistical Quality Control and Design of Experiments Software for Quality Improvement of SMEs

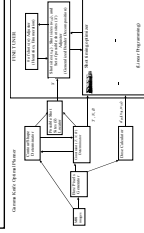
COLLABORATIONS

- B.Hobbs, John Hopkins University
- J. Duerk, Dept. of Radiology, School of Medicine, CWRU
- National Science and Technology Development Agency (NSTDA), THAILAND
- Q. Jackie Wu, Dept. Radiation Oncology, UH & Sch. of Medicine

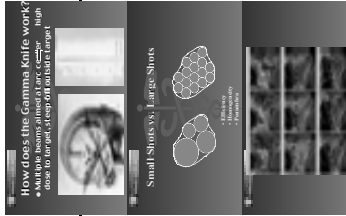
RESEARCH SPONSORS

- EPRI
- NSTDA
- American Cancer Society

Optimal Planner for Stereotactic Radiosurgery with Gamma Knife (with Q. Jackie Wu)



Decomposition-based Optima Gamma Knife Planner



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RESEARCH AREAS AND APPLICATIONS

- Modular Specification Methods for Software Systems
- Discovery of Problem Solving Strategies
- Expert Systems Applications

RECENT ACCOMPLISHMENTS

- Developed a method for modular specification of classes
- Characterized the kind of inheritance that can be used with modular specifications
- This implies that other kinds of inheritance, so called "subclassing", should only be used in special circumstances
- Empirically evaluated our method for discovering strategies
- Good strategies were discovered for a number of puzzles like Rubick's Cube
- Formulated necessary extensions for a number of other problems

APPROACH FOR MODULAR SPECIFICATIONS

- For modules we use the classes of Object Oriented Programming
- Each module has a separate interface with clients, ancestors and descendants
- For each interface there is a different specification language
- Study the properties of this kind of specifications
- The goal is to have the specifications of a class be complete; thus, classes can be implemented independently of one another

APPROACH FOR STRATEGY DISCOVERY

- Problem is specified in a special language
- Look for invariant properties of move sequences
- Invariants are used to define subproblems
- Order the subproblems so that solving one does not invalidate the solution to previous subproblems

EXPERT SYSTEMS APPLICATIONS

- Developed expert systems for a variety of difficult applications
- Worked with experts to extract domain knowledge
- Examples of industrial applications:
 - Fault diagnosis in discrete event systems
 - Predictive monitoring of injection molding
- An example of other applications is menu planning for given dietary constraints

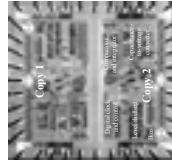


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RESEARCH AREAS AND APPLICATIONS

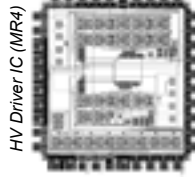
- MIXED-SIGNAL SENSOR INTERFACING AND COMMUNICATION
- Electrostatic bearing for micromotor with levitating rotor
- Wireless sensor interfacing for harsh (500 °C) environments
- Analog VLSI neural network for autonomous micro-robots
- High-speed, low-power beamformer for 3-D ultrasonic imaging



CVDM IC

RECENT ACCOMPLISHMENTS

- Sub-1fF Capacitance-to-Voltage conversion using Delta Modulation
- Multiplexed 60-V drivers in conventional CMOS for CTRNN memory



HV Driver IC (MR4)

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RESEARCH SPONSORS

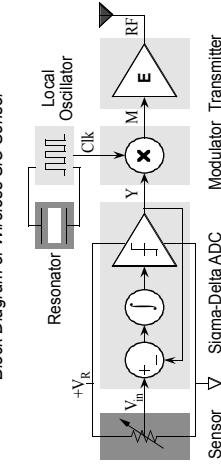
- NSF, \$88K/YR
- Glennan Microsystem Initiative, \$104K/YR
- DARPA, \$71K/YR
- Cleveland Clinic Foundation, \$88K/YR

- APPROACH
- IC/MEMS/PCB design, and PCB fabrication in CWRU MSIC Lab
- IC fabrication using DARPA/NSF MOS Implementation System
- MEMS fabrication using CWRU MFL and MCNC MUMPS

COLLABORATIONS

- NASA Glenn Research Center
- Cleveland Clinic Foundation and Queens University

Block Diagram of Wireless SIC Sensor



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RESEARCH AREAS AND APPLICATIONS

- Ultrasonics
- Electrical Networks
- Materials

APPLICATIONS

Monitoring On Site For Life

- Bearing wear (commercialized).
- Surface layers growth, strain and cracks.
- Fatigue testing in aggressive environment.
- Crack detection and characterization.

Monitoring Titanium Implants in Bones

- Bone penetration, resorption and regrowth in titanium cavities.

APPROACH

In a typical experiment, tiny ultrasonic transducers are implanted on both faces of a fatigue specimen along the principle axis. One transducer serves as the transmitter and the other as a receiver. Sharp ultrasonic signals are launched along the specimen monitoring simultaneously its length, diameter and the generation of cracks. Neither strain-gages or extensometers are necessary. Supported by NASA.

COLLABORATIONS

- G.R. HALFORD — Strength of Materials (NASA)
- J.L. Katz — Biomedical Engineering
- G. Welsch — Materials Sciences & Engineering

RESEARCH SPONSORS

- NASA

SELECTED RECENT JOURNAL PUBLICATIONS

- Hazony, D. (1999) Stress wave propagation when the elastic coefficients vary with depth. *Circuits Systems Signal Processing*, 18, No. 2, pp. 27-42.
- Hazony, D. (1997) Time limited and Band limited environment – signals and systems. *Circuits Systems Signal Processing*, 16, No. 2, pp. 1-24.
- Hazony, D. (1995) Impulse stress wave propagation in elongated bodies. *Circuits Systems Signal Processing*, 14, No. 4, pp. 525-238.
- Hazony, D. (1991) Edgeless short-pulse piezoelectric transducers. *J. Acoust. Soc. Am.* 86 (4), pp. 1230-1233.

PATENTS

A sequence of 8 patents has been evolved for on-site monitoring of wear members (such as bearings, seals, valves and clutches). The transducer is an integral part of the wear member.



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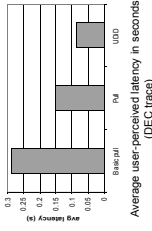
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Research Areas and Applications:

- Distributed Systems and the Internet
 - Caching, replication, and prefetching
 - Content delivery and data dissemination
 - Real-time distributed systems
- Randomized algorithms

Low-priority Traffic

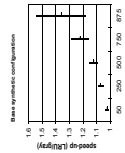
- Motivation
 - Fully utilize available bandwidth
 - Surfing behavior helped by prefetching
 - Traditional prefetching increases burstiness and delays



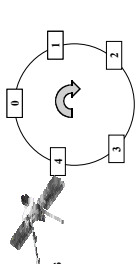
- Approach
 - Resource-triggered
 - Low-priority transport
- Features
 - Unobtrusive and scalable
 - Substantial latency reduction
 - Optimal scheduling policy

Data Dissemination

- Motivation
 - Asymmetric environments (e.g. satellites, cable TV)
 - Scalability
 - Retrieve Internet hot spots



- Approach
 - Cyclic broadcast
 - Cooperation with U. Pitt
- Client-site caching
 - Combine
 - access history with
 - waiting times to retransmission
 - Lower client waiting time



Internet Robotics

- Motivation
 - Interact with, modify, and control a remote physical environment
 - Industrial automation
 - Terrestrial and space exploration
 - Home robotics
- Approach
 - Agent-based software and object-based impedance control
 - Co-design of middleware and control software
 - End-to-end framework and application-level framing for QoS
 - Application-driven bandwidth partition and scheduling



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RESEARCH AREAS AND APPLICATIONS

- Nonlinear Control and Dynamic Systems
- Adaptive and Robust Control
- Nonholonomic Mechanical Systems
- Fault Detection and Diagnosis
- Rotating Machinery and Induction Motors

RECENT ACCOMPLISHMENTS

- NSF Career Award
- Developed General Passive Systems Theory and a Small Feedback Design Technique for Upper-Triangular Systems
- Developed a Powerful Tool known as Adding a Power Integrator for High-Order Lower-Triangular Systems
- Demonstrated Applications in Robotics, Nonholonomic and Under-Actuated Mechanical Systems, and Induction Motors



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RESEARCH AREAS AND APPLICATIONS

- Nonlinear and stochastic control theory and applications
- Model-based fault detection and diagnosis
- Integrated control and diagnostics of electrical machines
- Advanced Signal Processing for:
 - Fault detection and isolation
 - Speech recognition and speaker verification
 - Catalysis of physiological signals

RECENT ACCOMPLISHMENTS:

- Developed a model-based system for the detection and diagnosis of faults in rotating machinery
- Developed a tool wear condition monitoring system for drilling operations
- Develop algorithms for speed and number of ball estimation for ball bearing using vibration data



CWRU Vibration Test Rig

APPROACHES

- Hidden-Markov Modeling and diagnosis
- Model-based nonlinear filtering for real-time fault detection and diagnosis
- Nonlinear (stochastic) behavior using advanced signal processing and time series analysis techniques
- Passivity-based nonlinear control methods

COLLABORATORS

- Mechanical and Aerospace Engineering
 - Electronics Design Center
 - Rockwell International
 - CWRU School of Medicine
- ### RESEARCH SPONSORS
- ONR/Rockwell
 - EPRI/CAMP
 - NASA
 - NSF

RECENT ACCOMPLISHMENTS:

- Developed advanced algorithms for the detection and diagnosis of mechanical and electrical faults in induction machines
- Developed advanced nonlinear control algorithms for induction motors operating under unknown load variable rotor resistance and magnetic saturation



Rockwell Automation Motor Test Stand

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RESEARCH AREAS AND APPLICATIONS

- Intelligent Telecommunications Networks
- Multi-objective Manufacturing/Production Optimization
- Artificial Neural Networks and Clustering
- Facility Layout and Group Technology
- Decision Making Typology
- Design, Modelling, and Optimization of Systems

RECENT SPONSORS AND COLLABORATION

- NASA - Tele-communications Division: Intelligent Networks
- GE - Lighting Division: Layout-Group Technology, Clustering of HID bulbs facilities
- Parker Hannifin: Mechanability, Tool Life, Machine Set-up, and On-line Supervision
- B. F. Goodrich: Design & Production of New Polymers; Optimal Parameter Selection
- NSF: Mathematical Foundation for Machine Learning



INTELLIGENT TELE-COMMUNICATION NETWORKS

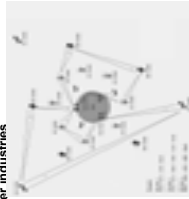
- Motivation
 - Develop intelligent design and optimization of tele-com networks and routers
 - Generate reconfigurable networks, routers, and packets
 - Improve quality and speed for space & terrestrial networks
 - Support the developing consumer industries

Approach

- Intelligent Mobile Agents
- Intelligent Packets
- Intelligent Routers
- Clustering & Swarm Algorithms
- Assimilation and Simulation

Collaboration

- NASA Glenn



DESIGN & ANALYSIS OF MANUFACTURING SYSTEMS

- Motivation
 - To develop a systematic approach for design, analysis, and optimization of operational systems by considering conflicting multiple criteria in decision making
- Approach
 - Interactive multi-objective optimization & decision making
 - Discovering problem domain and learning optimal decision making behavior
- Application areas:
 - Uni- and Bi- direction Network Layouts
 - Facility Layout/Re-layout
 - Scheduling and Sequencing
 - Resource Allocation and Aggregate Planning
 - Assembly Line Systems and Balancing



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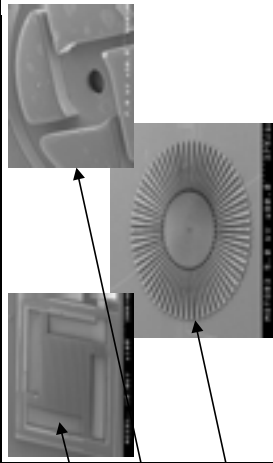
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Research Areas and Applications

- Microelectromechanical Systems (MEMS)
- Silicon Carbide Material and Process Technology
- Micromachining and Microfabrication Technologies

Recent Accomplishments

- Development of a Multi-Project Silicon Carbide (SiC) Surface Micromachining Process with Device Design Complexity Capabilities Paralleling the State-of-the-art in Silicon
- Development of Bulk Micromachining Techniques for SiC. Demonstrated by Fabrication of SiC Atomizers for Industrial and Medical Applications
- Development of a Nickel Wire Bonding Technology for High Temperature Operation of SiC Devices
- Development of Silicon Micromotors for Optical Scanning and Switching Applications



Approach

- Design/Modeling of New Sensors and Actuators
- Silicon Carbide for High Temperature Devices
- Fabrication/Process Technology Development

Collaborations

- Glennan Microsystems Initiative (http://www.glenman.org/)
- Ohio MEMSNet (mems.cwru.edu/memsnet)
- Aerospace MEMS Consortium (BFGoodrich and Parker Hannifin)
- NC State University (Prof. R. Davis on GaN)

Research Sponsors

- ARO, DARPA, NASA, NSF, CAMP



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RESEARCH AREAS AND APPLICATIONS

- Wireless systems / rfid and rf circuit design)
- Sensors (MEMS-based and optical)
- Image Processing
- Ad hoc computer networks, especially wireless
- Engineering applications of neural networks and pattern recognition

RECENT ACCOMPLISHMENTS

- Producing MEMS elements process for optical applications.



OPTICAL TESTING OF 1mm DIA, 7mm FLCONCAVE REFLECTORS FABRICATED USING MULTIPOLY™ MICROMACHINING

APPROACH

- Neural network signal processing
- Multipoly™ fabrication of controlled optical shapes
- Ad hoc wireless networks

COLLABORATIONS

- Rockwell Automation
- NASA Glenn Research Center
- Cleveland Clinic Foundation

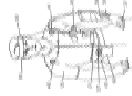
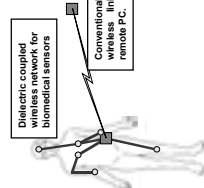
RESEARCH SPONSORS

- Rockwell Automation
- NASA



Wireless Biosensor Network

The goal of this work is to develop a wireless, low-loss intrabody communications system for biomedical sensors. Such a wireless system will have great advantages over the wired vest type systems currently used by astronauts and firemen.



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RESEARCH AREAS AND APPLICATIONS

- Mechatronics: design and control of intelligent electromechanical and robotic systems
- applications to:
 - rapid prototyping
 - reflexive, adaptive and learning systems
 - biomedical applications in orthotics, prosthetics and radiation oncology

RECENT ACCOMPLISHMENTS

- Image-Directed Radiation Oncology system at The Cleveland Clinic: successfully demonstrated value of robotically-assisted cancer treatment



0.5mm DIA MEMS MICROSCANNER FABRICATED USING SURFACE MICROMACHINING



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RESEARCH AREAS AND APPLICATIONS

- Global Change and Sustainable Human Development
- Mathematical Theory of General Systems

RECENT ACCOMPLISHMENTS

- UNESCO Scientific Advisor on Global Change
- Co-Director, Global-problematique Educational Network Initiative (GENIE)
- Co-Director, GENIE European Office, Polytechnic University of Catalonia, Terrassa, Barcelona, Spain
- Global Issues and Sustainable Human Development Undergraduate textbook

COLLABORATIONS

- European Commission: Sustainable Development and Information Age
- Iowa University
- St. Petersburg Technical University, Russia
- International Baccalaureate Organization (IBO), Geneva, Switzerland, New York, New York
- Tokyo Institute of Technology, Japan
- Chiba Institute of Technology, Japan
- University of Ulm, Germany

RESEARCH SPONSORS

- The David and Lucile Packard Foundation



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 http://www.eecs.cwru.edu/facstaff/newman.shtml

RESEARCH AREAS AND APPLICATIONS

- Mechatronics: design and control of intelligent electromechanical and robotic systems
- applications to:
 - rapid prototyping
 - reflexive, adaptive and learning systems
 - biomedical applications in orthotics, prosthetics and radiation oncology

RECENT ACCOMPLISHMENTS

- Image-Directed Radiation Oncology system at The Cleveland Clinic: successfully demonstrated value of robotically-assisted cancer treatment



Cutting a beam delivery tube / CO₂ laser
 Prototype for a robotically-assisted cancer treatment
 accurate cutting for 3D

APPROACH

- Collaborative, interdisciplinary design projects invoking skills in system modelling, analysis, and synthesis of creative solutions, typically exploiting real-time computer controls
- Depth of experience in force feedback for robotic assembly
- Biological inspiration for reflex and learning control

COLLABORATIONS

- The Cleveland Clinic (radiation oncology)
- Ford Motor Co. (force-guided robotic assembly)
- Dynamotors, Inc. (novel motor design and control)
- Geauga Rehabilitation Engineering (mechatronic orthotics)
- CWRU Dept of Biology, Mechanical Eng (agile manufacturing; learning and intelligent systems)
- CWRU Dept of Materials Science (rapid prototyping)

RESEARCH SPONSORS

- NSF
- NSF Dynamotors, Inc., Ford Motor Co., CAM-LEM, Inc., Sandia National Labs, The Cleveland Clinic, CAMP, CAISR, National Institute of Standards and Technology



Dynamotor: experimental drive with rotating electronics
 Mechatronic orthotic: leg brace
 ParaBox: prototype closed-chain manipulator. Vertical cut vs. tangent cut 3-D objects fabricated by CAM-LEM solid freeform fabrication system



CASE WESTERN RESERVE UNIVERSITY CASE SCHOOL OF ENGINEERING

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- RESEARCH AREAS AND APPLICATIONS**
- Web-Based Data Management
 - Multimedia Databases
 - Scientific Data Management Applications
 - Electronic Book Applications

RECENT ACCOMPLISHMENTS

- Querying, Storing and Playing out Multimedia Presentations: VSIOn (<http://ercyees.ces.cwrw.edu/vision>)
- Content-Based Querying of Video: GVisual (<http://ercyees.ces.cwrw.edu/gvisual>)
- Automated Multimedia Presentation Authoring: VidQuery (<http://ercyees.ces.cwrw.edu>)
- Electronic Classroom Project: A Web-Based Lecturing Environment (<http://ercyees.ces.cwrw.edu/ecp.html>)

APPROACH

(Please see <http://ercyees.ces.cwrw.edu>)

- Automated Multimedia Authoring Algorithms
- Electronic Book Data Modeling and Algorithms
- Extending the Capabilities of the Web XML Language
- Real-Time Scientific Database Algorithms

RESEARCH SPONSORS

National Science Foundation

- Extending XML with Bulk Text and Multimedia Data Semantics



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RESEARCH AREAS AND APPLICATIONS

- Database Systems with focus on
- Query Languages and Query Optimization
 - Access Methods and Index Structures
 - Data Integration and Data Compression with Applications in
 - Bioinformatics and Computational Genomics
 - Scientific and Statistical Databases
 - Data Warehouses and Web Databases

RECENT ACCOMPLISHMENTS

- An Object Oriented Language for Querying Graphs, GQDL, and Methodology for Processing GQDL Queries
- Querying Multimedia Presentations Based on Content
- Indexing Large Metric Spaces for Similarity Search Queries
- Genome Pathways Database
- Nearest Neighbor Search for Genomic Sequences

APPROACH

- Design and Implementation of Efficient and Scalable Techniques and Algorithms for Database Query Processing and Access
- Database Design and Modeling for novel data base applications
- Data Warehousing and Data Integration

RESEARCH SPONSORS

- NSF
- NASA
- Charles Wang Foundation
- Ohio Board of Regents

CENTER FOR COMPUTATIONAL GENOMICS, founding Member

Selected Professional Activities

- PROGRAM CHAIR:**
IEEE ICDE 2004, SSDBM 1999, ACM PODS 1987
- PROGRAM COMMITTEE MEMBER:**
ACM SIGMOD 2001, IEEE ICDE 2001, ICDM 2001, SSDBM 2001, ACM PODS 2000, VLDB 2000, SSDBM/2000
- JOURNAL EDITOR:**
•IEEE Transactions on Knowledge and Data Engineering (since 1998)
•ACM Transactions on Database Systems (TODS) (since 2000)
ACM SIGMOD Vice Chair (1997-2000)



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RESEARCH SPONSORS

National Science Foundation

- Extending XML with Bulk Text and Multimedia Data Semantics



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- RESEARCH AREAS AND APPLICATIONS**
- Embedded systems design, software, & hardware
 - Design automation of electronic systems
 - VLSI systems
 - Computer-Aided Design & Testing
 - Computer architecture and parallel processing

RESEARCH PROJECTS

Design and Test strategies for Embedded System-on-chip
Goal: develop methods, techniques and tools for design and testing complex System-on-Chip. Funded by NSF.

SYNTEST: High Level Synthesis and Test of VLSI Circuits
Goal: automated design of self-testable VLSI circuits from functional specs. Has been funded by SRC and industry to develop SYNTEST, a tool suite for designing self-testable circuits, from algorithms to silicon.

Specification and Design of an Advanced Image Processor
Goal: design and implement key image processing functions for color FAX applications. Funded by Rockwell and Contextant.

COLLABORATIONS

- Rockwell Automation
- Contextant
- Synopsys
- LSI Logic
- Intel
- National Science Foundation
- Rockwell
- Contextant
- Synopsys
- SRC

RESEARCH SPONSORS

National Science Foundation

SELECTED JOURNAL PUBLICATIONS

C. Papachristou, M. Norani, S. Shring, Multiple Clock Scheme for Low Power RTL Design, *IEEE Trans. On VLSI*, June 1999.

C. Papachristou, M. Babakov, K. Lai, High Level Test Synthesis for Behavioral and Structural Designs, *J. Electronic Testing*, October 1998.

C. Papachristou and M. Immaneni, Vertical Migration of Software Functions and Algorithms with Enhanced Microsequencing, *IEEE Trans. On Computers*, January 1993.

C. Papachristou and H.S. Lim, A Large, Crash Mapping Method for Parallel Scientific Computers, in *Parallel Computational Fluid Dynamics*, MIT Press, October 1992.

C. Papachristou and N. Sehgal, An Improved Method for Detecting Functional Faults in Semiconductor Memories, *IEEE Trans. On Computers*, March 1985. (Widely quoted in over 400 publications, implemented in industry.)



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RESEARCH AREAS AND APPLICATIONS

- Software engineering methodology
- Software testing and reliability
- Software architecture and design
- Distributed systems and applications
- Software for advanced manufacturing systems

RECENT ACCOMPLISHMENTS

- Developed new approach to software testing called observation-based testing
- Experimentally validated test data selection techniques
- Demonstrated new methods for estimating software reliability
- Developed software architectures for flexible manufacturing and force-guided assembly

OBSERVATION-BASED SOFTWARE TESTING

- Employs visualization and data mining techniques in software testing, debugging, and maintenance
- Substantially automated
- Reduces testing and maintenance costs
- Reveals how software is really used
- Permits measurement of software reliability

Visualization of Test Executions in OB





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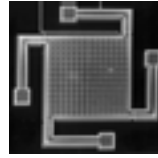
DARRIN J. YOUNG, Ph.D. (UC Berkeley)
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djy@jeo.cwrw.edu; 216-368-8945; 216-368-8039 (fax)

RESEARCH AREAS AND APPLICATIONS

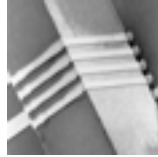
- MEMS Design and Fabrication Technology
- RF MEMS for Wireless Communications
- MEMS Sensors for Biomedical and Harsh Environments
- MEMS Power Generating Systems
- Low-Power, Low-Noise CMOS MEMS Interface ICs
- Low-power Telemetry Circuits Design

RECENT ACCOMPLISHMENTS

- Designed and Fabricated MEMS High-Q Tunable Capacitors
- Designed and Fabricated MEMS High-Q 3D RF Coils
- Implemented MEMS RF Low-Noise Oscillators



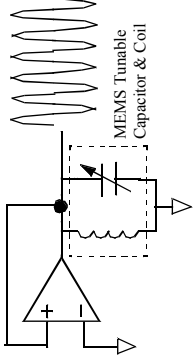
MEMS Tunable Capacitor



MEMS 3D RF Coil

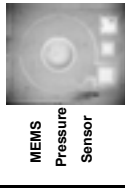
APPROACH

- Micromachined On-Chip High-Q Tunable Capacitors
- Micromachined On-Chip High-Q Three-Dimensional Coils
- Miniaturized Low-Noise RF Voltage-Controlled Oscillators

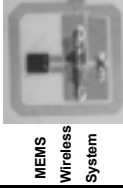


Micromachined Oscillator for Cellular Telephony

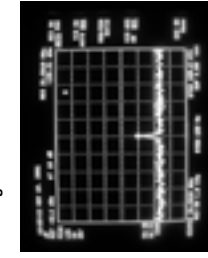
Micro-Power MEMS Wireless Sensing and Communications



MEMS Pressure Sensor



MEMS Wireless System



Received Sensor Information at 3-meter distance



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RESEARCH AREAS AND APPLICATIONS

- Programming languages
- Artificial intelligence
- Semantics of logic programming and commonsense reasoning
- Topology and computer science
- Formal languages, automata theory, and binary decision diagrams

Recent Accomplishments

- Partial information, order-theoretic approach to default reasoning to obtain better structural and algorithmic properties
- Relating disjunctive logic programming to Reiter's default extension in a power domain framework over algebraic cpos
- A Boolean matrix methodology to solve classical problems in automata theory
- Systematic generation of program logics from their semantics
- Classification of expressive power of nonmonotonic reasoning systems

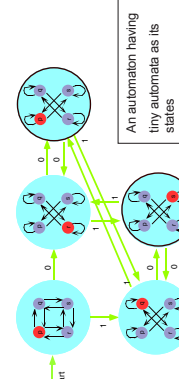
Approach

- The idea of partial information and successive approximation plays an important role in programming languages, and in artificial intelligence
- Algebraic, order-theoretic, combinatorial, topological and categorical methods can be combined and advanced for modeling complex systems
- Semantics based approach provides new insights to logic and computation
- Applications in traditional and emerging areas as a result of cross-fertilization of ideas and interdisciplinary research

Collaborations

- AI Laboratory, University of Michigan, Ann Arbor
- University of Goeborg, Sweden
- Dresden University of Technology, Germany

Vertical integration of multi-level abstraction



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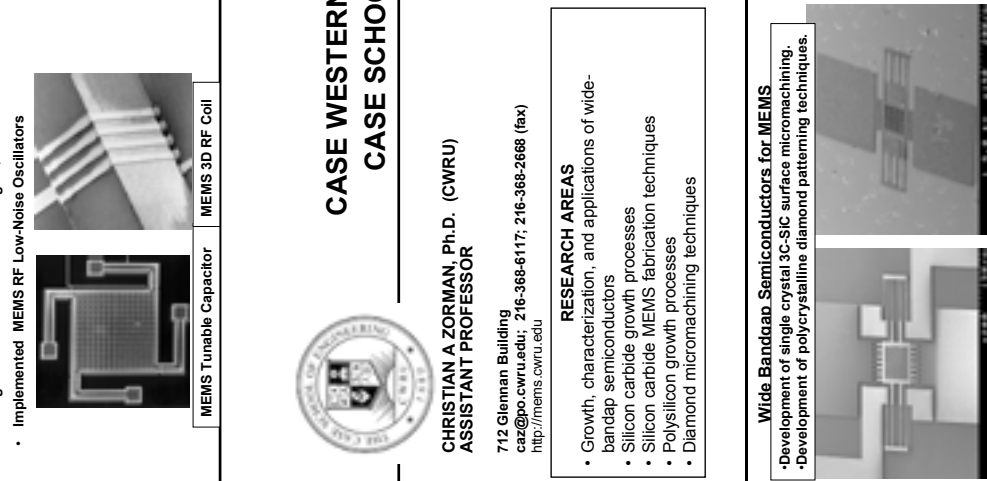
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RESEARCH AREAS

- Growth, characterization, and applications of wide-bandgap semiconductors
- Silicon carbide growth processes
- Silicon carbide MEMS fabrication techniques
- Polysilicon growth processes
- Diamond micromachining techniques

Wide Bandgap Semiconductors for MEMS

- Development of single crystal 3C-SiC surface micromachining.
- Development of polycrystalline diamond patterning techniques.



3C-SiC lateral resonator

Diamond lateral resonator



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APPROACH

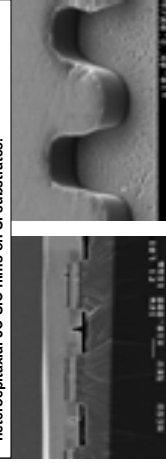
- Development of thin film deposition techniques for high quality single and polycrystalline 3C-SiC on large area substrates.
- Development of micromolding-based patterning techniques for thin film and bulk 3C-SiC.
- Development of 3C-SiC transition layer substrates for GaN growth on silicon.

CURRENT COLLABORATIONS

- **North Carolina State** : Pendeo-epitaxial growth of GaN Bulk micromachining of SiC
- **U.C. Berkeley**: Nanomechanical SiC structures
- **Caltech**: Tensile testing of SiC
- **Johns Hopkins Univ.**: Tensile testing of SiC
- **U. Erlangen (Germany)**: Elastic properties of SiC

Heteroepitaxy of 3C-SiC films on Si wafers

- 3C-SiC buffer layers for pendeo-epitaxial growth of GaN on Si.
- Micromolding techniques as an alternative to RIE for patterning heteroepitaxial 3C-SiC films on Si substrates.



GaN on Si using 3C-SiC

Micromolded 3C-SiC film



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RESEARCH AREAS AND APPLICATIONS

- Efficient Utilization of Spectrum for Space Telemetry
- Regenerative Ranging Measurements to Spacecraft
- Design of Power-Efficient Telemetry Schemes
- Characterization of Phase-Locked Receivers

APPROACH

- Stochastic analysis of frequency and polarization diversity
- Evaluation of alternative telemetry strategies
- Simulation of receiver synchronization functions

COLLABORATIONS

- Jet Propulsion Laboratory

RESEARCH SPONSORS

- Jet Propulsion Laboratory

RECENT ACCOMPLISHMENTS

- Analysis of dynamic data rate telemetry
- Analysis of adjacent-channel interference for QPSK carriers
- Design of phase-locked loops with programmable parameters