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RESEARCH INTERESTS

- Bionanotechnology and Biosensing
- Bioelectronics (interface between electronics and biological world)
 - Silicon-Bio Interface (hybrid biological/solid-state devices)
 - Non-silicon Electronics (protein/DNA electronics)
- Hybrid CMOS Design for Life Science and Environmental Monitoring Applications
- Biomedical Circuits and Instrumentation
- Bio-inspired Sensors and Systems
- Nanocomposite Biomaterials and Smart Sensors

EDUCATION

Ph.D. Electrical and Computer Engineering, Michigan State University, June 2009 (expected)

Advisor: Dr. Shantanu Chakrabartty (ECE), Co-Advisor: Dr. Evangelyn C. Alocilja (Biosystems)

Thesis: Forward Error-Correcting Biosensor: Modeling, Algorithm, and Fabrication

M.S. Electrical and Computer Engineering, Chinese Academy of Sciences, July 2004

Advisor: Dr. Tao Mei, Co-Advisor: Dr. Bing Liang

Thesis: Eye-in-Hand System of Extravehicular Mobile Robot

B.S. Automatic Control, Hefei University of Technology, July 2001

Supervisor: Dr. Kejun Xu

Thesis: Application of Neural Network on Robotic Hand Manipulation

HONORS & AWARDS

- Entrepreneurial Faculty for the 21st Century University Fellowship, Michigan State University, 2008-2009.
- Summer Dissertation Completion Fellowship, Michigan State University, 2008.
- K.L.Klomprens Fellowship, Michigan State University, 2008.
- Member of Sigma Xi (the International Honor Society of Science and Engineering).
- Featured Spotlight Nanotechnology Paper, Nanowerk, 2007.
- Fourth-Prize Award in International Student Experimental Hands-on Project Competition via Internet on Intelligent Mechatronics and Automation, 2004.
- Outstanding Graduate Student Fellowship, Chinese Academy of Sciences, 2002-2003.
- Best Undergraduate Thesis Award, Hefei University of Technology, 2001.
- Outstanding Academic Performance Award, 1st Prize, Hefei University Technology, 2000.
- Excellent Undergraduate Scholarship, 3rd Prize, Hefei University Technology, 1997-1999.

RESEARCH EXPERIENCE

Doctoral Dissertation Research: Development of Forward Error-Correcting Biosensor Based on Self-assembled Biomolecular Circuits

This project focuses on developing a nanobiosensor, which is embedded with error correction function to improve the reliability and accuracy. In this project our objective is to develop hybrid Bio-CMOS techniques, which combines selectivity and sensitivity of biological sensors with reliable computation on silicon to improve the performance of biosensors. Our approach is to use source-channel coding principles to embed forward error-correction on the biosensor and decode the output produced by the sensor using a reliable silicon based processor. Contributions:

- Fabrication and modeling of biomolecular circuit elements used for constructing the FEC biosensors
- Development of a simulation environment (Hybrid Bio-CAD model) for rapid evaluation of encoding/decoding algorithms
- Reveal a novel biological phenomena “co-detection” and development of a corresponding protocol that exploits non-linear interaction between different biomolecular circuit elements to detect trace quantity of pathogens.

Multi-channel Femtoampere-sensitivity Potentiostat Array for Biosensing Applications (March 2007 – January 2008)

Cooperate with another Ph.D student Amit Gore to design a multichannel potentiostat array based on a novel semi-synchronous SigmaDelta analog-to-digital conversion algorithm. The algorithm combines continuous time SigmaDelta with time-encoding machines, and enables measurement of currents down to femtoampere range. A 3-mm X 3-mm chip implementing a 42-channel potentiostat array has been prototyped in a 0.5- μ m CMOS technology. We have successfully applied the potentiostat array to a conductimetric biosensor for detecting *Bacillus Cereus* bacterium at different concentration levels.

Smart and Wearable Carbon Nanotubes/Poly(L-lactide) Nanocomposite Strain Sensors for Biomechanical Applications (October 2006 – December 2007)

A prototype of carbon nanotubes/poly(L-lactide) (PLLA) nanocomposites has been fabricated and nanocomposite strain sensors are designed based on piezoresistive property. Because of biocompatible properties of PLLA, this kind of nanocomposites strain sensor is ideal for the biomedical application and biomechanics. Contributions:

- The first nanocomposite strain sensor made by biocompatible material PLLA and it offers improved load transfer across the nanotubes by means of better interfacial bonding between polymer matrix and carbon nanotubes fillers.
- The gauge factor of the strain sensor can reach 30 and it is 15 times that of metallic foil strain gauge. It is one of the most sensitive nanocomposite strain sensors that has been reported in the literature.

Master Thesis: The Eye-in-Hand system for an Extravehicular Mobile Robot (September 2002 - June 2004)

Designed a multisensory robotic gripper for an extravehicular mobile robot. Different kinds of sensors such as force sensors, touch sensors and a pair of tiny cameras were embedded in the specially designed robotic gripper to provide multisensory function. Contributions:

- A DSP-based gripper controller was developed to achieve sensor data acquisition and transmission and the control of the gripper.
- In this project, I also proposed a novel multisensor fusion algorithm to detect robot contact state in the presence of inadequate sensory information.

Multi-sensory Smart Training System for Biomechanical Application (December 2003 – June 2004)

Designed a smart earthbag that is equipped with multiple sensors (force/torque and acceleration sensors). It can calculate the number of hits by the boxer automatically according to multi-sensory information and it has been used as a complementary training system for boxer athlete. Contributions:

- Project Manager and leader of a research team including one Ph.D student and two electronic engineers.
- Developed a sensor signal processing software to acquire multisensory information.

Undergraduate Thesis: Multi-Sensor Data Fusion for Judgement of Robotic Gripper Connecting States (January 2001 – July 2001)

When the mobile robot is working in the space workstation, it is important to ensure that the connection between the robotic gripper and object or space workstation is normal. Back-Propagation Neural Network and Radial Basis Function Neural Network are used to achieve the multi-sensor data fusion to derive the robotic gripper connection state information.

PATENTS

- Shantanu Chakrabartty and Yang Liu, “A Co-detection Protocol for Trace Detection of Pathogens on a Forward-error Correcting Biosensor”, MSU Disclosure TEC2009-0009, Filed July 2008.

GRANT PROPOSALS

- “Integrated Biosensing and Bioactuation using Miniaturized NMR and Nanoparticle Encoder”, NSF Emerging Frontiers in Research and Innovation program 2009 (EFRI-2009), in preparation.

TEACHING EXPERIENCE

Guest Lecturer for Graduate Course BE891, Michigan State University, 2008 Spring

- Presented invited talks about cutting-edge biosensors and bioelectronics technology to guest sessions of “Introduction to Biosensors” course

ECE418 Teaching Assistant, Michigan State University, 2006 Fall

- Responsibilities included planning experiment session of Cadence software for analog VLSI circuit design
- Organized problem solving sessions and question answer sessions

Supervisor of the Freshman Students, Hefei University of Technology, 1999-2000

- Responsibilities included helping freshman quickly adjust to campus life
- Initiated and stimulated students’ enthusiasm for college study
- Gave lectures and administered exams

INVITED PRESENTATIONS

- “Towards Reliable Multi-pathogen Biosensors using High-dimensional Encoding and Decoding Techniques”, *SPIE Symposium on NanoScience+Engineering*, San Diego, USA, August 2008.
- “Computer Aided Simulation and Verification of Forward Error-Correcting Biosensors”, *IEEE International Symposium on Circuits and Systems*, Seattle, USA, May 2008.
- “High-dimensional Encoding-decoding Techniques for Reliable Pathogen Detection”, Chemical Engineering, The City University of New York, New York City, USA, February 2008.
- “Bio-Silicon Interface”, Guest Lecture, Department of Biosystems & Agricultural Engineering, Michigan State University, East Lansing, USA, February 2008.
- “A Molecular Bio-wire based Multi-array Biosensor with Integrated potentiostats”, *IEEE Biomedical Circuits and Systems Conference*, Montreal, Canada, November 2007.
- “Carbon Nanotubes/Poly(L-lactide) Nanocomposite Strain Sensor”, Invited Presentation, Department of Kinesiology, Michigan State University, East Lansing, USA, March 2007.
- “MWNT/PLLA Nanocomposite and its Electrical Properties”, Invited Presentation in Graduate Student Seminar, School of Packaging, Michigan State University, East Lansing, USA, October 2006.

PUBLICATIONS

Journal Publications

- [1]. **Yang Liu**, and Shantanu Chakrabartty, "Factor Graph based Biomolecular Circuits Analysis for Designing Forward Error Correcting Biosensors" *IEEE Transactions on Biomedical Circuits and Systems*, under review.
- [2]. **Yang Liu**, Amit Gore, Shantanu Chakrabartty, and Evangelyn C.Alocilja, "Characterization of Sub-systems of a Molecular Biowire-based Biosensor Device", *Microchimica Acta*, Vol. 163, No. 1-2, pp. 49-56, 2008.
- [3]. **Yang Liu**, Shantanu Chakrabartty, and Evangelyn C.Alocilja, "Fundamental Building Blocks for Molecular Bio-wire based Forward-error Correcting Biosensors", *Nanotechnology*, Vol. 18, No. 42, pp. 424017(6pp), 2007.
- [4]. Amit Goradia, Zhiwei Cen, Clayton Haffner, **Yang Liu**, B.H.Song, Matt W.Mutka and N.Xi, "Pervasive Surveillance Networks: Design, Implementation and Performance Analysis", *International Journal of Distributed Sensor Networks*, in press.
- [5]. Kejun Xu, Qiaoli Li, **Yang Liu**, LiBiao Tong, and Tao Mei, "Multi-sensors Data Fusion Based Measurement of Wrist Force for Robots", *Chinese Journal of Scientific Instruments*, Vol. 24, No. 3, pp. 286-290, 2003.
- [6]. Kejun Xu, **Yang Liu**, and Tao Mei, "Multi-Sensor Data Fusion for Judgement of Robotic Gripper Connecting States", *Acta Metrologica Sinica*, Vol. 23, No. 4, pp. 287-293, 2002.

Journal Publications in Preparation

- [7]. **Yang Liu**, Shantanu Chakrabartty, and Evangelyn C.Alocilja, "Novel Biological Co-detection Phenomena and Protocol for Trace Detection of Multi-pathogens on a Forward Error Correcting Biosensor", *Sciences*, in preparation.
- [8]. **Yang Liu**, Shantanu Chakrabartty, and Evangelyn C.Alocilja, "Forward Error Correction Biosensors: Principles, Modeling, and Fabrication", *Biosensors and Bioelectronics*, in preparation.
- [9]. **Yang Liu**, Deng Zhang, Shantanu Chakrabartty, and Evangelyn C.Alocilja, "Array-Based Conductimetric BioChip with Nanoparticle Probes ", *Sensors Journal: A Special Issue on Nanotechnological Advances in Biosensors*, 2009, invited paper, in preparation.

Referred Conference Publications and Presentations

- [1]. **Yang Liu**, Evangelyn C.Alocilja, and Shantanu Chakrabartty, "Forward Error Correcting Biosensors: Modeling, Algorithm, and Fabrication", *IEEE Biomedical Circuits and Systems Conference*, Baltimore, USA, 2008. (To appear)
- [2]. Shantanu Chakrabartty and **Yang Liu**, "Towards Reliable Multi-pathogen Biosensors using High-dimensional Encoding and Decoding Techniques", *SPIE Symposium on NanoScience+Engineering*, San Diego, CA, 2008.
- [3]. **Yang Liu**, Shantanu Chakrabartty, Evangelyn C.Alocilja, "A Multiplexed Biosensor based on Bio-molecular Nanowires", *IEEE International Symposium on Circuits and Systems*, pp. 2006-2009, Seattle, USA, 2008.
- [4]. **Yang Liu**, Shantanu Chakrabartty, "Computer Aided Simulation and Verification of Forward Error-Correcting Biosensors", *IEEE International Symposium on Circuits and Systems*, pp. 1826-1829, Seattle, USA, 2008.
- [5]. **Yang Liu**, Amit Gore, Shantanu Chakrabartty, Evangelyn C.Alocilja, "A Molecular Bio-wire based Multi-array Biosensor with Integrated potentiostats", *IEEE Biomedical Circuits and Systems Conference*, pp. 29-32, Montreal, Canada, 2007.
- [6]. **Yang Liu**, Shantanu Chakrabartty, Dimitris Stamatis Gkinosatis, Amar K.Mohanty, and Nizar Lajnef, "Multi-walled Carbon Nanotubes/Poly(L-lactide) Nanocomposite Strain Sensor for Biomechanical Implants", *IEEE Biomedical Circuits and Systems Conference*, pp.119-122, Montreal, Canada, 2007.
- [7]. **Yang Liu**, Shantanu Chakrabartty, and Evangelyn C.Alocilja, "A Forward Error Correcting Biosensor Based on Molecular Nanowire", *Nanoelectronic Devices for Defense and Security Conference*, Crystal City, Virginia, 18-21 June 2007. (Oral Presentation)
- [8]. **Yang Liu**, Shantanu Chakrabartty, "Analog Encoding-Decoding in Computational Biosensors", *2007 Analog Decoding Workshp, Montréal, Canada*, May 24-25, 2007. (Oral Presentation)

- [9]. **Yang Liu**, Dimitris Stamatis Gkinosatis, Amar K.Mohanty, and Shantanu Chakrabartty, “Carbon Nanotube/Poly lactide Nanocomposites for Wearable Strain Sensors”, *Nano and Giga Challenges in Electronics and Photonics*, Phoenix, Arizona, March, 2007, U.S.A. (Oral Presentation)
- [10]. **Yang Liu**, Amit Goradia, Yonghui Xue, and Ning Xi “Event Based Methodology for SuperMedia Enhanced Internet-Based Teleoperation”, *IEEE International Conference on on Robotics and Biomimetics*, pp. 67-72, Kuming, China, Dec.2006.
- [11]. Zhiwei Cen, Matt Mutka, **Yang Liu**, Amit Goradia, and Ning Xi, “QoS Management of Supermedia Enhanced Teleoperation via Overlay Networks”. *Proceedings of 2005 IEEE/RSJ International Conference on Intelligent Robots and Systems*, pp. 1630-1635, Edmonton, Alberta, Canada, 2005.
- [12]. Zachary Nichol, **Yang Liu**, Paul Suchyta, Mathew Prokos, Amit Goradia and Ning Xi, "Super-Media Enhanced Internet-Based Real-Time Teleoperation", *Hands-On International Mechantronics and Automation Conference*, July, 2005.
- [13]. **Yang Liu**, Tao Mei, Xiaohua Wang and Bing Liang, “Multisensory gripper and local autonomy of extravehicular mobile robot”, *IEEE International Conference on Robotics and Automation*, Vol.3, pp. 2969-2973, May, 2004.

PROFESSIONAL ACTIVITIES

- Member of Sigma Xi
- Student Member, IEEE, IEEE Circuit and System Society, IEEE Engineering in Medicine and Biology Society
- Member of Overseas China Education Foundation
- Technique Reviewer for the IEEE International Symposium on Circuits and Systems (2007-2009); IEEE Biomedical Circuits and System Conference (2007-2008); 2008 IEEE International Conference on Robotics and Biomimetics; 2006 9th International Conference on Control, Automation Robotics & Vision; IEEE International Conference on Robotics and Automation (2004-2006); 2005 IEEE/RSJ International Conference on Intelligent Robots and Systems.

MEDIA REPORTS

- Our nano-biosensor research has been featured by many internet media including spotlight articles from: *Nanowork* (No.1 nanotechnology portal), *FoodNavigator*, *Medgadget*, *Michigan Small Tech Newsletter*, and *East Lansing News Topix*.
- Internet robot teleoperation project (my past project) was covered in Hong Kong TVB television for the Internet-based Robotics Competition, 2005.

REFERENCES

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