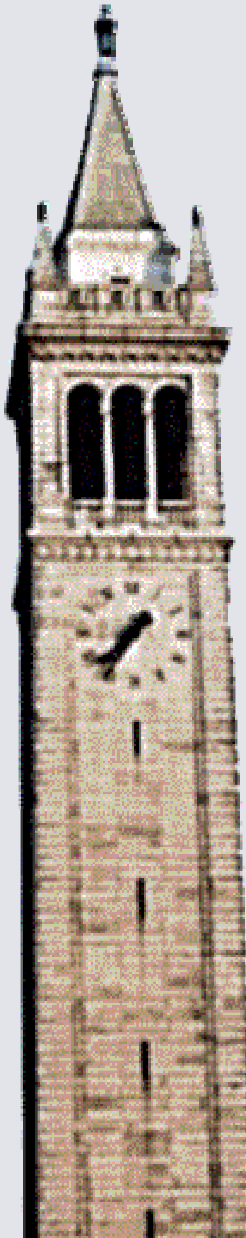
Outreach: Summer Programs and Undergraduate Research

Edited and presented by
Jonathan Sprinkle
EECS, UC Berkeley

Chess Review
November 21, 2005
Berkeley, CA



Overview

- Summer Programs
  - SUPERB: Summer Undergraduate Program in Engineering Research at Berkeley

    Berkeley University of California

  - SIPHER: Summer Internship Program in Hybrid and Embedded Software Research

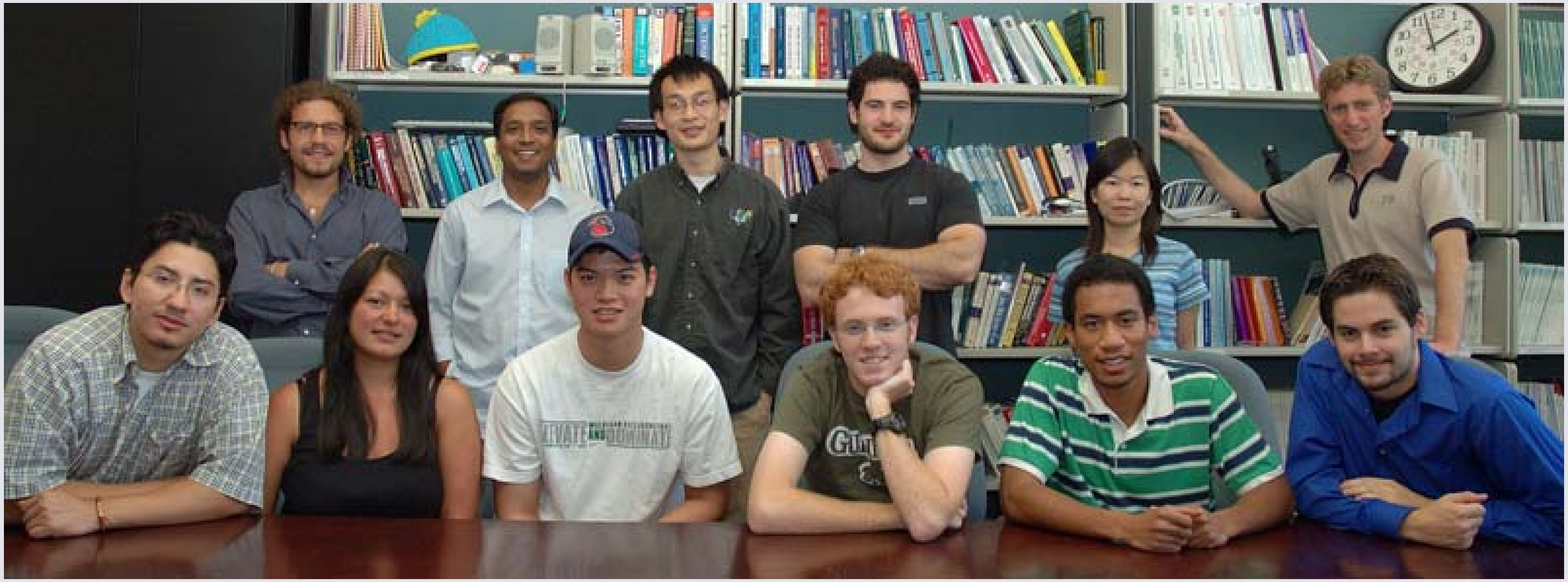
    VANDERBILT UNIVERSITY

- Previous Summer Students (Updates)
- Undergraduate Research

SUPERB-IT 2005

http://chess.eecs.berkeley.edu/superb/

- Sponsored six undergraduate students
- Paired with six individual mentors
- Designed projects to cross-fertilize



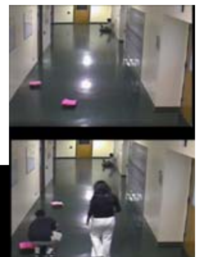
CHESS-sponsored participants in the SUPERB Program.
L-R (Back, Mentors) Alessandro Pinto, Parvez Ahammad, Haiyang Zheng, Aaron Ames, Yang Zhao, Alessandro Abate
L-R (Front, Student Researchers) Rey Romero, Lana Carnel, Simon Ng, Bobby Gregg, Murphy Gant, Shams Karimkhan

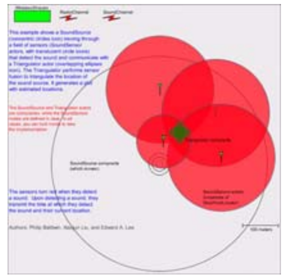
SUPERB: Projects Overview

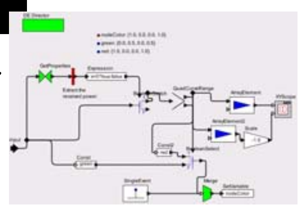
Camera Networks

Lana Carnel

Visual Segmentation Code





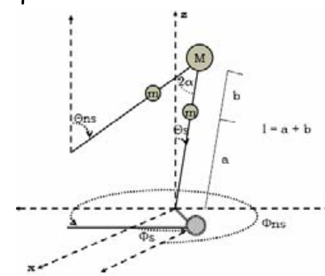


Camera and Network Modeling

Murphy Gant

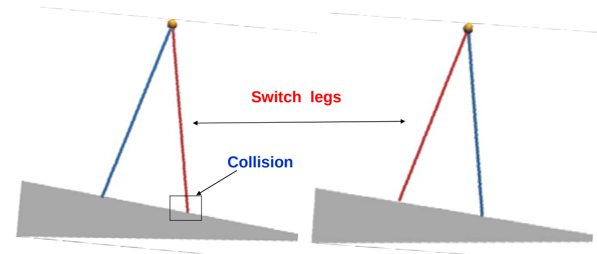
Hybrid Systems Theory and Modeling

Derivation of Equations of Motion



Bobby Gregg

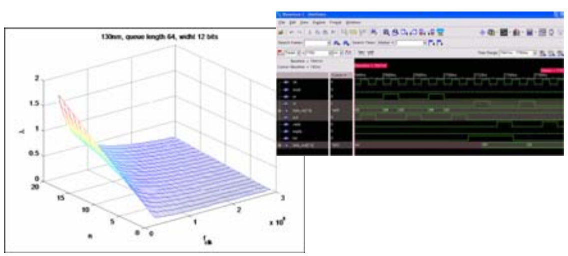
Simon Ng



Modeling and Simulation with HyVisual

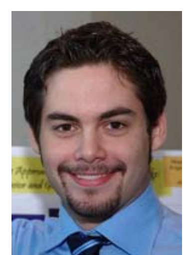
Modeling/Analysis On-Chip Networks

Reinaldo Romero

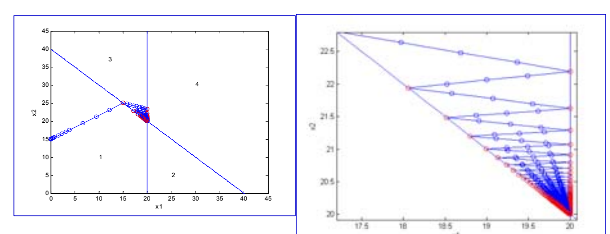


Tradeoff Analysis in Design

Zeno in Communications Networks



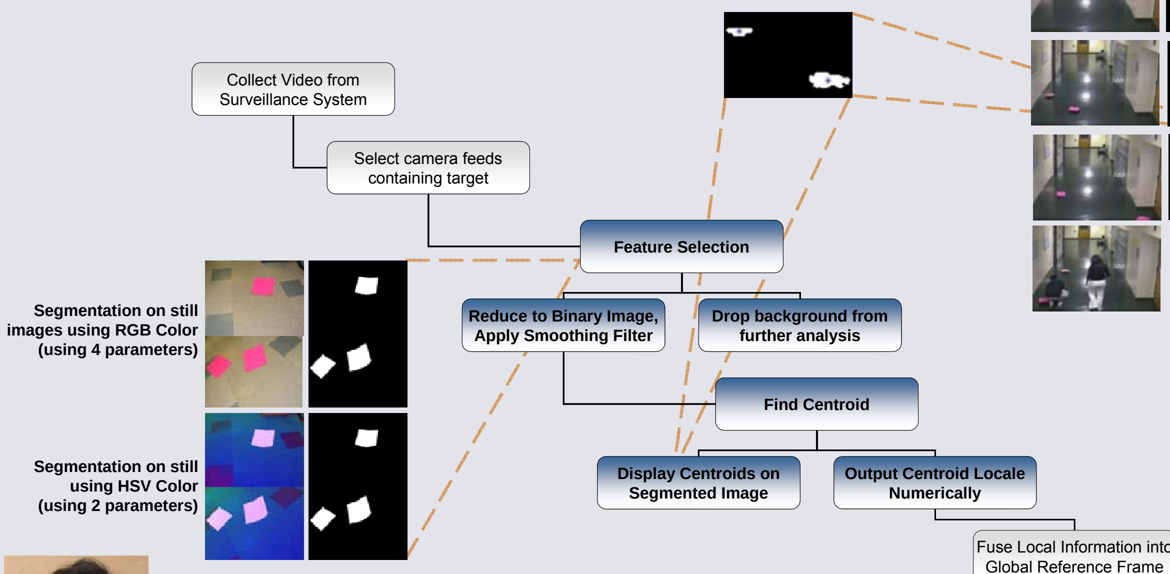
Shams Karimkhan



Visual Target Segmentation and Identification

Lana Carnel

- Lana Carnel,
  - Sophomore, University of Tennessee, Knoxville
  - Previous Degree in Film Studies



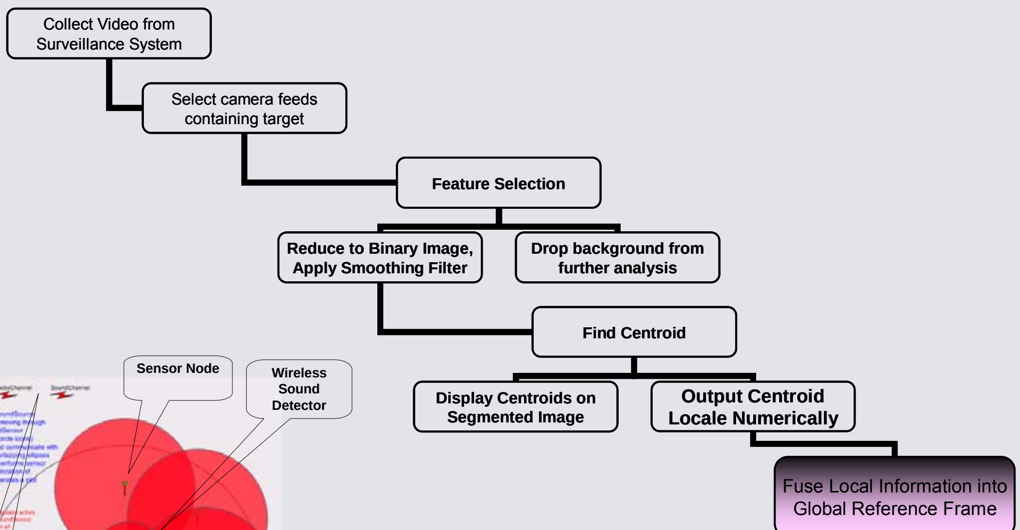
Selected video frames and resulting segmentation and identification

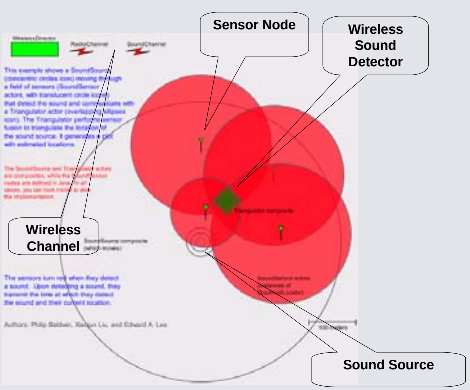
Research continues in this area by Lana's Mentor, Parvez Ahammad

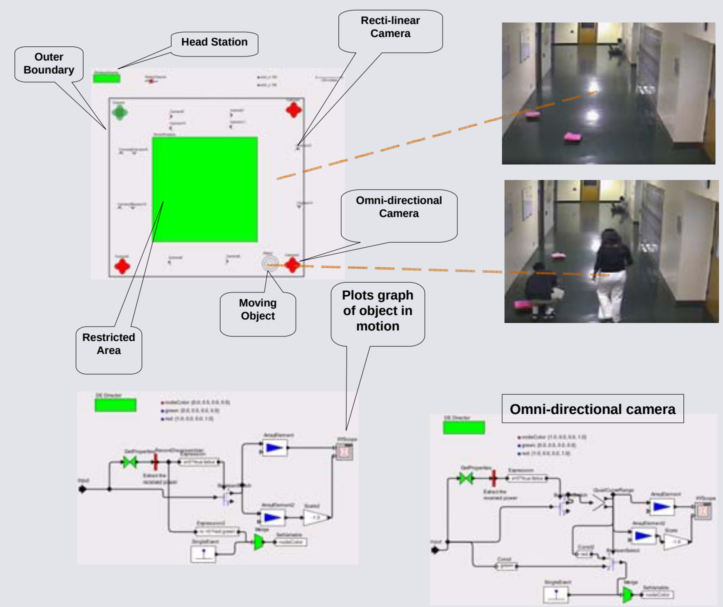
Modeling of Distributed Camera Networks

Murphy Gant

- Murphy Gant,
  - Sophomore, Diablo Valley Community College
  - Since, transferred to UC Berkeley







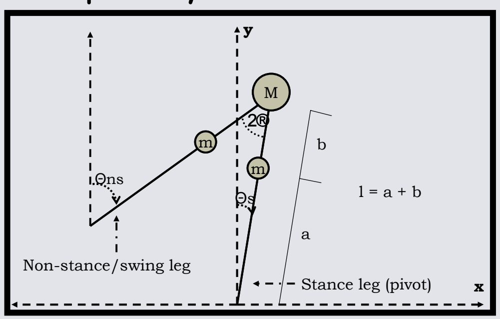
Murphy used the VisualSense Ptolemy II domain, which is the research topic of his mentor, Yang Zhao

Hybrid Reduction of a Bipedal Walker from Three to Two Dimensions

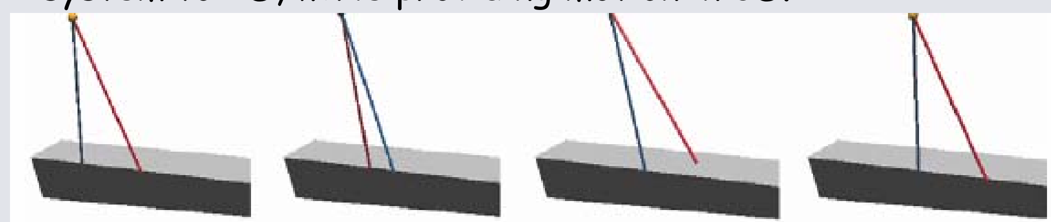
Bobby Gregg

- Bobby Gregg
  - Junior, UC Berkeley
  - Continued research into this academic year

Motion: 2D
Complexity: 4 variables

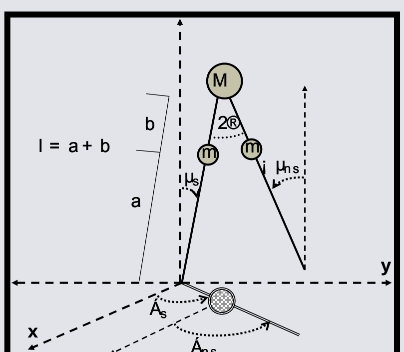


•Existing methods for state exploration do not scale up to allow addition of multiple degrees of freedom.
•This work used Hybrid Lagrangian Reduction to effectively reduce the dimensionality of the modeled system to 2D, while providing motion in 3D.

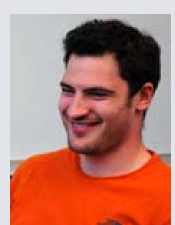


Periodic 2D Walking: Reduced Model (M = 178kg, m = 89kg, a=b=0.5m, and c = 0.01)

Motion: 3D
Reduced complexity: 4 vars



Motion: 3D
Complexity: 8 vars



Bobby applied emerging research techniques of his mentor, Aaron Ames, to this problem, and continues to work in this area after the program is completed.

Modeling, Simulation, and Analysis of a Bipedal Walker

Simon Ng

Simon Ng

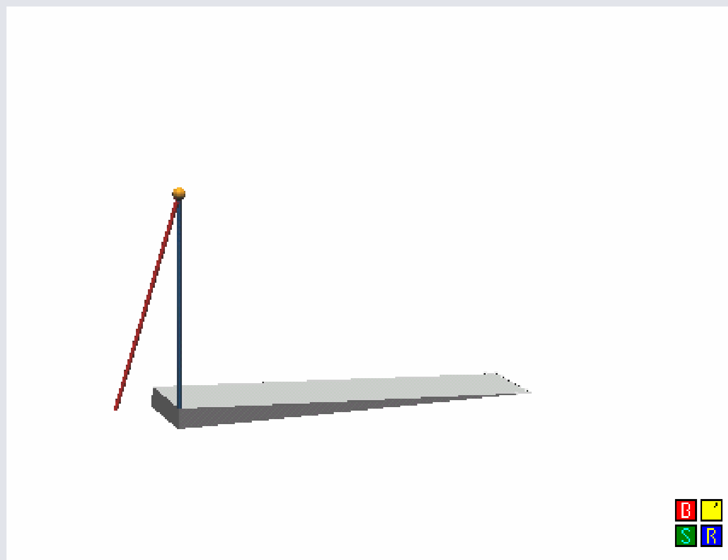
Simon worked closely with his mentor Haiyang Zheng, who is the manager of the HyVisual modeling domain in Ptolemy II. Haiyang continues this work because of the SUPERB interaction.

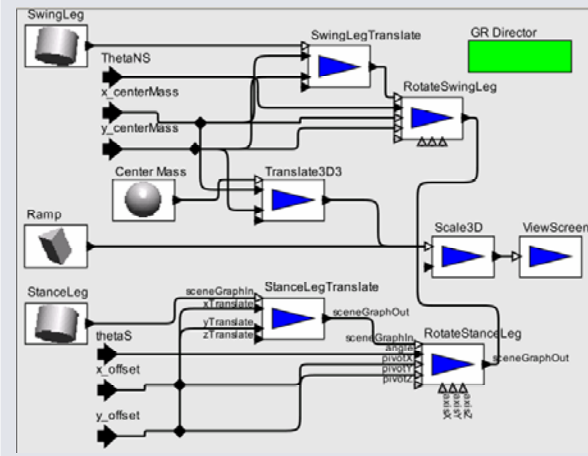
- Junior, Michigan State University
- Verified equations derived by Bobby Gregg

Dynamical Modeling (visualization independent)

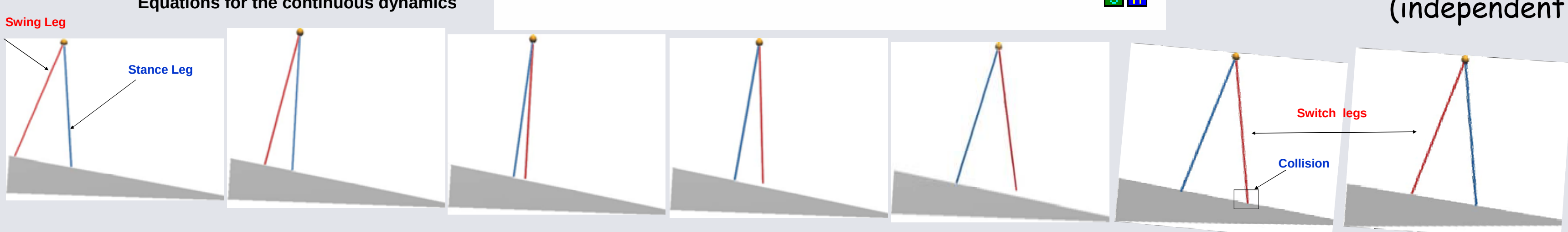
$$M(\Theta)\ddot{\Theta} + F(\Theta,\dot{\Theta})\dot{\Theta} + g(\Theta) = 0$$

Equations for the continuous dynamics





Physical Visualization (independent of model)

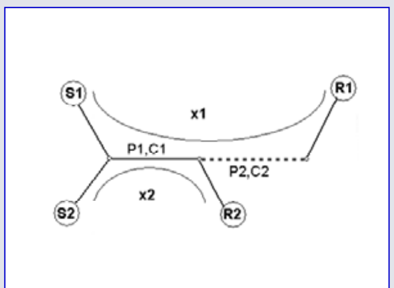


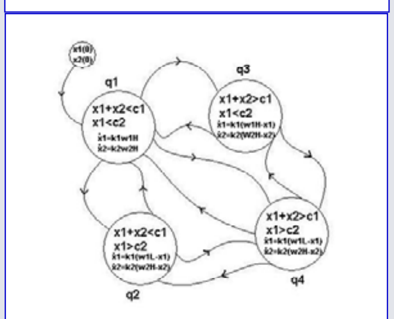
A Hybrid Systems Approach to Communication Networks: Zeno Behavior and Guaranteed Simulations

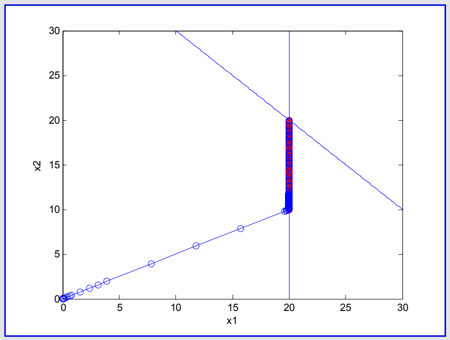
Shams Karimkhan

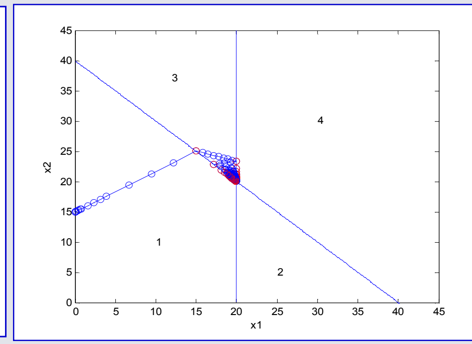
- Shams Karimkhan
  - Junior, Wright State University

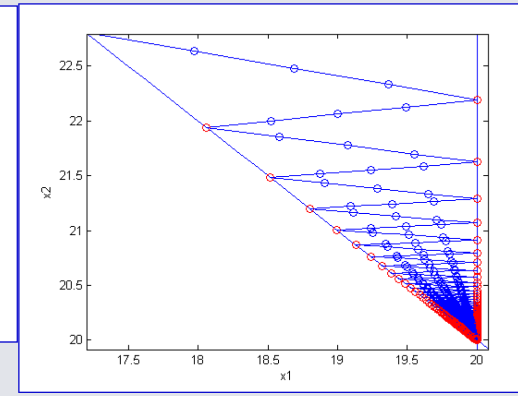
Switching Model of TCP Network



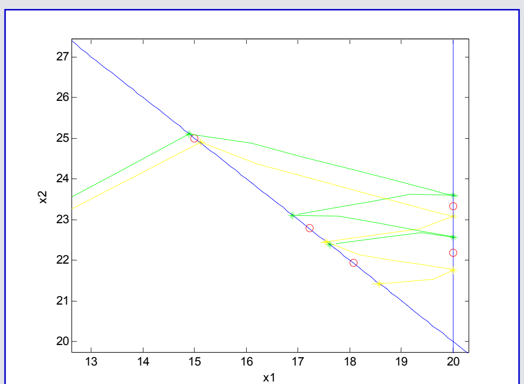








Sample Trajectory w/ Zeno Behaviors: Chattering (L) Actual (Above, R)



Introduction of local error into simulation, to investigate guaranteed simulation

Shams worked with his Mentor, Alessandro Abate, to see this application in a new light, and provide these Zeno examples.

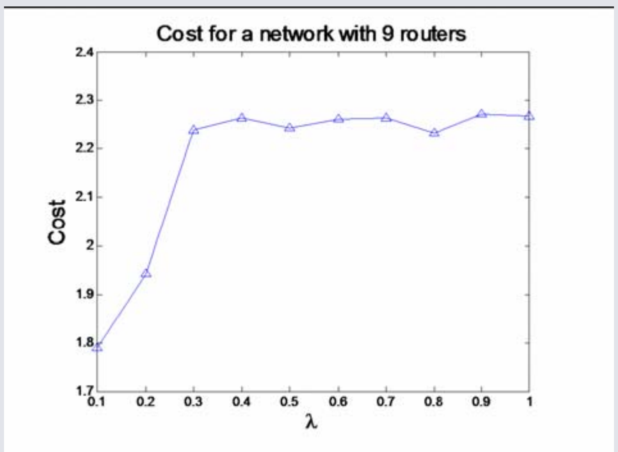
This work provided the foundation for subsequent papers by Abate and others which proved the Zeno Behaviors exhibited in the above graphics.

Modeling and Analysis of On-Chip Networks

Reinaldo Romero

- Reinaldo (Rey) Romero
  - Junior, Pennsyvania State University

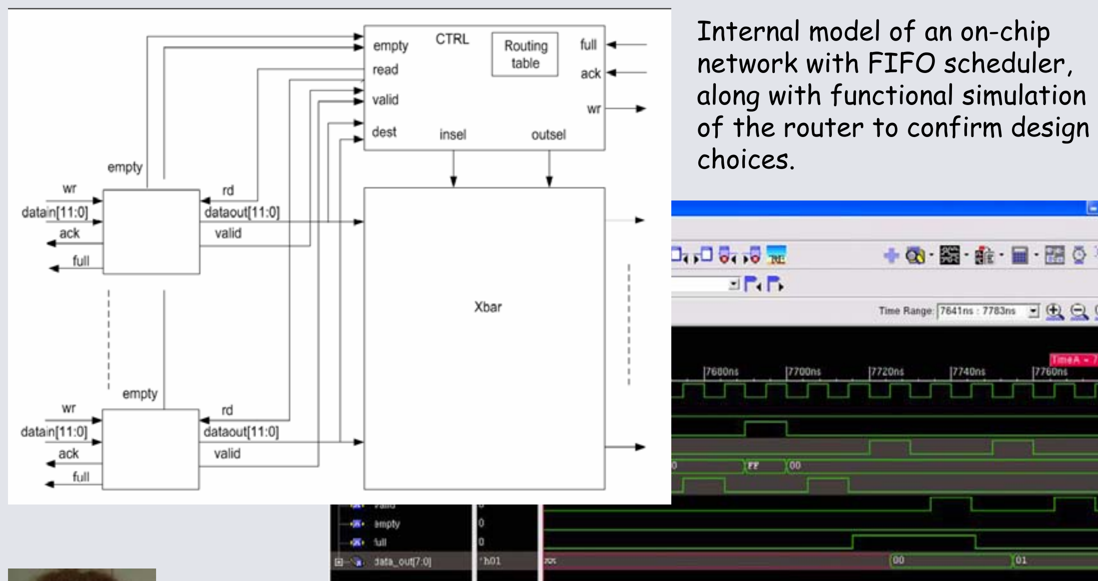
•derived an expression for computation/communications trade-off
•predicted how future communication topologies will look
•analyzed on-chip networks using simple analytical models.



$$\text{Cost} = \sum_{e \in E} C_e(e) + \lambda \sum_{v \in R} C_v(v)$$

$$C^0_e(e) = \text{®!}\ (e) l^2(e)^2{}_W\, d_W \quad 0 \quad 1$$

$$C^0_v(v) = \text{®@} \sum_{(i;v) \in E} !\ (i;v) A\ ^2{}_R \frac{n}{f_{clk}}$$

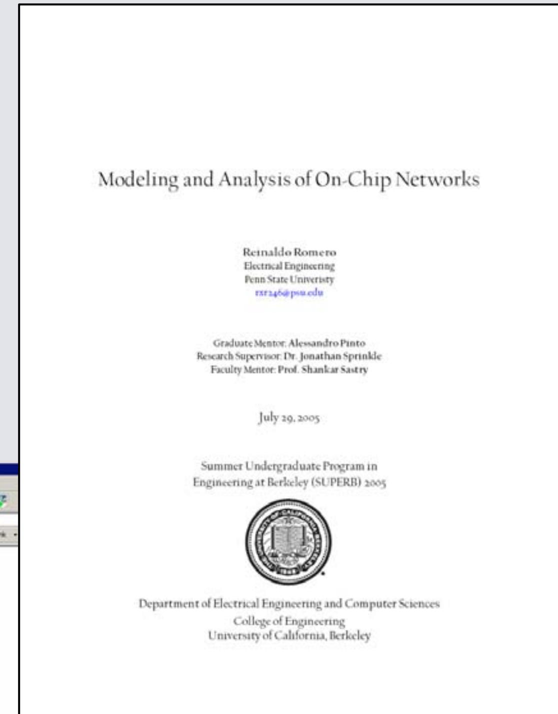


Internal model of an on-chip network with FIFO scheduler, along with functional simulation of the router to confirm design choices.

Rey's development of the energy and connectivity costs and network design models, was supervised by his Mentor, Alessandro Pinto

Other Tasks

- LaTeX template design
- Poster template
- Website/weblog updates
- Final Poster and Final Paper



Modeling and Analysis of On-Chip Networks

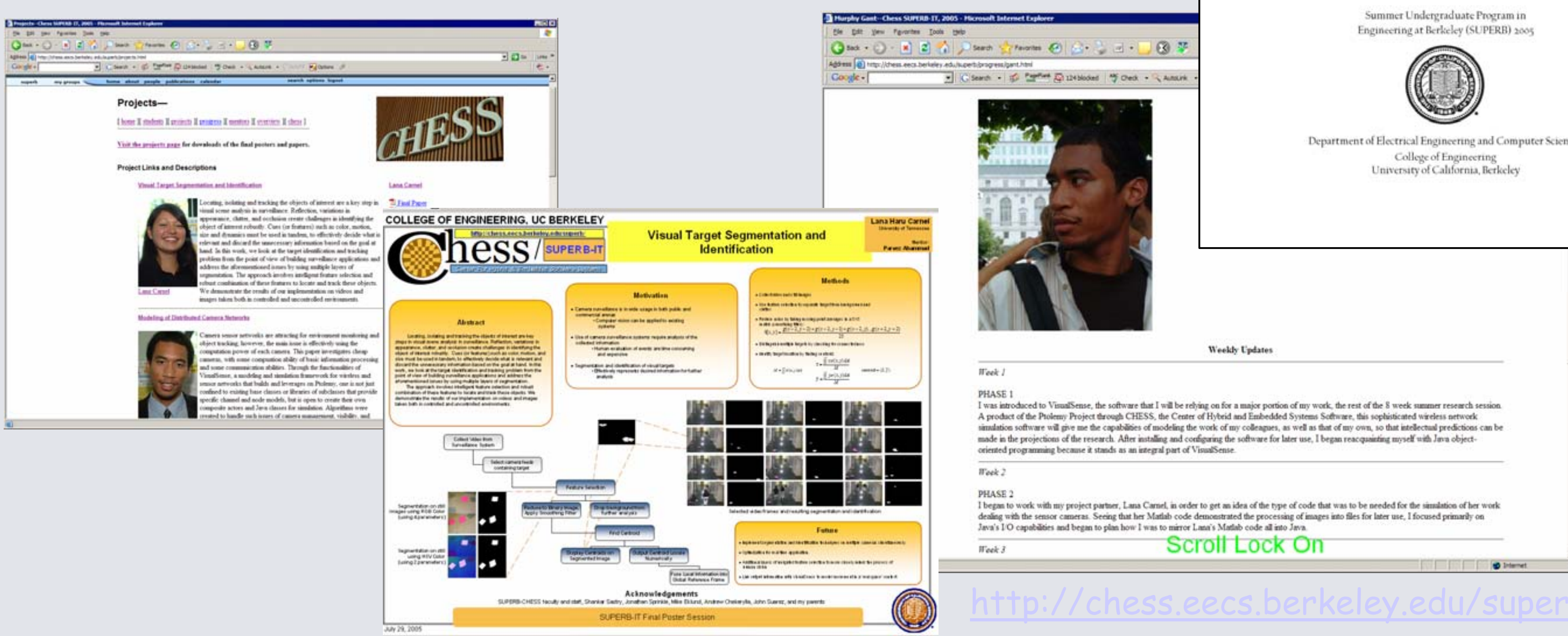
Reinaldo Romero
Electrical Engineering
Penn State University
rsr246@psu.edu

Graduate Mentor: Alessandro Pinto
Research Supervisor: Dr. Jonathan Sprinkle
Faculty Mentor: Prof. Shankar Sastry

July 29, 2005

Summer Undergraduate Program in
Engineering at Berkeley (SUPERB) 2005

Department of Electrical Engineering and Computer Sciences
College of Engineering
University of California, Berkeley



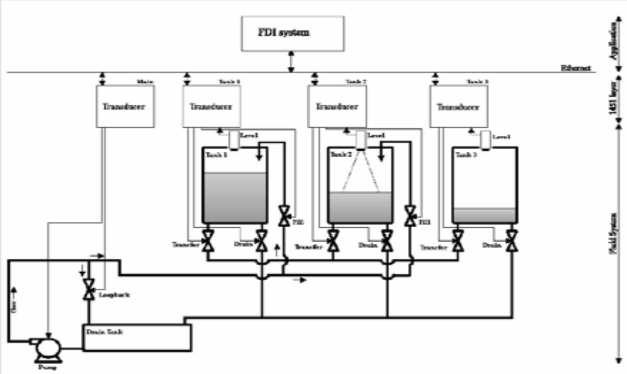
http://chess.eecs.berkeley.edu/superb/

SIPHER 2005

- Sponsored 8 undergraduate students
  - Karlston Martin (Fisk University)
  - Shantell Hinton (Vanderbilt University)
  - Alicia Vaden (Tennessee Tech University)
  - Chanel Mitchell (Johnson C. Smith University)
  - Omar-Abdul Ali (Vanderbilt University)
  - Lauren Mitchell (Vanderbilt University)
  - Sarah Francis (Western Kentucky University)
  - Ryan Thibodeaux (Vanderbilt University)
- Also sponsored 2 faculty members
  - Charles R. Hardnett (Spelman College)
  - Stephen V. Providence (North Carolina A&T State U)

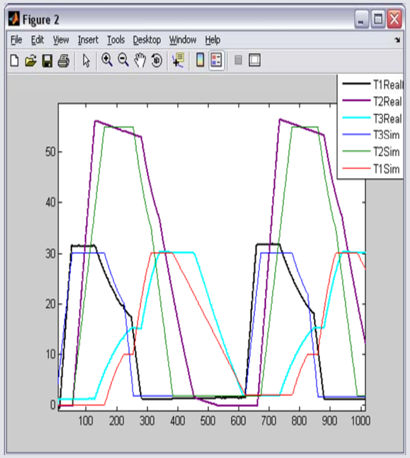
Process Control using Model-based Tools

- Karlston Martin, Fisk University
- Shantell Hinton, Vanderbilt University

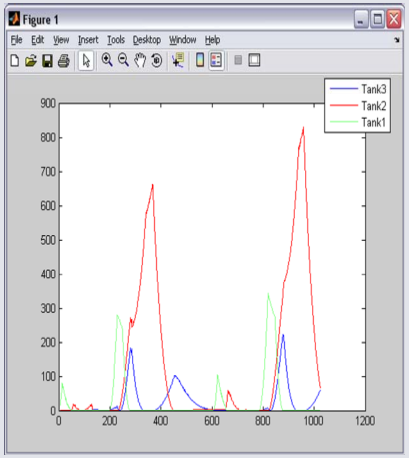


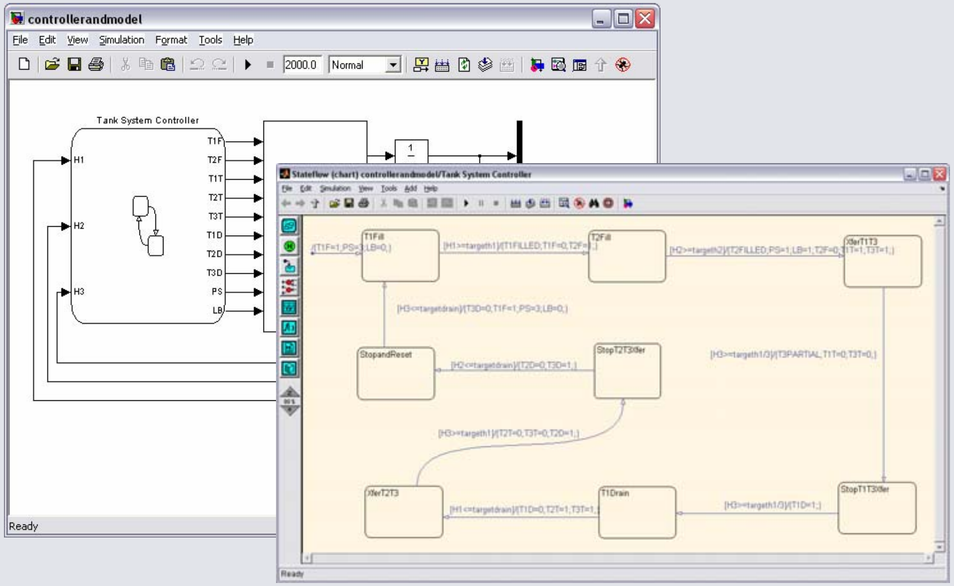
Canonical 3-Tank System Example

Real Data vs. Simulated Data



Plot of Residuals for each Tank





Simulation Model using Hybrid Bond Graphs, along with controller

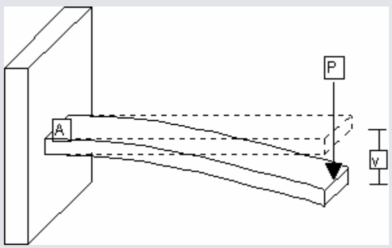
Performed under the mentorship of Chris Beers, a former SIPHER participant, with faculty support from Gautam Biswas.

Embedded Controllers for Vibration Control

Alicia Vaden

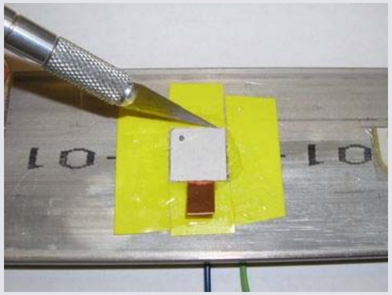
- Alicia Vaden (Tennessee Technological University)

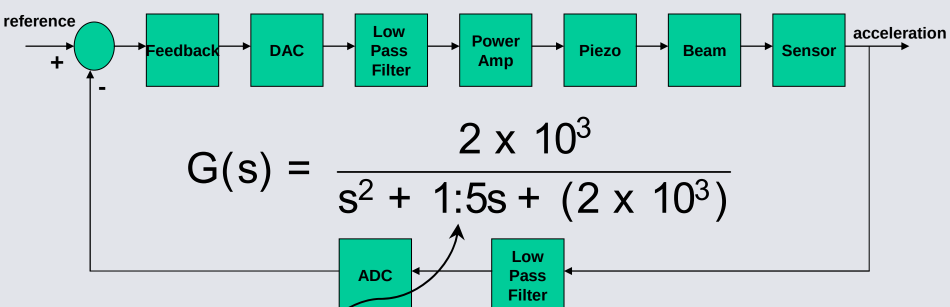
$$v(L) = -\frac{PL^3}{3EI}$$



Model and analyze the vibration response of a cantilevered beam.

Design a smart material-based controller that will reduce the vibrations of the beam.



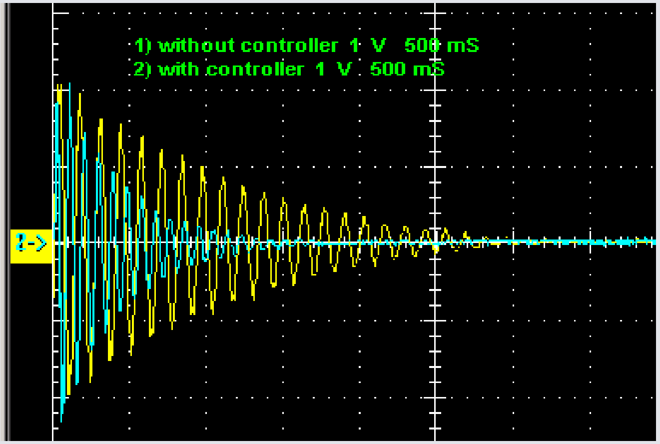


$$G(s) = \frac{2 \times 10^3}{s^2 + 1.5s + (2 \times 10^3)}$$

$$c(t) = e^{-\zeta\omega_n t}\sin(\beta\omega_n t + \theta)$$

$$a(t) = c_1 e^{-\zeta\omega_n t}$$

$$G = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$$

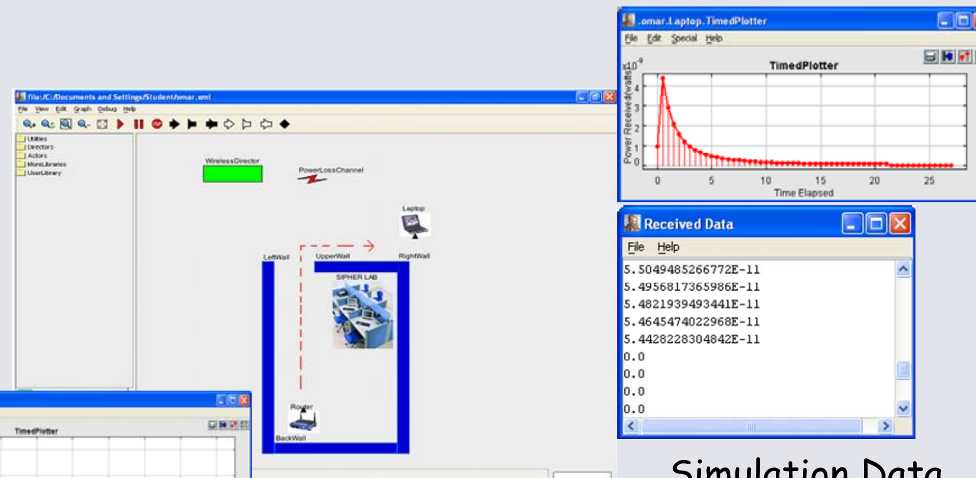


Performed under the mentorship of Tao Tao, with faculty support from Ken Frampton.

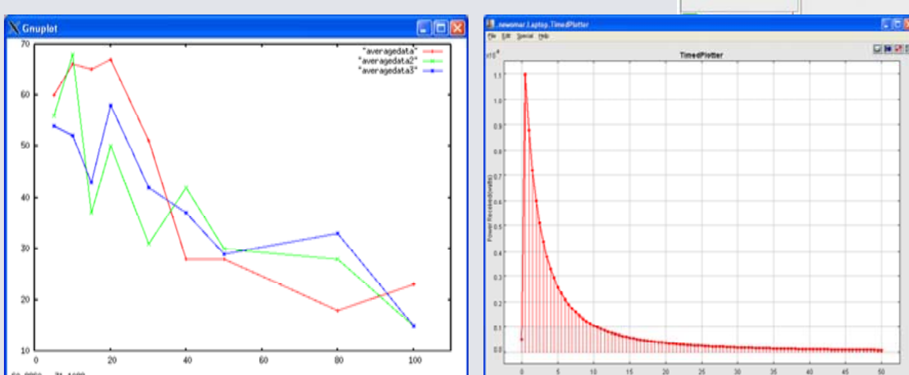
Sensor Networks

- Chanel Mitchell, Johnston C. Smith University
- Omar Abdul-Ali, Vanderbilt University

Investigation of signal strength dissipation of a wireless network using Ptolemy and experimental data gathered from a laptop and a router



Simulation Data



Observed data (3 Trials, left) vs. Predicted (simulated) Data

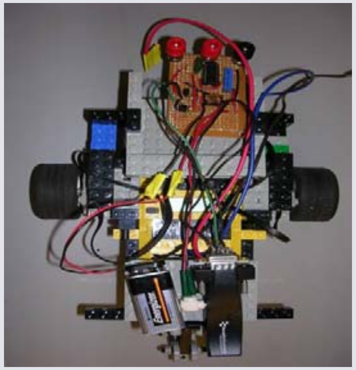
Performed under the mentorship of Andrew Dixon, with faculty support from Ken Frampton and Gautam Biswas.

Autonomous Robot Control

Lauren Mitchell

Sarah Francis

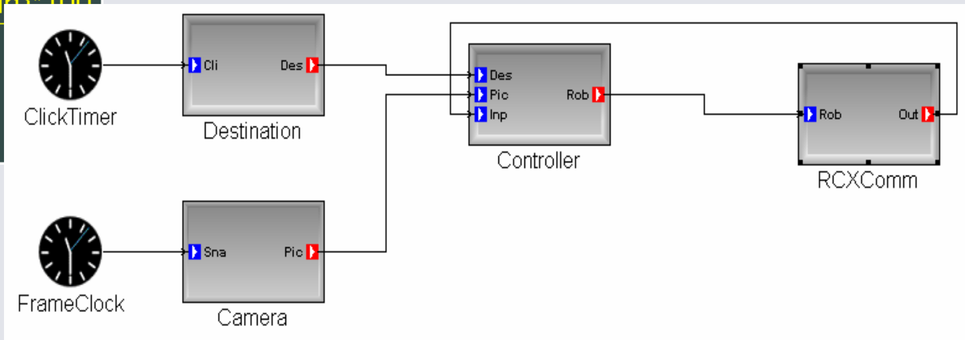
- Lauren Mitchell, Vanderbilt University
- Sarah Francis, Western Kentucky University



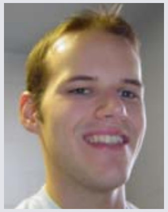
$$123 \geq H \leq 134$$
$$22 \geq S \leq 40$$

$$H = q*(Blue - Red) + 120$$
$$q = \frac{60}{RGBmax - RGBmin}$$
$$S = \frac{(RGBmax - RGBmin)*100}{RGBmax}$$
$$V = \frac{RGBmax*100}{255}$$

- Success Criteria:
  - Robot reaches target point within two turns
  - Robot has reached the target when it is between 0 – 6 cm from point
  - Robot consistently follows path repeatedly



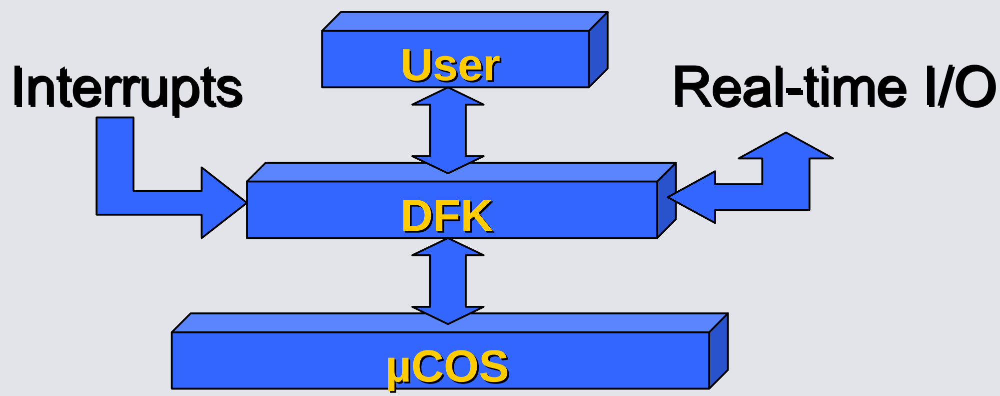
Embedded Software Tools



Ryan Thibodeaux

- Ryan Thibodeaux, Vanderbilt University

Port the SMOLES DataFlow Kernel to the Motorola 9S12DP256B evaluation board to enable students in Microcontrollers II to test models of embedded systems in a real world environment



SIPHER: 2 Sponsored Faculty Projects

Charles R. Hardnett

Charles R. Hardnett

- Dept. of Computer Science, Spelman College, Atlanta, GA

Stephen V. Providence

Stephen V. Providence

- Dept. of Computer Science, North Carolina A&T State U., Greensboro, NC

Objective: Embedded System Development class with electronic courseware

http://fountain.isis.vanderbilt.edu/fountain/Teaching/2005

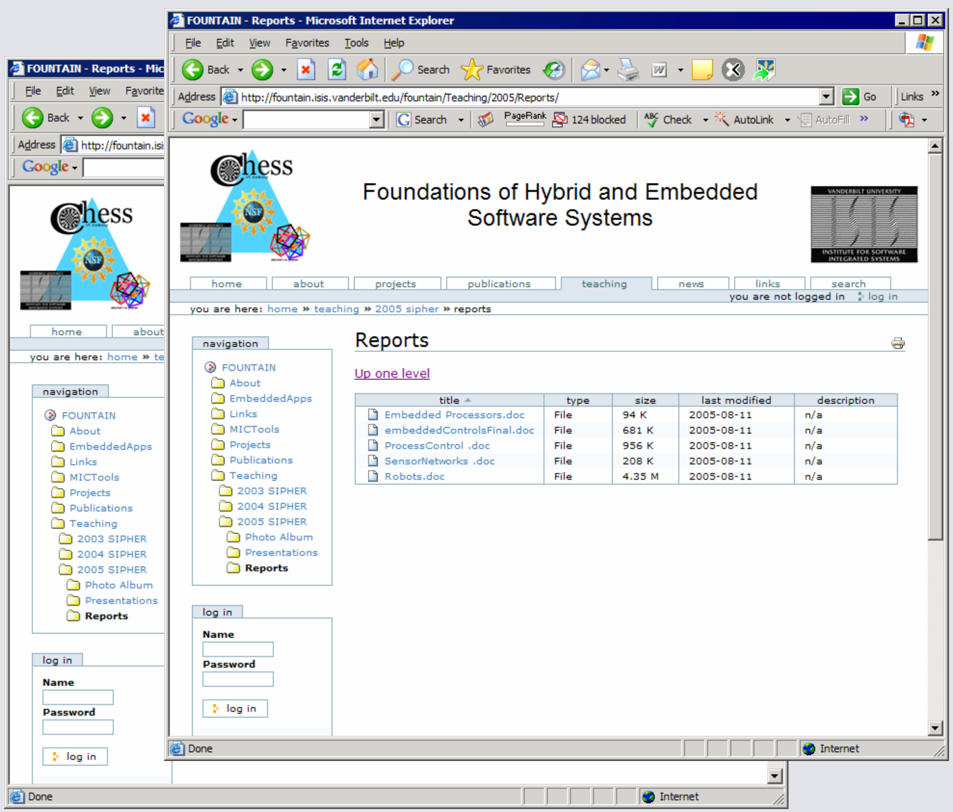
SIPHER Faculty Project

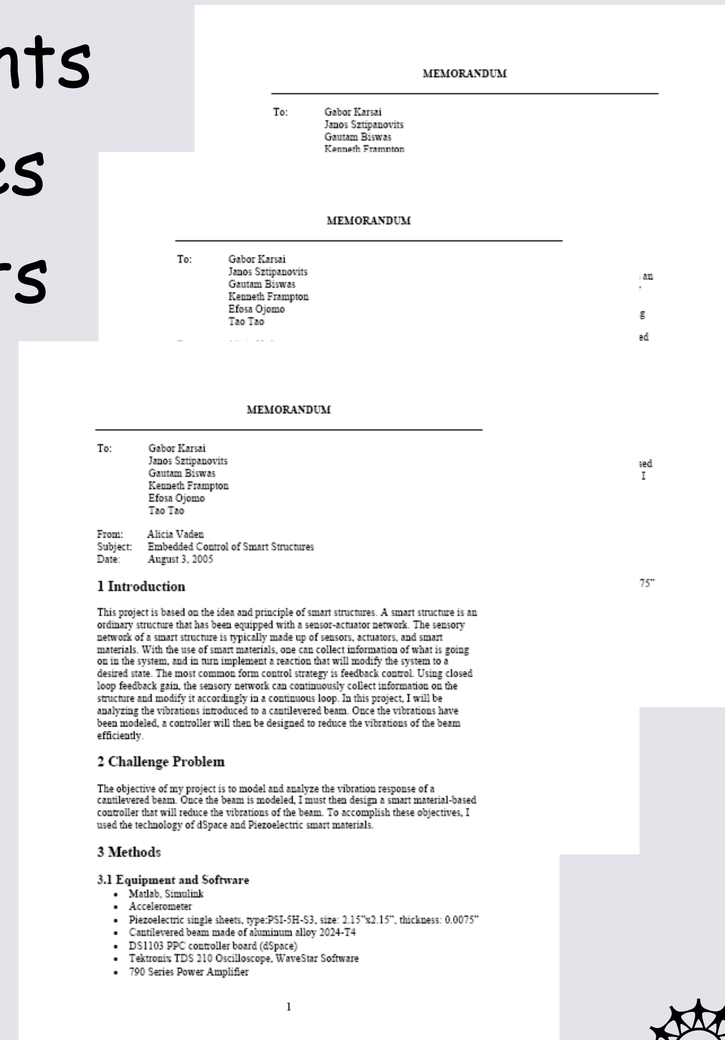
Embedded Systems Course Development

1. 1. System-On-Chip Architectures or Embedded Systems Definitions and descriptions with examples. (1 week)
2. Digital Signal Processors, Field Programmable Gate Arrays and Advanced RISC Machines Definitions and descriptions with examples. (1 week)
3. Embedded Applications such as: Communications, Security, Video Manipulation, Graphics Manipulation and Automotive Sensors and Case-Study of In-vehicle Networks (2 weeks)
4. Designing Applications, Language selection and Processing requirements, Communication requirements, Real-time constraints, ILP and the need for customization (1 week)
5. GPP Programming paradigm, Explore techniques for GPP programming and optimization using GPP programming tools, Trimaran (#1 Choice), Vex (#2 Choice), Profiling and Compilation options, (3 weeks)
   - Programming Project: Optimize one or two benchmarks from the automobile benchmark suite (MiBench and EEMBC)
6. FPGA programming paradigm A Compiler and Library e.g. CoDeveloper from ImpulseC, A synthesis tool e.g. Synopsis, Simulation tool (VHDL simulation), and a light treatment of VHDL and Tool optimizations. (4 weeks)
   - Programming Project: Port an automotive benchmark to work on this paradigm within Impulse C
7. DSP Programming Paradigm TI simulator and compiler and Optimizations for DSP. (3 weeks)
   - Programming Project: Port an automotive benchmark to TI DSP platform and compare with other paradigms

SIPHER Activities

- Website, chronicle of events
- GME/Metamodeling Classes
- Lab visits, and social events




MEMORANDUM

To: Gabor Karsai
Janos Sztipanovits
Gautam Biswas
Kenneth Frampton
Efosa Ojomo
Tao Tao

From: Alicia Vaden
Subject: Embedded Control of Smart Structures
Date: August 3, 2005

1 Introduction

This project is based on the idea and principle of smart structures. A smart structure is an ordinary structure that has been equipped with a sensor-actuator network. The sensory network of a smart structure is typically made up of sensors, actuators, and smart materials. With the use of smart materials, one can collect information of what is going on in the system, and in turn implement a reaction that will modify the system to a desired state. The most common form control strategy is feedback control. Using closed loop feedback gain, the sensory network can continuously collect information on the structure and modify it accordingly in a continuous loop. In this project, I will be analyzing the vibrations introduced to a cantilevered beam. Once the vibrations have been modeled, a controller will then be designed to reduce the vibrations of the beam efficiently.

2 Challenge Problem

The objective of my project is to model and analyze the vibration response of a cantilevered beam. Once the beam is modeled, I must then design a smart material-based controller that will reduce the vibrations of the beam. To accomplish these objectives, I used the technology of dSpace and Piezoelectric smart materials.

3 Methods

3.1 Equipment and Software

- Matlab, Simulink
- Accelerometer
- Piezoelectric single sheets, type:PSI-5H-S3, size: 2.15"x2.15", thickness: 0.0075"
- Cantilevered beam made of aluminum alloy 2024-T4
- DS1103 PPC controller board (dSpace)
- Tektronix TDS 210 Oscilloscope, WaveStar Software
- 790 Series Power Amplifier

1

Undergraduate Research

- Berkeley Undergrad Research Course
    - Bipedal Robotic Walking: From Theory to Practice
  - Emerged from Bobby Gregg and Simon Ng's summer project
  - Taught by Aaron Ames (SUPERB Mentor) and Shankar Sastry
- Ongoing and inspired research has produced at least one paper submission, and will have others, with undergraduate authors

Aaron D. Ames, Haiyang Zheng, Robert Gregg and Shankar Sastry. "Is there Life after Zeno? Taking Executions past the Breaking (Zeno) Point." *2006 American Control Conference*, Minneapolis, MN (Submitted), June, 2006.