AGENDA – CAP Executive Board Meeting – June 5, 2019 – 5:00-7:30 PM

5:00 – 6:00 Networking Hour – Engineering Student Projects

Haptic Interfaces Engineers for Exploration (E4E) NanoEngineering Technology Society (NETS)
Artificial Muscle Actuators Human-Powered Submarine

6:00 – 6:15 CAP Chairman – Nik Devereaux, Viasat

- New CAP Partners: Aira, D&K Engineering, GKN Aerospace, Hewlett-Packard, ServiceNow, ViaTouch Interactive Media
- Haptic Interfaces Presentation

Andrea Frank, 2nd year Ph.D Student, Computer Science & Engineering
Aamodh Suresh, 3rd year Ph.D Student, Mechanical & Aerospace Engineering

6:15 – 6:45 Dean’s Report – Albert P. Pisano

- Rising Rankings and Scaling Education
- Advancing Research Collaborations
- Franklin Antonio Hall Update
- Systems Engineering & Co-op Status
- Strategic Plan 2020
- Engineering All Four Years (E4) Initiative Progress – Professor Steven Swanson, Computer Science & Engineering

6:45 – 7:05 Faculty Presentation – Michael Yip, Asst. Professor, Electrical & Computer Engineering

Machine Learning Applications for Robot Control and Planning

7:05 – 7:20 Breakout Session – Strategic Plan 2020

Table Discussion and Report Out

7:20 – 7:30 CAP Business – William W. Dyer, Director, Corporate Affiliates Program

- CAP Talent Programs Updates
- Research Expo Results
- MAE Senior Project Showcase
- Masters of Advanced Studies (MAS) Enrollment
- Spirit of Solar CAP Executive Cruise Save-the-Date
- Upcoming Events

Dates to Remember

June 12, 2019 MAE Senior Project Day
June 24, 2019 Deadline: Fall 2019 MAS Enrollment
September 30, 2019 CAP Executive Spirit of Solar Cruise
October 2, 2019 New Faculty Welcome
October 4, 2019 Shu Chien Lifetime Achievement Celebration
October 4, 2019 Sustainable Power & Energy Center (SPEC) Research Summit
October 10, 2019 Fall CAP Executive Board Meeting
October 23, 2019 Center for Wearable Sensors (CWS) Research Summit

Jacobs School CAP Mission: Drive the corporate affiliate strategy and build productive, substantive relationships between companies, faculty and students to achieve goals in research, recruitment and education in the interest of enhancing the reputation of the Jacobs School.
2020 Strategic Plan – Discussion Questions

What are the bold, relevant breakout moves to enable the Jacobs School to accelerate our march to cachet?

- What are the important grand challenges that the Jacobs School is uniquely positioned to address?

- What is the role of systems engineering and data analytics in the modern engineering curricula?

- How can we innovate on industry-academia partnerships for the benefit of society?

- How can we rebrand Engineering as the intellectual hub for addressing complex societal problems that can no longer be resolved by deterministic models in siloed disciplines?

- How can we attract the best talent that represents changing demographics and culture?

Notes:
Welcome
CAP Executive Board
June 5, 2019
CAP Chairman and Vice Chairman

Nik Devereaux
Director of Software Engineering
Viasat

GB Singh
Director of Engineering
Solar Turbines

Welcome
Welcome New CAP Partners

- Aira
- DK Engineering
- GKN Aerospace
- HP
- ServiceNow
- VIA Touch

UC San Diego
Jacobs School of Engineering
Corporate Affiliates Program
Wearable haptic navigational aid for the blind via ungrounded kinesthetic feedback

Andrea Frank and Aamodh Suresh

MAE 207: Haptic Interfaces
Professor Tania Morimoto
Department of Mechanical and Aerospace Engineering
University of California, San Diego
I. Motivation
"The ability to move about and travel safely without assistance is one of the cornerstones of independence for people who are blind or visually impaired."

Traditional Solutions

- Personal guides
- Guide dogs
- White canes
Technical Solutions

but...

- GPS dependent
- Specific infrastructure
- Inappropriate modes of communication
- Monopolizes hands
Our solution

- Wearable haptic device
- Mimics a personal guide leading the VIP by the shoulder
- **Mobile ungrounded kinesthetic feedback** via simple eccentric mass arm
Our solution

- GPS Independent
- No Infrastructure
- Specific Infrastructure
- Inappropriate modes of communication
- Monopolizes hands
- Intuitive Haptic Guidance
- Hands-Free
II. Device Design
Working and Assembly of device

**Working**
- User feels a ‘pull’ from torque acting from weights.
- Stepper motor controls the direction of the ‘pull’ precisely.
- User can be guided through an obstacle environment.

**Signaling**
- Vibration: start/stop notification
- Torque angle: direction
Mechanical Design

- 3D printed parts.
- Modular design.
- Easy to manufacture and assemble.
- Variable torque design.

Motor Connector
Torque arm extender
Weight holder
Tungsten Weights
Electrical/ Electronics Design

- Stepper motors for precision and accuracy.
- Raspberry Pi 3 microcontroller.
- L298N motor drivers.
- Eccentric motor for vibro-tactile feedback.
III. Evaluation
Correct = \begin{cases} 
1 & \text{if guess is correct} \\
-1 & \text{if guess is incorrect.} 
\end{cases}

Confidence \in \{i \in \mathbb{Z} : i \in [0, 5]\}

Score = Correct \times Confidence
User Study I: Effect of Torque

$$\tau = F \cdot r$$

![Graph showing effect of torque with different lengths and weights.](image)
User Study II: Effect of Angle

Angle: Between $-90^\circ$ and $90^\circ$ in $15^\circ$ intervals
User Study II: Effect of Angle

Angle: Between -90° and 90° in 15° intervals

Score

0°  30°  60°  90°
User Study III: Effect of Transitions

Transitions:
1. Front to Left (FL)
2. Front to Right (FR)
3. Left to Front (LF)
4. Left to Right (LR)
5. Right to Front (RF)
6. Right to Left (RL)
User Study III: Effect of Transitions

Key Observations:
- People relied on transitions more than absolute position
- Duration of movement also played a part
IV. Contributions
• Novel, ungrounded indoor navigational aid for VIPs
• Average confidence score of 3.63 /5
• Transitions more informative than absolute state
V. Ongoing Work
AI and user feedback integration

- Camera for active perception
- Risk-Aware path planning [1]
  - Nobel prize winning Prospect Theory to model human perception of environment
  - Sampling based planner to generate optimal paths in perceived environment
  - Machine Learning to learn the human perception model
- Natural and intuitive human-like motion
- Incorporate preliminary user feedback to improve design

Thank you! Questions?
DEAN’S BRIEF

Albert P. Pisano
Dean, Jacobs School of Engineering

Accelerating the March to Cachet
Rising Rankings!
(US News, March 2019)

• #6 Best Public Engineering School in US
• #11 Overall, up from #17 in 2016
Transforming Engineering Education....at Scale

• 250 Faculty, over 90 hires in last 5 years

• 2,749 Degrees Conferred in 2018
  • #2 in nation for bachelor’s degrees awarded to women
  • #3 in nation for bachelor’s degrees awarded overall
  • 2.3x growth in master’s
Research & Innovation Leader

- $188M Research Expenditures in FY2018
  CAGR 6% Over 4 Years

- Approximately 1/3 of research is in partnership with industry
  136 Jacobs School technologies licensed in the last 5 years
Agile Research Centers and Institutes

- Nano-Immuno Engineering (NEW!)
- Contextual Robotics
- Wearable Sensors
- Wireless Communications
- Microbiome Innovation
- CHO Systems Biology
- Extreme Events Research
- Machine Integrated Computing and Security
- Visual Computing
- Engineered Natural Intelligence
- Sustainable Power and Energy
- Deep Decarbonization Initiative
Nano-Immuno Engineering Agile Center

• Bio-Inspired Materials and Technologies to Activate, Cloak from, or Program the Immune System.

• Innovations to treat and prevent Cancer, Heart Disease, Autoimmune or Infectious Disease.

• NanoEngineering, Bioengineering, Moores Cancer Center
Agile Research Centers Foster Industry Collaboration
(70 Partners)
Franklin Antonio Hall

Industry-relevant research centers under one roof creates a powerful ecosystem to build the digital future

UC San Diego
JACOBS SCHOOL OF ENGINEERING
Corporate Affiliates Program
Research Vision for the Digital Future

- Precision Healthcare
- Distributed Renewable Energy
- Smart Materials
- Autonomy
- Machine-integrated Security
- Cryptography
- Privacy
- Authentication

- Sensors
- Hardware
- Machine Vision
- 5G Networks

- Data Science
- Machine Learning
- Edge Computing
- Bioinformatics

UC San Diego
Jacobs School of Engineering
Corporate Affiliates Program
Collaboratories for the Digital Future

Machine-Integrated Computing and Security
Institute for the Global Entrepreneur
Halıcıoğlu Data Science Institute
Wearable Sensors
High Energy Density Science

NanolImmunology Engineering | IEM
Precision Genomics | Salk
Contextual Robotics Institute
Sustainable Power and Energy
Wireless Communications
Innovation Ecosystem: Precision Medicine

- Machine-Integrated Computing and Security
- Institute for the Global Entrepreneur
- Halıcıoğlu Data Science Institute
- Wearable Sensors
- High Energy Density Science
- NanoImmuno Engineering | IEM
- Precision Genomics | Salk
- Contextual Robotics Institute
- Sustainable Power and Energy
- Wireless Communications
Innovation Ecosystem: Sustainable Cities

- Machine-Integrated Computing and Security
- Institute for the Global Entrepreneur
- Halıcıoğlu Data Science Institute
- Wearable Sensors
- High Energy Density Science
- NanoImmuno Engineering | IEM
- Precision Genomics | Salk
- Contextual Robotics Institute
- Sustainable Power and Energy
- Wireless Communications
Innovation Ecosystem: Connected Health

- Machine-Integrated Computing and Security
- Institute for the Global Entrepreneur
- Halıcıoğlu Data Science Institute
- Wearable Sensors
- High Energy Density Science
- NanoImmuno Engineering | IEM
- Precision Genomics | Salk
- Contextual Robotics Institute
- Sustainable Power and Energy
- Wireless Communications
Franklin Antonio Hall Groundbreaking

Save the Date!
15 November 2019 @ 3 p.m.
You Said
- The proposed content is on point
- Go beyond ECE undergrads—consider a schoolwide BS/Co-op/MS program
- Make sure we add “stickiness” for corporate partners
- Include live design, test-driven design; models and visualization
- Make sure to focus on ethics and humans in the loop
- Machine Learning and AI will be key skills for the future

We Did
- All feedback part of the White Paper for Systems Engineering
- Reinforced our resolve to move forward with this initiative, incorporating components recommended by CAP
- Faculty recruitment underway
- Now expanding beyond ECE to Mechanical/Aerospace and Structural Engineering
- Goal of “Stickiness and Industry Connection” inspiring new ideas on Co-op as Innovation Accelerator
Co-op Pilot Summer-Fall 2019

- First in the UC System
- Pilot to run July-December 2019
- Over 450 student applicants

Thank you to our 13 participating CAP Partners

[Logos of participating companies]
The Jacobs School Today

- One of the nation’s largest engineering schools, providing leadership, talent and technology at scale
- Graduates recognized for core engineering knowledge that enables them to solve new problems
- Research powerhouse known for biotechnology & communications.....but we are much broader
- Working with industry is part of our DNA
- The engineering schools of the next decade will collaborate their way to greatness...
The Jacobs School in the Next decade

- Sustained Performance → Reputation (10 Yrs)
- Sustained Reputation → Cache (20 Yrs)
- Drive towards relevance and cache
- No silver bullet—broad set of coordinated efforts
- Striving toward recognition (not ranking)
- Last Strategic Plan 2013
- Need unified voice of the faculty to ensure the right culture, attitude and inclusive Strategic Plan
What are the bold, relevant breakout moves to enable the Jacobs School to accelerate our march to cachet?

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Faculty Presentation

Steven Swanson
Professor, Computer Science & Engineering

Experience Engineering all Four Years (E4) Initiative
E4 Initiative: Hands-on Classes for All Engineering Students

• Founded ~2015

• Advantages of hands-on learning
  • Increased student engagement
  • Increased retention
  • Better-prepared for the real jobs

• Hands-on courses in all six engineering departments
  • Freshmen and sophomores – Get them early!
  • Extending to the upper-division
The Envision Maker Studio

- **Facilities**
  - 3500 sq ft of making space
  - 2100 sq ft of classrooms

- **Tools**
  - 3D Printers
  - Laser cutter
  - Hand tools

- **Staff**
  - Staff director, assistant director, and faculty director
  - ”Envisionaries” – student support staff

Jesse Dewald  Curt Schurgers
The Envision Maker Studio
Classes in EnVision (per quarter)

<table>
<thead>
<tr>
<th>ACADEMIC QUARTER</th>
<th>NUMBER OF CLASSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>WQ 2016</td>
<td>4</td>
</tr>
<tr>
<td>SQ 2016</td>
<td>2</td>
</tr>
<tr>
<td>FQ 2016</td>
<td>5</td>
</tr>
<tr>
<td>WQ 2017</td>
<td>7</td>
</tr>
<tr>
<td>SQ 2017</td>
<td>6</td>
</tr>
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<td>FQ 2017</td>
<td>7</td>
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<td>WQ 2018</td>
<td>9</td>
</tr>
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<td>8</td>
</tr>
<tr>
<td>FQ 2018</td>
<td>8</td>
</tr>
<tr>
<td>WQ 2019</td>
<td>10</td>
</tr>
<tr>
<td>SQ 2019</td>
<td>9</td>
</tr>
</tbody>
</table>
Total Enrollment in EnVision (per quarter)

NUMBER OF STUDENTS

ACADEMIC QUARTER


357  96  308  338  482  529  548  414  641  571  545


0  100  200  300  400  500  600  700
What’s Next for E4?

• Extending reach to upper division courses
• Coordinating with other hands-on initiatives across JSOE
  • Building a maker culture
  • Extending deeper into curricula
  • Avoiding replicated effort and easing access
• Evaluation of Teaching Effectiveness
  • What works best in hands-on education?
  • How can we track student success?
Faculty Presentation

Michael Yip
Assistant Professor, Electrical & Computer Engineering

Machine Learning Applications for Robot Control and Planning

UC San Diego
JACOBS SCHOOL OF ENGINEERING
Corporate Affiliates Program
Machine Learning Applications for Robot Control and Planning

Michael Yip, Ph.D.
Assistant Professor, Electrical and Computer Engineering

ucsdarclab.com
Acknowledgements

Students
Nikhil Das
Florian Richter
Ahmed Qureshi
Dimitri Schrieber
Winnie Kuang
Naman Gupta
Yuheng Zhi
Mrinal Verghese
Aaron Gunn

Other Collaborators
Ryan Orosco (Otolaryng.)
Phil Weissbrod (Otolaryng.)
Steve Hong (Otolaryng.)
Alex Norbash (Radiology)
“The basic assumptions of most existing [robot] manipulation algorithms are not being satisfied in targeted application areas.

Truly autonomous manipulation will depend on the robot’s ability to acquire adequate, task-relevant environmental models when they are not available.”
Surgical Robotics Today

... and 60+ more
The Robot Process

Goal

Task Plan

A task or subtasks

Motion Plan

Trajectory

Controller

Environment

Sensing of people, objects, constraints

Physical Constraints

People

Robot

Objects

People

Robot

Objects
The Robot Process

- Goal
  - Task Plan
    - Motion Plan
      - Trajectory
    - Physical Constraints
  - Sensing of people, objects, constraints
- Environment
  - People
  - Objects
  - Robot
Levels of Autonomy

DaVinci: Direct Control
Mako Surgical: Shared Control
Cyberknife: Supervised Autonomy
None: Full Autonomy
Saving lives across the US and the World

Robotic surgery to expand surgical access to high-quality, consistent, and immediate surgery.
The Golden Hour Rule
Key barrier to telerobotic surgery is **signal latency and degradation**
Without time delay

With time delay

% increase of time vs. Latency (ms)

Number of error vs. % Time increase
Clinician-specific Dynamic Scaling

Tailor motion scaling (shown to statistically reduce chance of errors) to specific clinician preferences or styles.
Each doctor is different

Least Errors

Fastest Time
Augmented Reality Predictive Displays

Real-time visualization of expected instrument position over the delayed video stream.

Delayed Video

Commanded Poses
19% reduction in procedure time without negatively affecting human error
Learning Visuo-Haptic Feedback

Machine vision provides virtually generated haptic cues
Learning Controllers

Many complex systems have:
- Inaccurate or unknown system models
- Unknown environment dynamics

We can learn to control complex systems
(BUT Wait! Not neural networks just yet!)
- Large Training Time
- Large amounts of data needed
- Lose sense of understanding
Online Model-free Control
Visual Adaptation

Ego-centric Navigation
Motion Planning
Applications
What are some challenges?

- Time Constrained
- Optimality
- Safety-Aware
- Dynamic Environments
Sampling: Configuration Space

Moving robot

Moving Obstacles
Retrieving C-space Map

Naïve Approach: Run geometric collision detector on mesh bodies for all possible interactions: computationally costly!
**Fastron**: Classifier-based Collision Checker for Fast and Power-Efficient Collision Checking

*Model-free classifier and active learning strategy to replace costly geometric collision checks*

The kernel Perceptron Classifier
Active Learning Strategy

**Exploitation:**
Sample near boundary to observe dynamical changes

**Exploration:**
Sample in new areas
Uniform or directed sampling
Responsive modeling in moving environments
Complexity vs. Computation

Number of Workspace Obstacles
Broad applications

Robotics

CAD

Animation and Videogames

Simulation
Significant Mobile Planning Applications

![Graph showing performance comparison between GPU and CPU for different batch sizes. The graph indicates that the GPU performs significantly better than the CPU as the batch size increases.](image)

*more soon...*
Breakout Session – 2020 Strategic Plan

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William W. Dyer
Director, Corporate Affiliates Program, Jacobs School of Engineering

CAP Business
Jacobs School Corporate Affiliates Program
CAP Team update

Erica Kosa
Interim Manager
Talent Programs (TIP, Co-op, general recruitment)
JacobsTIP@eng.ucsd.edu
Talent Programs 2019

Team Internship Program & Cooperative Education (Co-op)

Thank you to all 2019 TIP & Co-op Partners!
Start Early: 2019-2020 Recruitment

Schedule your Recruitment Strategy Meetings with the CAP Team!

• Students are accepting offers earlier and earlier
• Competition is fierce, especially in the Fall
• Utilize CAP to target the right students for your organization

Contact:
Paula Kreger
Services Manager, Corporate Affiliates Program
pkreger@eng.ucsd.edu | 858-534-3148
Biomimetic Nanoemulsions as a Blood Substitute for Oxygen Delivery in vivo

- NanoParticles that look and act like red blood cells
- Blood substitute with 3-month shelf life
- Does not activate immune system

Many thanks to our CAP sponsors!
Mechanical & Aerospace Engineering
Senior Project Showcase

Stop by to chat with graduating seniors and see their capstone design hardware and posters

- Date: Wednesday, June 12, 11:30am – 2:30pm
- Location: Price Center West Ballrooms
- 51 posters across Aerospace, Environmental, and Mechanical Engineering

Contact:
Professor Nate Delson
ndelson@ucsd.edu
858-534-0655
mae.ucsd.edu/design
MAS programs are interdisciplinary engineering degrees designed for working professionals with classes taught on Fridays and Saturdays every other week.

Architecture-based Enterprise Systems Engineering (AESE)
Engineering professionals with 5+ years of relevant professional experience who are in a position to drive enterprise systems

Wireless Embedded Systems (WES)
Engineering professionals with a background in CS / EE who want to enhance their understanding of IoT, edge computing, and 5G (6G...)

Data Science and Engineering (DSE)
Engineering professionals with a background in CS / Math / Statistics with substantial experience in data analysis

Fall 2019 Enrollment Deadline: June 24, 2019
Spirit of Solar CAP Executive Cruise

Save the date!
30 September 2019, 5-7:30pm
All Upcoming Opportunities

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October 10, 2019  Fall CAP Executive Board Meeting
October 23, 2019  Center for Wearable Sensors (CWS) Research Summit
Thank You CAP Executive Board!

Next Board Meeting: October 10, 2019