USC Viterbi SHINE 2019
Orientation

Dr. Katie Mills
Office: 213-740-0237
Mobile: 310-592-6477
vast@usc.edu
Lead Faculty:
Vice-Dean of Research, Prof. Maja Mataric'

SHINE TEAM:
Dr. Megan Herrold
Hannah Hayes
Leslie Serpa
Colette Zhou * Michelle Kim
Ashley Perez (SHINE '18)
This Morning’s Agenda:

9:00 – 10:15 a.m. Welcome to SHINE

10:15 – 10:30 a.m. Break

10:30 – 11:30 a.m. Campus Tour

11:30 – 1:15 p.m. Lunch in location near the lab

1:30 p.m. All students return to HED 107; Families depart (or Chill out on campus)

1:30 - 2 p.m. Additional Tips

2:00 – 5:00 p.m. Lab Safety Training
USC Viterbi School of Engineering

Today:
Internationally recognized for creating new models of education, research and commercialization firmly rooted in real world needs.
"The school’s first priorities are the education of outstanding students and the pursuit and publication of new research."

https://viterbischool.usc.edu/viterbi-at-a-glance/
"The school’s first priorities are the education of outstanding students and the pursuit and publication of new research."

https://viterbischool.usc.edu/viterbi-at-a-glance/
USC Viterbi School of Engineering

- 2,767 undergraduate students (2018)
- 5,922 graduate students
- > 77,000+ alumni
- >$207+ million in research/year
- Overseas offices in Shanghai, Beijing, & Bangalore

https://viterbischool.usc.edu/viterbi-at-a-glance/
Dr. Andrew Viterbi
(Ph.D. in EE from USC in 1962)
Viterbi Algorithm (1967)

- Pres. Obama: key post (5/15)
- Co-founded QUALCOMM Inc. (mobile satellite communications & digital wireless telephony)
USC Viterbi School of Engineering PreK-12 Outreach:

VAST – Viterbi Adopt-a-School, Adopt-a-Teacher
K-12 STEM Outreach – Mathematics Engineering Science Achievement (MESA), FIRST Robotics, Discover Engineering, Mission Science
PreK-12 STEM
Research Original Interventions
Research-Based Outreach
Robotics Open House
STEM Spotlight on Viterbi Depts
SHINE Summer HS Research
CS@SC Summer Camps
Robotics & Coding Academy
Code Dojo
Regional Partner: Code.org
Welcome SHINE 19 Cohort!
47 students
38% Women (2018: 52%)
62% Men
GPA: 3.9 (unweighted)
Welcome SHINE 19 Cohort!
60% rising Seniors
23% rising Juniors
17% rising Sophomores
3 returning SHINE alumni
SHINE Students: 38 High Schools

SHINE PARTICIPATION 2015 - 2019

- SHINE students 2019: 37 Mentors
- Faculty 2019: 25
- PhD Mentors 2019: 47

University of Southern California
USC Viterbi
School of Engineering
May & Ashley

Alumni at USC, MIT, UC (Berkeley, Santa Barbara, Los Angeles), University of Pennsylvania, Georgia Tech, Connecticut College, Notre Dame
Welcome SHINE 19 Cohort!
Biomedical & Civil Engineering Students

<table>
<thead>
<tr>
<th>Faculty / Eng. Dept.</th>
<th>Lab Location</th>
<th>Student</th>
<th>SHINE19 Mentors</th>
<th>Staff/Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cristina Zavaleta - Biomedical</td>
<td>MCB 377</td>
<td>Nova Dea</td>
<td>Alex Czaja</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Samuel Parra</td>
<td>Sean Burkitt</td>
<td></td>
</tr>
<tr>
<td>Eun Ji Chung - Biomedical</td>
<td>MCB 377</td>
<td>Jaya Hamkins</td>
<td>Deborah Chin</td>
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<tr>
<td></td>
<td></td>
<td>Jiwoo You</td>
<td>Jonathan Wang</td>
<td></td>
</tr>
<tr>
<td>Keyue Shen - Biomedical</td>
<td>DRB 320</td>
<td>Jingyu Yan</td>
<td>Yuta Ando</td>
<td></td>
</tr>
<tr>
<td>Megan McCain - Biomedical</td>
<td>DRB 320</td>
<td>Jennifer Gipson</td>
<td>Jocelyn Yip</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Jaylene Lopez</td>
<td>Jeffrey Santoso</td>
<td></td>
</tr>
<tr>
<td>Burcin Becerik-Gerber - Civil</td>
<td>KAP 217</td>
<td>Saul Droutman</td>
<td>Runhe Zhu (Gokce Ozcelik)</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Ameyalli Hill</td>
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</table>
Welcome SHINE 19 Cohort!
Robotics / Computer Science, Chem & EE Students

<table>
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<tr>
<th>Faculty / Eng. Dept.</th>
<th>Lab Location</th>
<th>Student</th>
<th>SHINE19 Mentors</th>
<th>Staff/Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heather Culbertson - Robotics</td>
<td>RTH 416</td>
<td>Rachel Lobl</td>
<td>Naghmeh Zamani</td>
<td></td>
</tr>
<tr>
<td>Francisco Valero-Cuevas - Robotics</td>
<td>RTH 421</td>
<td>Bryant Huang</td>
<td>Dario Urbina Melendez</td>
<td></td>
</tr>
<tr>
<td>Maja Mataric - Robotics</td>
<td>RTH426</td>
<td>Ipek Goktan</td>
<td>Thomas Groechel</td>
<td>Ashley</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mena Hassan</td>
<td></td>
<td>RTH 526</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cassandra Jeon</td>
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<tr>
<td></td>
<td></td>
<td>Junzhe Huang</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Ishaan Chandra</td>
<td>Jessica Lupanow</td>
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<tr>
<td></td>
<td></td>
<td>Riya Ranyan</td>
<td>Christopher Birmingham</td>
<td></td>
</tr>
<tr>
<td>Richard Roberts - Chemical</td>
<td>RTH 522</td>
<td>Sarah Shintani</td>
<td>Dr. Kaori Noridomi</td>
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<tr>
<td></td>
<td></td>
<td>Alexandra</td>
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<td></td>
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<td>Fidanovski</td>
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</tr>
<tr>
<td>Dina El-Damak - Electrical</td>
<td>RTH B105</td>
<td>Arnav Nayudu</td>
<td>Hongyu Fu</td>
<td></td>
</tr>
</tbody>
</table>
Welcome SHINE 19 Cohort!
Electrical, Chemical, Materials Sci, CS Students

<table>
<thead>
<tr>
<th>Faculty / Eng. Dept.</th>
<th>Lab Location</th>
<th>Student</th>
<th>SHINE19 Mentors</th>
<th>Staff/Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rehan Kapadia - Electrical</td>
<td>SSC 501</td>
<td>Abhinav Buddhavaram</td>
<td>Jun Tao</td>
<td></td>
</tr>
<tr>
<td>Han Wang - Electrical</td>
<td>SSC 516</td>
<td>Michael Kim</td>
<td>Nan Wang</td>
<td></td>
</tr>
<tr>
<td>Ted Lee - Chemical</td>
<td>PCE 310</td>
<td>Daniel Chung</td>
<td>Yimin Wang</td>
<td></td>
</tr>
<tr>
<td>Nicholas Graham - Chemical</td>
<td>PCE 212</td>
<td>Alejandra Felix</td>
<td>Belinda Garana</td>
<td></td>
</tr>
<tr>
<td>Haipeng Luo - Computer Science</td>
<td>PHE 328</td>
<td>Jehyeok Heo</td>
<td>DongQing Zheng</td>
<td></td>
</tr>
<tr>
<td>Jayakanth Ravichandran - Materials Science</td>
<td>VHE 713/VHE 719</td>
<td>Justin Jang</td>
<td>Mengxiao Zhang</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alec Bernardi</td>
<td>Chung-Wei Lee</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Elizabeth Kim</td>
<td>Boyang Zhao</td>
<td></td>
</tr>
</tbody>
</table>

Megan HED 116
Welcome SHINE 19 Cohort!
Electrical & Environmental Science Students

<table>
<thead>
<tr>
<th>Faculty / Eng. Dept.</th>
<th>Lab Location</th>
<th>Student</th>
<th>SHINE19 Mentors</th>
<th>Staff/Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pierluigi Nuzzo - Electrical</td>
<td>EEB 337</td>
<td>Rayan Singh</td>
<td>Yinghua Hu</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pratham Gandhi</td>
<td>Chanwook Oh</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Jason Song</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constantine Sideris - Electrical</td>
<td>EEB</td>
<td>Matthew Burke</td>
<td>Fangzhou Wang</td>
<td></td>
</tr>
<tr>
<td>Manuel Monge - Electrical</td>
<td>BHE 102, 106</td>
<td>Jordan Jaross</td>
<td>Manuel Monge</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dhruv Aggarwal</td>
<td>Manuel Monge</td>
<td></td>
</tr>
<tr>
<td>Daniel McCurry - Environmental</td>
<td>BHE 201</td>
<td>Andrew Sung</td>
<td>Euna Kim</td>
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<tr>
<td></td>
<td></td>
<td>Max Edelstein</td>
<td>Lily Shi</td>
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<tr>
<td></td>
<td></td>
<td>Angel Trujillo</td>
<td>Zakiyyah Brown</td>
<td></td>
</tr>
<tr>
<td>Amy Childress - Environmental</td>
<td>BHE 201</td>
<td>Pearson Mewbourne</td>
<td>Allyson McGaughey; Sophia Plata</td>
<td></td>
</tr>
<tr>
<td>Adam Smith - Environmental</td>
<td>BHE 201</td>
<td>Sarah Burke</td>
<td>Yamrot Amha; Ali Zarei-Baygi</td>
<td></td>
</tr>
</tbody>
</table>

Hannah
EEB 248
### Welcome SHINE 19 Cohort!
**Aerospace Engineering Students**

<table>
<thead>
<tr>
<th>Faculty / Eng. Dept.</th>
<th>Lab Location</th>
<th>Student</th>
<th>SHINE19 Mentors</th>
<th>Staff/Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alejandra Uranga - Aerospace</td>
<td>RRB 108</td>
<td>Achintya Pinninti</td>
<td>Saakar Byahut</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Katelyn Sulett</td>
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<tr>
<td></td>
<td></td>
<td>Marco Valadez</td>
<td>James Croughan</td>
<td></td>
</tr>
<tr>
<td>Mitul Luhar - Aerospace</td>
<td>RRB 107/BHE 110</td>
<td>Noah Shen</td>
<td>Mark Hermes</td>
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<tr>
<td></td>
<td></td>
<td>Jacklyn Oldoerp</td>
<td>Shilpa Vijay</td>
<td></td>
</tr>
<tr>
<td>Geoffrey Spedding - Aerospace</td>
<td>RRB 108</td>
<td>Luke Harris</td>
<td>Bradley McLaughlin</td>
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<tr>
<td></td>
<td></td>
<td>Tianhao Wei</td>
<td></td>
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</tr>
</tbody>
</table>
1. Nearest Neighbour - Pick v. add nearest vertex to v....

2. Greedy - Sort edges from small to large, add them....
   - Cheapest
   - Closest
   - Farthest

3. 2-factor Approx.

4. k-opt, ..., k-opt

M = 5

G

\[ \text{our tour} \leq 2 \cdot \text{tour} \]
USC Viterbi School of Engineering

SHINE Process:

1. Professors volunteered for SHINE
2. Students applied
3. Dr. Mills & SHINE Team screen applicants & create dossiers
4. Professors reviewed applicants & selected them
5. Here you are today!
SHINE Structure

Professor

Ph.D. Mentors & Labmates

SHINE Cohort
University Research
(USC = Research 1 University - #1 job is research)

- Professor
  - Ph.D. students
  - Masters & Undergrads
  - SHINE
  - others
University Research
(USC = Research 1 University - #1 job is research)
Prof. Mataric’ winner of the Presidential Award for Excellent in Science, Math, & Engineering Excellence in 2011
University Research (USC = Research 1 University)

- Professor
- Ph.D. students
- Masters & Undergrads
- SHINE
- others
2018
$6.653 Billion
down 11.2% from
2016 actual
Funds 8,000 grants/yr
only 19% of grants funded
University Research (USC = Research 1 University)

Professor

Ph.D. students

Masters & Undergrads

SHINE

others

Research Lineage
Need Research Progeny
University Research
(USC = Research 1 University)

- Professor
  - Ph.D. students
    - Masters & Undergrads
    - SHINE
    - others

- Prof’s write proposals, go to NSF in DC, recruit Ph.D.s, leadership in prof orgs
  - Post-docs & Ph.D. students conduct research
SHINE is also based on research in engineering education
SHINE is also based on research in engineering education.
<table>
<thead>
<tr>
<th>Statics</th>
<th>Thermodynamics</th>
<th>Structural Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Results of force systems</td>
<td>• Thermodynamic Properties, Laws, and Processes</td>
<td>• Physical Properties of Building Materials</td>
</tr>
<tr>
<td>• Equivalent force systems</td>
<td>• Equilibrium</td>
<td>• Deflection</td>
</tr>
<tr>
<td>• Equilibrium of rigid bodies</td>
<td>• Gas Properties</td>
<td>• Deformations</td>
</tr>
<tr>
<td>• Frames and trusses</td>
<td>• Power Cycles and Efficiency</td>
<td>• Column and Beam Analysis</td>
</tr>
<tr>
<td>• Centroid of area</td>
<td>• Heat Exchangers</td>
<td>• Implementation of Design Codes</td>
</tr>
<tr>
<td>• Area moments of inertia</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Dynamics</th>
<th>Circuit Theory</th>
<th>Hydrologic Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Kinematics (e.g., particles and rigid bodies)</td>
<td>• Series and Parallel Circuits</td>
<td>• Hydrology</td>
</tr>
<tr>
<td>• Mass moments of inertia</td>
<td>• Kirchhoff’s Laws</td>
<td>• Water Distribution and Collection Systems</td>
</tr>
<tr>
<td>• Force acceleration (e.g., particles and rigid bodies)</td>
<td>• Resistance, Capacitance, and Inductance</td>
<td>• Watershed Analysis</td>
</tr>
<tr>
<td>• Impulse momentum (e.g., particles and rigid bodies)</td>
<td>• Wave forms</td>
<td>• Open Channel</td>
</tr>
<tr>
<td>• Short, energy, and power (particles and rigid bodies)</td>
<td>• Signals</td>
<td>• Closed Conduits (Pressurized)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mechanics of Materials</th>
<th>Mechanical Design</th>
<th>Mechanics</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Stress Types and Tensile</td>
<td>• Manufacturing Processes</td>
<td>• Laboratory and field tests</td>
</tr>
<tr>
<td>• Material Characteristic Properties, and Comp.</td>
<td>• Machine Elements (e.g., springs, pressure vessels, beams, piping, frames and gages)</td>
<td>• Tension Control</td>
</tr>
<tr>
<td>• Heat Treating</td>
<td>• Machine Control</td>
<td>• Geological Properties and Classifications</td>
</tr>
<tr>
<td>• Stress-Strain Analysis</td>
<td></td>
<td>• Soil Characteristics</td>
</tr>
<tr>
<td>• Material Deformation</td>
<td></td>
<td>• Bearing Capacity</td>
</tr>
<tr>
<td>• Material Equations</td>
<td></td>
<td>• Drainage Systems</td>
</tr>
<tr>
<td>• Phase Diagrams</td>
<td></td>
<td>• Foundations and Retaining Walls</td>
</tr>
<tr>
<td>• Mohr’s Circle</td>
<td></td>
<td>• Slope Stability</td>
</tr>
<tr>
<td>• Young’s Modulus</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Fluid Mechanics</th>
<th>Computer Architecture</th>
<th>Environmental Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Fluid Properties</td>
<td>• Computer Hardware</td>
<td>• Ground and Surface Water Quality</td>
</tr>
<tr>
<td>• Pumps, Turbines, and Compressors</td>
<td>• Computer Software</td>
<td>• Wastewater Management</td>
</tr>
<tr>
<td>• UFL, Drag, and Fluid Resistance</td>
<td>• Processors and Microprocessors</td>
<td>• Environmental Impact Regulations and Tests</td>
</tr>
<tr>
<td>• Fluid Statics and Motion (Bernoulli’s Equation)</td>
<td>• Interfacing</td>
<td></td>
</tr>
<tr>
<td>• Pneumatics and Hydraulics</td>
<td>• Memory</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Electrical</th>
<th>Process Design</th>
<th>Process Flow, Piping, and Instrumentation Diagrams</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Interiors</td>
<td>• Process Controls and Systems</td>
<td>• Recycle and Bypass Processes</td>
</tr>
<tr>
<td>• Photons</td>
<td></td>
<td>• Industrial Chemical Operations</td>
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</table>

**SHINE is not summer school!**

**SHINE is also based on research in engineering education**
SHINE is also based on research in engineering education.

SHINE is experience, practice, habits of mind.
SHINE is also based on research in engineering education.
SHINE is also based on research in engineering education

Engineering Habits of Mind
SHINE’s mentors
- the center of SHINE
The Scholarly Research Process:

- Research Question
- Literature Review
- Methods
- Results/Discussion
- Communication:
  - Peer Review
  - Poster
The Scholarly Research Process:

- **Research Question**
- **Literature Review**
- **Communication:**
  - Peer Review
  - Poster
- **Results/Discussion**
- **Methods**

---

University of Southern California

USC Viterbi
School of Engineering
The High School Research Experience:

- Correct answer
- Timed for period
The Actual Research Experience:

• Lots of downtime
• Takes years
The Scholarly Research Process:

- Research Question
- Literature Review
- Methods
- Results/Discussion
- Communication:
  - Peer Review
  - Poster
How to shine at SHINE:

1. Communicate with your Mentor & research team – introduce yourself to others, don’t be shy
2. Check in with your Mentor each morning, before taking lunch & when leaving at day’s end
3. Confirm lunch w/ Mentor: refrigerator? Time?
4. Work out general schedule with your Mentor
5. Ask your Mentor how to communicate if you become ill or late – text, email, phone?
6. Bring a notebook & laptop each day. Make sure it is safe when you leave the lab for lunch, etc.
7. Bring your USC ID each day
How to shine at SHINE:

• Take notes – keep a lab notebook & laptop
• Ask questions of everyone in your lab, be bold
• Consider keeping a diary or journal of your experiences – how does your understanding of research change over these 7 weeks? What can you learn about people, about yourself?
• Use downtime in the lab to:
  • Study the lab’s Website
  • Read the lab’s publications – assignment
  • Review past SHINE Posters
  • Do your literature search in USC library databases
How to shine at SHINE:

• Always follow lab safety procedures – failure to do so may result in termination from the SHINE program

• Don’t post to any social media about the lab or your fellow SHINE students unless you have explicit permission to do so

• Try to have lunch with someone new from SHINE every day – don’t stick with the people you know
Schedule Agreement between SHINE Student and SHINE Lab

We need to have a general idea of what days and times we can expect to find the SHINE students in the lab; this is useful so we can check in occasionally, to see how things are going or perhaps to take photos.

We highly recommend that SHINE students plan on a M/W/F schedule with a lunch break from noon – 1 pm so that the cohort can see each other and eat together. Friday cohort trainings are mandatory, so plan on being involved with the cohort every Friday from 10 a.m. – 1:30 p.m. – lunch is included on Fridays. No work on weekends or after 6 p.m.

<table>
<thead>
<tr>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recommended!</td>
<td></td>
<td>Recommended!</td>
<td></td>
<td>Everyone plan on being here from 9:30 a.m. – 1:30 p.m.; you can go to your labs after 1:30.</td>
</tr>
</tbody>
</table>
Library Training in Lit Review
& Annotated Bibliography Assignment

1. Automated Proxemic Feature Extraction and Behavior Recognition: Applications in Human-Robot Interaction
   by Mead, Rose; Atrekh, Amin; Matarić, Maja J.
   Permalink
   In this work, we discuss a set of feature representations for analyzing human spatial behavior (proxemics) motivated by metrics used in the social sciences....
   Journal Article: Full Text Online

2. Using Socially Assistive Human-Robot Interaction to Motivate Physical Exercise for Older Adults
   by Facio, J.; Matario, M. J.
   Proceedings of the IEEE, 2012, Volume 100, Issue 8
   Permalink
   In this paper, we present the design, implementation, and user study evaluation of a socially assistive robot (SAR) system designed to engage elderly users in...
   Journal Article: Full Text Online

3. Editorial
   by Gi, Shuhi Sam; Matarić, Maja J.
   International Journal of Social Robotics, 01/2012, Volume 4, Issue 1
   Permalink
   Journal Article: Full Text Online

4. Robots for Use in Autism Research
   by Scassellati, Brian; Henny Admoni; Matarić, Maja
   Annual Review of Biomedical Engineering, 08/2012, Volume 14
   Permalink
   Autism spectrum disorders are a group of lifelong disabilities that affect people's ability to communicate and to understand social cues. Research into...
   Journal Article: Full Text Online
### SHINE19 Cohort Calendar

<table>
<thead>
<tr>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>wk 1</td>
<td>6/17/2019 Day 0</td>
<td>9am (meet @ GFS 106) Orientation, Lunch &amp; Lab tour 1-4pm: Lab Safety Training (students only)</td>
<td>6/19/2019 Day 2</td>
<td>6/20/2019 Day 3</td>
</tr>
</tbody>
</table>

- **Wednesday & Friday Workshops**
- **Cohort Lunches**

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**Practice presenting your poster with your mentor**

- **POSTERS DUE**
- 9:30am - 12pm (TBD) Cohort Meeting
- College Admissions Workshop

- **10am - 12pm (TBD) Cohort Debriefing and Dessert**
- 9:30am - 1:30pm (MCB 101) Cohort Meeting & Civil Eng Workshop (Ashtari Alyal)
- Circuit Workshop Prof. Sidelsky
MatLAB Training – Tues – Web (6/18-19)
BBQ Will Be July 10, 2019
The Scholarly Research Process:

- Research Question
- Literature Review
- Communication: Peer Review, Poster
- Results/Discussion
- Methods
The main goal of scientific research is to find solutions through trial and error (and statistics) that can be replicated and verified by others. Sharing research findings moves from informal to peer reviewed:

**Informal -> Formal (Peer Reviewed & Published) -> Nobel Prize!**

Poster Sessions are a first step in publicly sharing your findings.

Like a grown-up version of the Science Fair!

http://www.personal.psu.edu/drs18/postershow/
SHINE Poster Session – Thursday, August 1, 2019
Utilizing Infrared Sensors for Thermal Comfort

Victoria Sanchez / victoria146@mts.ks.edu
Marymount High School, Class of 2019
USC Viterbi Department of Civil Engineering, SHINE 2017

Introduction & Objective

Research in Ventilation and Air Conditioning systems commonly use fixed points or standards, which automatically set the temperature and humidity for thermal comfort. This way, the entire indoor environment maintains the temperature and humidity at these fixed points. However, there is always a focus on improving the comfort levels of these systems.

In this project, we sought to discover the relationship between non-invasive thermal comfort and the energy consumption of buildings. Non-invasive methods of measuring the thermal comfort levels and energy consumption of buildings can help in reducing the energy usage and improving the comfort levels.

Methodology

We tested the hypothesis that by using non-invasive thermal comfort and energy consumption measurement, we could achieve better comfort levels and reduce energy usage.

Results

The results showed that by implementing non-invasive thermal comfort and energy consumption measurement, we could achieve better comfort levels and reduce energy usage.

Acknowledgments

I would like to thank my mentor, Dr. Reza Khaleghi, for his guidance and support throughout this project. I would also like to thank the other team members for their contributions and efforts.

Acquired Skills

I learned how to code, build sensors, and analyze data. I also learned how to work with Arduino and other electronics.

Future Work

I plan to continue this research and work with other teams to develop a more comprehensive system for measuring thermal comfort and energy consumption.
Development of Multi-Electrode Neural Probes for Rat Hippocampal Recordings

Leo Slow, slowlew@yahoo.com
Glen A. Wilson Class of 2016
University of Southern California, Department of Biomedical Engineering

Introduction

The primary purpose of MEIDS is to engineer extremely miniaturized technology, which can be implanted in the medical field. Our research objective strives to fabricate a neural probe designed to observe the neural networks responsible for the formation of memories in the hippocampus. The process to create a device capable of recording electrical signals within a rat’s brain is a long and complex one. First, we created brain probes using methods of photolithography. We designed and fabricated flexible, multi-electrode Parylene probes to record spikes from the Cornu Ammonis (CA) areas CA1 and CA3 and the Dentate Gyrus (DG) region of rat hippocampus. This array of eight, custom-made, flexible neural probes with eight recording sites per probe targets particular hippocampal cell layers. The array also enables long-term hippocampal recordings of rats as they interact with complex, environmental spatial cues. The flexibility of the probes enables better integration with surrounding brain tissue and less micro-damage to nearby neurons when compared to damage caused by metal microwires to neurons. Since the probes are flexible, they must be temporarily stiffened in order to insert into brain tissue. Our research utilizes a block of a biocompatible adhesive, Polyethylene Glycol (PEG), to temporarily decrease the effective length of the probes, enabling them to penetrate brain tissue. In parallel to helping to develop an effective insertion technique, I designed and fabricated a printed-circuit board to connect the electrical traces on our probe to the appropriate electrical recording system.

Objectives

1. Fabricate flexible neural probes:
   - Inserting probes is a traumatic event for the brain, which causes a scar and dead zone to form around the recording sites and limits the probe’s ability to obtain neural signals.
   - Using a more flexible material, rather than the traditional metal substrates, alleviates this damage.
   - We use Parylene, a USP Class VI material that is flexible and micromachinable to construct the device.
2. Test various techniques to provide temporary stiffness to neural probes:
   - Flexible probes must be temporarily stiffened during insertion in order to penetrate brain tissue.
3. Design a printed-circuit board to connect probes to electrical recording system:
   - We will be using software to design our printed-circuit boards, which will be part of our electrical connection scheme.

Research Process

Neural Probe Fabrication:

- Probes were microfabricated by using photolithographic techniques. (Fig. 5)
- Parylene served as the base substrate and insulation layer for our devices.
- Platinum electrode recording sites, traces, and contact pads will be lithographically patterned on top of the base layer using e-beam deposition at a thickness of 2.000 Å, followed by lift-off.
- Electrodes and contact pads will be subsequently exposed by DRIE and the probes will be cut out from the substrate.

Optimizing Insertion of Probes into Brain:

- Temporary stiffening techniques range from coating probes with a dissolvable, biocompatible stiffener to using microwire scaffolds to support the probes during insertion.
- We explored the use of Polyethylene Glycol (PEG) blocks to temporarily stiffen flexible probes during insertion into brain phantom gel (Fig. 9).
- The process of creating these PEG blocks involved the use of molds made from silicone rubber. This involved using a three-layer mechanism, with the first layer as a base. The second layer served as a proctor for our insertion tool (black rectangular object). The third layer contained an opening for the PEG to be poured into.
- In collaboration with the Borger Lab, we inserted our sham probes into the rats. First, these rats were ensured to be sterile and clean. Next, we applied anesthesia to the rat with the correct quantity, ensuring the rat will have a painless experience.
- The sham probes were carefully positioned above the proper insertion zone.
- We used dental cement to secure the probe in place. When we retracted our insertion apparatus, the probe would remain robust and secure. The procedure was concluded to be successful, as the probes inserted properly without fail.
- A via was performed to drain the blood by flushing formamide through the rat’s body, known as a perfusion.

Fabrication of PCB for Electrically Connecting Probes to Neural System:

- Eagle was used to develop printed-circuit boards and sockets for our device.
- We used Eagle to create multiple parts for our device. This includes schematics, devices, symbols, and packages.
- After we complete all elements of our design, we will send the file to a fabrication house. The fabrication house uses our file to create a printed-circuit board, which will be used in our device to encode the memories from a rat into data readable by computers.

Relativity to My STEM Coursework

The research we did at the lab involves heavy use of theoretical knowledge to comprehend. For example, we were exploring different options of inserting our probes into the brain phantom gel, we came up with the possibility of utilizing magnification. Background knowledge from my Advanced Placement physics class provided valuable insight. Without this knowledge, I would not have been able to communicate with my fellow peers in the lab. In addition, our lab group wanted to find the force of insertion of the probe. Again, my experience from Advanced Placement physics provided me the ability to suggest research-based solutions to the given problem. Such solutions included the use of the impulse-momentum formula, as well as Newton’s second law. The scientific method was also presented to me at a higher level. Overall, my research abilities were greatly enhanced and also increased in formality. In high school, this will give me a report as an edge compared to my other peers. The scientific integrity of my lab report will increase, due to the overarching factors between high school and university science overall. My background knowledge from high school courses was beneficial in my participation.

Future of Project

The device will undergo many various parts to perfectly meet the needs of the probe. After the device is successfully fabricated, it will be tested on a live rat. The device is expected to analyze brain waves and neural firing in the rat’s hippocampus. This beneficial data will contribute to the study of the formation of memories in the brain. Eventually, if the project proves to be efficient, there is a possibility of commercialization. This may benefit millions of lives, including but not limited to, people who suffer from Alzheimer’s disease. Other memory-related disorders may also be treated with this device.

Acknowledgements

Dr. Eris Meng, Ahuva Weintal, David King, Huiying Xu, Craig Timms. Dr. Kate Mills, Luping Wang, Biomedical Microsystems Lab, Kenny Chan
Ultrathin Single Crystalline Silicon Solar Microcells for Unassisted Photoelectrochemical Water Splitting

Shirley Zhang; shirley8023zhang@gmail.com
Arcadia High School, Class of 2016
Mark Family Department of Chemical Engineering and Materials Science

Introduction
During the eight weeks of SHINE Program, I worked under Professor Jongseung Yoon who focuses his researches on chemical engineering. Even though there were several projects going on at the same time, they all had the same purpose, which is to maximize the performance of monocrystalline silicon in photovoltaics systems. This is important because silicon can produce renewable and sustainable power sources. The solar energy produced will not only reduce utility costs, but also minimize effects on global climate.

Objectives & Impact of Professor's Research
- Silicon is the 2nd abundant material on earth and has been dominantly used in photovoltaics. However, massive implementation has been limited due to the high cost as raw wafer materials account for more than 50% of the production cost.
- Ultrathin silicon can reduce the amount of silicon used in the device. However, the performance is limited due to the weak optical absorption of silicon with a band gap. (band gap: energy difference in electron volts between the top of the valence band and the bottom of the conduction band in semiconductors)
- Specific technological areas of interest include high performance, low cost photovoltaic and photoelectrochemical water splitting systems.

Impact of Professor Jongseung Yoon's Research
- The goal is to develop approaches that can achieve an efficient utilization in silicon solar cells without sacrificing their performances.
- Use sunlight instead of battery to drive the water splitting systems.

Photovoltaics
- Photovoltaics (PV) is the method of converting solar energy into direct current electricity using semiconducting materials
- The photovoltaic effect refers to photons of light exciting electrons into a higher state of energy, allowing them to act as charge carriers for an electric current.
- When light energy strikes the solar cell, electrons are knocked loose from the atoms in the semiconductor material, if electrical conductors are attached to the positive and negative sides, forming an electrical circuit, the electrons can be captured in the form of electricity.

Working Principle of Solar Cells
- The p-n junction
- P-n junctions are formed by joining n-type and p-type semiconductor materials
- Since the n-type region (n = negative) has a high electron concentration and the p-type region (p = positive) has a high hole concentration, electrons diffuse from the n-type side to the p-type side. Similarly, holes flow by diffusion from the p-type side to the n-type side.
- Due to the difference in concentration, it creates an electric field inside the semiconductor structure.
- If the electrons and holes were not charged, this diffusion process would continue until the concentration of electrons and holes on the two sides were the same.

Water splitting system
- Electrolysis uses electricity to decompose water molecule into oxygen and hydrogen. When high enough electric potential is applied, anode oxidize water molecule into oxygen and proton, while cathode reduces the proton into hydrogen.
- Photoelectrochemical water splitting promises a solution to the problem of large-scale solar energy storage. However, its development has been impeded by the poor performance of photoanodes, particularly in their capability for photovoltage generation.
- It is an artificial photosynthesis process in a photoelectrochemical cell used for the dissociation of water into its constituent parts, hydrogen and oxygen using sunlight.
- Hydrogenated microcrystalline silicon thin film promise new solar-cell materials. Their advantages include minimal use of semiconductor resources, large-area fabrication using low-cost methods, and no photodegradation of solar cell characteristics.
- The minimum potential difference (voltage) needed to split water is 1.23V at 0 pH.

Silicon Water Fabrication
- It is a multiple-step sequence of photo lithographic and chemical processing steps during which electronic circuits are gradually created on a silicon wafer.
- Nitride film deposition
- It is formed on the wafer by CVD method using allane and ammonia gases.
- RCA clean is the procedure to remove the organic contaminants, thin oxide layer, and ion contamination
- Photolithography coating
- The wafer is uniformly coated with a thick ultraviolet (UV) light sensitive liquid called photoresist.
- The coating is applied while the wafer is spinning.
- Masking
- Masking is used to protect one area of the wafer while working on another.
- This process is referred to as photolithography or photo-masking.
- Exposure
- A photo aligner aligns the wafer to a mask and then projects an intense light through the mask and through a series of reducing lenses, exposing the photoresist with the mask pattern.
- Opposite regions on the mask block the UV light.
- Etching
- The wafer is then "developed" (the exposed photore sist is removed) and baked to harden the remaining photore sist pattern.
- Doping
- Atoms with one less electron than silicon (such as boron), or one more electron than silicon (such as phosphorous), are introduced into the area exposed by the etch process to alter the electrical character of the silicon.
- These areas are called P-type (boron) or N-type (phosphorous) to reflect their conducting characteristics.
- Probe testing
- Mechanical probe station utilizes manipulators which allow the precise positioning of thin needles on the surface of a semiconductor device.
- It is used to acquire signals from the internal nodes of a semiconductor device

How This Relates to My STEM Coursework
- In my high school science classes, the experiments I do usually have set procedures and known results. We are given the methods to prove the textbook results.
- The actual research labs I have worked in at Shinkle requires me to apply the physics, chemistry, and calculus knowledge that I have learned to prove the hypothesis through various experiments.
- This experience strengthened my prior knowledge and expanded my overall skill in STEM research.

Next Steps for Myself and Advice for future SHINE students
- The next steps for myself:
  - I will continue to pursue my interest in chemical engineering.
  - I am also planning to join a research group in college.
- Advice for future SHINE students
  - Choose the department that interests you.
  - You don't have to be sure of what you want to major in college because almost all the research done in this program involves different fields of engineering.
- Even though my research group focused more on chemical engineering, it also required the knowledge of electrical and mechanical engineering. The fun part is that the program gives high school students opportunities to explore their potential majors and participate in the advanced laboratory.

Acknowledgements
- Dr. Jongseung Yoon
- Taylor Alcantor
- Yuhou Xie
- Dr. Kate Mills
- Tracy Charles
- Boju Gai
- Luping Wang
The Effects of Oblique Shock Waves on Fluids

Alan Ton – Walnut High School Class of 2016
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University of Southern California – Department of Aerospace and Mechanical Engineering

Introduction
- Shock waves are types of pressure waves that are able to travel faster than the speed of sound
- Due to their potentially high velocities, they may also carry large amounts of energy – and inflict damage
- Shock waves can be generated by earthquakes, explosions, bullets, and more
- Dr. Veronica Ellasson seeks to understand more about the nature of shock waves

Objectives of Professor’s Research
- Learn more about shock waves
- Find a way to mitigate the harmful effects of shock waves
- Develop a method to focus and redirect shock waves
- Research may lead to:
  - Stronger soldier body vests and helmets
  - Higher structural integrity for buildings
  - Better ships and planes
  - Advanced bomb defenses

Experimental Design
The inclined shock tube is able to propagate shock waves at any desired angle. Three pressure sensors were placed towards the end of the driven section to retrieve information about the fired shock wave.

STEM Knowledge: Past & Present
- Calculus
- Physics
- Thermodynamics
- Fluid Mechanics
- Compressible Flow
- Rocket Engineering
- Microsoft Excel
- MATLAB
- Lab tools

The Next Steps
- A wider array of materials should be tested (i.e., non-Newtonian fluids)
- Make experimentation more efficient
- Possible construction of armor incorporating investigated substances

Data and Results

<table>
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<tr>
<th>Incident Mach Number</th>
<th>35 psi</th>
<th>45 psi</th>
<th>77 psi</th>
<th>85 psi</th>
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</thead>
<tbody>
<tr>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.5</td>
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</table>

The chart above shows the Mach numbers that we are able to achieve with Hongjoo’s inclined shock tube.

Regular vs. Irregular Reflection
- 85 psi of compressed air; water medium; \(\leq 45^\circ\)
- 85 psi of compressed air; corn starch medium; \(\leq 45^\circ\)
- 85 psi of compressed air; water medium; \(\leq 20^\circ\)

Special thanks to Dr. Veronica Ellasson, Hongjoo Jeon, Stylianos Koumlis, Nick Amen, Orlando Delpino Gonzáles, Shili “Stone” Qiu, Qian Wan, Jonathan “Jack” Gross, Arturo Cajal, Gabe Glasser, Natalie Nguyen, Hang Wei, VAST Administrator Katie Milis, Luping Wang, Justin Puroz, and Dennis Lin
Using Socially Assistive Robots and Creating an Annotator from Scratch

Bhav Patel bhavpatel1995@uol.com
La Salle High School '16

Introduction

My name is Bhav Patel. I am currently a rising senior at La Salle High School and intend on majoring in Astronautical Engineering. This summer I worked in the Interaction Lab at USC under Dr. Mataric and was mentored by Caitlyn Clabaugh. This lab falls under the discipline of computer science. I had two over-arching projects which were: To build an annotation GUI for future use of having children use in data collection and to use "Dash and Dot," two children's robots, to see if they were viable in teaching children how to code/program.

Objectives & Impact of Professor's Research

My lab mentor Caitlyn Clabaugh is currently working on teaching younger children through robots. This holds certain advantages such as learning through play and exploring learning styles (especially with preschoolers where there is little to no research on their learning styles). Contributing to the general goal of the lab, Caitlyn's work furthers the process of bringing robots into our daily lives. Specifically, these robots are called SAR's or socially assistive robots.

How This Relates to My STEM Coursework

I now see STEM as something completely different. I have learned that half the battle is grants, paperwork, and management. An example of which the countless IRB's I saw in the Interaction Lab. On top of that, I have now seen that although research is much of finding out what works, it is also just as much finding out what doesn't work.

Overall, bringing this back to my high school (La Salle High School), I can now see, at least within STEM, classes and clubs with a fresh outlook. Mostly, this will go towards the robotics club, where I have now realized the frustration of people in the club (myself included!) when something doesn’t work. I now find it critical to know what doesn’t work as opposed to just what works. Finding out what doesn’t work will always improve the final product.

Skills Learned

I have learned the following skills and techniques:

**How to build a basic graphical user interface (GUI)**
- I have learned to code (introductory-proficient level) with the following languages: HTML/CSS, Java, and Python.

**Using a SAR robot**
- How to use various sensors at the right moment to create a fluid and life-like movement.
- Beyond the lab, I took tours with my SURE lab mentor, Eric, and learned of the vast differences that encompass various labs. It was interesting seeing my lab, which looks like a line of computers on desks as opposed to a classic "basement lab" that Eric worked in.

My Next Steps

The biggest thing I will take back from this is programming. I learned around 4 different languages this summer and their different areas of expertise. Originally I knew C++ and struggled immensely, but now I have a newfound respect for programming and its uses. I now want to build several GUI’s and other Java/Python applications, and perhaps practice HTML & CSS websites.

Acknowledgements

Special thank you to: Dr. Mataric, Caitlyn Clabaugh, Dr. Katie Mills, Luping Wang, Steven Tsung-Han Sher, Eric Westphal, and Tracy Charles
The Certificate Ceremony
Presentations follow the Poster Session
### Pulsed Laser Deposition Growth from Highly Densified Perovskites Ceramics to Form 2DEG

**Introduction**

A two-dimensional electron gas (2DEG) was discovered accidentally in 2004 at the interface between two materials, LiTaO₃ and Bi₂O₃. Due to the tight confinement in this thin structure, the quantum energy levels for carriers, and offers a system of high mobility electrons.

### Synthesis Process

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Preparation of target material</td>
</tr>
<tr>
<td>2</td>
<td>Deposition of thin film</td>
</tr>
<tr>
<td>3</td>
<td>Characterization of sample</td>
</tr>
</tbody>
</table>

### PLD Concepts & Results

- **Results**: High-quality 2DEG formation with high mobility and stability.
- **Applications**: Potential in high-performance electronics and optoelectronics.

### Characterization Process

- **Technique**: X-ray Diffraction (XRD) of the 2DEG sample
- **Image**: Shows the crystal structure and phase purity of the 2DEG layer.

### Professor's Research & My Role

Professor Rashid's group focuses on the preparation of high-quality 2DEG materials using pulsed laser deposition (PLD). My role involves the characterization of these materials and the development of novel 2DEG devices.

### Acknowledgements

- Thomas Oren
- Shiyan Liu
- Dr. Jayant...
Acknowledgements

Apart of CDFP has been a great experience; I would have never been able to do this without so many people. I would like to thank for Elaine Borneman, Derek and Rachel Ashcroft for guiding me to this amazing experience. Thank you, Emily, and Nasir for being there for me. Thank you, Dr. Kate Mill for being there for me. Thank you, Dr. Kate Mill for being there for me.
USC Transportation - Shuttle

Union Station Tram Pick-Up Location

Map Not to Scale
USC Transportation – Metro Expo Line

Expo/Vermont

Expo/USC
USC Transportation – Metro Expo Line

Students (K-8 and 9-12)

Student (K-8 and 9-12) TAP Card

Student (K-8 and 9-12) 30-Day Pass - $24
Student (K-8 and 9-12) Single One-Way Fare - $1

To obtain a K-12 Student TAP Card, submit a completed application, with required documentation.

https://www.metro.net/riding/fares/students-k-8-and-9-12/
Parking

Get a summer school parking pass

WHO WANTS TO CARPOOL OR BUDDY UP ON PUBLIC TRANSPORTATION?

🌟 We are here @ GFS
USC Department of Public Safety

Campus is closed to people without USC ID between 9 p.m. – 6 a.m.

Public Safety officers and campus ambassadors stationed all around.

More information in the SHINE Orientation Packet.

SHINE students will not be left alone in the lab.

Add Public Safety phone #s to your cell phone
NEXT STEPS:

1. See you in DRB 145 6/20 @ 9:30
2. SHINE Poster Session & Certificate Ceremony Thursday, 8/1
How to shine at SHINE:

If you have any problems, concerns, or questions, contact Dr. Mills right away:

kmills@usc.edu
Office: 213-740-0237     DRB 254
Cell: 310-592-6477
After Campus Tour, go directly to Lunch

MCB 102 (Profs. Zavaleta, Chung, Shen, McCain, Becerik-Gerber)
RTH 526 (Profs. Culbertson, Valero-Cuevas, Mataric’, Roberts, El-Damak)
EEB 248 (Profs. Nuzzo, Sideris, Monge, McCurry, Childress, Smith)
HNB 107 (Profs. Uranga, Luhar, Spedding)

Students: Return to HNB 107 by 1:30 for Lab Safety Training