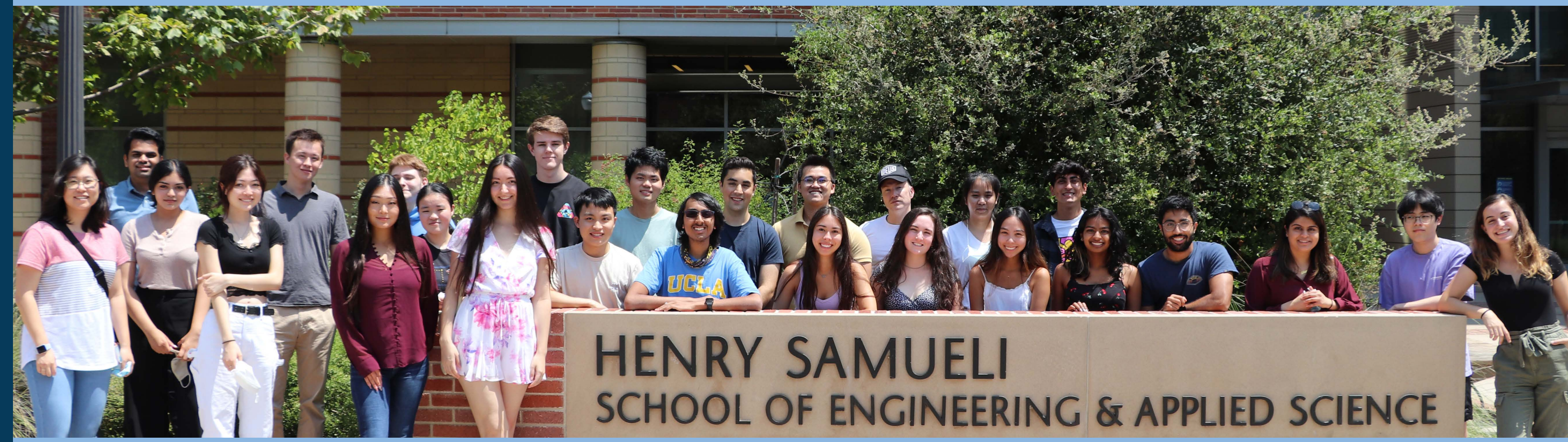
UCLA Samueli School of Engineering

Functional Nanomaterials

SURP 2021

UCLA SAMUELI SUMMER UNDERGRADUATE RESEARCH PROGRAM



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DEAN'S MESSAGE

Ronald and Valerie Sugar Dean

The Summer Undergraduate Research Program (SURP) provides an intensive summer research experience in a wide range of engineering and physical science fields. Undergraduate students from all walks of life participate in research with UCLA Samueli School of Engineering faculty to gain real-world lab experience.

Due to the COVID-19 pandemic that is still affecting us this summer, SURP has had to transition the program into a remote learning environment for many of its scholars. Despite this challenge, SURP's many scaffolding resources and social events have still been able to occur and students were able to:

- Conduct research in a cutting-edge field at a world-renowned research institution.
- Meet and network with a community of peers who have similar goals and interests.
- Create a professional scientific poster and publish a research abstract.
- Learn to communicate research outcomes and present a detailed Summary of Project.
- Gain a competitive advantage for engineering graduate schools.
- Learn how you can impact your community as an engineer.

This year, a record 66 undergraduate students were selected to join the 2021 SURP cohort, spread out across 31 faculty in 6 engineering departments. We are happy to announce 64% of these are women, 20% are underrepresented minorities, and many are first generation and low income students. SURP is involved with ongoing efforts in fostering a more diverse, equitable and inclusive community at UCLA Samueli Engineering.

Creating new knowledge is a very difficult yet important task, and these high-performing students have done an outstanding job working through the rigors of academic research. These students should be very proud of all that they have accomplished in a short time this summer. I encourage you to explore our publication and learn about all the cutting-edge knowledge that is being created here.

Sincerely,

Dr. Jayathi Murthy
Ronald and Valerie Sugar Dean

Arlene Constantino

Electrical Engineering
Sophomore, El Camino College

LiDAR Data Classification Using Convolutional Neural Network Based on Pointnet Architecture

FACULTY ADVISOR
Chee Wei Wong

DAILY LAB SUPERVISOR
Jaime Flor Flores

DEPARTMENT
Electrical and Computer Engineering

ABSTRACT
Convolutional neural networks are the state-of-the-art algorithm for object classification. Due to the various types of objects that are processed and to facilitate training, typical convolutional neural networks (CNNs) require data preprocessing like zero padding or 3D to 2D space projections and do not work with point cloud data. Light Detection and Ranging (LiDAR) is one of the main technologies used in self-driving cars and terrain mapping. Since LiDAR uses time of flight from laser beams to create a 3D map of the area, the generated data is a point cloud. In order to solve these problems, here we present an implementation of CNNs using a modified PointNet architecture. PointNet architecture is directly capable of taking a point cloud and running it on the classification algorithm, which is much more efficient than transforming the data before being fed to the network. In this study, we optimize the said convolutional neural network based on PointNet architecture. We train the model using LiDAR data taken in Westwood and tune its parameters accordingly to achieve close to state-of-the-art performance. As of now, in preliminary testing, the model achieves an 89.82% training accuracy. The goal is to further achieve a model that can be able to map external environments to aid driver-safety and autonomous navigation.

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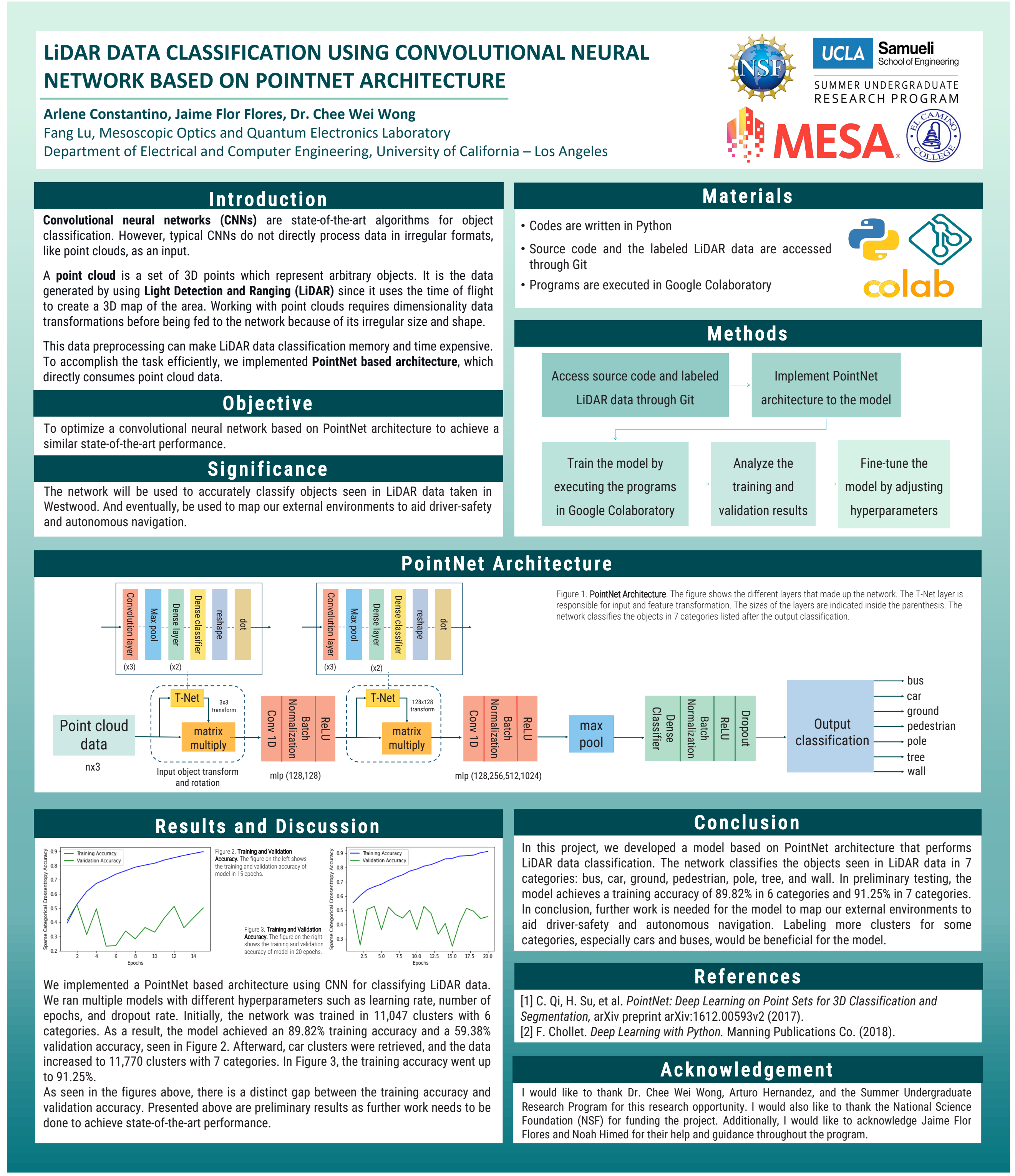

Kim Kha

Mathematics
Junior, Mount Saint Mary's

Enoch Huang

Electrical Engineering
Freshman, UCLA

Amanda Hacker

Electrical Engineering
Freshman, UCLA

Wearable & Mobile Bioanalytical Technologies for Personalized Medicine

FACULTY ADVISOR
Sam Emaminejad

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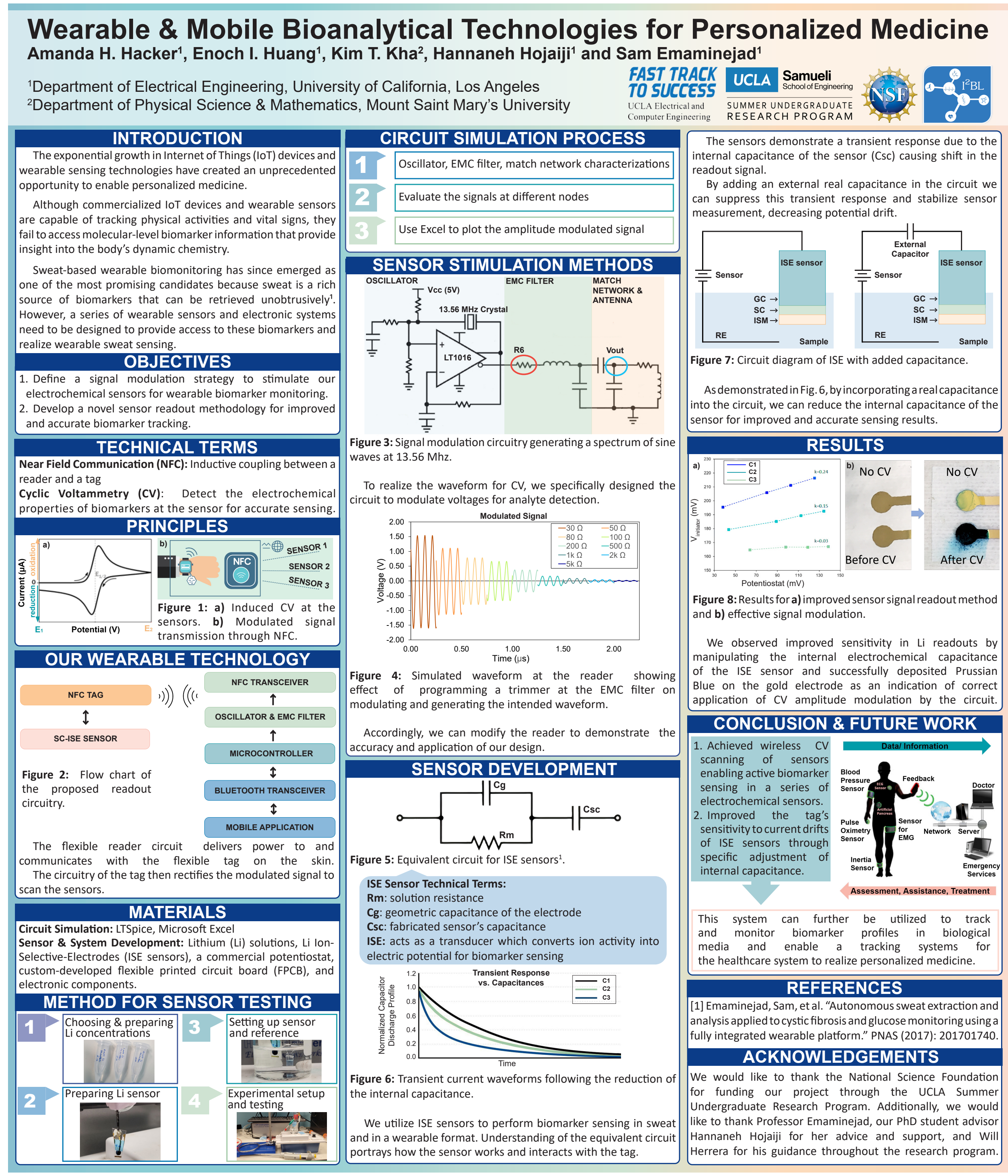
DEPARTMENT
Electrical and Computer Engineering

ABSTRACT

Exponential growth in Internet of Things (IoT) devices and wearable sensing technologies has created an unprecedented opportunity to enable personalized medicine through real-time individual biomonitoring. Although these commercialized platforms are capable of tracking physical activities and vital signs, they fail to access molecular-level biomarker information which provide insight into the body's dynamic chemistry. Thus, as sweat is a rich source of biomarkers that can be retrieved unobtrusively, sweat-based wearable biomonitoring has emerged as one of the most promising candidates to merge this gap. By designing and integrating compact electrochemical sensors into wearable electronic devices, we can non-invasively and accurately track specific biomarkers in sweat and provide actionable feedback about users' health status. We develop a signal modulation strategy to stimulate our electrochemical sensors for wearable biomarker monitoring. We also design a novel sensor readout methodology for improved and accurate biomarker tracking. Then, we integrate these designs into a wireless electrochemical readout circuitry to noninvasively track intended biomarkers. As a result, we successfully demonstrate our signal modulation solution's efficacy through electrodeposition of prussian blue films. Additionally, we show this sensing methodology improves signal readout and sensitivity by 3 times. Thus, we can non-invasively track subjects' biomarkers and underlying health status in a wireless and wearable format. This platform can further be utilized for real-time glucose monitoring in diabetic patients without requiring conventional painful extraction methods, or monitoring lithium levels in bipolar patients for drug abuse/compliance.



Jillian Pantig

Computer Engineering Sophomore, Irvine Valley College

A Process for Implementing Accessible Cardstock-made Robot Cars Equipped with A Variety of Robotic Behaviors

FACULTY ADVISOR

Ankur Mehta

DAILY LAB SUPERVISOR

Ankur Mehta

DEPARTMENT

Electrical and Computer Engineering

ABSTRACT

As the world rapidly turns to robots, it is important to make robot creation ubiquitous, but there are barriers – accessibility and limitation of resources – that inhibit such phenomena. In this study, we proposed and tested a possible solution that can lessen those barriers by building origami robots made with accessible resources. Origami is defined as the Japanese art of folding. To test our hypothesis, we implemented a process that fabricates origami robot cars made from single-layered materials like cardstocks while ensuring that these cars can still carry out several robotic behaviors. The process includes gathering accessible hardwares, programming behaviours using Arduino, designing the origami-inspired body of the car using LEMUR's RoCo, and testing the car to determine if its origami-structure can handle the programmed robotic functionalities: driving on a variety of surfaces, using differential and pivot steering, detecting obstacles, implementing PID control through IMU and visual sensors, and enabling communication with other robots through mesh networking. The scheme yielded robot cars that are useful and fairly accessible with cardstock-made bodies and with a variety of robotic behaviours as mentoned above. The result of our study justifies that the implementation of origami robots has a huge potential in terms of lessening the resource-related barriers of robot creation which increases both the number of people who can build robots and the probability of robot creation being ubiquitous.

Krish Shah

Computer Engineering
Freshman, UCLA

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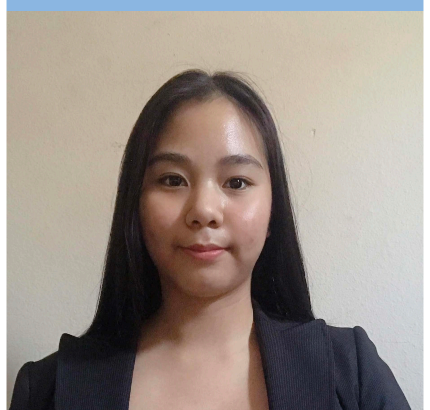

Biochemistry
Sophomore, Mount Saint Mary's University

William Clark

Computer Science
Sophomore, Los Angeles City College

Expanding Human-Computer Interaction via Object Recognition Implemented into a Hand Signal Actuated Robotic Arm (SARA)

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Xiang 'Anthony' Chen

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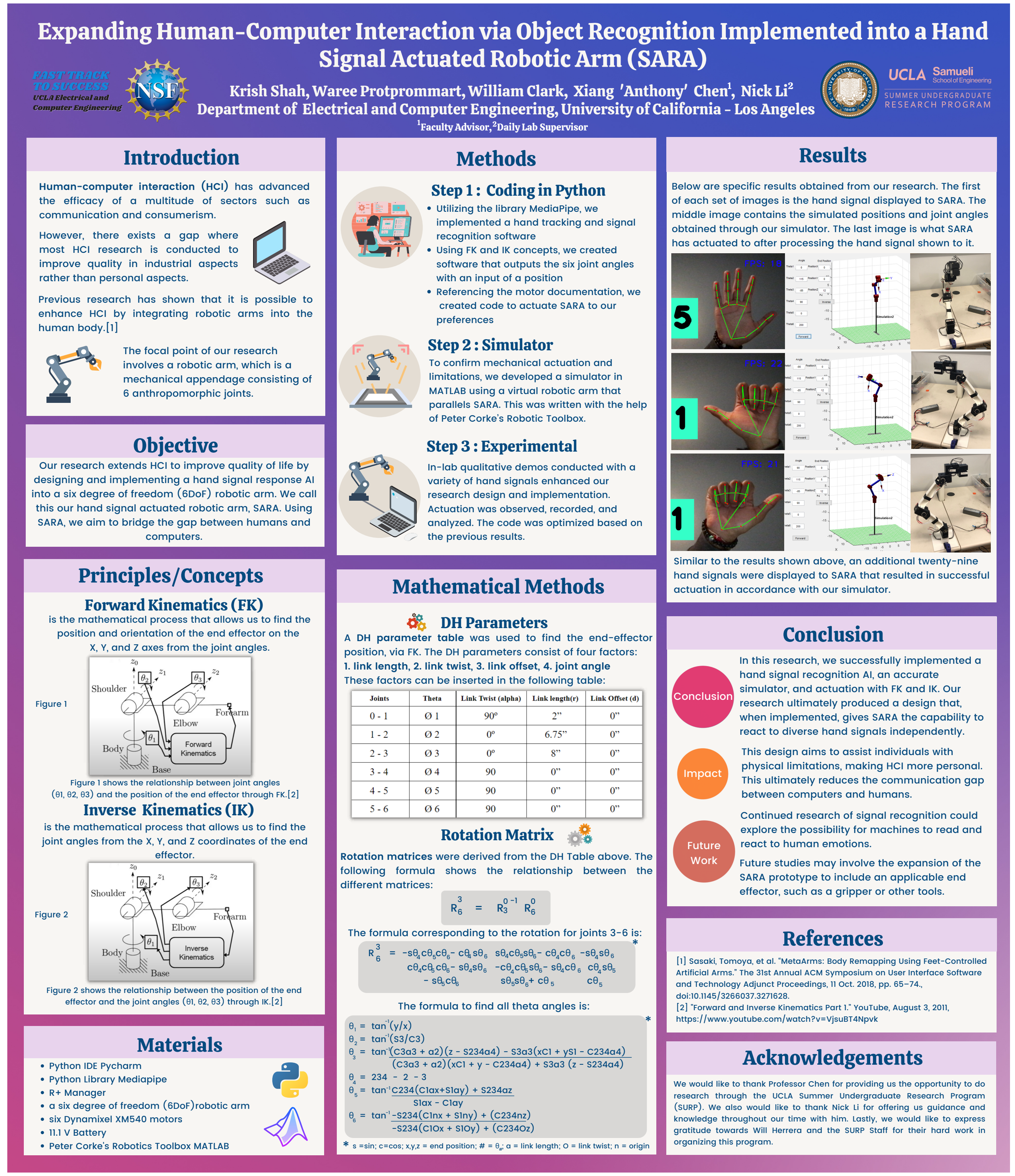
ABSTRACT

Human-computer interaction (HCI) has advanced the efficacy of a multitude of sectors such as communication and consumerism. However, there exists a gap where most HCI research is conducted to improve quality in industrial aspects rather than personal aspects. Our research extends HCI to improve quality of life by designing and implementing a hand signal response AI into a six degree of freedom (6DoF) robotic arm. We call this our hand signal actuated robotic arm, SARA. An implementation of forward kinematics (FK) and inverse kinematics (IK) in python allows the robotic arm to actuate in response to complex hand signals, made possible via our hand recognition software. This software presents a real-time object-tracking process that recognizes hand signals by finger landmark mapping. A rule classifier distinguishes different variations of raised fingers. To confirm mechanical actuation and limitations, we developed a simulator in MATLAB using a virtual robotic arm that parallels SARA. Our research ultimately produced a design that, when implemented, gives SARA the capability to react to diverse hand signals independently. Qualitative demos conducted with a variety of hand signals validated our research design and implementation. A set of thirty-two hand signals was displayed to SARA that resulted in successful actuation in accordance with the simulator. The application of this design aims to assist individuals with physical limitations, making HCI more personal. The success of implementing a hand signal response AI makes the interaction with a robotic arm intuitive, ultimately expanding the scope of HCI to enhance the human experience.



David Zheng

Electrical Engineering
Freshman, UCLA

Serina Mummert

Physics
Sophomore, Citrus College

Flexible Prined Circuit Boards for Panofsky Quadrupole Electron Beam Guiding

FACULTY ADVISOR

Rob Candler

DAILY LAB SUPERVISOR

Benjamin Pound

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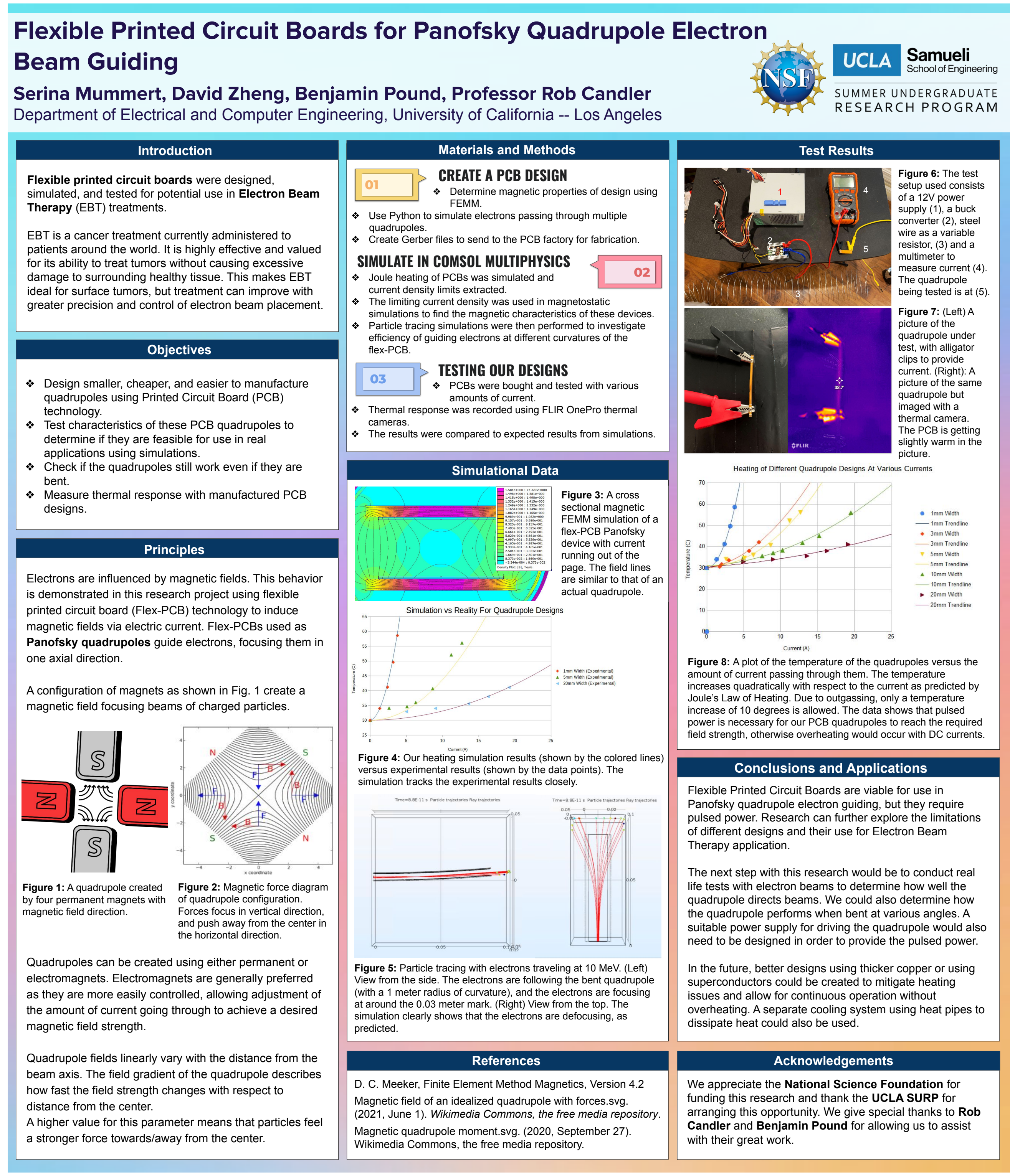
ABSTRACT

Electron beam therapy (EBT) utilizes electrons to kill cancer cells with up to 60% less radiation affecting surrounding healthy tissue compared to photon-based radiation therapies. EBT typically uses cm-scale beams; this project focuses on using Panofsky quadrupoles to guide sub-millimeter beams in a flexible and changeable trajectory so that beam placement, and therefore treatment outcomes, are improved. Flexible Printed Circuit Boards (PCBs) were designed in a Panofsky quadrupole-like geometry, which consists of parallel copper traces that generate a quadrupolar magnetic field. The flexible material of the PCB allows for manipulation of electron beams in hard-to-reach areas for deeper tissue treatment. Joule heating of the PCBs was simulated in COMSOL Multiphysics, and the limiting current density extracted. The limiting current density was used in magnetostatic simulations to find the magnetic characteristics of these devices. Particle tracing simulations were then performed to investigate efficiency of guiding electrons at different curvatures of the flex-PCB. Flex PCBs were fabricated for testing and the thermal response of the PCBs was experimentally measured using a FLIR OnePro thermal camera.



SURP is an umbrella program that administers and scaffolds summer undergraduate research opportunities within UCLA Samueli Engineering. SURP participating sub-programs include National Science Foundation (NSF) Research Experience for Undergraduates (REU) Sites, Samueli Research Scholars (SRS) Program, Faculty-funded grants, and Electrical and Computer Engineering Fast Track Program.

William Herrera, the director of SURP, is also director of UCLA Samueli Engineering's Undergraduate Research and Internship Program (URP/UIP) during the academic year. URP/UIP is committed to helping you find research/internship opportunities. Our Peer Advisors are trained to help you with any questions and concerns you may have, and appointments are available on our website.

For any questions about these resources, please reach out to us at urp@seas.ucla.edu and uip@seas.ucla.edu, or scan the QR code on the next page to get to our website.

We also encourage you to follow us on social media to stay updated on future professional development event and opportunities.

seasoasa.ucla.edu/undergraduate-research-program/

Samueli Engineering Undergraduate Research and Internship Program

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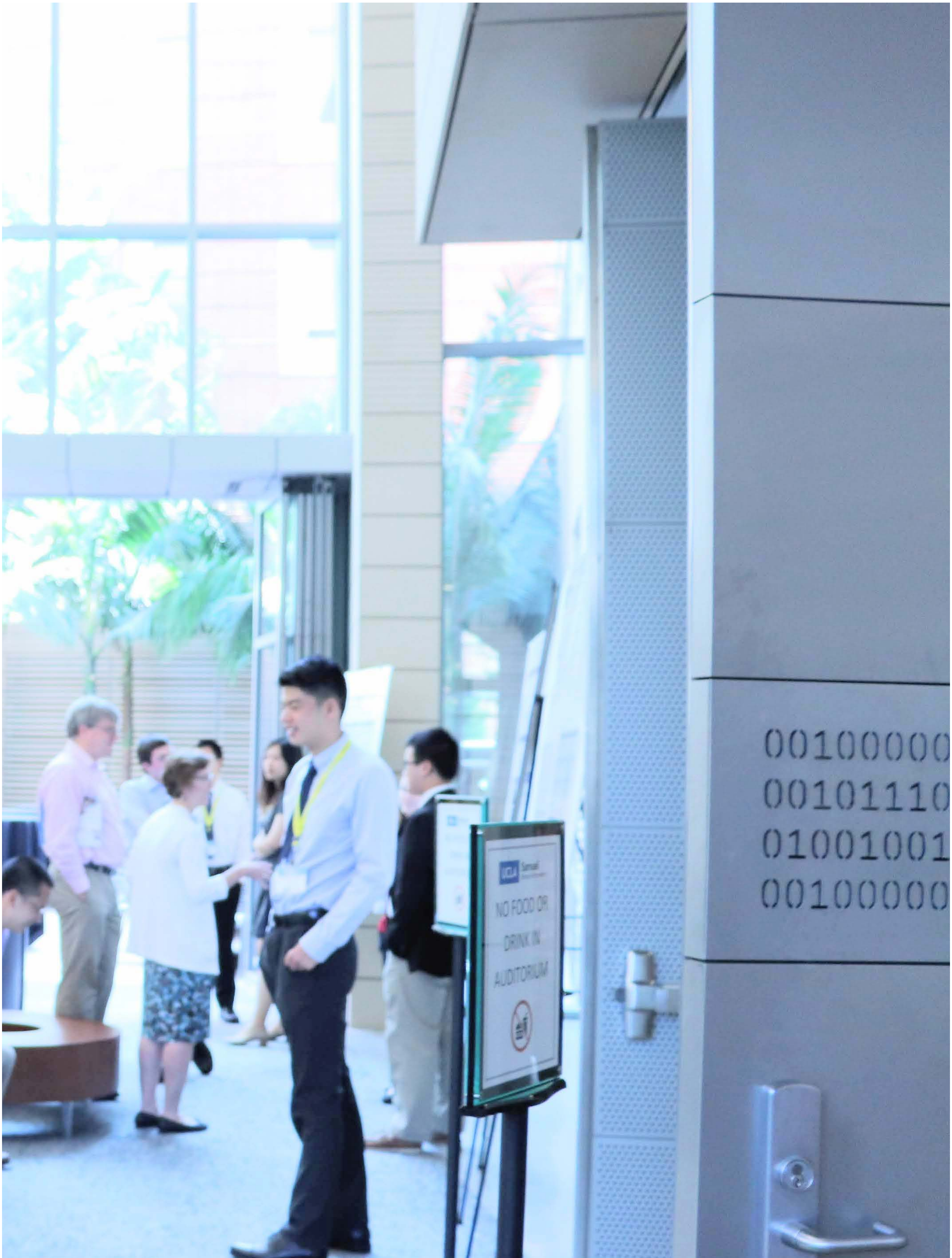
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