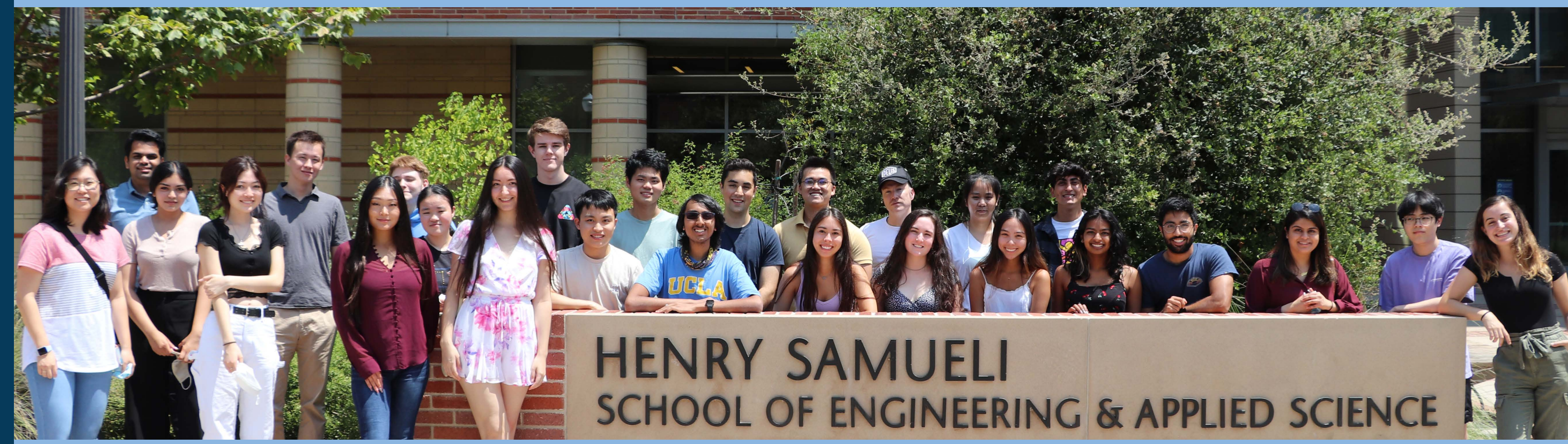
Samueli School of Engineering

Interactive Systems

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.

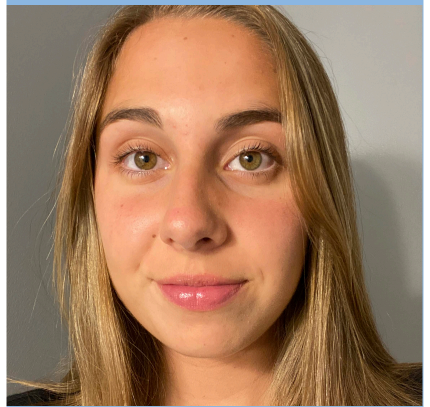
This year, a record 66 undergraduate students were selected to join the 2021 SURP cohort, spread out across 31 faculty in 6 engineering departments. We are happy to announce 64% of these are women, 20% are underrepresented minorities, and many are first generation and low income students. SURP is involved 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

Sarah Kimak



Computer/Cognitive Science Freshman, University of Delaware

Analyzing the Effectiveness of Social Robots in Children's Speech Assessments

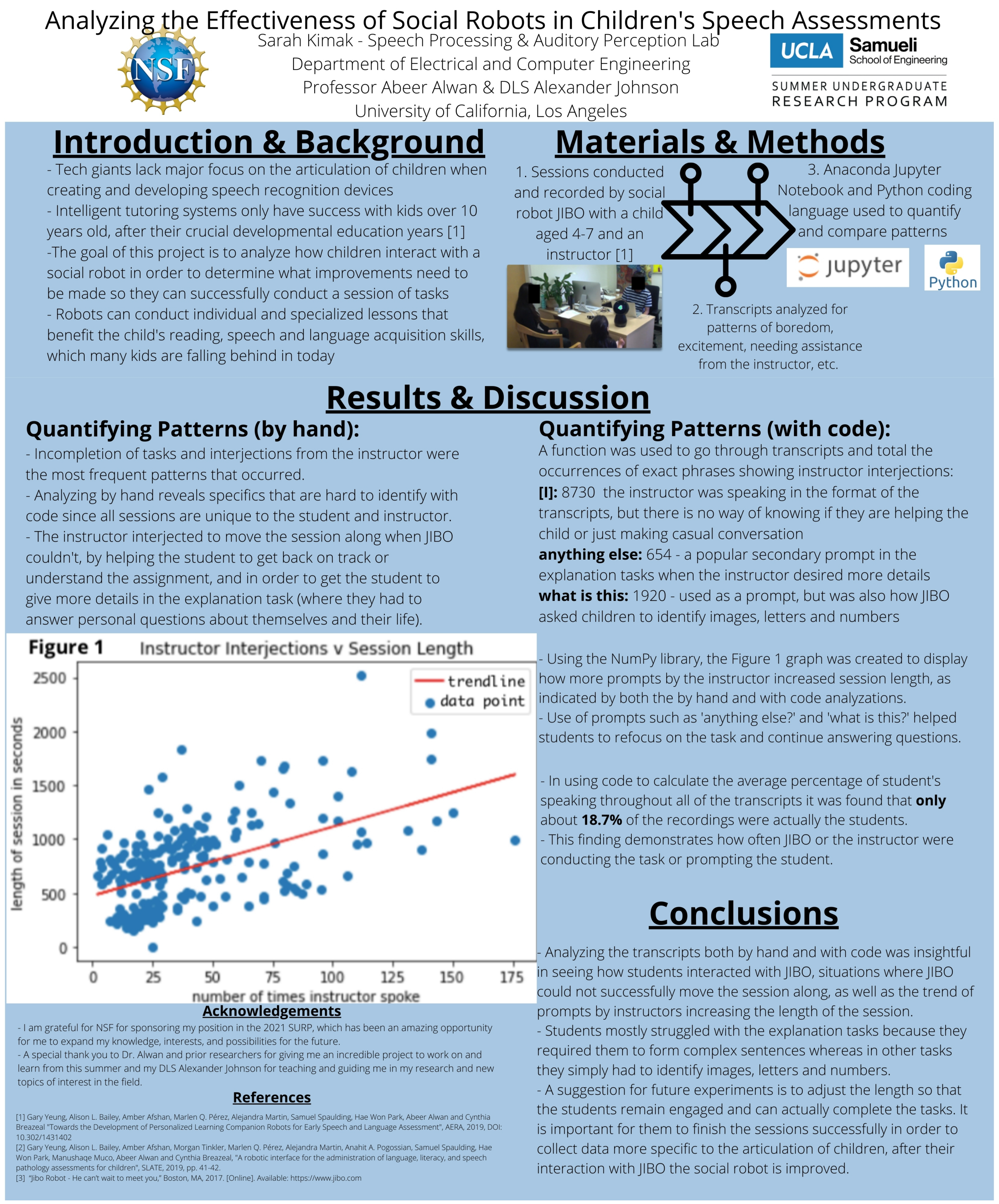
FACULTY ADVISOR
Abeer Alwan

DAILY LAB SUPERVISOR
Alexander Johnson

DEPARTMENT
Electrical and Computer Engineering

ABSTRACT

Speech recognition devices have vastly transformed people's way of life, as everyone knows of "hey google" and "Alexa," but there are greater possibilities with such systems including improving the early education of children. Many children are behind in their reading and speech acquisition skills, a direct result of lack of exposure to vocabulary and oral skills. While other companies have created intelligent tutoring systems, they do not possess the ability to pick up on the acquisition of children. In order to determine the success of a young child interacting with a social robot, a series of tasks were completed and recorded with an instructor, child and the robot JIBO. These sessions were analyzed to quantify patterns in interactions such as boredom, excitement, and frustration. The data concluded that boredom and prompts from the instructor occurred most often, showing that young children struggle the most with staying focused during the long tasks. The more interjections from the instructor, the longer the sessions lasted since they kept the children on track, but it was found only 18.7% of the recordings were a child speaking. It's suggested the tasks be shortened so that there can be more success in the students completing all of the tasks to be recorded and analyzed for future sessions. Social robots can be used in classrooms, clinician offices and even at home to develop learning at a young age that is most beneficial for the future.



Grace Kwak

Electrical Engineering
Freshman, UCLA

Printable Robotic Boat Swarms with Actuation and Sensing Capabilities

FACULTY ADVISOR

Ankur Mehta

DAILY LAB SUPERVISOR

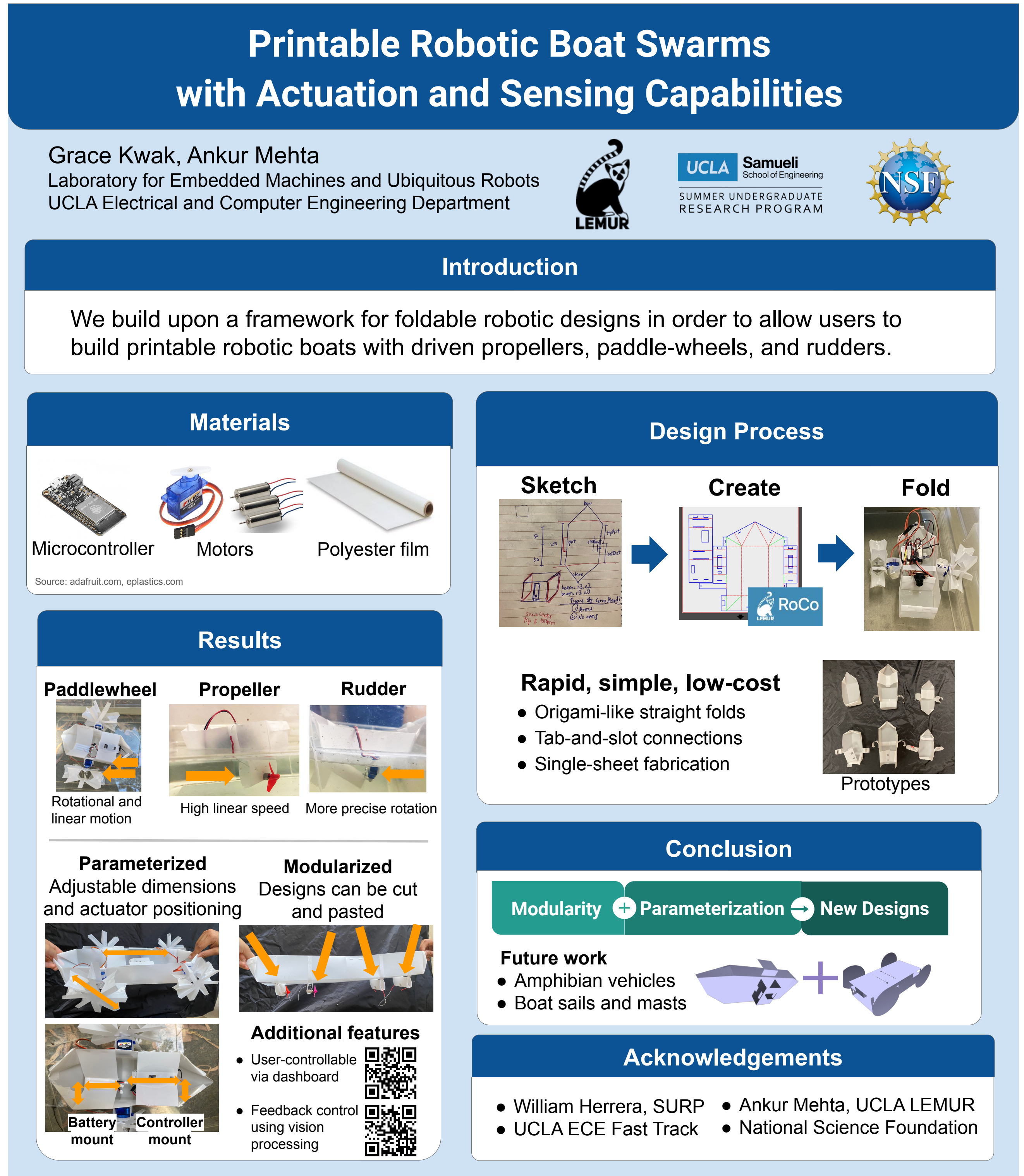
Ankur Mehta

DEPARTMENT

Electrical and Computer Engineering

ABSTRACT

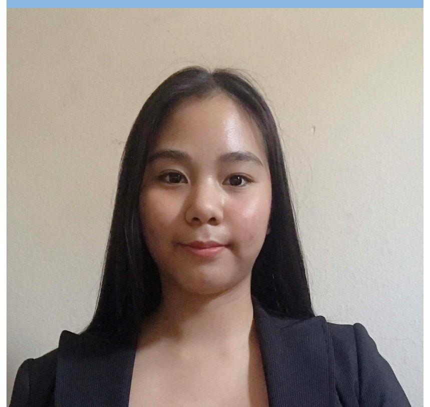
The design and development of robotic devices remains limited to those with considerable time, funds, and technical expertise. Our goal is to increase the accessibility of robotics so that the average person can design and create their own robotic boats. I set out to provide a variety of boat hull morphologies with three new actuation capabilities: a propeller, paddlewheel, and rudder. After designing the 2D layout of these origami-inspired boats, I implemented them in the Robot Compiler (RoCo) framework for generating foldable robotic designs, thus allowing a user to add any actuation capability to any boat hull by setting parameters in code. I then used a paper cutter to cut out inexpensive thin plastic sheets into foldable boats with actuators driven by continuous rotation servos and DC motors. I found that the propeller produces fast linear motion, the paddlewheel enables motion that is linear and rotational, and the rudder adds more precise steering capabilities. In order to test my boats' autonomous capabilities such as following a colored object, I integrated my boats with OpenMV cameras and inertial measurement units (IMUs), which provided basic feedback-controlled movement. I found that given this relatively small set of tools and materials, it's possible to generate a wide variety of robotic boats. This work establishes a foundation for the community at large to rapidly, easily, and inexpensively create novel types of robotic boats.



Krish Shah

Computer Engineering
Freshman, UCLA

Waree Protprommart



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)

FACULTY ADVISOR

Xiang 'Anthony' Chen

DAILY LAB SUPERVISOR

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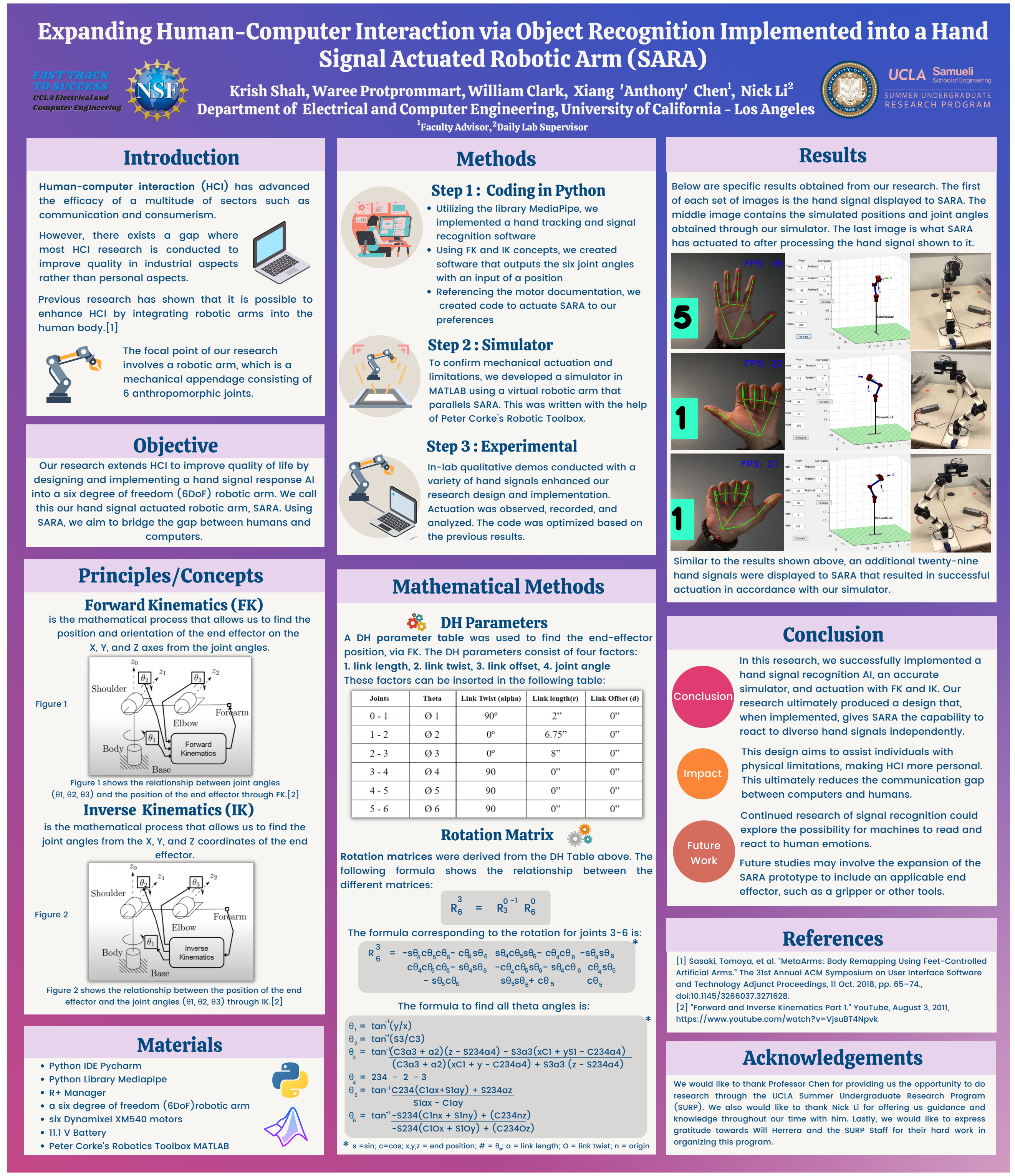
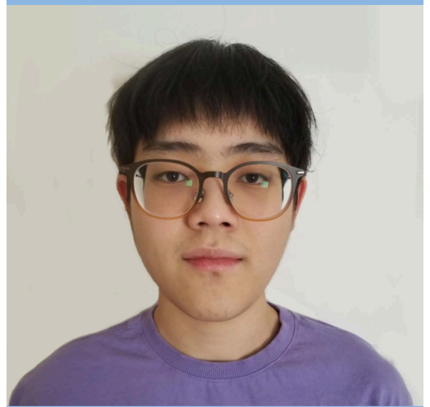
Electrical and Computer Engineering

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.



Jaehoon Song



Computer Science
Freshman, Irvine Valley College

Origami Webapp User Interface & Integration of New Designs

FACULTY ADVISOR

Ankur Mehta

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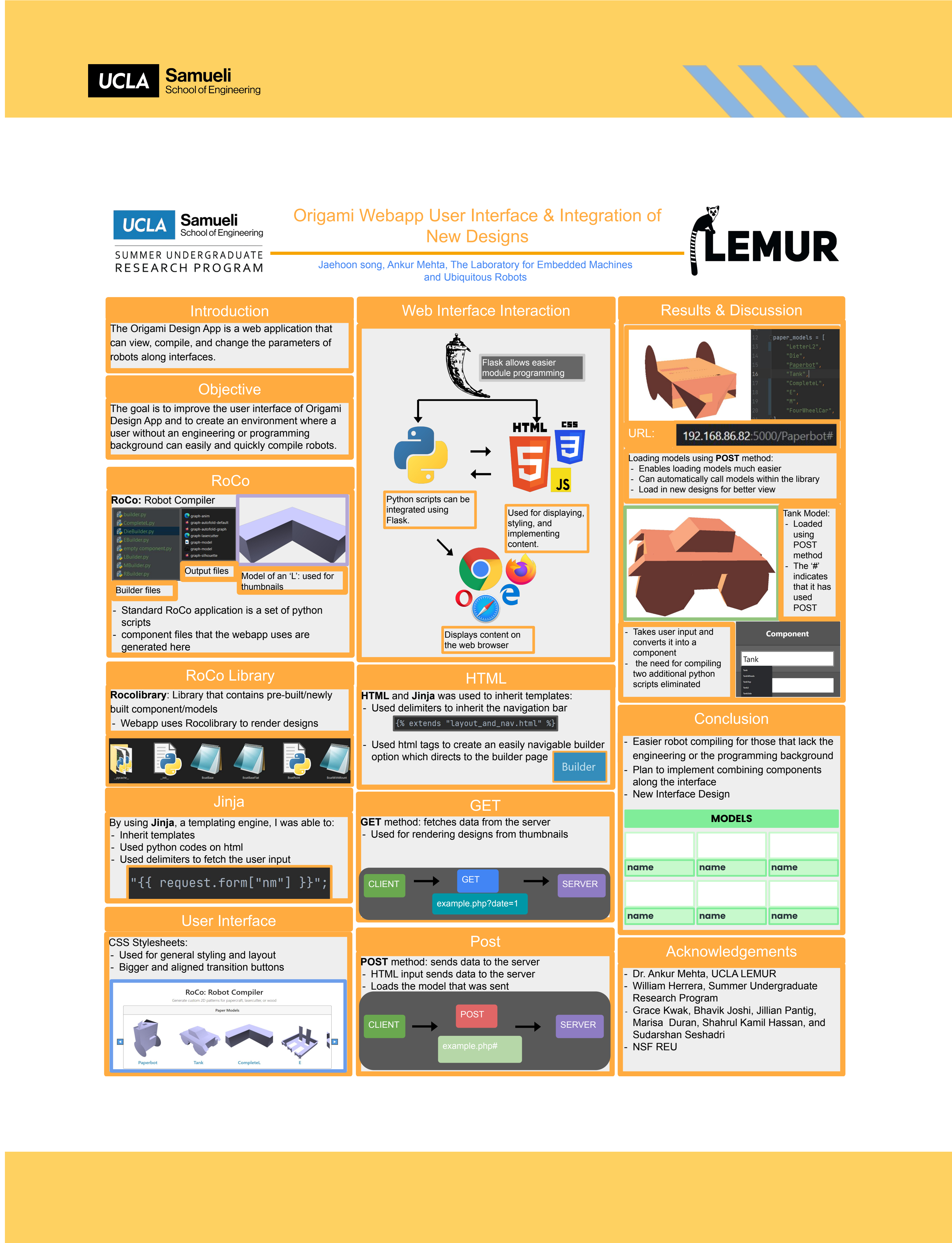
Ankur Mehta

DEPARTMENT

Electrical and Computer Engineering

ABSTRACT

The Origami Design App is a web application that can view, compile, and change the parameters of robots along interfaces. UCLA's LEMUR originally designed this webapp as a means to make robot compiling easier for those that lack the engineering or the programming background. I integrated some of the functionalities such as being able to view necessary component files when inputting a subcomponent into a html form by using a PATH method. This is significant because a user could potentially compile a robot easier or faster than using the standard RoCo application. I also edited some of the existing user interface such as editing the style of transitioning buttons with css files to provide the user with optimal visual experience. For the future, I plan to conduct a user study to observe that the changes I have implemented have benefited the Origami Design App and prove that the changes within the user interface were successful. I also plan to implement the functionality to combine components along interfaces which will most likely reduce the time that a user needs to spend in order to design a robot.



Tyler Xu

Electrical Engineering
Freshman, UCLA

A Personalized Approach to Federated Learning

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Suhas Diggavi

DAILY LAB SUPERVISOR

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DEPARTMENT

Electrical and Computer Engineering

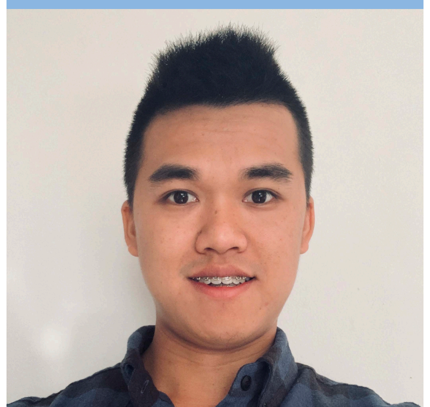
ABSTRACT

Federated learning, a machine learning technique, has been gaining popularity as a method of protecting user data privacy for modern-day devices while still providing a great user experience by only sending model updates to the server instead of exchanging sensitive data. However, utilizing a singular global model is extremely restricting as the data is exceedingly diverse, which limits the global model from maximizing performance for each individual client. This heterogeneously distributed data across multiple clients is the primary motivation in utilizing personalized versions of federated learning. In this research, we implement algorithms that use personalized federated learning techniques such as clustering clients and utilizing temporary models for communication. Various hyperparameters - batch size, local communication rounds, number of clients - are adjusted to maximize the algorithm's accuracy levels. The algorithms are implemented using PyTorch (a machine learning library developed by Facebook's AI Research Lab) and both trained and tested using the CIFAR-10 image dataset. Using random heterogeneously distributed data, the algorithms converge to higher accuracy levels through these personalization techniques when compared to traditional federated learning utilizing a singular global model. Personalized federated learning is a key component within future machine learning applications - such as connecting autonomous vehicles - as it combines the effectiveness of traditional machine learning with crucial cloud security and data privacy protection.

Jolin Zhang

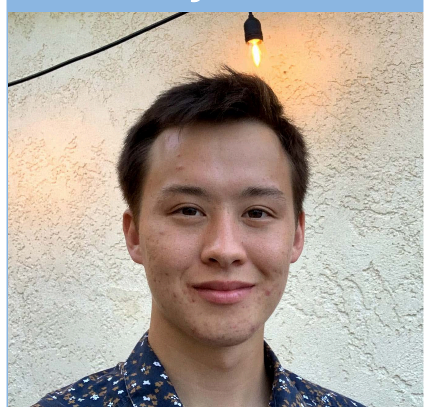
Computer Engineering
Freshman, UCLA

Trung Vong



Computer Science
Sophomore, East Los Angeles College

Rudy Orre



Computer Science
Sophomore, El Camino College

Reinforcement Learning in an Imperfect Information Game

FACULTY ADVISOR

Gregory Pottie

DAILY LAB SUPERVISORS

Sunay Bhat, Jeffrey Jiang

DEPARTMENT

Electrical and Computer Engineering

ABSTRACT

Reinforcement learning (RL) has been a growing subset of machine learning with increasing success and promise - but it has just begun to be used in complex, multiplayer environments and games. An agent learns in a complex environment through trial and error, beginning from fully random trials and finishing with sophisticated actions. We apply RL to the imperfect information game known as Liar's Dice, which presents a challenging mix of two-player dynamics and partial information to explore. The game forces players to call bluffs and doubt opponents while reading others' potential actions. Implementing reinforcement learning to imperfect information games allows us to find successful strategies and models in dynamic Markov Decision Process (MDP) environments that require sequential decision making. Utilizing both Python and MATLAB, we employed the popular Q-learning method of RL to train agents that begin with random actions or to use a combination of fixed strategies against others. An agent employing Q-learning improved its win rate from 50% to only 65% within 1,000,000 episodes against a simple agent. On the other hand, an agent that made decisions based on various fixed strategies available increased its win rate from 11% to 77.7% with 100,000 episodes. Those varying speeds demonstrate the difficulty of learning and the variability of Q-learning in a game with partial information. In future work, we may compare counterfactual regret minimization and more state-of-the-art RL algorithms, which would expand our understanding of various methods of a partially observed, dynamic environment such as Liar's Dice. By studying this game, we hope to one day broaden our results to the education space, a similar Markov process where individuals also make decisions sequentially. Using intervention tools such as quizzes and lectures, the interactions between students and instructors may be refined to improve student learning outcomes.

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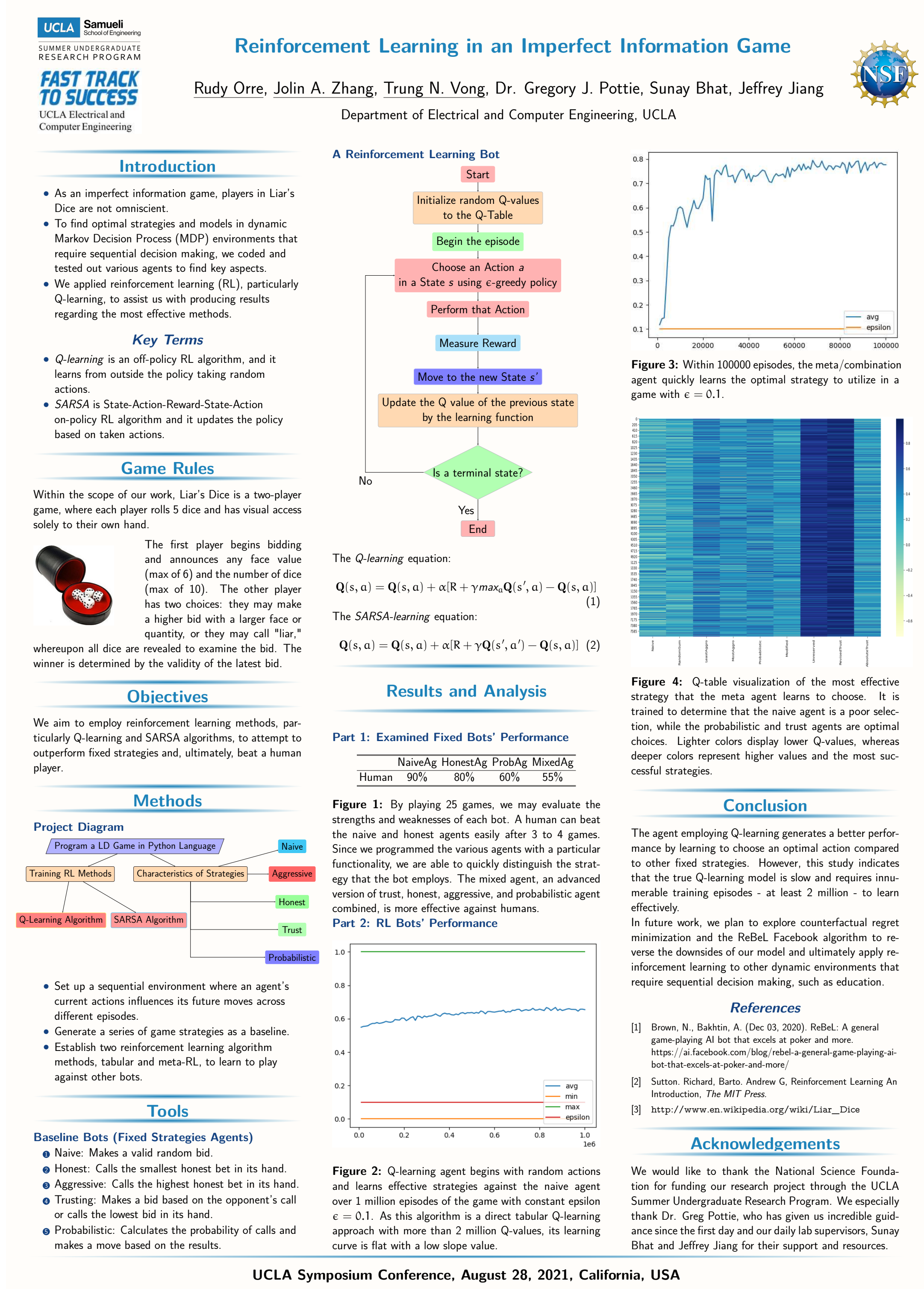

SURP is an umbrella program that administers and scaffolds summer undergraduate research opportunities within UCLA Samueli Engineering. SURP participating sub-programs include National Science Foundation (NSF) Research Experience for Undergraduates (REU) Sites, Samueli Research Scholars (SRS) Program,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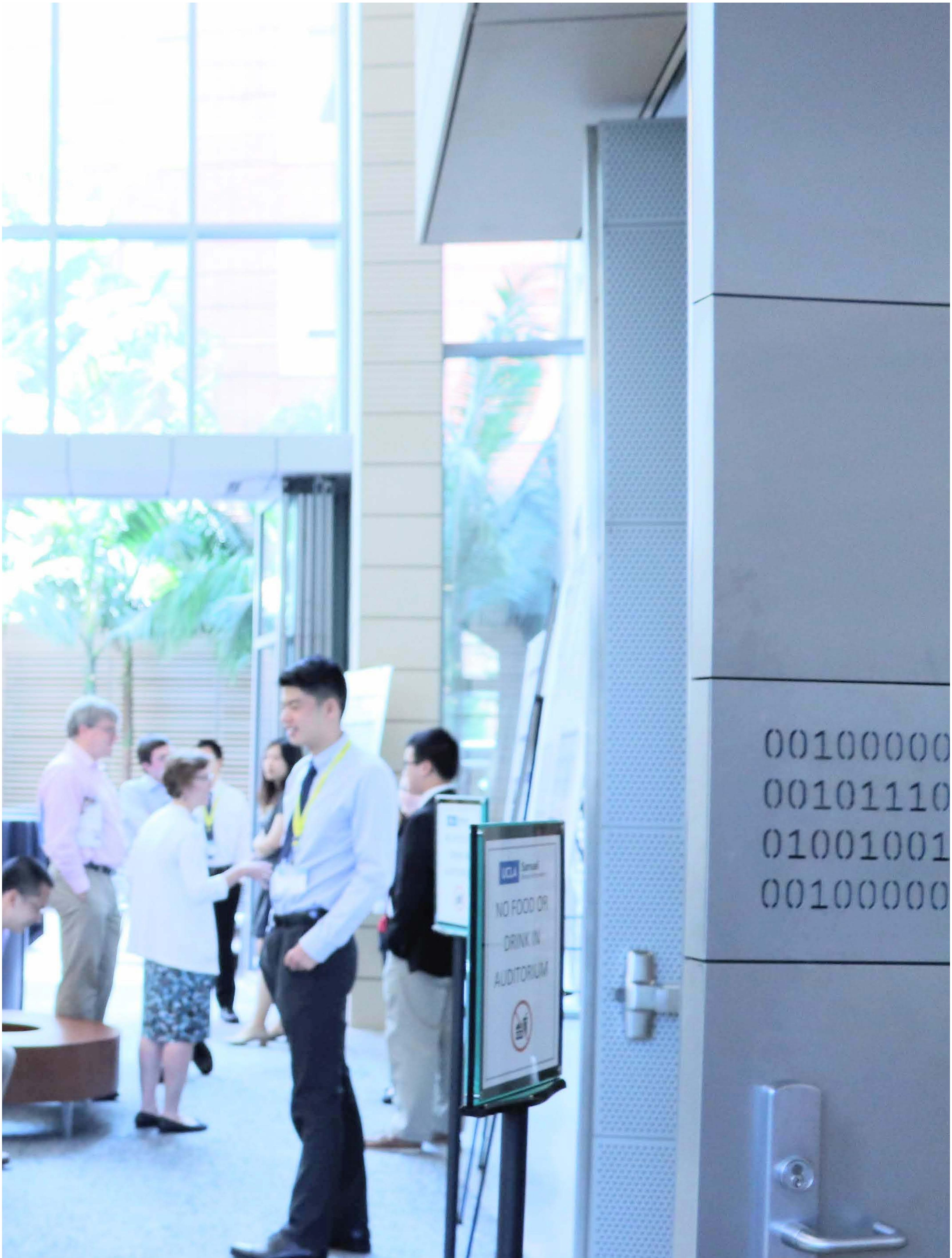
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