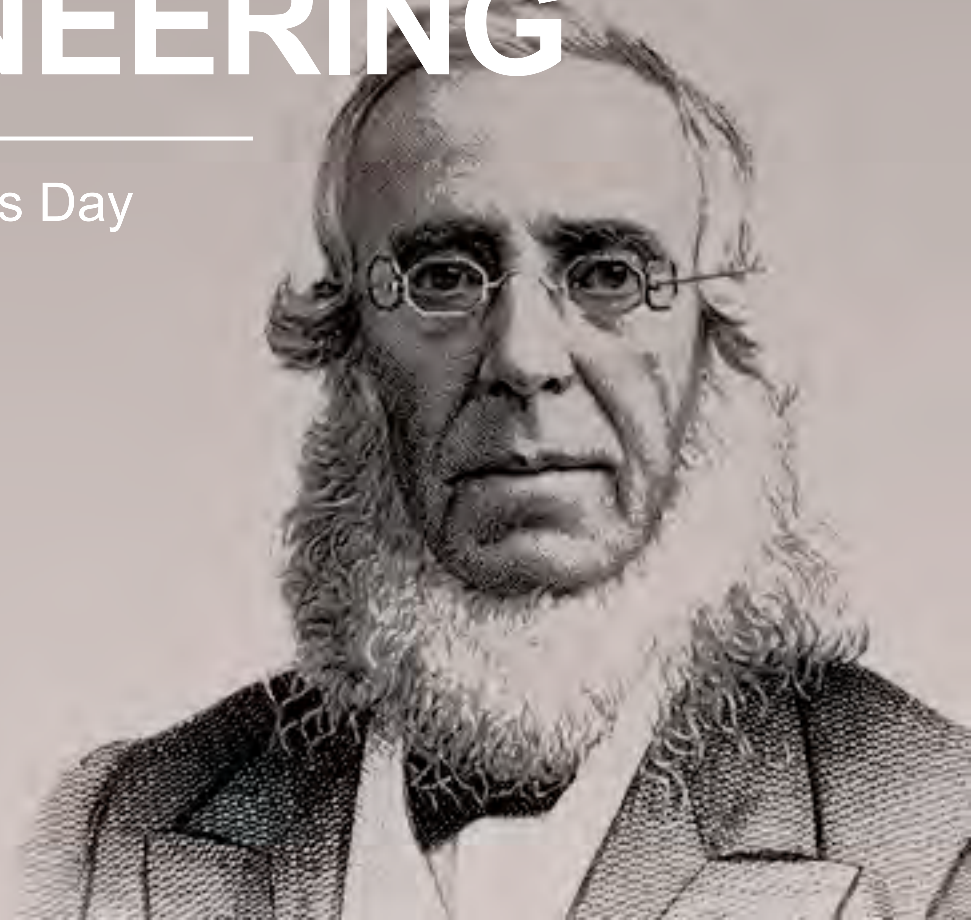
COOPER UNION ELECTRICAL ENGINEERING

Admitted Students Day

2020



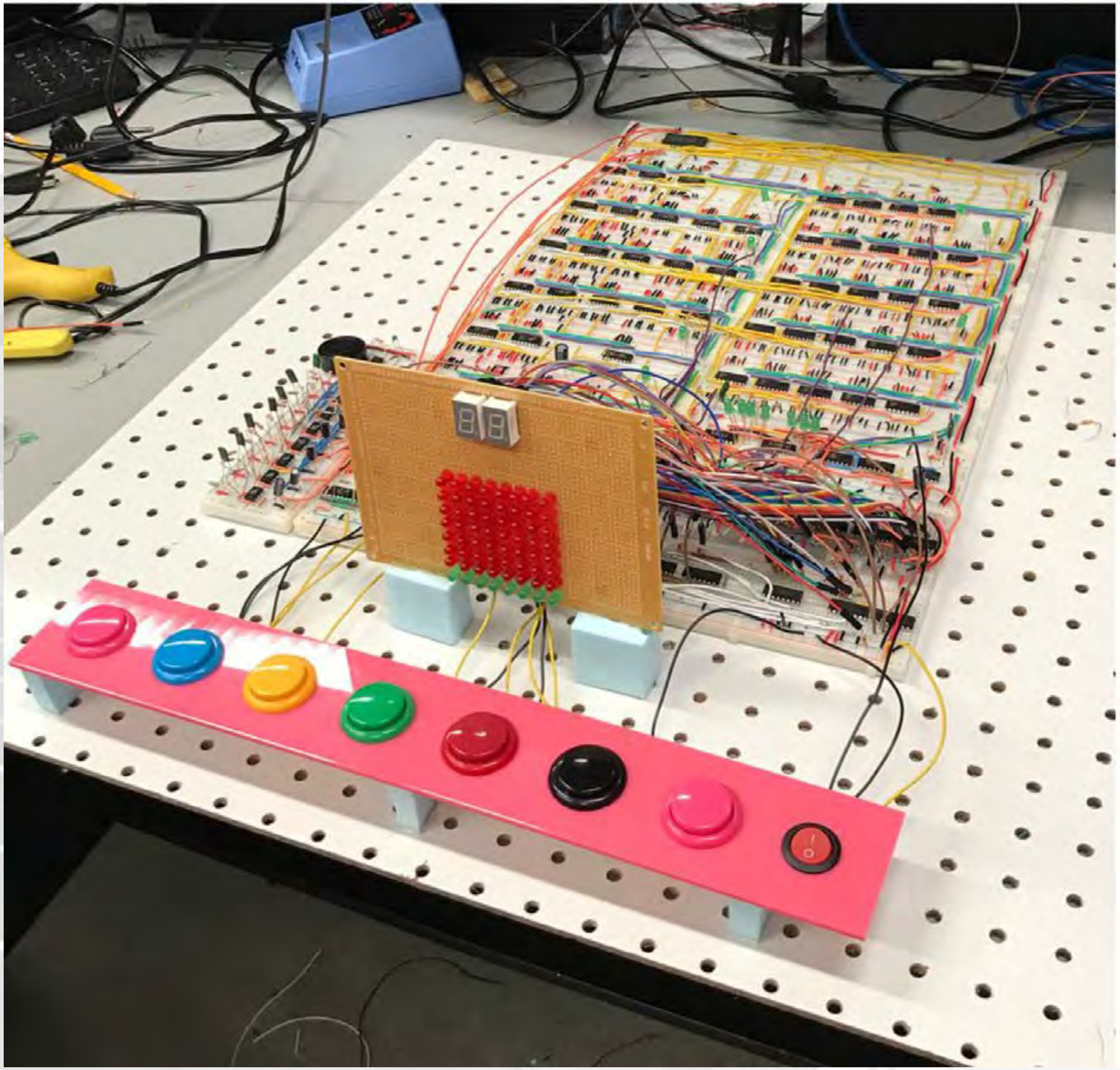
What is Electrical Engineering?

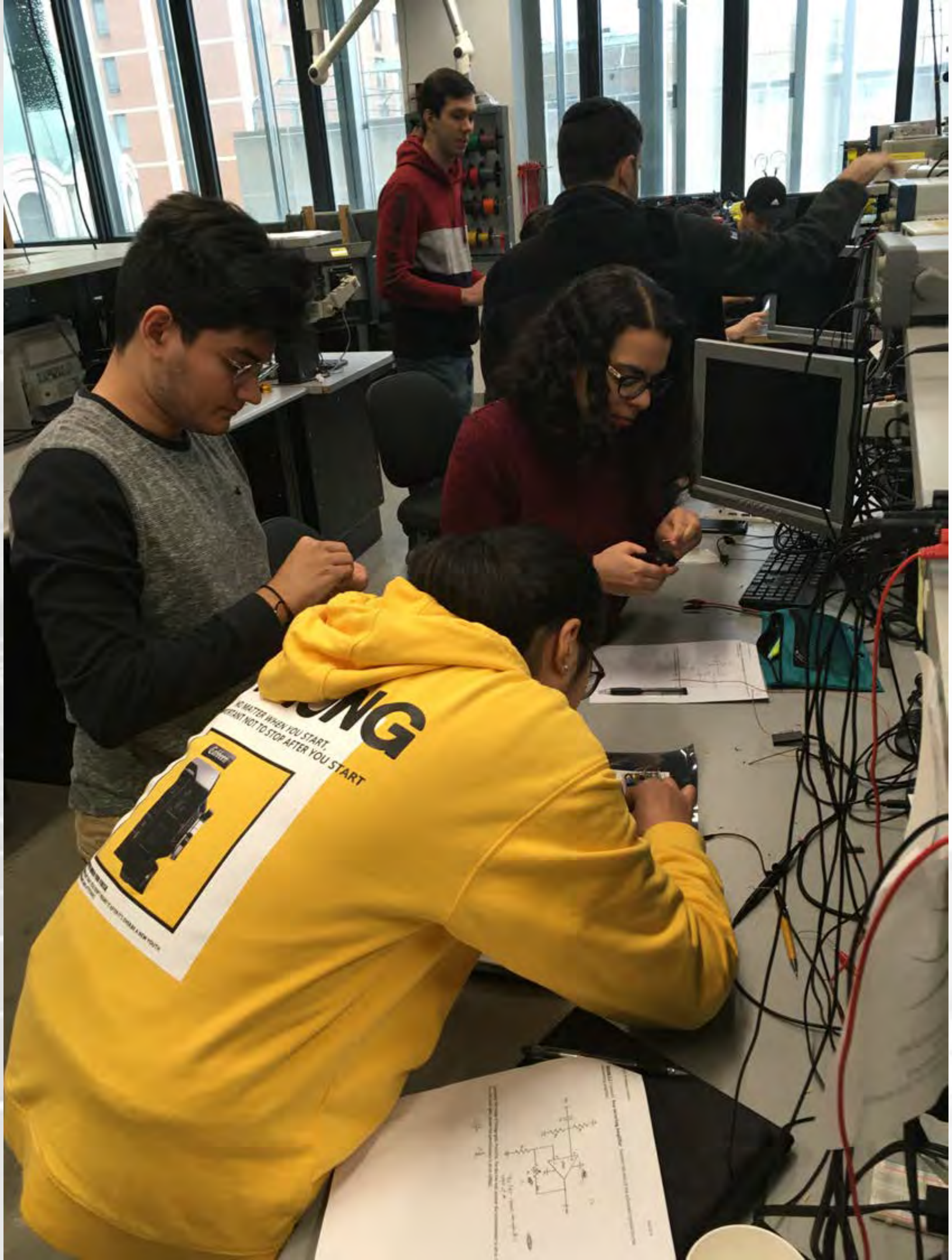
DEVICES

SIGNALS

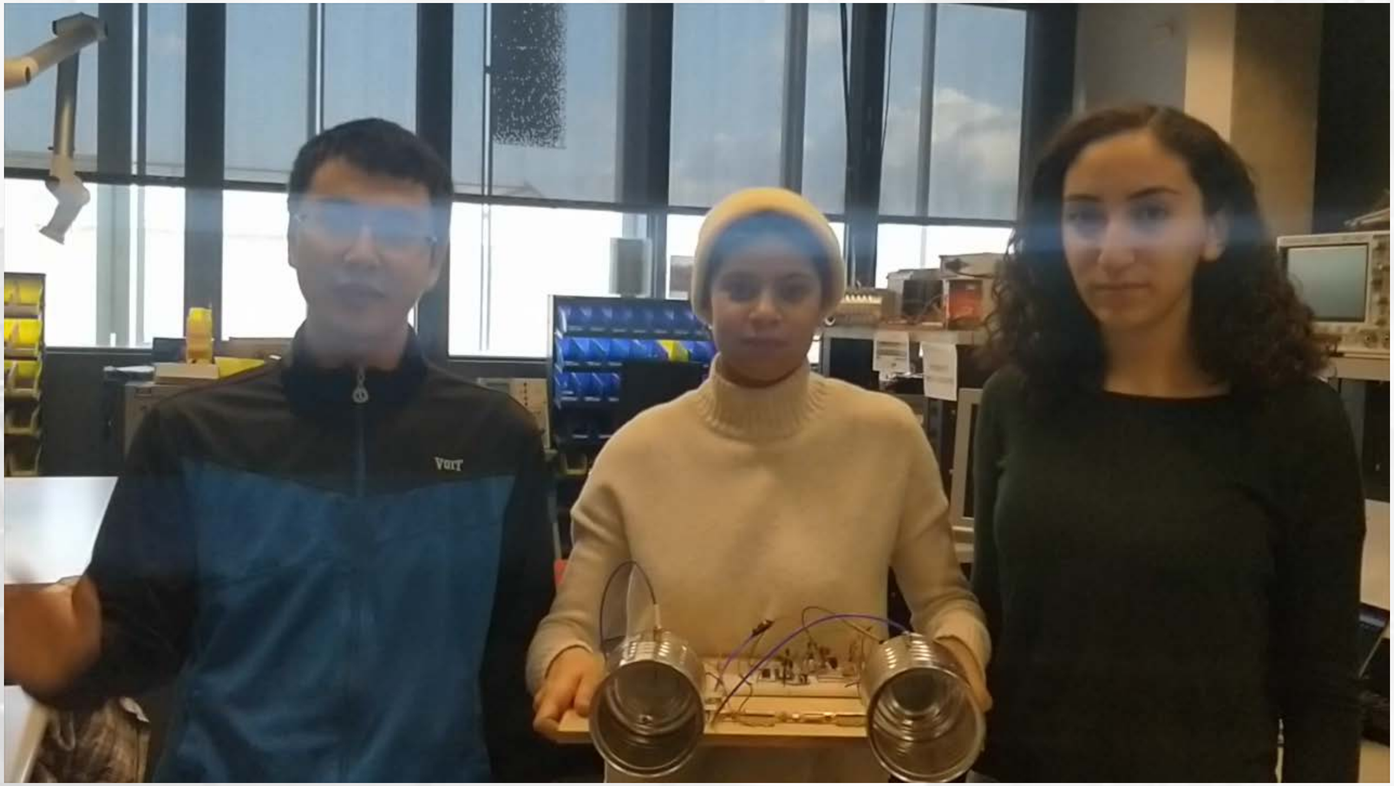
COMPUTING

First Year Digital Logic Design Project: Guitar Hero





Sophomore Coffee Can Radar Project



Sophomore Coffee Can Radar Project

Microwave specturm Analyzer
Group 1A

Benjamin Kaplan
Guy Bar Yosef
Jonathan Pedoeem

UNDERSTANDING

DOING

EXPLAINING

Senior Project

Development of Al-InAs Transistors for Scalable Quantum Computing

Aziza Almanakly, Michael Lendino, Armaan Kohli
Advisors: Professor Sam Keene, Professor Javad Shabani

Background

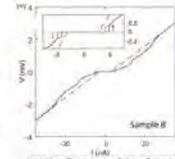
• Scalable qubit characterization in the cryogenic environments required for their operation is a standing challenge in the quantum computing industry.
• Presently, semiconductor manufacturers are well-equipped to characterize devices at room temperature on a large scale.
• Al-InAs room-temperature transistors can be operated as superconducting qubits at cryogenic temperatures.


Google Sycamore Quantum Processor


Inside of a Cryogenic Dilution Refrigerator

Objective

•We aim to analyze the relationship between room-temperature and cryogenic properties to increase the efficiency of room-temperature predictive measurements for cryogenic qubit yield.
•We design Al-InAs transistor devices that we simulate in nextnano and fabricate at the CCNY ASRC Nanofabrication Facility.

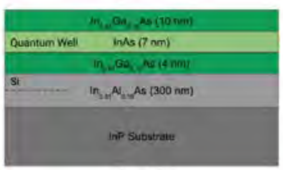


Ideal Low Temperature Device Behavior

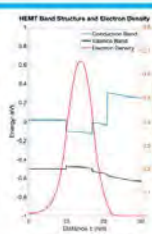
$$I_c = \frac{\Delta^{Al}}{eR_n} \quad L_Q \propto \frac{1}{I_c} \quad f_Q \propto \frac{1}{\sqrt{L_Q C_Q}}$$

Normal Resistance to Qubit Frequency

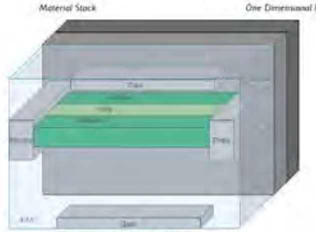
Simulations

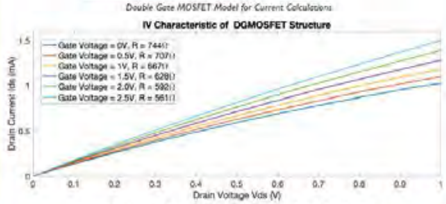


Material Stack



One Dimensional Results

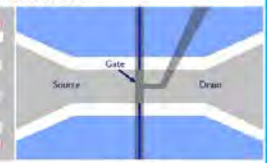

Double Gate MOSFET Model for Current Calculations



Current Calculations to Estimate Channel Resistance for Several Gate Voltages

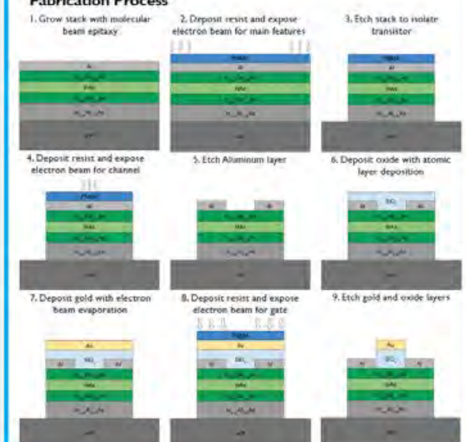
Design and Fabrication


Full View of Six Transistor Chip



Single Transistor Layout

Fabrication Process



Next Steps

• Sweep aspect ratios of DGMOSFET structure to model dependence of channel resistance on transistor geometry.
• Fabricate several chips with transistors of different geometries.
• Perform room temperature and low temperature device characterization, and compare to simulations.

References

[1] J. Shabani *et al Appl. Phys. Lett.* **114**, 103104 (2019)
[2] Shabani, J. *et al. Phys. Rev. B* **93**, 155402 (2016).
[3] Wen, F., Shabani, J. & Tutuc, E. *arXiv:1905.13008* (2019).
[4] K. S. Wickramasinghe *et al. Appl. Phys. Lett.* **113**, 262104 (2018)
Thanks to the members of Shabani lab.

SHARE - Synchronized Headsets for Augmented Reality Experiences

Chris Brancato, Sahil Patel, Ross Kaplan, Shalin Patel

Problem

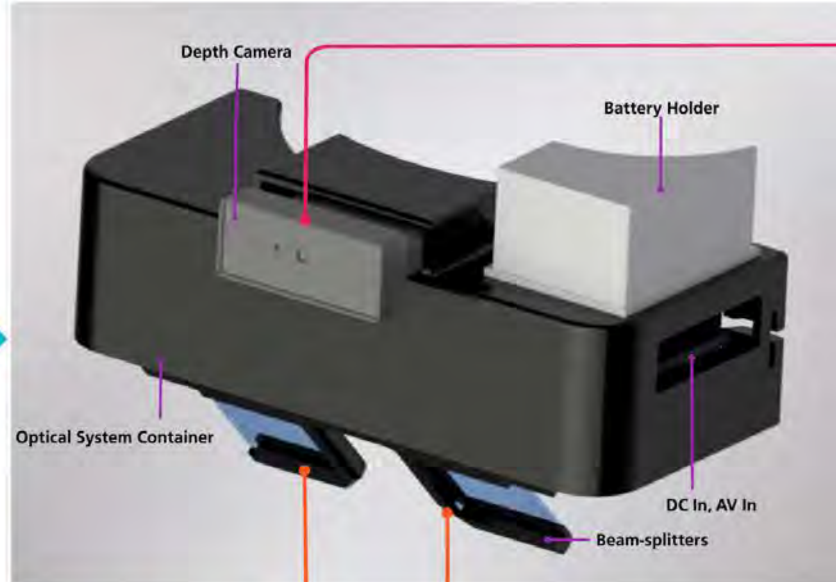
Modern virtual and augmented reality systems are interactive, detailed, and immersive. Users, however, are unable to interact with each other in many of these systems. A virtual space for multiple users to interact in is needed.

Solution

Our augmented reality system, SHARE, enables two users to share the same virtual space. Two headsets, each equipped with an optical and hand tracking system, overlay an interactive game of checkers on the user's field-of-view.

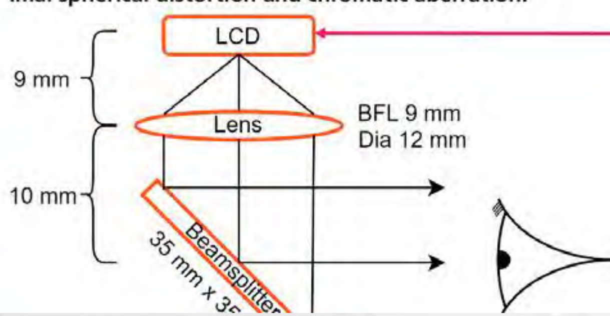
Challenges

- Maximizing magnification and field-of-view of the optical system
- Minimizing infrared interference between multiple depth cameras



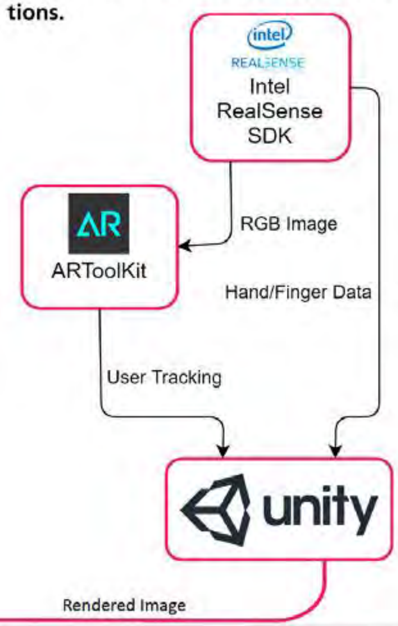
Optical System

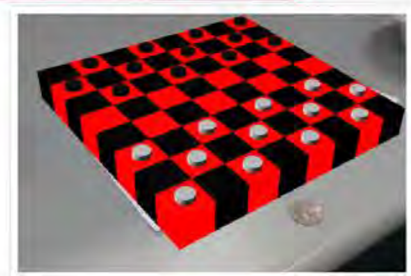
Our optical system utilizes LCD micro-displays, aspheric and achromatic collimator lenses, and beam-splitters for the projection of rendered images. Our choice of components allows the user to view focused virtual images with minimal spherical distortion and chromatic aberration.



Software System

Our software system uses the Intel RealSense SDK, Unity, and ARToolKit to generate the user's view of the virtual environment and to process interactions.

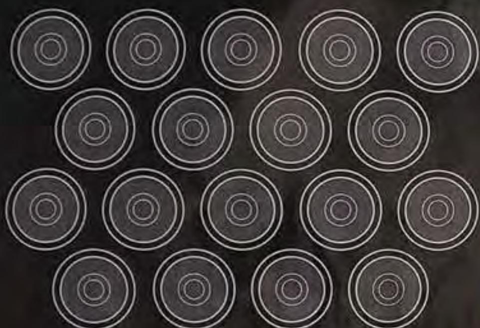




HEAR

WHY?

Speaker design has been traditionally focused on the audio reproduction. Little thought has been given to the delivery aspect—the choices are between sharing music with everyone (non contact speakers) or only yourself (headphones). While headphones get the job of isolating sound for one person, it's not always the most practical solution.



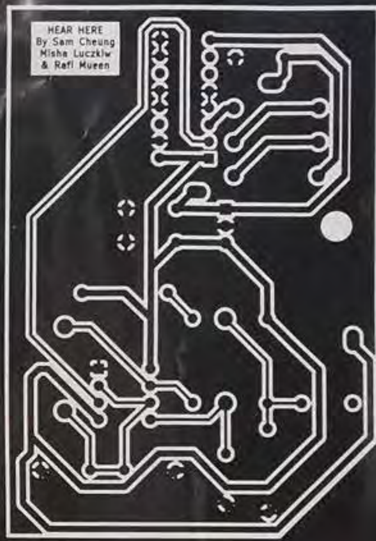
HEARING ULTRASOUND

Normally, humans cannot hear frequencies above 20 kHz. However, this is the case with pure tones—due to nonlinear interactions of the air molecules at such tiny wavelengths, modulated ultrasound demodulates in to audible sound!

THE COOPER UNION

HERE

Sam Cheng Misha Luczkiw Rafi Mueen



CAMERA TRACKING

A core component of the project is the tracking base. This mount system allows the on board Raspberry Pi to track the user via a 1 MP camera feeding an OpenCV script. Two servo motors control the theta and phi angles, which allows a full hemisphere of aural coverage.

Advised by Professor Carl Sable

Senior Project: Tracking with a Drone

Outdoor Tracking

Senior Project: A Blimp Visits the Great Hall

Guess the Engineering Lab

Prof. Sam Keene

Machine Learning & Data Science

Working with Art & Architecture

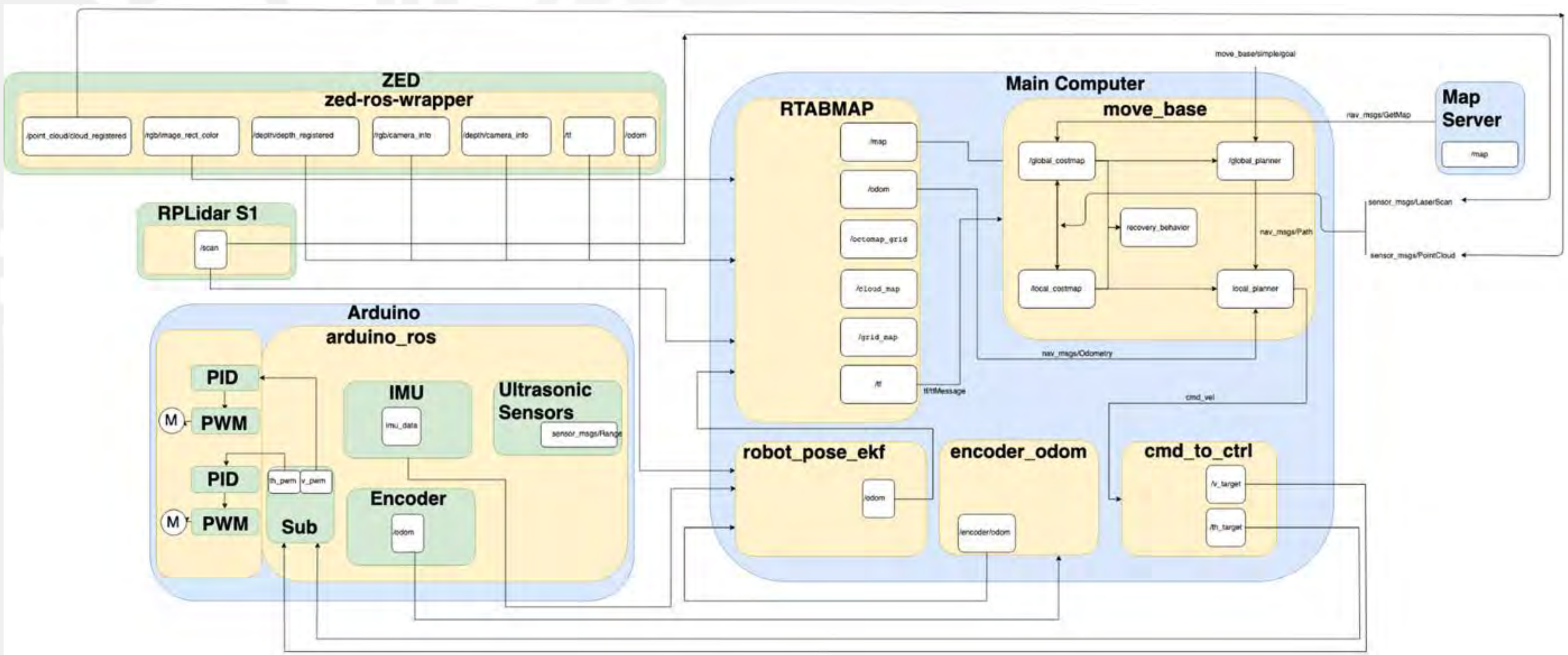
Autonomy Lab

Sustainable, Mobile & Agile

Connected Communities Lab

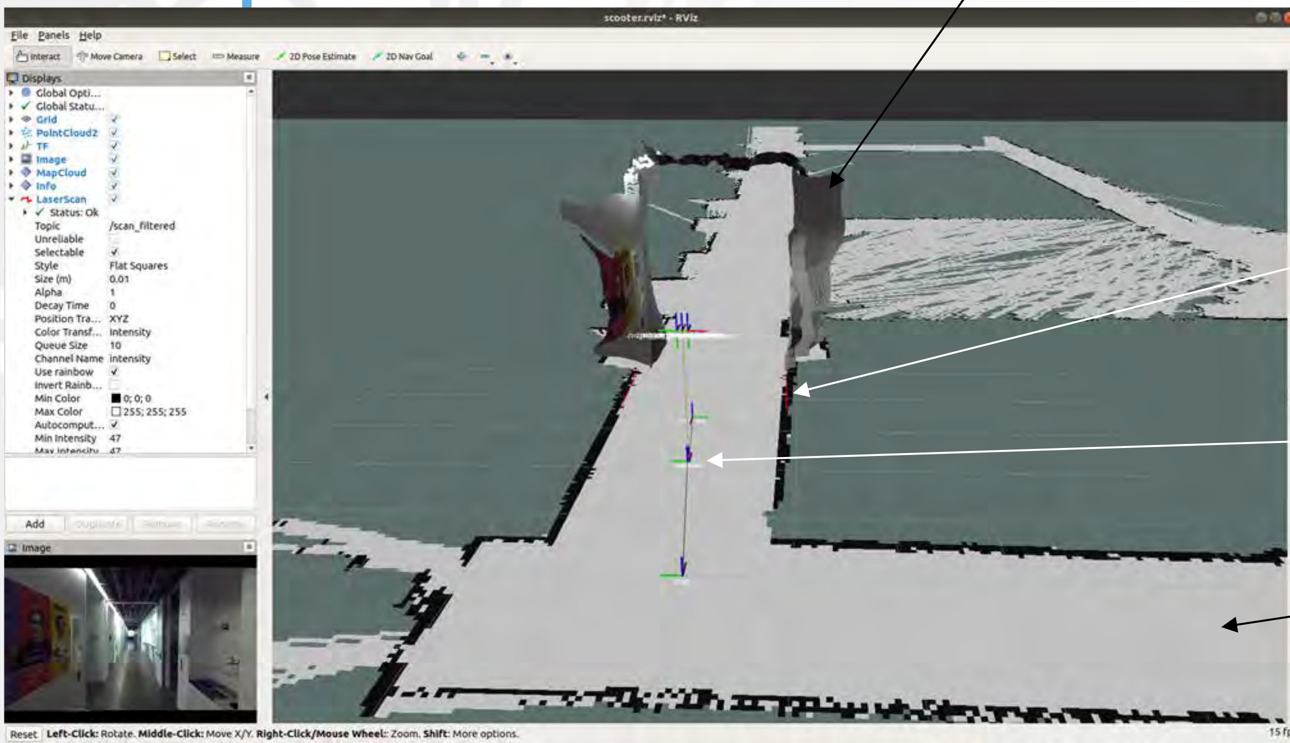
Accomplishments

Software



ZED
zed-ros-wrapper
/point_cloud/cloud_registered
/rgb/image_rect_color
/depth/depth_registered
/rgb/camera_info
/depth/camera_info
/tf
/odom
RPLidar S1
/scan
Arduino
arduino_ros
PID
PWM
M
PID
PWM
M
th_pwm
v_pwm
Sub
IMU
imu_data
Ultrasonic Sensors
sensor_msgs/Range
Encoder
/odom
Main Computer
RTABMAP
/map
/odom
/octomap_grid
/cloud_map
/grid_map
/tf
tf/tfMessage
move_base
/global_costmap
/global_planner
recovery_behavior
/local_costmap
local_planner
nav_msgs/Path
nav_msgs/Odometry
move_base/simple/goal
nav_msgs/GetMap
Map Server
/map
sensor_msgs/LaserScan
sensor_msgs/PointCloud
robot_pose_ekf
/odom
encoder_odom
/encoder/odom
cmd_to_ctrl
/v_target
/th_target
cmd_vel

Sample Localization RVIZ



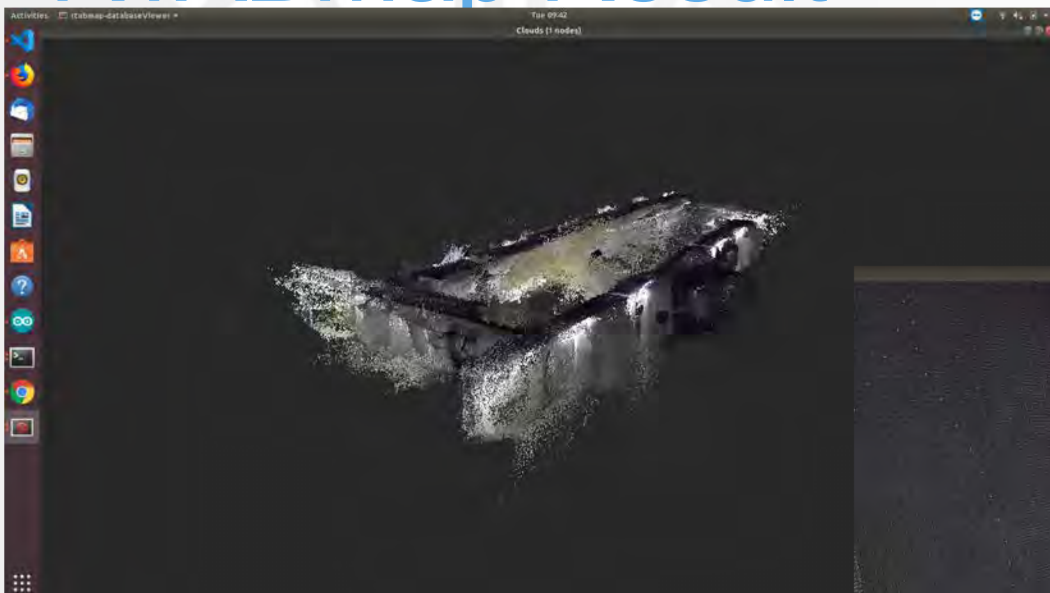
Local Map

Local 2D Lidar

Localization TF

Global Map

RTABMap Result

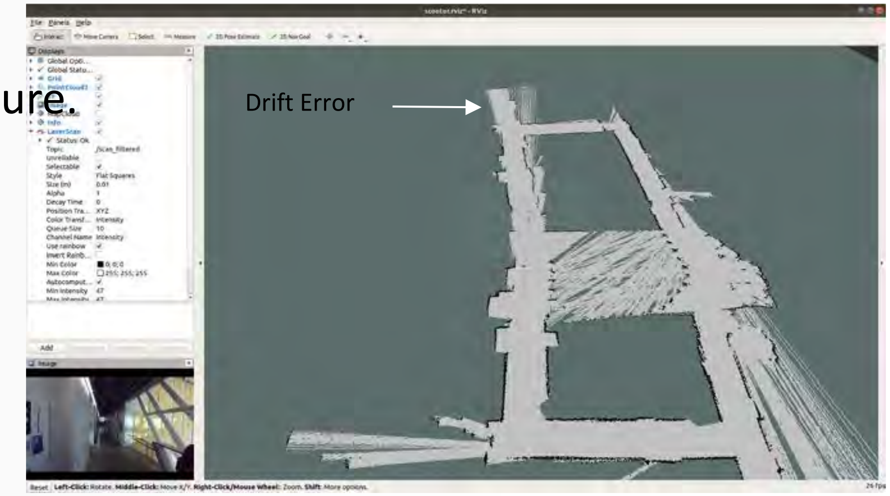


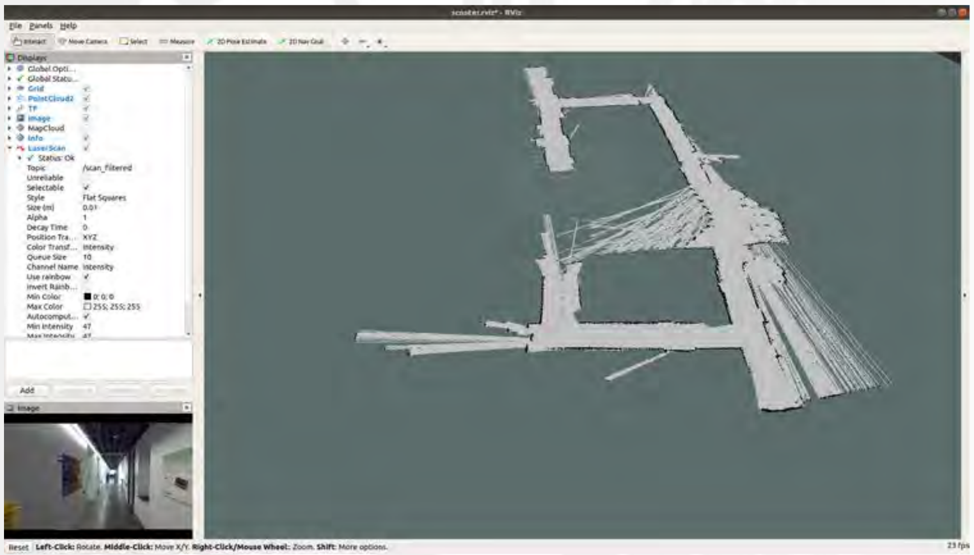
Generated 3D Point Cloud

Generated 3D Point Cloud

Loop Closure

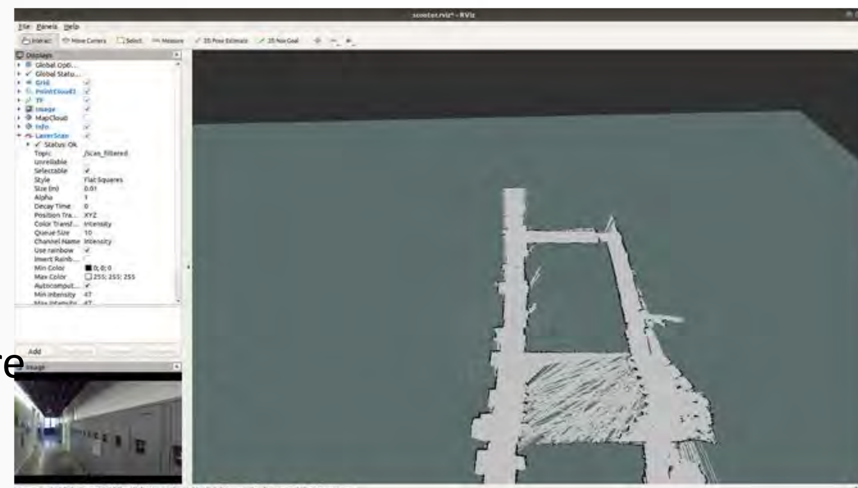
With Loop Closure.
One full lap





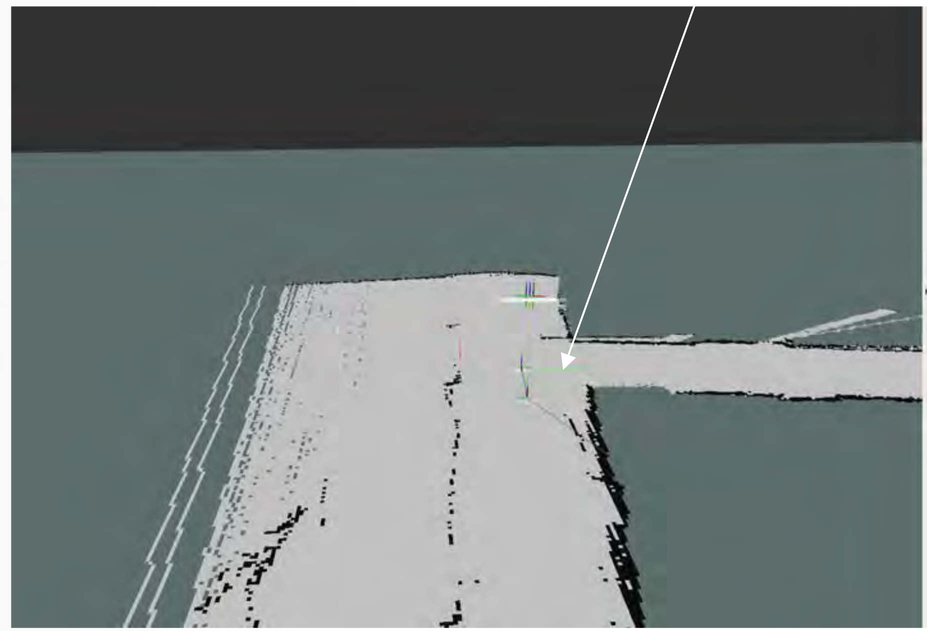
Without Loop Closure.
¾ of a lap

With Loop Closure
Two full laps

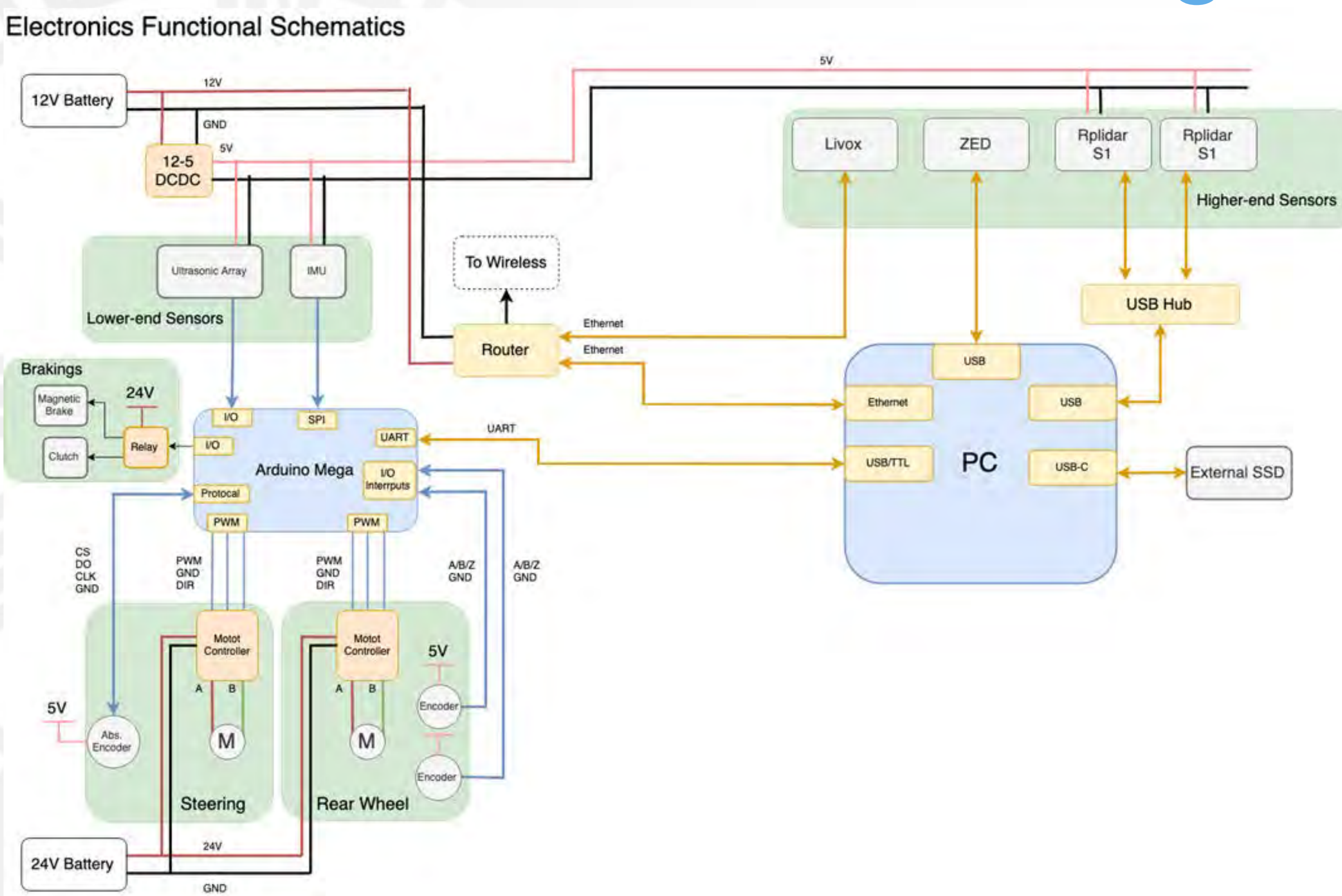


Move Base


Global Plan
2nd Lap Around
Position of
Scooter and
Sensors


Global Plan
4th Lap Around

Hardware: Functional Block Diagram



Our Graduates are LEADERS

Jobs Upon Graduation

Amazon
Apple
BAE Systems
Bloomberg
CACI
Credit Suisse
Goldman Sachs
Google
Harris
IBM
Lucent (LGS)
Mini-Circuits
NVIDIA
Red Balloon Security

Graduate Schools

Boston U
Cardozo Law School
Columbia
Cornell
Duke
Icahn School of Medicine
Johns Hopkins
MIT
Stanford
U Chicago
U Michigan- Ann Arbor
USC
U Texas- Austin
Yale

The Curriculum

- High expectations!
- Rigorous, emphasizing conceptual thinking and problem solving, extending and generalizing context.
- Combined with significant project work in each of 4 years.
- Required courses completed in 3 years (except for Senior Projects)

- Can take GRADUATE LEVEL COURSES while undergraduate, and count them towards MASTERS DEGREE at Cooper

- Flexibility: TWO TRACKS:
  - Signal Processing & Electronics:
    - Hardware Design
    - Engineering Electromagnetics
    - Integrated Circuit Engineering
    - Linear Algebra
  - Computer Engineering
    - Data Structures & Algorithms
    - Operating Systems
    - Software Engineering
    - Discrete Mathematics

Electives:

- Advanced Digital Hardware Design
- Artificial Intelligence
- Bayesian Machine Learning
- Bioelectronics
- Bio-Instrumentation & Sensing
- Computer Graphics
- Communication Coding
- Communication Electronics
- Compilers
- Cybersecurity
- Data Science for Social Good
- Databases
- Deep Learning
- Design with Operational Amplifiers
- Digital Speech & Audio Processing
- Electromechanical Energy Conversion
- Financial Signal Processing
- Frequentist Machine Learning
- Machine Learning and Art
- Microwave Engineering
- Modern Control (**cotaught with MechEng)
- Natural Language Processing
- Radar & Sensor Array Processing
- Satellite Communications
- Smart Cities & Autonomous Systems
- Wireless Communications

Independent Studies:

Adaptive Filters
Advanced Artificial Intelligence
Advanced Compilers
Advanced Deep Learning
Advanced Financial Signal Processing
Advanced Probability & Stochastic Processes
Analysis of NYC Tax Dataset
Design with FPGA
Digital Image Processing
Digital Video
Empathetic Robots
Fourier Optics (**taught by Dean Shoop)
Inferred Causality
Machine Learning Lab
Quantum Information Theory
Wavelets & Multiresolution Imaging
(**cotaught by EE & Math Dept Chairs)

Etc etc etc etc

Other Courses:

Data Visualization
EE Pedagogy (**IS)
Emerging Technology Ideation
Entrepreneurship
Ethics for Computer Science
Philosophy of Information (**IS)
Sports Medicine
Technology Roadmapping (**IS)

Minors:

Computer Science
(administered by EE Dept)

Math

Humanities & Social Sciences