## **Undergraduate Research Rotations**

Department of Electrical and Computer Engineering Brigham Young University

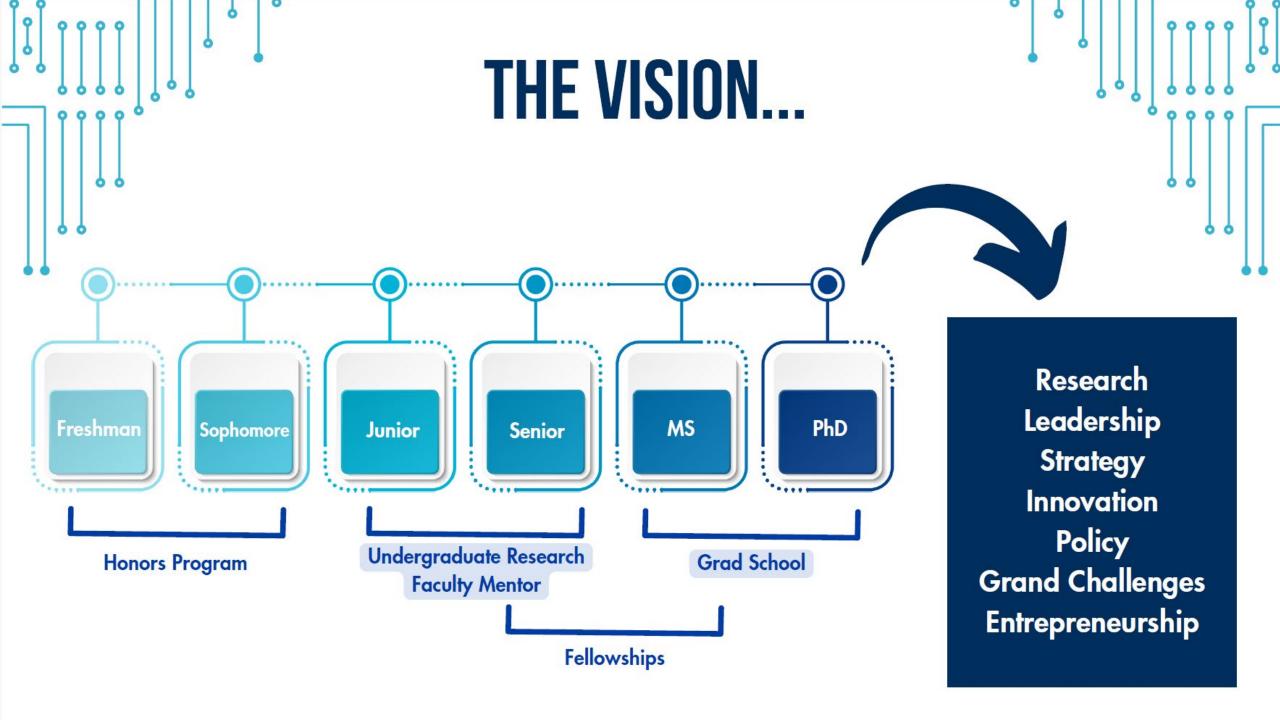
Prof. Karl Warnick



ece.byu.edu/honors



ieee.byu.edu www.ieee.org/join



ATRAJECTORY
TO
OPPORTUNITIES

A graduate fellowship can be a key to your engineering success. Begin now to prepare for fellowship applications and place yourself on a trajectory to opportunity.

#### 1 FRESHMAN

Participate in the BYU Honors Program

#### 2 SOPHOMORE

Find a faculty mentor

Apply for an ORCA Grant

#### 3 JUNIOR

Participate in undergraduate research
Publish a research paper
or give a conference presentaton

#### OPPORTUNITIES

Breakthrough research Leadership Strategy nnovation Policy Grand challenges

#### 4 SENIOR

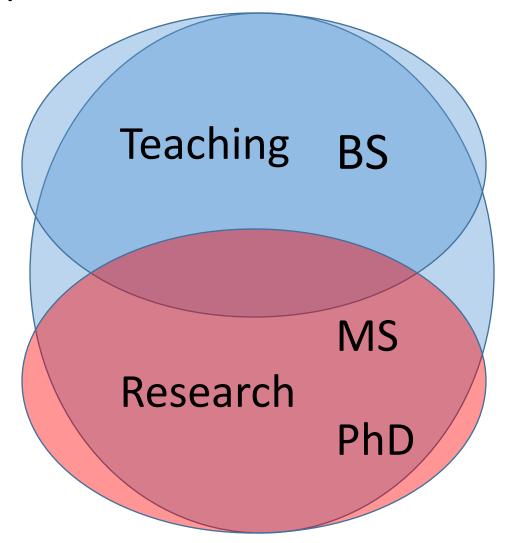
Apply for fellowships

#### 5 GRAD SCHOOL

Pursue an MS or PhD—or both

BYU IRA A. FULTON COLLEGE ENGINEERING AND TECHNOLOGY

## The University's Two Worlds



## What is undergraduate research?

#### Most commonly:

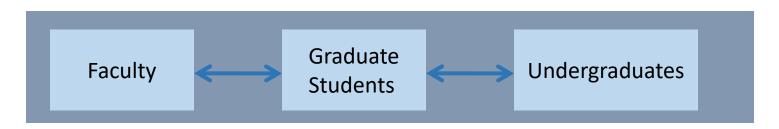
- A student is hired in the Junior or Senior year by an faculty member as a research assistant (paid)
- Works with graduate students and other team members on an open research question, experiment, mathematical analysis, numerical simulation, or hardware design
- 10-15 hours per week (or up to 20) in Fall and Winter, more hours during Spring/Summer terms
- May go on to obtain an MS or PhD degree at BYU or elsewhere, apply for prestigious national fellowships, publish a paper on original research

#### Other modes:

- Independent research
- Unpaid or volunteer research
- Research in other departments

## Benefits of Undergraduate Research

- Apply classroom knowledge
- Be a part of world-class research projects
- Enriches the university experience
- Form close connections with faculty and graduate students
- Work in a stimulating collaborative team environment
- Obtain academic year and summer stipends
- Prepare for Capstone Project
- Assistance with graduate school admissions and fellowships



## Details

- At the undergraduate level, classes come before research
- My goal is for you to have a good experience and prepare for future work on the job or graduate school
- No set expectation for work hours. 10-15 hours per week is typical
- What do undergraduate research assistants do?
  - Work in a lab with graduate students
  - Design hardware, build PCBs, test setups
  - Develop embedded software
  - Test a device or system
  - Debug hardware
  - Conduct experiments & take measurements using lab equipment
  - Attend weekly group meetings



## Graduate Research Fellowships

#### Additional funding for graduate school and a prestigious, competitive opportunity

- Start application process in August/September of your Senior year
- Strong academic record (3.8+ GPA, but can be lower)
- Undergraduate research is a huge help with the application

#### **Examples:**

- National Science Foundation Graduate Research Fellowship \$43k/year + \$10k education allowance
- Department of Defense NDSEG Fellowship \$37k/year plus tuition and fees
- NASA Fellowship \$200k+ total value over three years

#### PRESTIGIOUS NATIONAL FELLOWSHIPS IN ENGINEERING

#### GRADUATE RESEARCH FELLOWSHIPS

Winners typically go to top U.S. graduate schools Worth \$30,000–60,000 per year

Aim for 3.8 GPA or higher

Participate in undergraduate research

Apply in the fall of your senior year

Generally reserved for U.S. citizens or U.S. persons

BYU's engineering program has a good track record of successful candidates



National Science Foundation



Department of Defense



Department of Energy



NASA



SMART



Hertz

#### GRADUATE STUDY ABROAD FELLOWSHIPS

Winners go to graduate school in the United Kingdom or elsewhere

Various dollar values

Aim for 3.9 GPA

Seek broadening experiences

Apply at the end of your junior year

Generally reserved for U.S. citizens or U.S. persons

Can be very competitive



Fulbright



Gates



Marshall



Mitchell



Rhodes

#### UNDERGRADUATE SCHOLARSHIPS

Good practice for graduate fellowships Can be worth several thousand dollars Apply as a sophomore or junior



Goldwater



Tau Beta Pi



Phi Kappa Phi



For more information, contact your department fellowship expert (listed below) or visit www.et.byu.edu.

CHEMICAL ENGINEERING: John Harb, 801-422-4393, john\_harb@byu.edu

CIVIL ENGINEERING: Michael Scott, 801-422-6324, michael.scott@byu.edu

ELECTRICAL AND COMPUTER ENGINEERING: Karl Warnick, 801-422-1732, warnick@ee.byu.edu

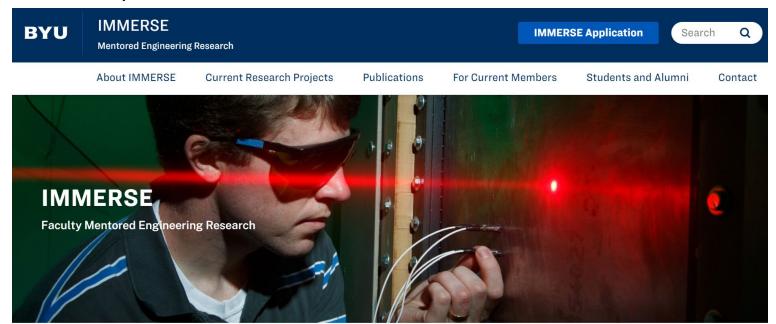
MECHANICAL ENGINEERING: David Fullwood, 801-422-6316, dfullwood@byu.edu

SCHOOL OF TECHNOLOGY: Richard Helps, 801-422-6305, richard helps@byu.edu

More info at honors.ee.byu.edu

## IMMERSE Undergraduate Research Experience

immerse.byu.edu

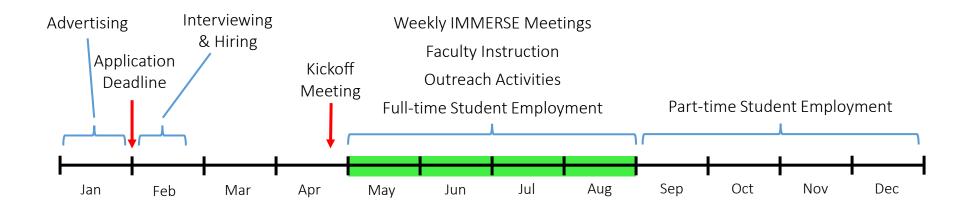


#### What is IMMERSE?

Watch the Video



## **IMMERSE** Calendar



Most ECEn Research groups participate in IMMERSE and research positions are filled by applying at immerse.byu.edu. For non-IMMERSE research groups contact the faculty director to apply for a position

## Research Rotations

Visit the research lab(s) of your choice at the scheduled times (see handout)

During the rotation visit:

What you do is up to you and the faculty advisor

You might:

Talk with the faculty advisor about research opportunities

Visit a research group meeting and meet other students in the group

Tour the lab and find out what goes on there

The purpose is to get a flavor for the research lab and an idea of what the project is like

Interest in graduate school and reasonable GPA are desirable

No obligation, but could lead to a paid research assistant position, Honors thesis topic, or other opportunities

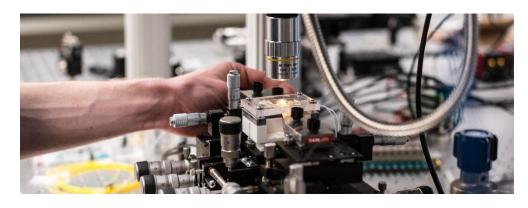
## Research Projects and Groups

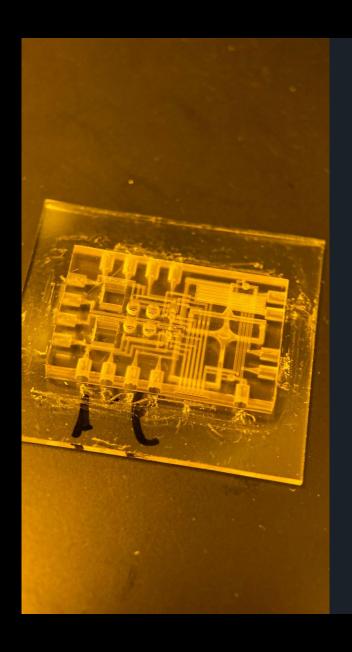


Using the quantum properties of light for computing, communications, and sensing. camacholab.byu.edu

#### Students in our research group:

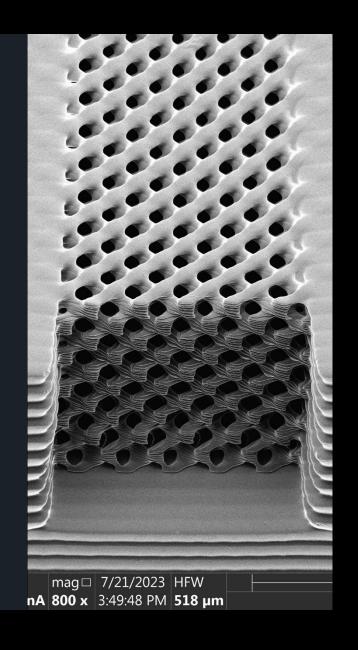
- 1. Use quantum entanglement in their everyday lives.
- 2. Design and build integrated photonic circuits.
- 3. Eat pizza at least once a month.
- 4. Work with amazing collaborators from Harvard, MIT, and other top schools.
- 5. Publish papers.





## Generalized 3D Printing for Lab-on-a-Chip Fabrication Prof. Greg Nordin

- Create sub-micron high resolution
   3D printers and materials
- New microfluidic components and structures
  - Densely integrated, high functionality chips
- Interdisciplinary biomedical and bioresearch applications



## Derek Hansen

#### Human Computer Interaction (HCI)

- Augmented, Virtual, & Mixed Reality
- App to help those with Aphasia (trouble speaking post stroke)
- Developing visual language for cyber weaknesses & attacks

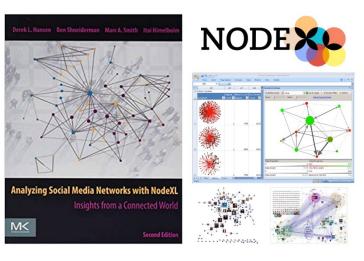
#### Fighting Disinformation & Spear Phishing

- Use of LLMs to create and identify personalized disinformation
- Social Network Analysis

#### Authentic educational simulations and games

- Alternate Reality Games
- Playable Case Studies
- Mixed Reality Escape Room







## Dr. Manwaring Medical Device Innovation Collaborative (MEDIC) Lab

#### We have interest in

- Low- and middle-income country telehealth technologies
- Fetal and maternal health monitors
- Neurodegenerative disease treatment

#### We have External Collaborations

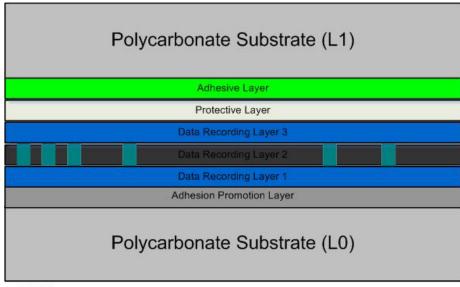
- Alcohol/drug addiction recovery technologies
- Insomnia/pain treatment
- Fetal monitoring
- Traumatic brain injury prevention

#### Are you interested in/do you have

- Embedded systems
- Signal processing
- Analog/digital circuit design
- RF Antennas & RADAR
- PC application design
- EM simulation
- Mechanical design
- Hands on work
- Curiosity
- Drive/passion for helping people
- Committed team players

### **Lunt Research Group: Data Storage**

#### Optical (M-Disc)



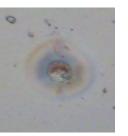
L0: 0.6 mm APL: ≈20 nm DRL1, 2, 3: ≈20 nm Protective Layer: ≈20 nm Adhesive Layer: ≈20 μm L1: 0.6 mm

#### Optical (Tape)

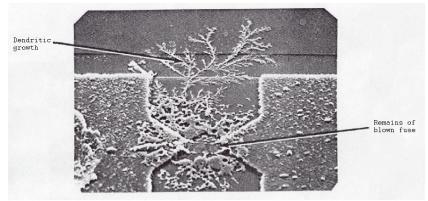


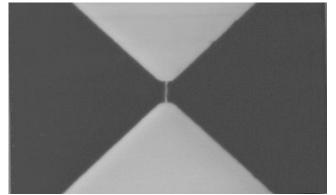






Solid State (PROM, WORM)





orators:

Collaborators: Wood Chiang (ECEN) Matthew Linford (Chem)

Solid State: Data Life Expectancy



## NET Lab

NET

- Long-range low-power wireless networking
- Air quality monitoring in Utah and Mongolia
- Sensor data processing and machine learning
- Privacy and security of sensor networks
- Help make the Internet of Things a reality!



#### engadget

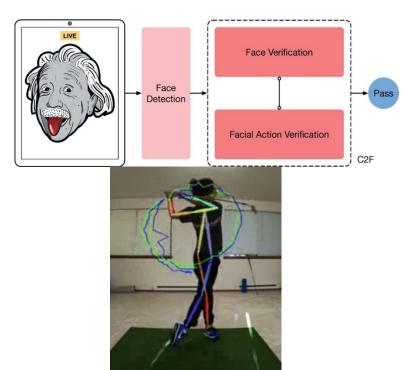


BYU researchers extend WiFi range by 200 feet with a software upgrade

Their protocol doesn't require hardware like mesh network routers.

## Robotic Vision Lab — rvl.byu.edu - Lee

- Artificial Intelligence
  - Two-Factor Identity Verification
  - Performance Evaluation in Sports
  - Al Assistant Football Coach
- High-Performance Visual Computing
  - Deep Learning on FPGA
  - Low Latency Target Tracking
- Robotic Vision
  - Self-Driving Car
- Visual Inspection Automation
  - Food Quality Inspection
  - Foreign Material Detection
  - Fish Species Recognition





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## Non-Invasive Neurosurgeries

- Use ultrasound to kill tumors
- Use MRI to watch it happen

Steven Allen
Electrical and Computer
Engineering
spallen@byu.edu
Fridays, 3:00 PM

#### Field Robotic Systems Lab

We are interested in the development of <u>perception</u>, <u>navigation</u>, <u>planning</u>, <u>and</u> <u>reasoning</u> algorithms and tools that <u>increase the</u> <u>reliability</u> of autonomous <u>field robotic systems</u>, enabling them to consistently perform realwork in complex unstructured environments.

For more information contact Dr. Mangelson at: <a href="mangelson@byu.edu">mangelson@byu.edu</a>



Autonomous Underwater Navigation and Mapping



Automated Fault-Diagnosis and Verification



Autonomous Multi-Agent Underwater Inspection



Hardware Accelerated Navigation/Planning

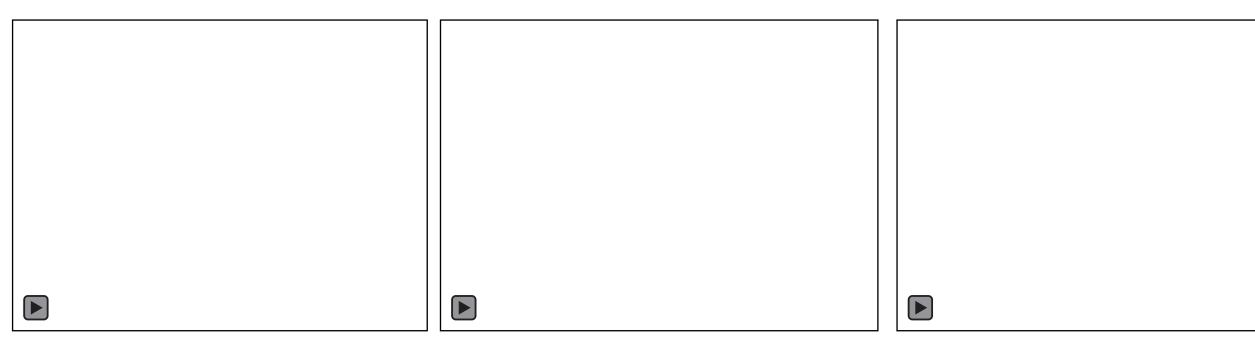


Autonomous Wheelchair Navigation



## Cooperating Unmanned Vehicle Research

Objective: develop control and estimation algorithms that increase the capabilities of unmanned autonomous vehicles.



Cooperative Control: Agents work to encircle a maneuvering target.

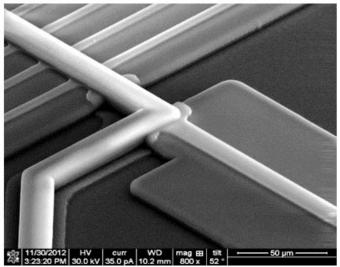
Collision Avoidance: Agents detect and deconflict conflicts with other aircraft.

Distributed Estimation: Aircraft cooperatively work to estimate danger regions in a region.

For more information contact Dr. Peterson at: cammy.peterson@byu.edu

## Microengineering Research Group





- Class 10 Cleanroom
- Semiconductors in the U.S.A.



- World leader in optofluidics
- Lab-on-chip and bioengineering
- Integrated optics
- Solid-state devices
- Excellent placement in semiconductor industry

Professor Aaron Hawkins https://hawkins.byu.edu

## Smalley Lab

Creating a lowcost holographic video monitor

Looking for volunteers to use ultrasound to make holograms you can touch!

## **BYU Configurable Computing Lab**

ccl.byu.edu

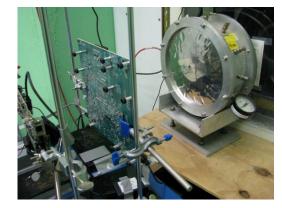
**FPGA Reliability, Hardware Security, Embedded Systems** 

#### Gain experience with:

- Custom FPGA design
- Embedded systems, Linux & device drivers
- Reliable FPGA systems for space applications
- Python programming, opensource software projects



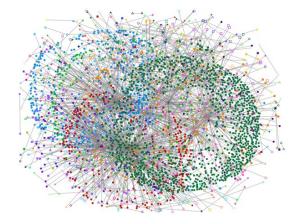
Installing Sandia/BYU experiment in space shuttle



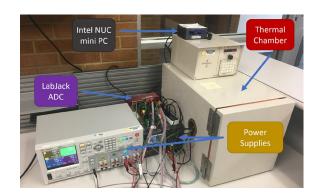
Neutron Radiation testing (Los Alamos National Labs)



Design, manufacture, & test Printed Circuit Boards (PCB)



Secure FPGA hardware design tools



FPGA artificial aging and device characterization



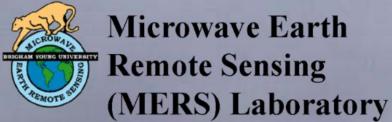
Prof. Mike Wirthlin wirthlin@byu.edu



Prof. Jeff Goeders jgoeders@byu.edu

#### **Relevant Skills**

- Digital/FPGA Design
- Embedded Systems
- Python, C/C++
- PCB, Circuit Design

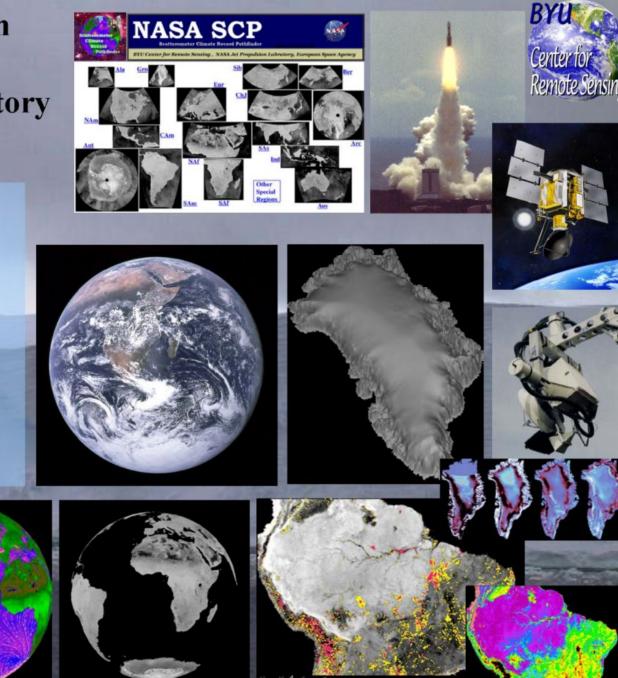


Dr. David Long

**Center for Remote Sensing** 

MERS conducts research in remote sensing of the Earth including:

- Remote sensing
- Development of advanced microwave sensors
- Satellite sensor system design
- Satellite data scientific data analysis and processing



www mers byu edu



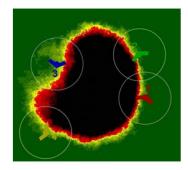
One of BYU's two spacecraft in orbit



We also build and fly spacecraft

## MAV Research @ BYU (Beard)





**Cooperative Control** 

Path Planning
Trajectory Generation



• UAV / UGV

· Consensus seeking

Cooperative timing problemsCooperative persistent imaging

Cooperative fire monitoring

- Wind compensation
- Collision avoidance
  - Optic flow sensor

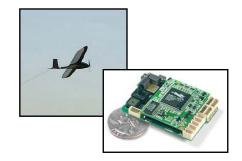
· 3D Waypoint path planning

Laser ranger



Image Directed Control

**Autonomous Vehicles** 



- Geo-location
- Target tracking
- Precision landing
- · Collision avoidance
- Autopilot design for small UAVs
- Attitude estimation
- Adaptive control
- Tailsitter, quadrotor GNC

## Nanomechanical Biosensors Dr. Greg Nordin

#### Integration of:

- MEMS (microelectromechanical systems)
- Silicon photonics
- Microfluidics (lab-on-a-chip)

#### • Applications:

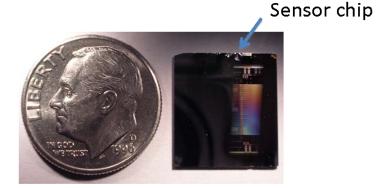
- Medical diagnostics (cancer, disease)
- Biowarfare agent detection
- Intelligence agency & homeland security

#### Tools used:

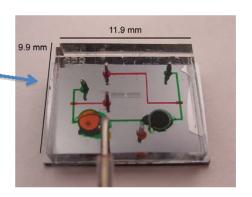
- Cleanroom
- Scanning electron microscopy (SEM) & focused ion beam (FIB)
- Photonic readout & control
- Fluidic control
- Experiment automation



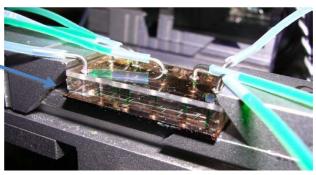
Linear sensor array



High speed microfluidic pump

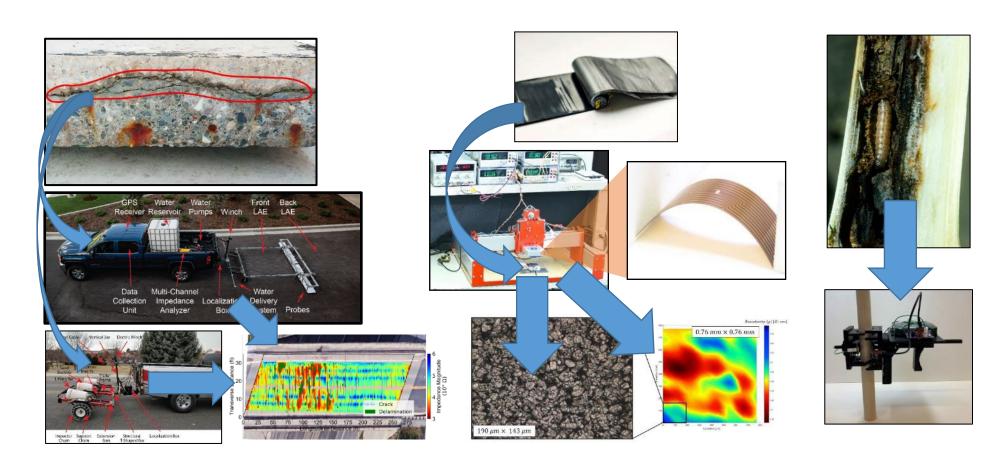


Integrated sensor & microfluidic chips



## Mazzeo Research Group

Topics: Bridges (nondestructive evaluation at high speed), Batteries (Li-ion electrode microstructure), Bugs (Agriculture IoT)



#### **BYU Smart Antenna Systems & Radio Astronomy Systems Labs**

Prof. Karl F. Warnick

#### Research Areas:



Radio Astronomy Systems (with Dr. Brian Jeffs), BYU Focal L-band Array for GBT (FLAG) used liquid helium cooled electronics to create the world's most sensitive astronomical phased array antenna

Multichannel, broadband, real time digital signal processing for imaging arrays, 10 Gbe networked FPGA implementations



Phased array antennas for satellite communications, electronically steered satellite communication ground terminals, highest efficiency planar arrays reported in the literature

Communications antennas and sensors for unmanned air vehicles, collision avoidance radars for UAV sense and avoid









NavAir



**Agilent Technologies** 

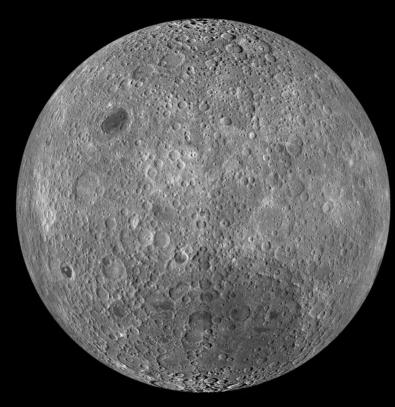






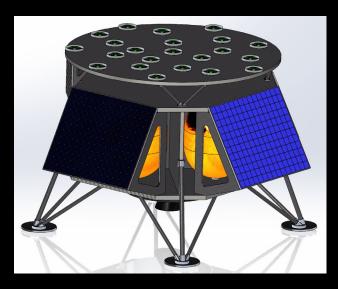


## BREAKTHROUGH LISTEN



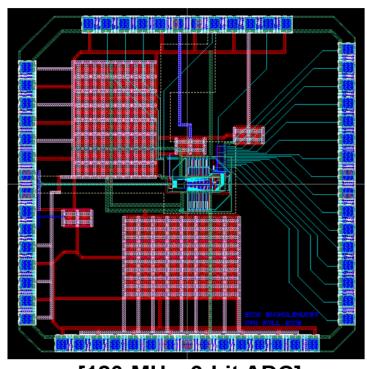
LUNAR FARSIDE TECHNOSIGNATURE AND TRANSIENTS TELESCOPE (LFT3)

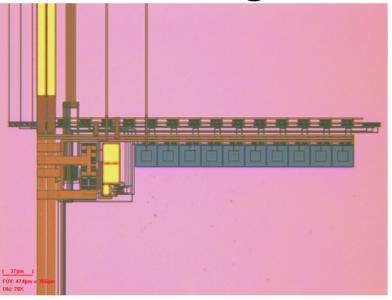




CONTACT WARNICK@BYU.EDU

## RF/Analog/Mixed-Signal Integrated Circuits, Dr. Shiuh-hua Wood Chiang





[CMOS image sensor]

[120-MHz, 9-bit ADC]

- Cutting-edge research on
   High-performance data converters
  - Low-noise instrumentation amplifiers
  - Biodetectors
  - Implantable sensors



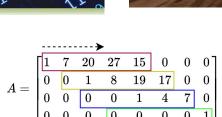
## Dr. Harrison – Partner in the Information Theory and Communications Engineering (ICE) Lab

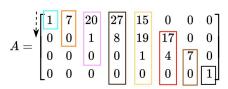
- Physical-layer security: using noise in the communications channel for security.
- Secret codes: optimizing codes that keep secrets and correct errors.
- Cryptography
- Machine Learning
- Sports Analytics



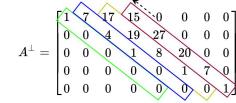


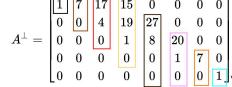


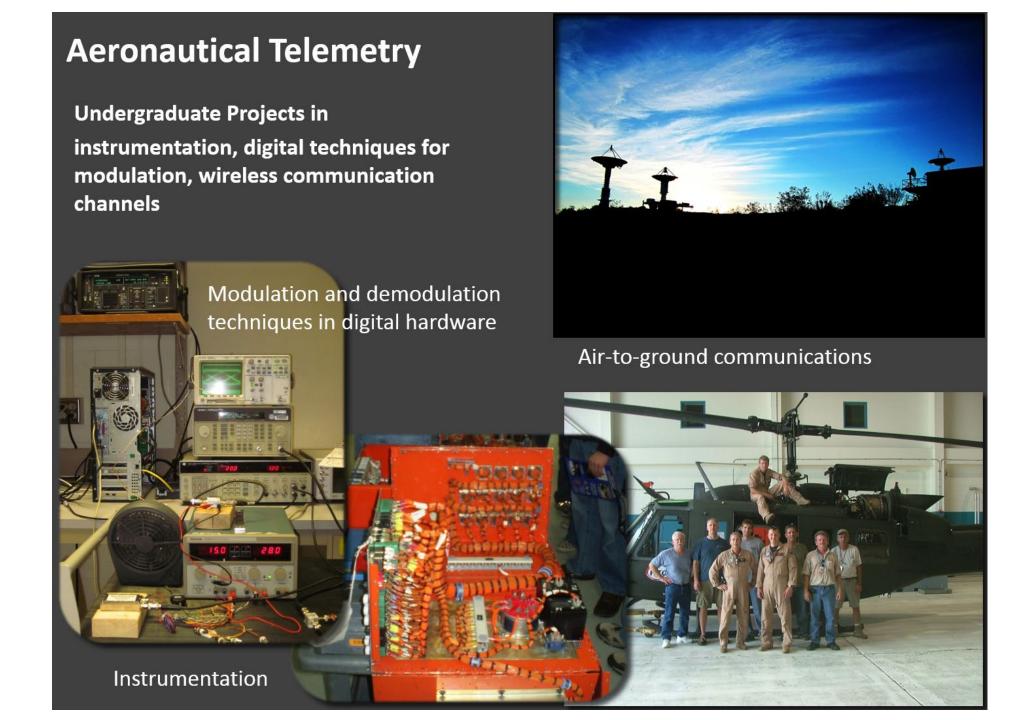












## Research Rotations

#### What to do:

- 1. Attend one or more Research Rotations group lab meeting or office hour times (see the schedule at ece.byu.edu/honors/activities)
- 2. Learn about the lab, meet the faculty director, converse with other students, and talk with the faculty director about opportunities for research.

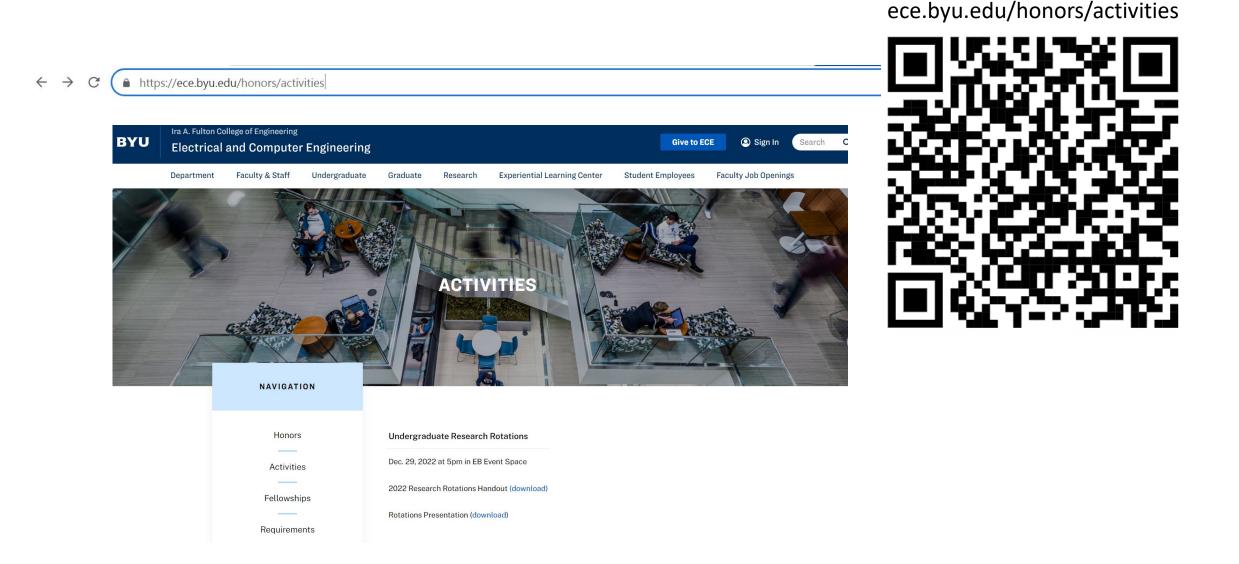
If the research lab participates in the IMMERSE program, you can also be involved in summer IMMERSE activities (see immerse.byu.edu).

If you can't make the meeting time or no time is listed, contact the faculty director by email.

You can attend as many lab rotations meetings as you would like.

If you cannot meet at the listed time, contact the faculty director during regular office hours.

## Research Rotations Schedule



## **BYU** Electrical & Computer Engineering

#### Fall 2023 Undergraduate Research Rotations

#### What to do:

- 1. Attend one or more of the following research rotation lab meeting or office hour times
- 2. Learn about the lab, meet the faculty director, converse with other students, and talk with the faculty director about opportunities for research
- 3. If the research lab participates in the IMMERSE program, you can also be involved in summer IMMERSE activities (see immerse.byu.edu)
- 4. If you can't make the meeting time or no time is listed, contact the faculty director by email

Microwave Earth Remote Sensing Lab, <u>Cubesats</u>	Dr. Long	Noon on Tuesdays in EB 446 or email long@ee.byu.edu
Microengineering Research Group	Dr. Hawkins	Office (EB 460B) on Mondays at 2 pm, Thursdays at 3pm, or email ahawkins@byu.edu
Configurable Computing Lab	Dr. Wirthlin and Dr. Goeders	Tuesday 12/5 at 1pm in CB 461
Radio Astronomy Systems	Dr. Warnick and Dr. Jeffs	Tuesdays at 1pm in 402 EB, or email warnick@byu.edu
Smart Antenna Systems	Dr. Warnick	Thursdays at 10am in EB 402 or CB 450, or email warnick@byu.edu

