Undergraduate Research at ASU's Polytechnic Campus

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ASU's Polytechnic Campus Engineering Degree

- Engineering degree (automotive systems, electrical systems, mechanical engineering systems, and robotics)
- Project spine – students take a project course every semester
- Introduction to coding
  - Start students with Excel in first project course, entering an equation is difficult for some
  - Arduino in the next 2 project courses, EGR 102/EGR 201
  - EGR 219 Computational Modeling of Engineering Systems, Matlab/Simulink and C++

Foundations of Engineering Design II

- The second project course for freshman engineers and a core course for a general engineering degree
  - engineering design process
  - prototyping skills
  - basic circuits
  - introduction to coding
  - team work skills
  - entrepreneurial mindset

The Project: User Centered Design – Agriculture Sector

Everybody eats! Have you ever wondered how the crops from a field just outside this campus make it to the grocery store shelf?

In this project your team will improve the technology in the farm-to-fork supply chain. Teams of 3-5 people will define the problem, develop a solution, and build a functional prototype using mechatronic motion (**using an Arduino, sensor, and motor is a requirement for this project**) as a team.

The Project: User Centered Design – Agriculture Sector

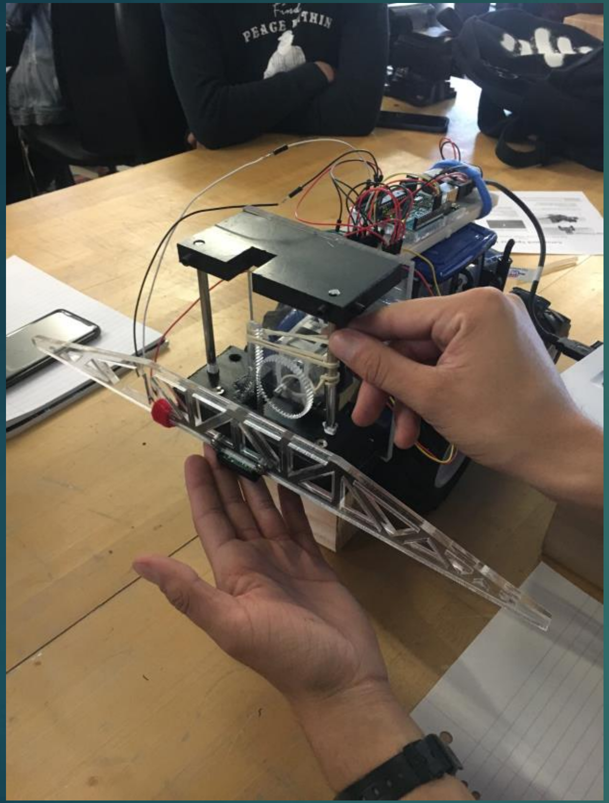
- This project will include the following activities:
  - Empathize with the user group (farmers) and understand their concerns about a specific agriculture problem
  - Define (in detail) the specific problem that your team will address to make a positive impact for your user group's experience
  - Must have some mechanical part/moveable part that must be automated using an Arduino, motor, and sensor
  - Benchmark and brainstorm possible design solutions and functions for your idea to perform
  - Create a **functional prototype** of your team's most promising solution
  - Present your final prototypes to the class **during the project demonstration day**

The Project Selection

- Select a problem
  - Planter: automatically adjust each box, or set of boxes, rate of spread
  - Sprayer: automatically adjust the height of the sprayer booms
  - Combine/Grain Cart: be able to set the combine as a primary with the tractor and gran cart as secondary to adjust speed and distance through auto steering
  - Pivot Irrigation System: adjust each irrigation drop, at a variable rate, the amount of water flow based on terrain
  - Rain Gauge: a rain gauge with a daily flush that automatically controls the rate of rotation of the irrigation system

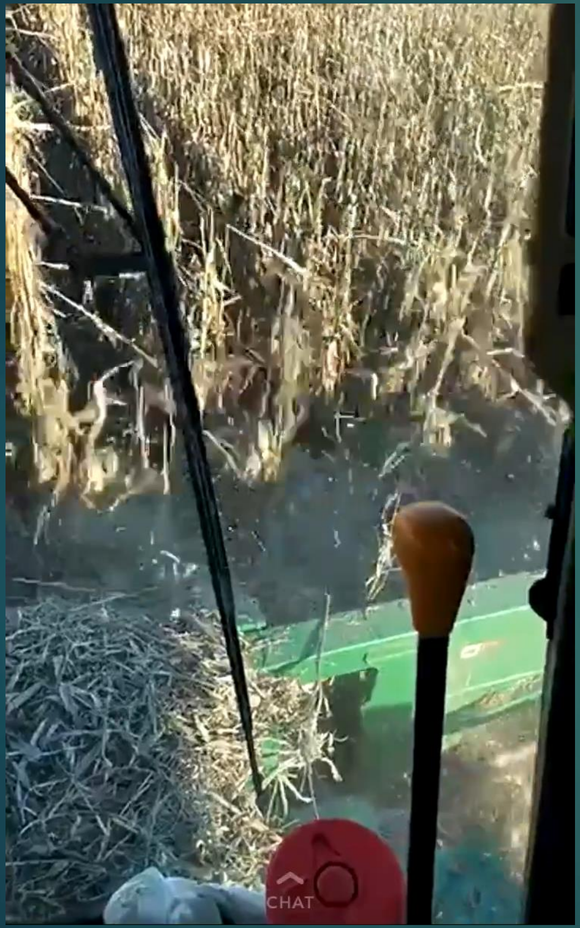
Results: Planter

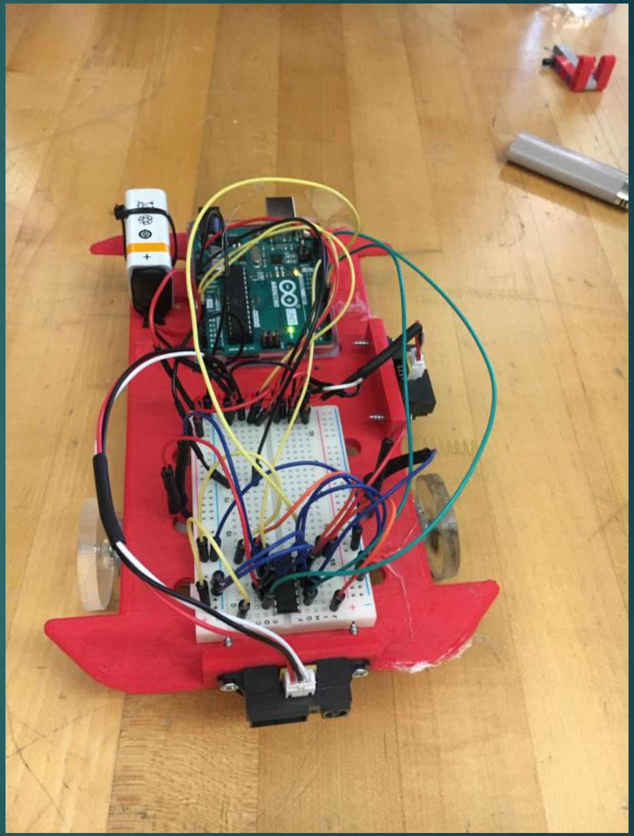
Results: Sprayer



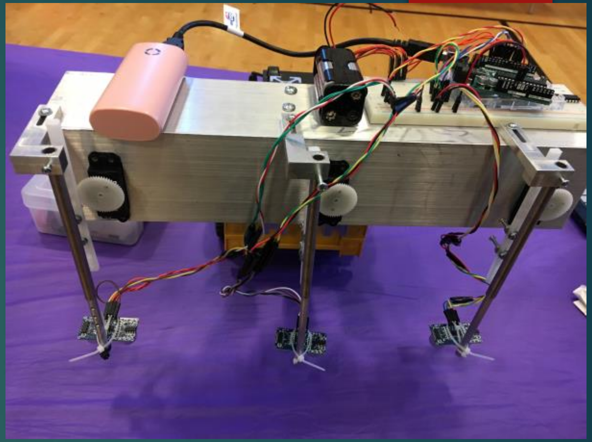
https://poly.engineering.asu.edu/advising/

Results: Combine/Grain Cart

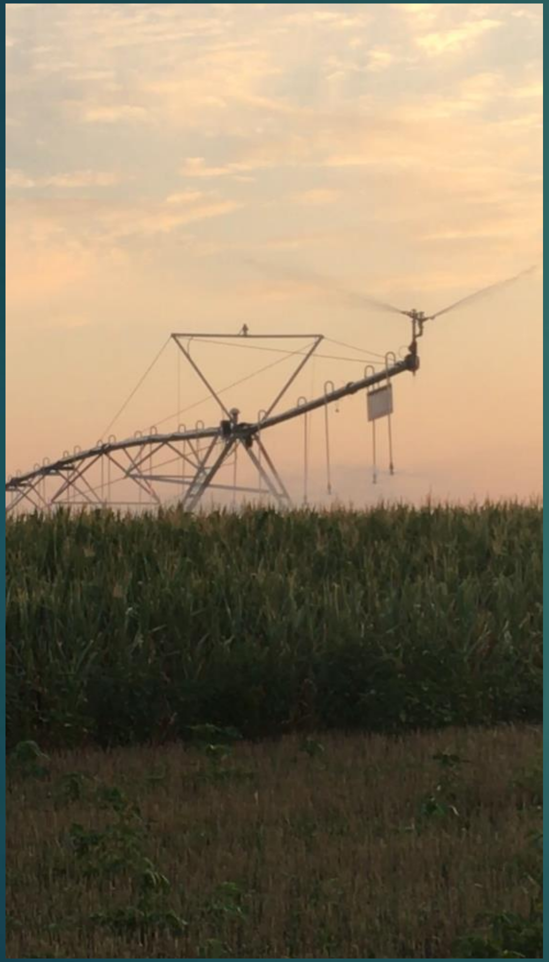


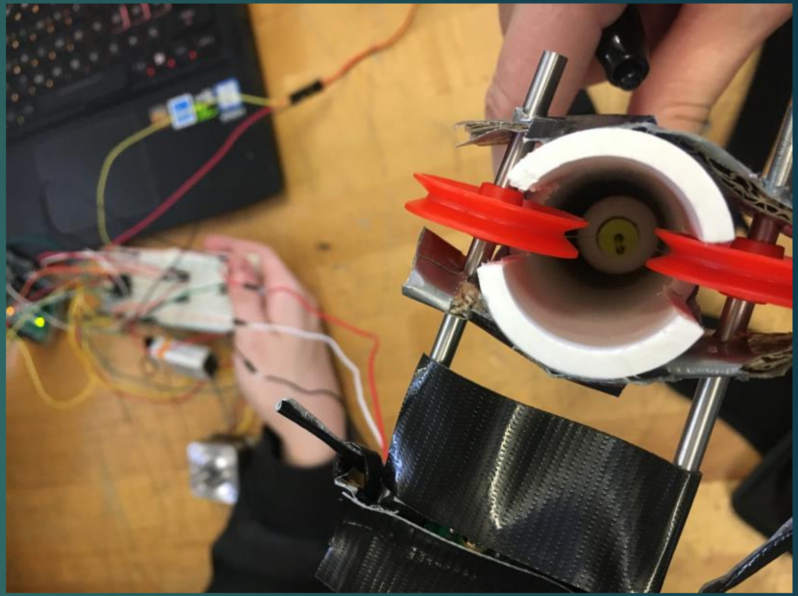


Results: Pivot Irrigation System



Results: Pivot Irrigation/Rain Gauge





Example Code

```
//if the object is far away the device moves down
//This comment indicates that if the position read from the IR sensors is large, the device will move downwards.

if (volt > 2.6) { //This states that if the voltage values are greater than 2.6, the following code will continue.

pos = 0; //This creates a position variable determining that the position will remain at zero.

myservo.write(pos); //This sends the voltage values as positions to the Servo motor, allowing it to move accordingly.

delay(100); //This creates a delay of 100 milliseconds.
}

//if the object is close the device moves up
//This comment indicates that if the position read from the IR sensors is small, the device will move upwards.

else if (volt < 1.3) { //This states that if the voltage values are less than 1.3, the following code will continue.

pos =180; //This creates a position variable determining that the position will move from zero to 180.

myservo.write(pos); //This sends the voltage values as positions to the Servo motor, allowing it to move accordingly.

delay(100); //This creates a delay of 100 milliseconds.
}
```

Project Conclusion

- This project started with a KEEN Professorship Mini-Grant to develop a project in the agriculture sector Fall 2017
- The project has become an integral part of the Foundations of Engineering Design II class
- Students have continued with undergraduate and graduate research in the agriculture sector

EGR 219 Computational Modeling of Engineering Systems

- A team project that mimics expectations for an engineering internship. The students must develop a Matlab App or Simulink model to test a fitness watch. They must present their findings and recommendations in both verbal and written formats, much like they would for a manager.
- The Matlab/Simulink project
  - B F!t, a fitness technology firm, has hired your team to model new, proprietary technology. B F!t is developing a sensor similar to other fitness watches. However, they are wanting to use their own proprietary algorithms. Your team will be given a specific hiking path to test out their algorithms (Team#path.xlsx). Do not alter the data in the Excel spreadsheet, any data manipulation must be made in Matlab.

Matlab/Simulink Project

- The owners of B F!t want two specific plots, one being the hiker's heart rate and the other the hiker's elevation during the hike. In addition to the plots, they also want numerical calculations of total elevation gained (don't count the downhill parts) and of total calories burned. Your team must type up a report detailing the equations the team used and the resulting plots/information. In the appendix of the report, you must include your Matlab code. If you use Simulink or Matlab App, the appendix must also contain a screen shot of your design. Your team must also give a presentation of the results and a demonstration of the final Matlab or Simulink product.

Matlab/Simulink Project: The Equations

- $CaloriesBurned(t) = \frac{-55+0.63*HR(t)+0.2*weight+0.2*age}{4} * time(t)$ (1)

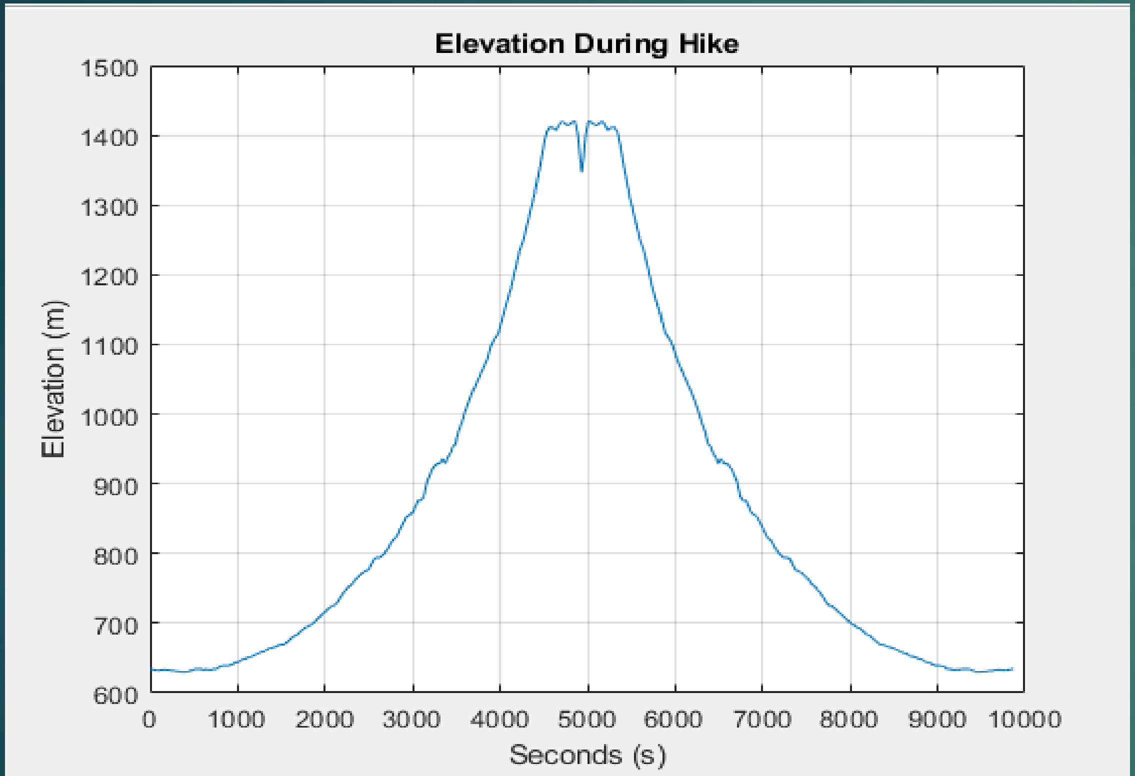
- $PO(t) = 250 + 5.3 * slope(t) * 250$ (2)

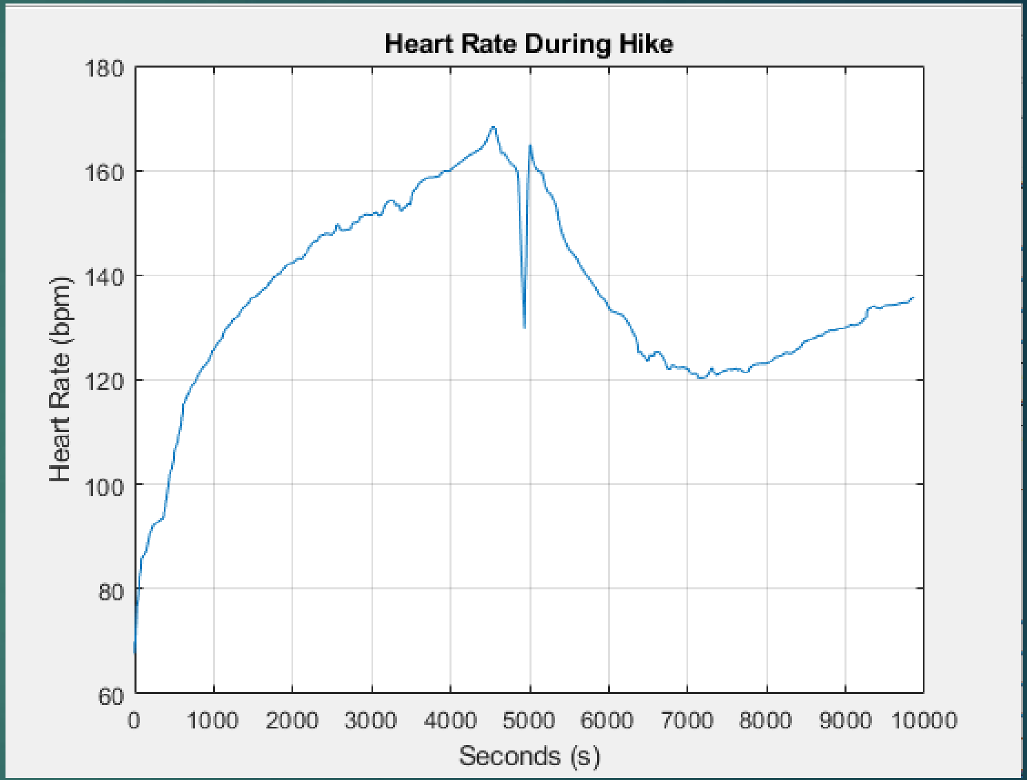
- $HRss(t) = HRrest + 0.27 * PO(t)$ (3)

- $HR(t+1) = HR(t) + \frac{1}{tr} * (HRss(t) - HR(t))$ (4)

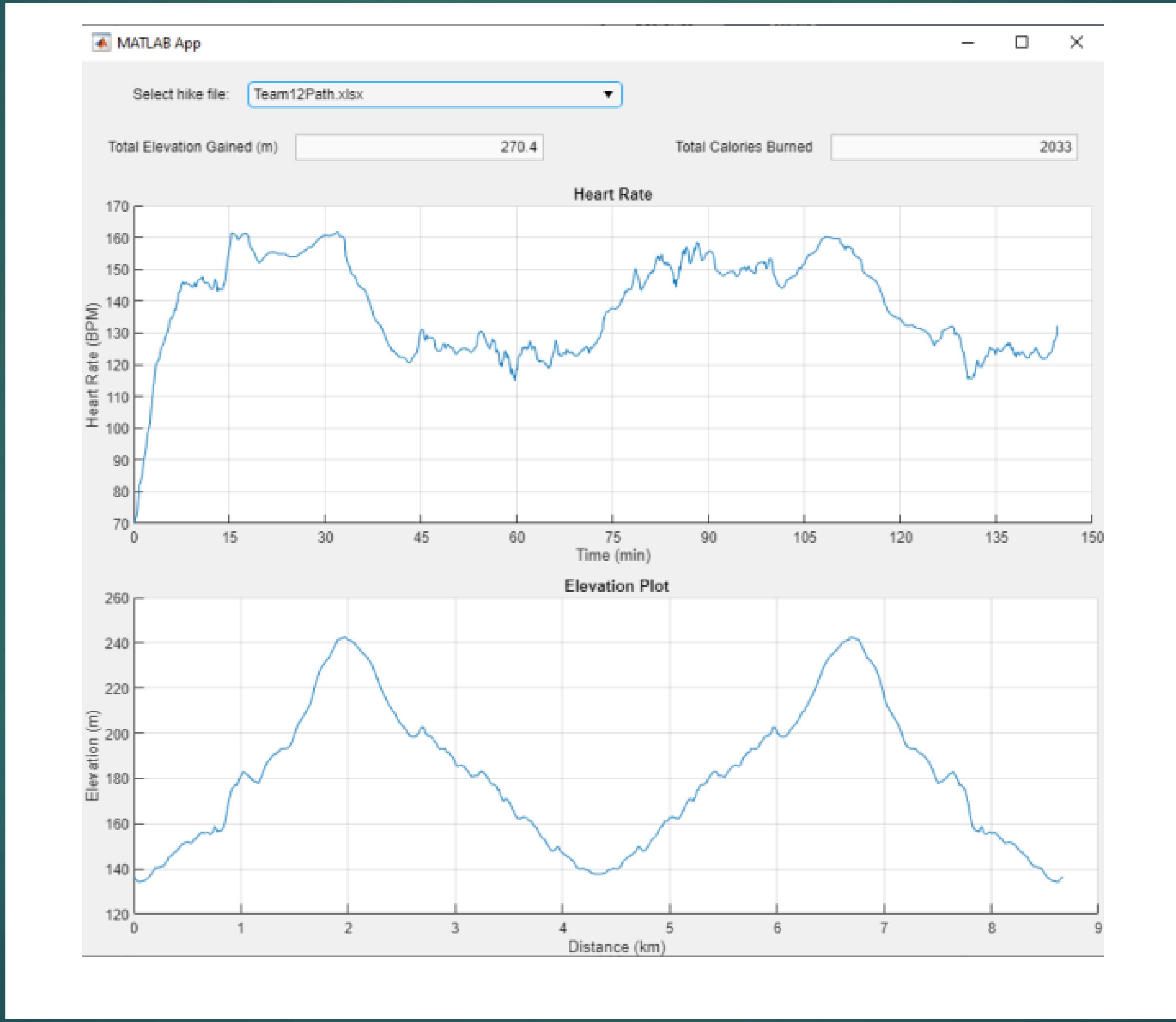
- Resting heart rate is 70 beats per minute (bpm) and his maximum heart rate is 170bpm. Hikes at a constant rate of 1 meter/second.

Matlab/Simulink Project





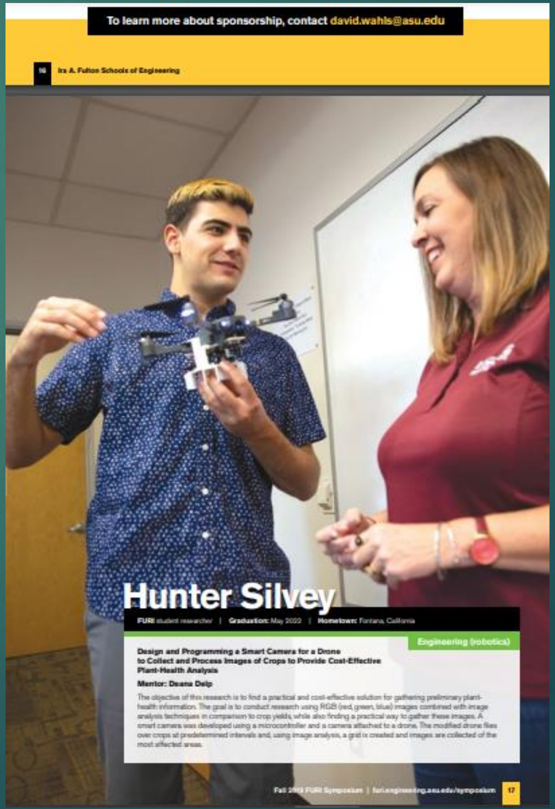
Matlab/Simulink Project

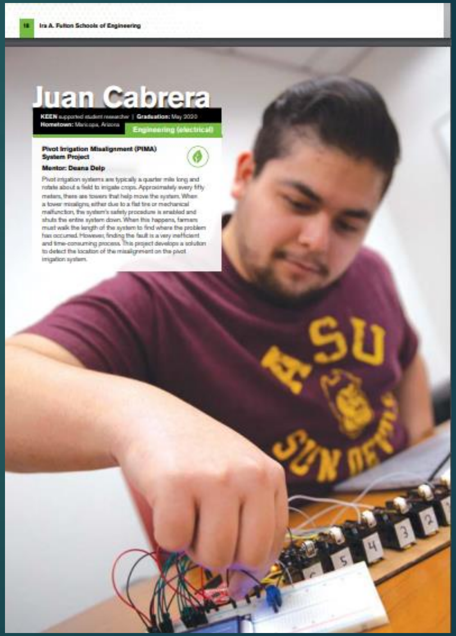


FURI: Fulton Undergraduate Research Initiative

An opportunity for students to work with faculty in a research capacity

- Hands-on lab experience
- Thesis-based research
- Travel to national conferences





FURI: Fulton Undergraduate Research Initiative

Cost-Effective Plant-Health Analysis using Drone Technology and Image Processing

Objective

- Provide cost-effective, early detection plant health analysis

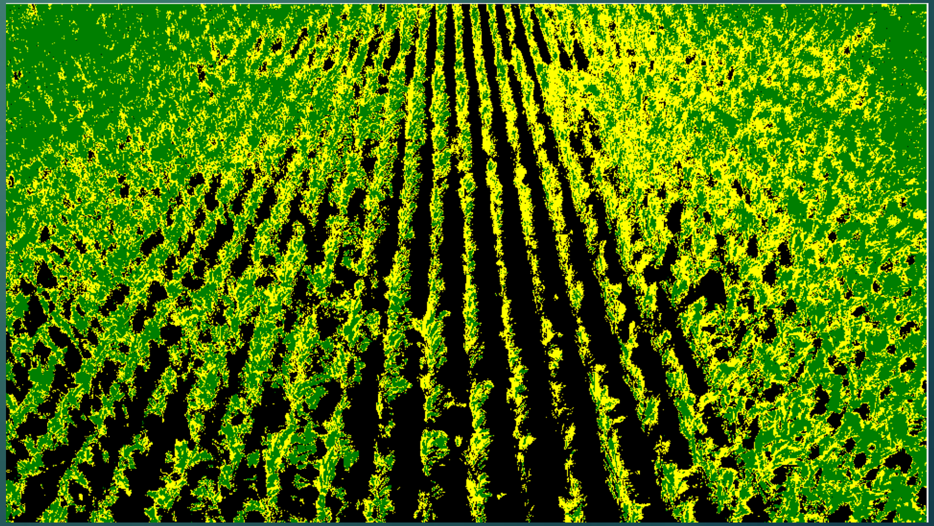
Impact of Research

- This research is in line with the sustainability research theme. The implementation of this research would be low-cost and easy to implement, thus making aerial drone inspection of crops available to almost anyone. The results of this research would help determine insect infestation, water stress, and quality of the landscape to help produce more food for global consumption along with conserving water and lowering chemical exposure to the environment and the food chain.

FURI: Fulton Undergraduate Research Initiative

Results

- VARI (Visual Atmospheric Resistance Index)
- $VARI = \frac{Green - Red}{Green + Red - Blue}$
- The RGB photos in combination with VARI can be a cheap and relatively effective alternative to paying for expensive NIR cameras and image processing software.



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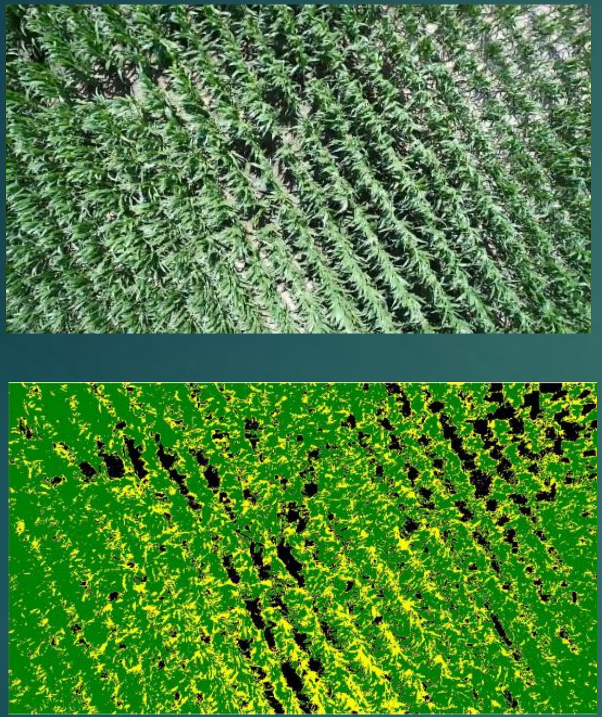
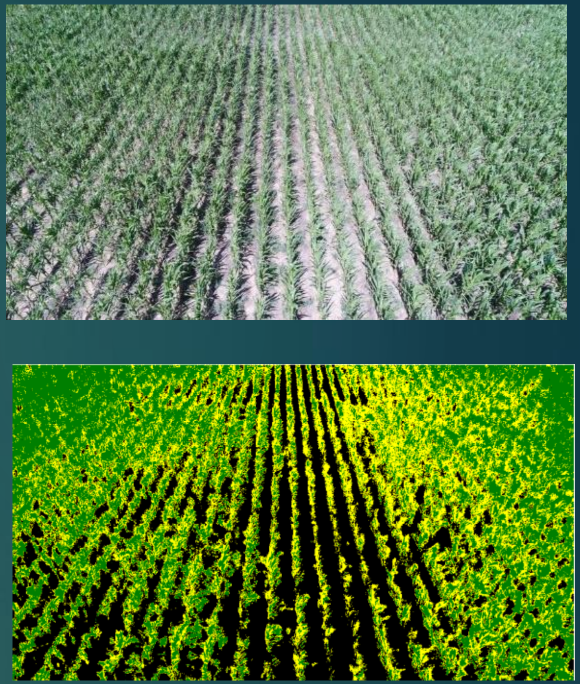


Field A
% Green = 80.2%
% Yellow = 20.8%
Actual Yield = 208 bsh/ ac

Field B
% Green = 54.85%
% Yellow = 45.25%
Actual Yield = 44.6 bsh/ ac



Field C
% Green = 61.35%
% Yellow = 38.75%
Actual Yield = 55.5 bsh/ ac

Conclusion

- ASU's Fulton Schools of Engineering is promoting a user-centered focus and undergraduate research
  - KEEN Entrepreneurial Mindset 3C's (Curiosity, Connections, Creating Value)
- Questions or connections reach out to deana.delp@asu.edu

Thank you!