Soft-bodied Robotic Arm Module (SAM)

Maria-Adeliz Ordonez, Brandon Gresham, Lucas Garcia,
Ryan Thompson, Pakawan Phokapant

EXCELLENCE in SENIOR DESIGN

An Electrical and Computer Engineering Capstone Showcase

Soft-bodied Robotic Arm Module (SAM)

Designing, Prototyping, and Testing a Pneumatically Actuated Modular SAM

**By: Maria-Adeliz Ordonez, Brandon Gresham, Lucas Garcia,
Ryan Thompson, & Pakawan Phokapant**

Scan me!

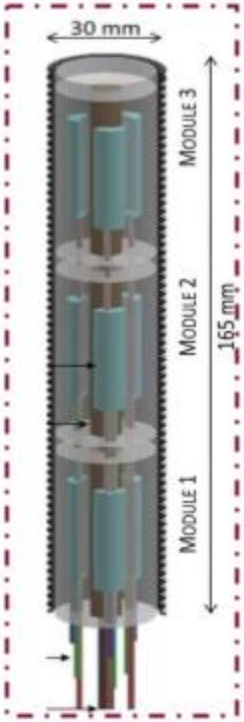
UTD Excellence Showcase
05/16/2022

Senior Capstone Project
based on De Falco work

Overview and Application (SAM)

Mission: *Design, prototype, and test a pneumatically actuated modular soft-bodied robotic arm.*

- Rigid vs Soft robotics
- Complex manipulation in cluttered and unstructured 3D environments
    - Medical and agricultural
- Pneumatic actuation
- CAD modeling & 3D printing
- Testing for mathematical controls
- Arduino-based controller to achieve desired orientation



Multi-module Variable Stiffness Manipulator

NM STATE

Maria-Adeliz Ordonez (ME//EE), Ryan Thompson (ME), Lucas Garcia (EP//EE), Brandon Gresham (EE)

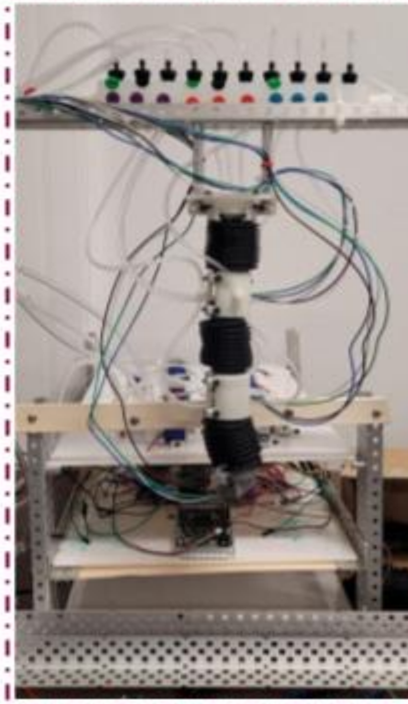
Fabrication & CAD (SAM)

Needs

- Three segments with strong air chambers
- Sensor for each segment
- Organized transportable stand for electronics
- Detailed fabrication process

Solutions

- Two types of silicone
- Developed optimal fabrication process
- CAD and 3D printed parts
- Created electronics "tower" and base



Top: SAM Module
Bottom: VEX Base
Right: Final Product

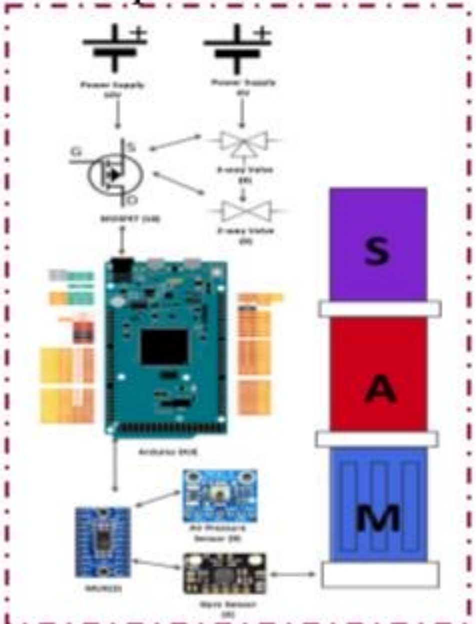
NM STATE

Maria-Adeliz Ordonez (ME//EE), Ryan Thompson (ME), Lucas Garcia (EP//EE), Brandon Gresham (EE)

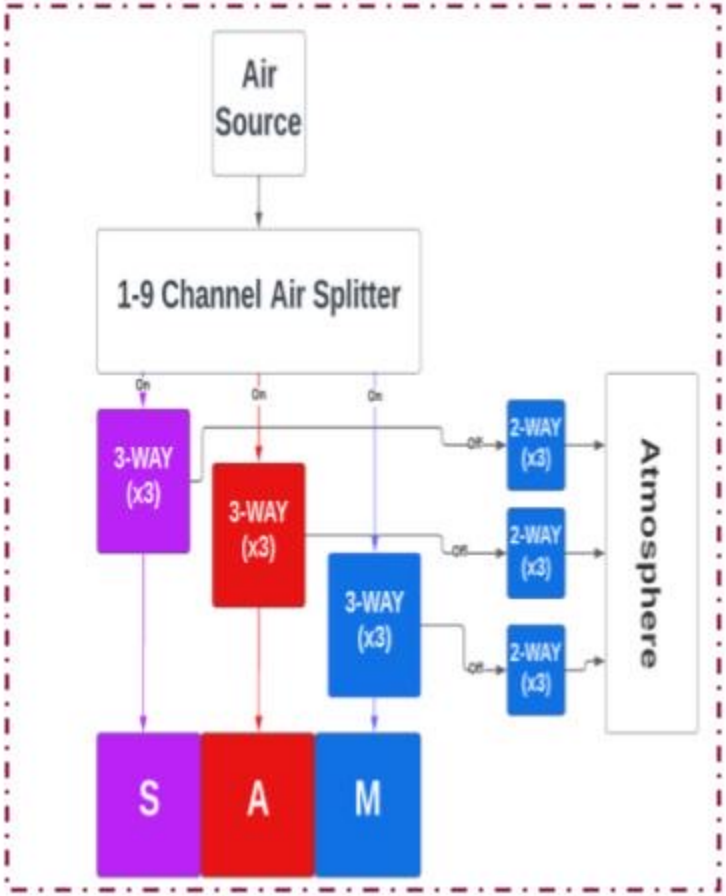
Code & Controls (SAM)

Electronics and Code

- **Inputs:** spherical coordinates (r, θ, φ)
- **Output:** specific orientation
  - Reverse kinematic equations



Pneumatics



Electronic (Left) & Pneumatic (Right) Control Diagram

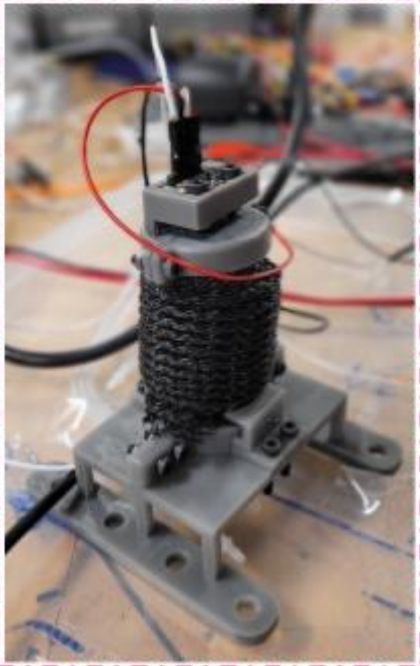
Maria-Adeliz Ordonez (ME//EE), Ryan Thompson (ME), Lucas Garcia (EP//EE), Brandon Gresham (EE)

Final Product

Soft-bodied Robotic Arm Module (SAM)

Goals achieved:

- Scale up to 3 segment SAM
- Reach a position in 3D space
- Customer satisfied



Fall 2021

Spring 2022

Pioneering a new frontier!

Questions?
Thank you!

Maria-Adeliz Ordonez (ME//EE), Ryan Thompson (ME), Lucas Garcia (EP//EE), Brandon Gresham (EE)

THE UNIVERSITY OF TEXAS AT ARLINGTON

Linear Transformer Driver

Lucas Contreras, Austin Davis, David Martinez

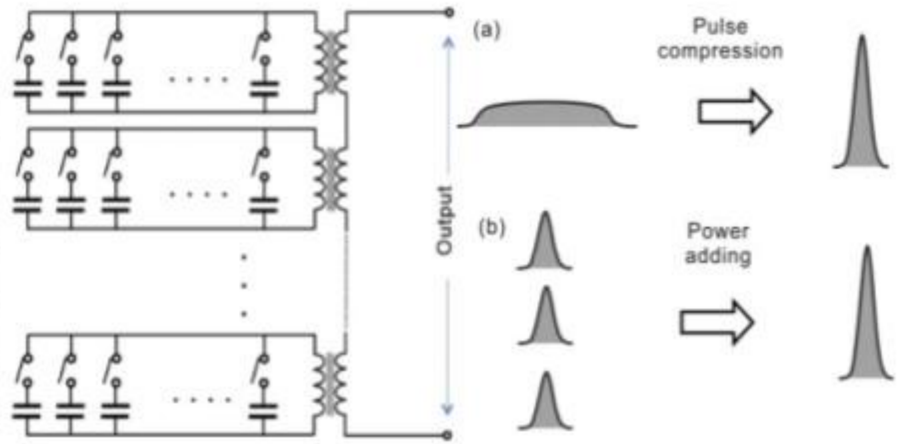
EXCELLENCE in SENIOR DESIGN

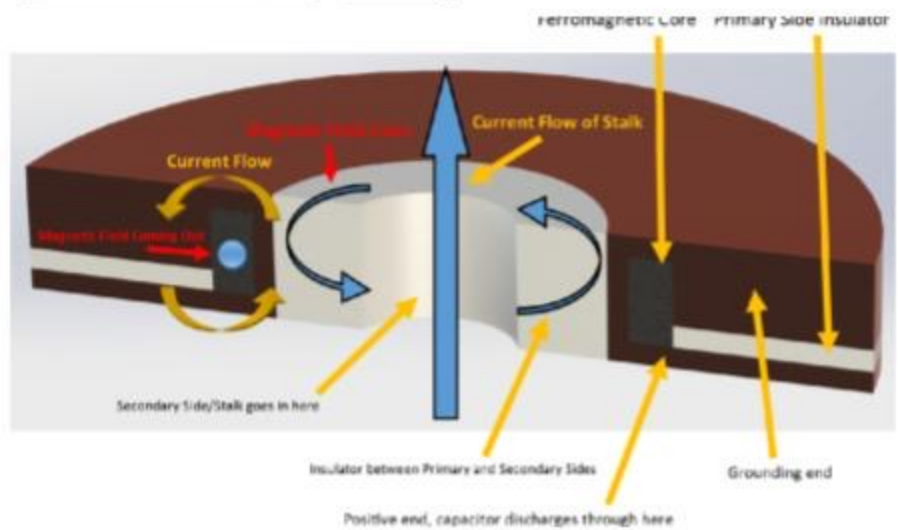
An Electrical and Computer Engineering Capstone Showcase

LINEAR TRANSFORMER DRIVER

Lucas Contreras(EE), Austin Davis(EE), David Martinez(EE)

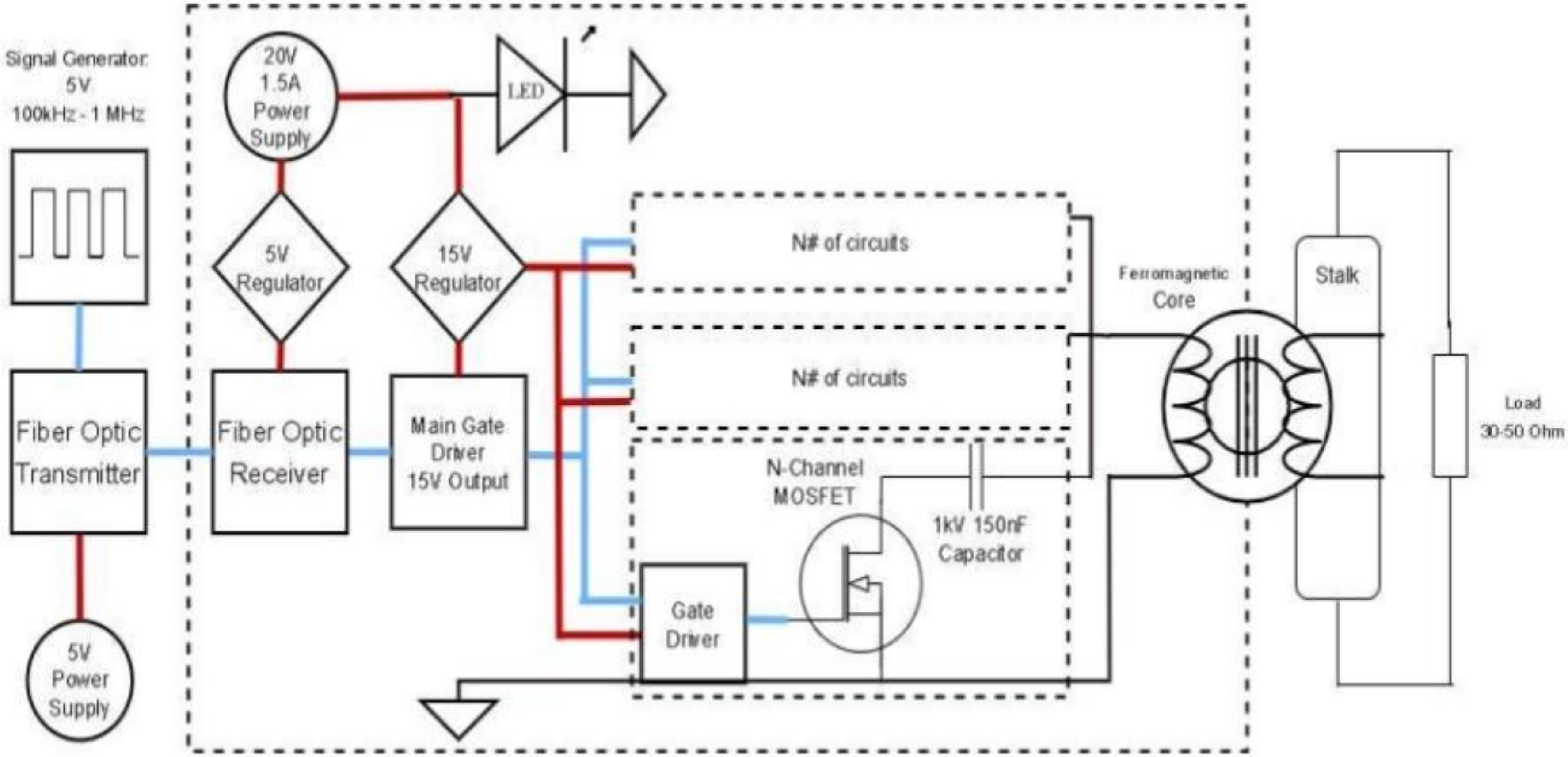
OVERVIEW: The Linear Transformer Driver is a pulsed power supply that works though the principle of voltage adding. As opposed to other pulsed power supplies, such as a Marx generator, the LTD utilizes many smaller, over the counter components that store energy storage and act as switches, reducing component stress while improving rise-time and obtaining waveform control. By firing multiple primary modules onto a common secondary of the transformer, lower voltage circuits are summed into one or multiple higher power pulses. A simple LTD module, capable of operation at 1kVDC, has been designed and studied at voltages as high as 120VDC. The eventual goal is to stack 30 bricks to achieve a 30kV output pulse with a rise time within nanoseconds. The design and results collected to date will be presented.





LINEAR TRANSFORMER DRIVER

Lucas Contreras(EE), Austin Davis(EE), David Martinez(EE)



UTA ENGINEERING

LINEAR TRANSFORMER DRIVER

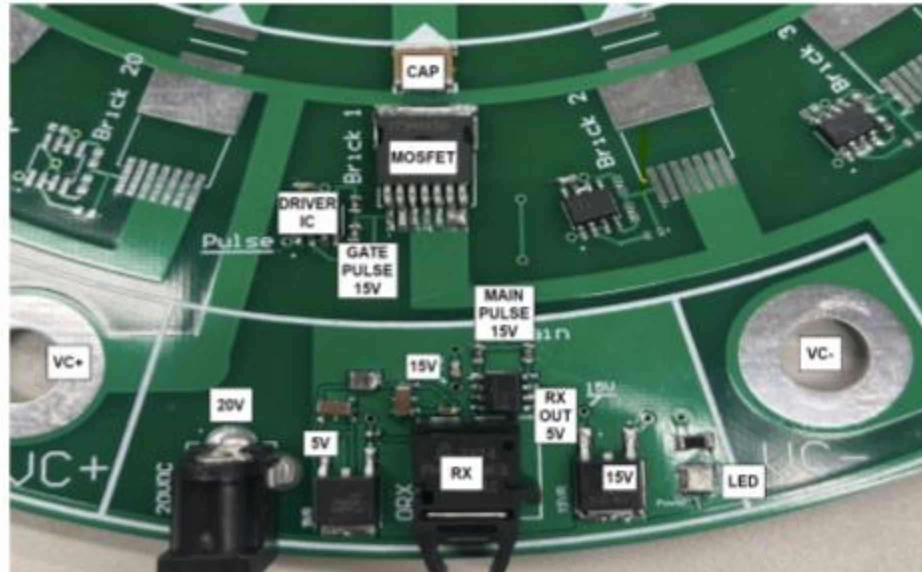
Lucas Contreras(EE), Austin Davis(EE), David Martinez(EE)

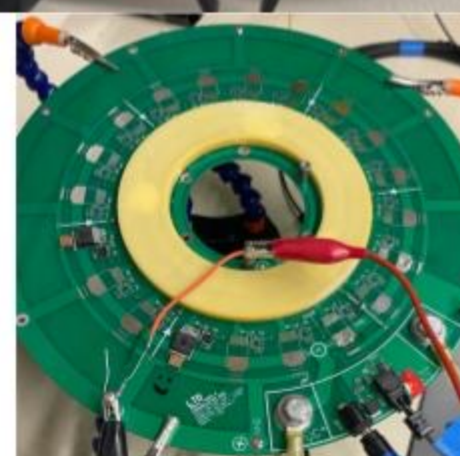
PULSED POWER & ENERGY LAB

One of the main benefits of using the LTD is that the components used in it are common "over the counter" components.

The components themselves only have to be rated for the Vcc charging voltage instead of the total output voltage as other systems out there with similar characteristics.

This LTD also uses MOSFETS as switches which allows us to control the output waves with the switching of the FETs.



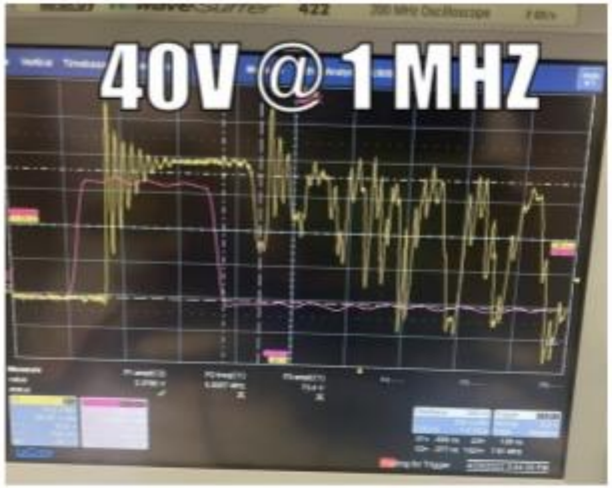


UTA ENGINEERING

LINEAR TRANSFORMER DRIVER

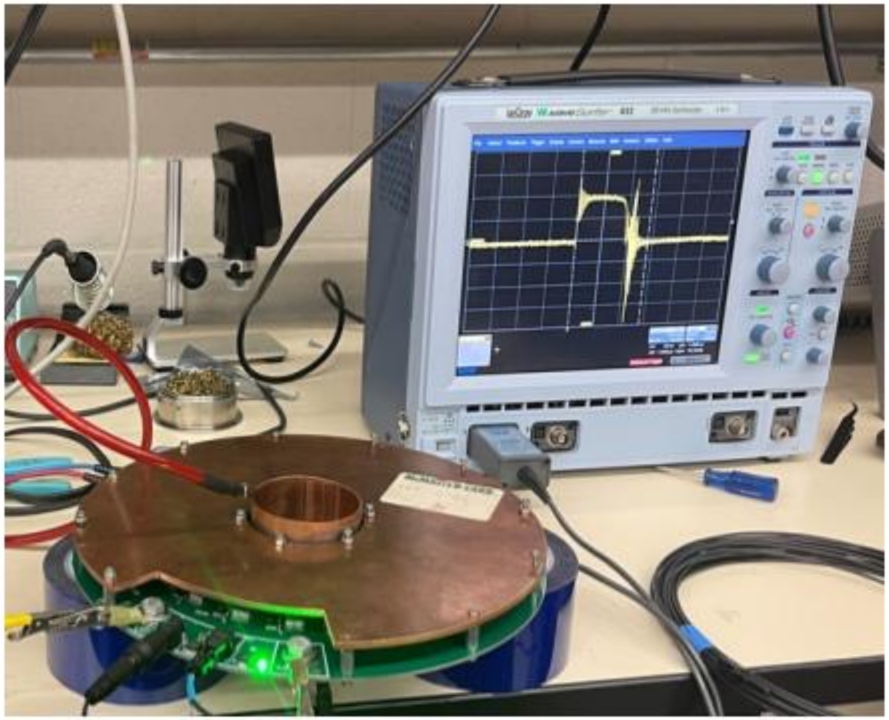
Lucas Contreras(EE), Austin Davis(EE), David Martinez(EE)

PULSED POWER & ENERGY LAB



LINEAR TRANSFORMER DRIVER

Lucas Contreras(EE), Austin Davis(EE), David Martinez(EE)



Following our design of the LTD, the last team will be implementing more control of the device. Once all modules are added, there will be a controller via a microcontroller or high speed device such as an FPGA board. Outputs of each module will be be able to be individually controlled to delay responses and sequences to determine the device's overall power amplitude and waveform shape. Safety concerns will be maintained more as a final design will include an all in one design for the controller and transmitting signal and charging sources rather than manually triggering the ross relay.

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Modi-Fly

Joshua Barron, Ruben Castillo, JD Wilson

EXCELLENCE in SENIOR DESIGN
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UTSA Joshua Barron (EE) Ruben Castillo (EE) JD Wilson (CPE)

Modi-FLY

UTSA®
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2022 ExCEllence in Senior Design

Dr. Yongcan Cao
Dr. Jonathan Votion
Joshua Barron - Electrical Engineering
Ruben Castillo - Electrical & Computer Engineering
JD Wilson - Computer Engineering
Karina Elizondo - Marketing

Limitations with Current Drones

- The current drone market is dominated by the Chinese company DJI.
- They have a drone for most tasks, from $1K cinematography drones to $20K agriculture drones.
- However, these drones are very specialized and have to be sent in for repairs. This means that their users typically must buy multiple drones for different tasks and when repairs are needed, they are expensive and take at least a month.

Our Background Research

- We talked to over 15 people in the drone industry. Including Drone Companies, Hobbyist, Cinematographers, and Researchers.
- The largest concerns are as follow:
  1. Price
  2. Form factor (collapsible to fit in a backpack)
  3. Sensors
  4. Sound
  5. Repairability

Our Solution

To meet these needs we developed an affordable drone that can be configured to fit multiple roles

Our drone can toollessly swap between:

- Arms
- Modules
- Batteries

This enables it to perform roles such as:

- Cinematography
- Deliveries
- Drone Light Shows

Joshua Barron (EE) Ruben Castillo (EE) JD Wilson (CPE)

Safety Software

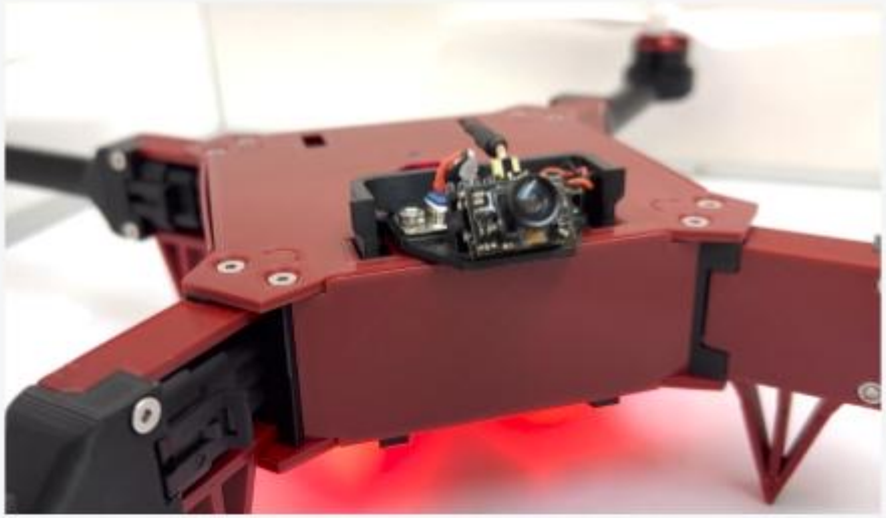
- To improve safety in the drone operation, we developed our own User interface
  - The user selects the modules they have attached
  - Our software tells the drone and uploads the correct flight parameters
  - Before takeoff the drone will check that the correct module(s) are attached
  - For advanced users there is a Compatibility option that allows hot swapping modules

Top Module Selection

Bottom Module Selection

How we meet the Market needs

1. **Cost:**
   a. The drone is more affordable ($271 for the basic drone package)
2. **Form factor:**
   a. Since the modules and arms are toolless, they can be quickly removed to fit the drone into a smaller package
3. **Sensors:**
   a. 8 Modules (5 distinct sensors)
4. **Sound:**
   a. Can toolessly swap to larger arms for a quieter configuration
5. **Repairability:**
   a. The user can replace single arm, module, or individual broken piece instead of replacing the drone



Smart Sign Language Glove

Andy Bui, Hamza Islam, Ninghao Shi,
Jimmy Nguyen, Eugene Lin, David Wang

UTDesign II — Smart Sign Language Glove

Team: 1377
Mentor: John Hansen

Andy Bui(EE) Hamza Islam(EE) Ninghao Shi(EE) Jimmy Nguyen(CE) Eugene Lin(CE) David Wang(EE)

Description / Background

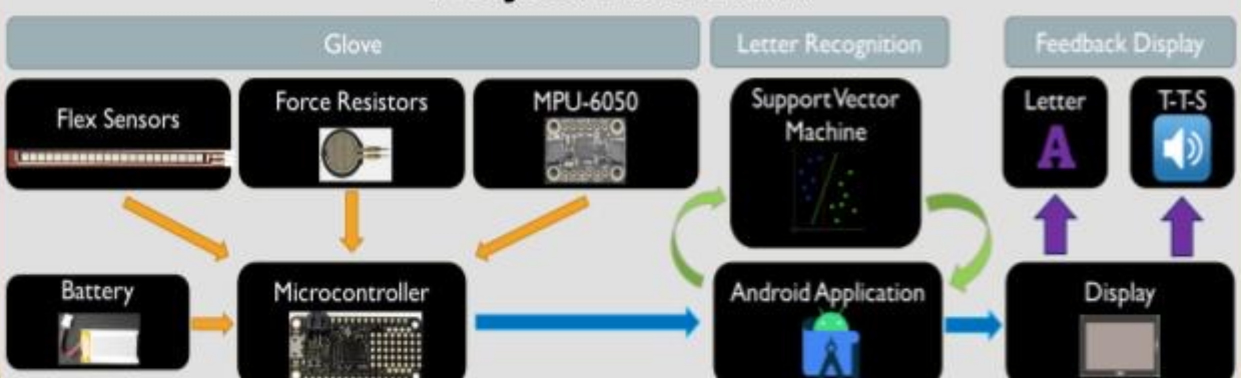
- Sign Language is the use of hand gestures and movement to simulate letters and phrases in order to communicate.
- ASL is the primary mode of communication of those with impaired senses with 10M Americans hard of hearing and 1M deaf.
- Goal is to encourage communities to become more ASL friendly. Make learning more accessible and welcoming.
- Create a glove that analyzes hand position and motion in order to translate into an English alphabetical letter.

Design

a) SD1 Prototype

b) SD2 Final Design

Project Flowchart



Performance Metrics

- Cost: ~$155
- Weight: ~1.5 oz
- Battery: 12+ Hours
- Glove Sensor to SVM Recognition Rate: **98%**
- DNN Alternative (Subject Independent): **98%**
- Frame Process Time: 50ms
- 3.3V Based Design
- Text-To-Speech

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Demonstration of D.A.V.I.D.

Mario Escarcega, Meghan Cephus, Donovan Caruso, Trung Le Ethan Osch, Nicolas Sheerin, Autumn Weber, Juliana Barstow, Nakii Tsosie, Quincy Bradfield, Skyler Hughes, Alex Bethel, Kimberley Kelso, Joseph Coston

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The Miner 49ers:
Demonstration of D.A.V.I.D.

ME: Mario Escarcega, Meghan Cephus, Donovan Caruso, Trung Le Ethan Osch, Nicolas Sheerin, Autumn Weber, Juliana Barstow, and Nakii Tsosie. EE: Quincy Bradfield. CS: Skyler Hughes, Alex Bethel, Kimberley Kelso, and Joseph Coston

Advisors: Dr. Arvin Ebrahimkhanlou and Dr. Seokbin Lim

New Mexico Institute of Mining and Technology

Sponsored By:

NASA RMC Lunabotics, Nuclear Waste Partnership LLC, NMT's AIAA Club, New Mexico Space Grant Consortium, NMT SGA, MechE Department, and NMT Academic Affairs

Demonstration of D.A.V.I.D

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Directed Autonomous Vehicle for Interspacial Digging

Goal: The primary goal of the project is to **design**, **build**, and **test** a lunar excavating robot such that it can support the Artemis mission along with NASA's Human Exploration and Operations Mission Directorate.

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Demonstration of D.A.V.I.D

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Critical Requirements

1. Weight ≤ 80 kg
2. Envelope Volume ≤ 1.1 x 0.6 x 0.6 m
3. Maximum Volume ≤ 1.1 x 0.6 x 1.5 m
4. Excavate regolith > 1 kg

Technical Performance Measurements

1. Successfully excavate, transport, and deposit collected regolith
2. Overcome any obstacles such as craters and boulders
3. Move and excavate in a timely and effective manner that is < 15 minutes
4. Implement safety measures to avoid any potential hazards
5. Implement autonomous behavior and mapping such that it can perform any of the above tasks

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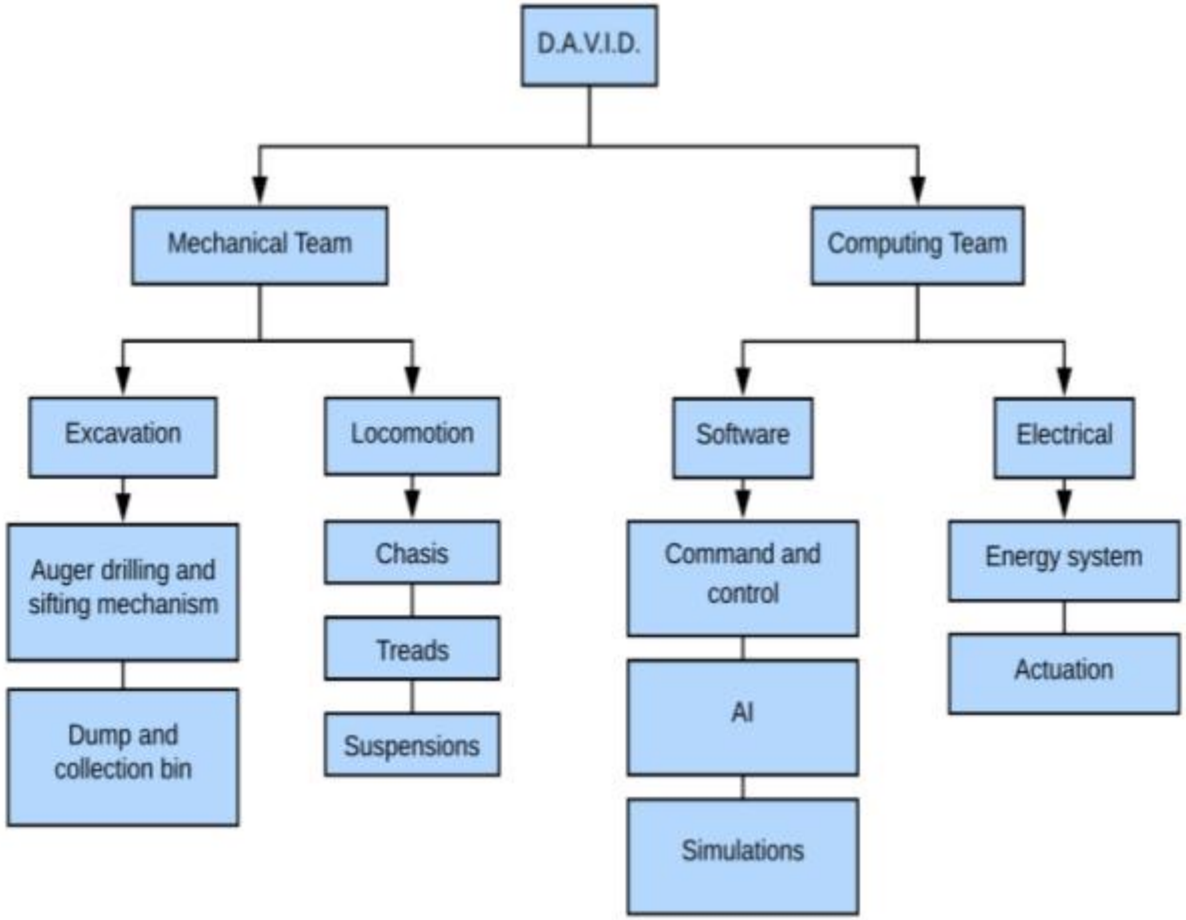

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Demonstration of D.A.V.I.D

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Proof of Life Video

Team Website

NMT Mechanical Engineering

NMT Graduate Studies

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Nanoscale Photonic Keys for Security Enhancement

Anthony Salazar, Jim Foster, Rithvik Ramesh,
Teddy Hsieh, Vivian Rogers

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An Electrical and Computer Engineering Capstone Showcase

Spring 2022 Honors Senior Capstone

Nanoscale Photonic Keys for Security Enhancement

University of Texas at Austin, Cockrell School of Engineering
Department of Electrical and Computer Engineering.

Faculty, Technical advisors:
Dr. Seth Bank, Venkata Suresh Rayudu

Team members:
Anthony Salazar (ECE), Jim Foster (ECE), Rithvik Ramesh (ECE + Physics), Teddy Hsieh (ECE + Chemistry), **Vivian Rogers (ECE)**

Problem Definition:

- Need for **high-security**, **physical** lock and key system
- Strong anti-counterfeiting
- Large-scale, CMOS-compatible manufacturing

Problems to address:

- Vulnerabilities of conventional authentication methods (e.g. physical keys, RFID, passwords)
- Ease of **counterfeiting**
- **Human error**
- Difficulty detecting data breaches

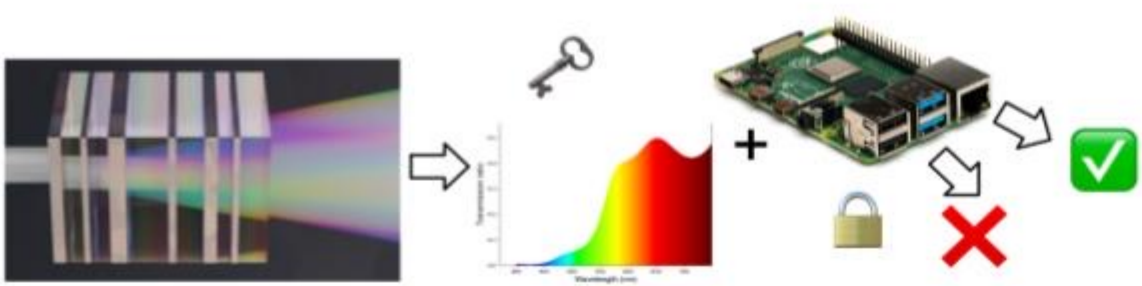
Solution: Optical Physical Unclonable Functions

PUF:

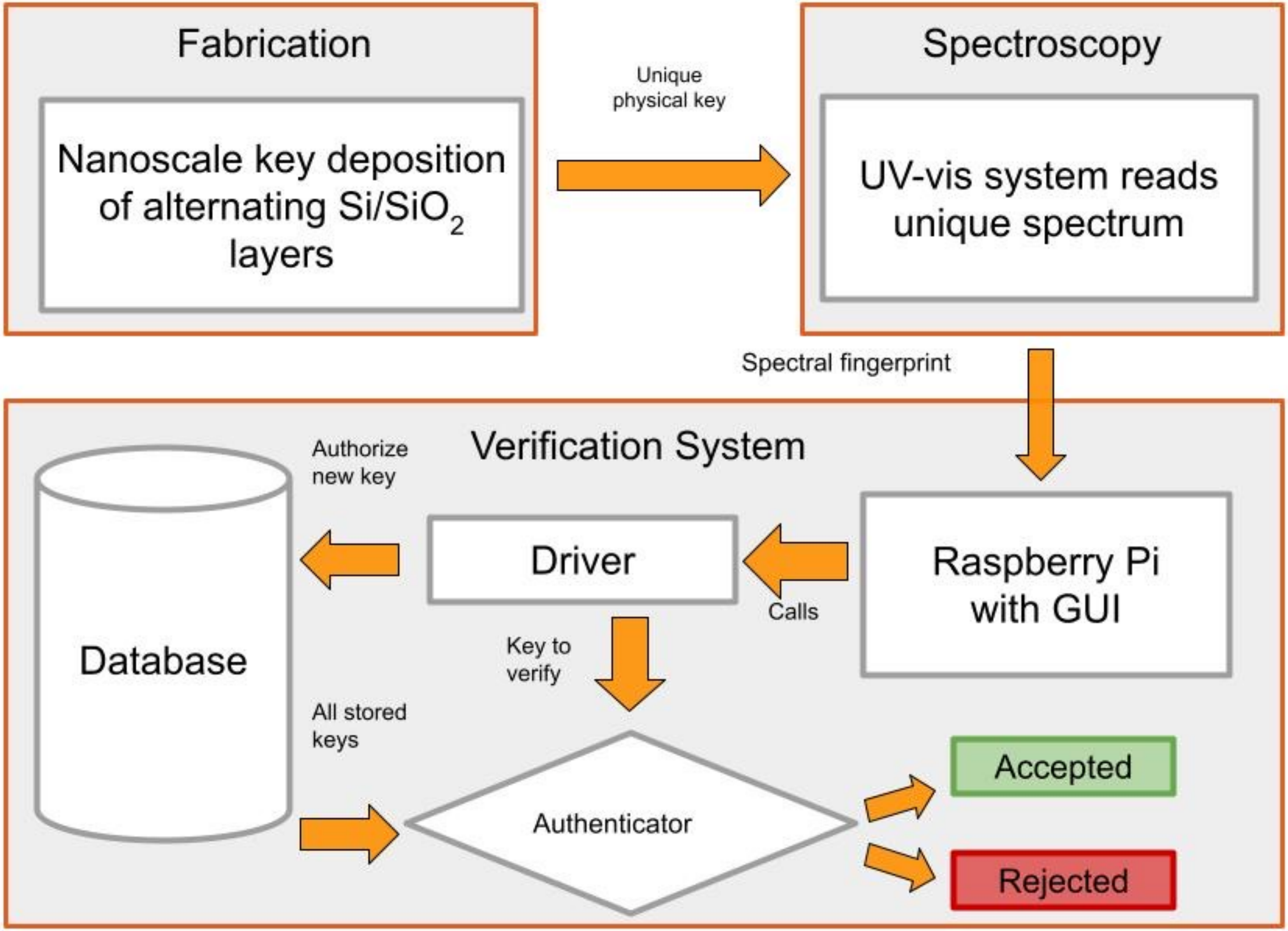
- **Physical** device/structure
  - Prevent digital vulnerabilities - Rowhammer, NVM copies
  - Less user error
- **Unclonable** -> data leak protection
  - Manufacturing require nanofabrication
  - Inherent variations in fabrication
    - Impossible to duplicate
- **Function** -> each input receives instance-specific response

Implementation: "Photonic quasicrystals"

- ~10 to 200 nm thin films of Glass/Silicon
- Unique structure -> unique optical spectrum
  - Unique solutions to maxwell's equations
- Complements existing security system

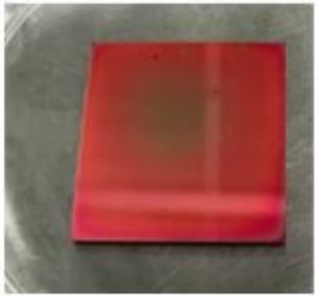


Optical PUF   Unique spectrum   Lock / authenticator

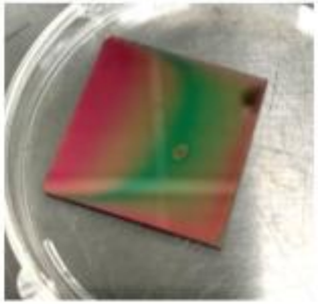

Fabrication
Nanoscale key deposition of alternating Si/SiO_2 layers
Unique physical key
Spectroscopy
UV-vis system reads unique spectrum
Spectral fingerprint
Verification System
Authorize new key
Database
Driver
Calls
Raspberry Pi with GUI
Key to verify
All stored keys
Authenticator
Accepted
Rejected

Hardware: Key fabrication and spectral UV-vis measurements

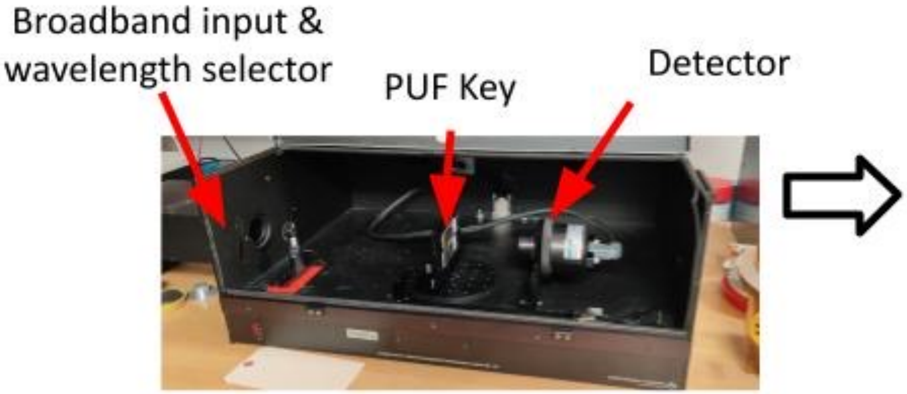
- Keys deposited using Plasma-Enhanced Vapor Deposition
  - **(PECVD)**
- Alternating **silicon/glass thin films** on glass substrate
- **3 prototypes:** 4 layer **α**, 14 layer $\boldsymbol{\beta_1}$, 14 layers $\boldsymbol{\beta_2}$
  - Calibrate deposition rates using ellipsometry
  - No cracks/bubbles from alternating material deposition
  - Inducing spatial variations to differentiate keys
    - Cleave sample into many keys
- Transmission spectra measured using UV-vis spectroscopy

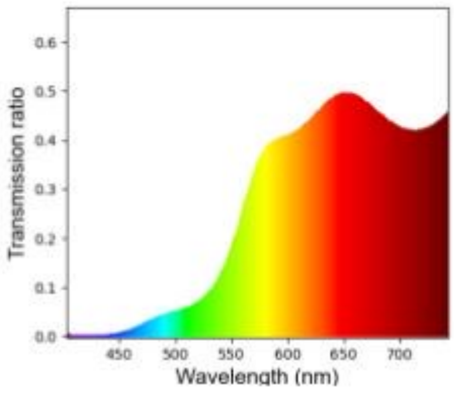


Chip $\boldsymbol{\beta_1}$

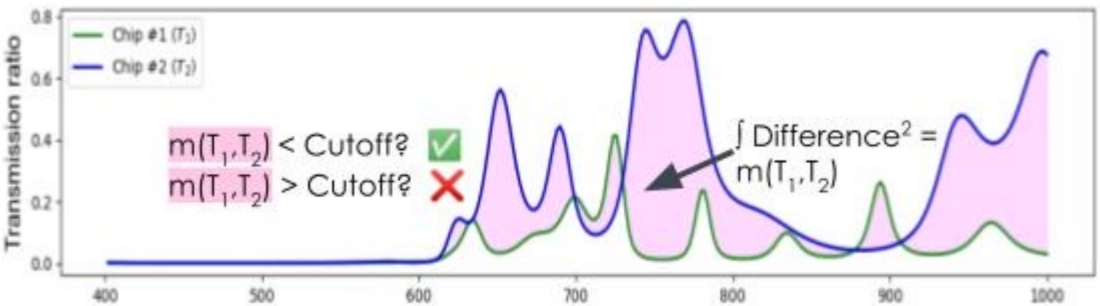


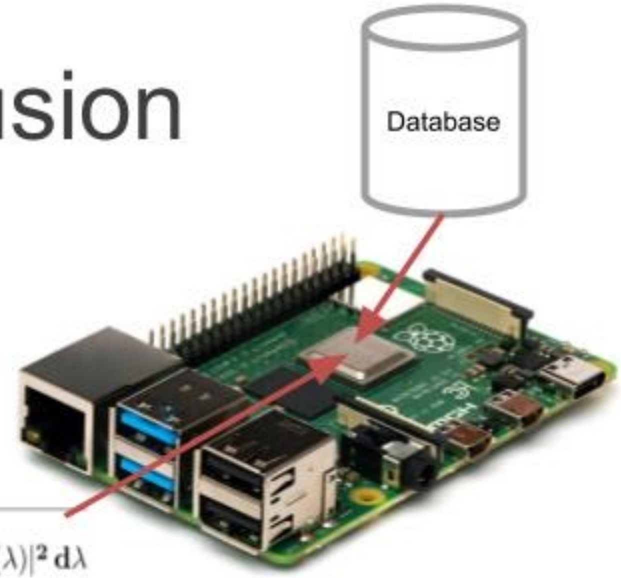
Chip $\boldsymbol{\beta_2}$





Software testing and conclusion





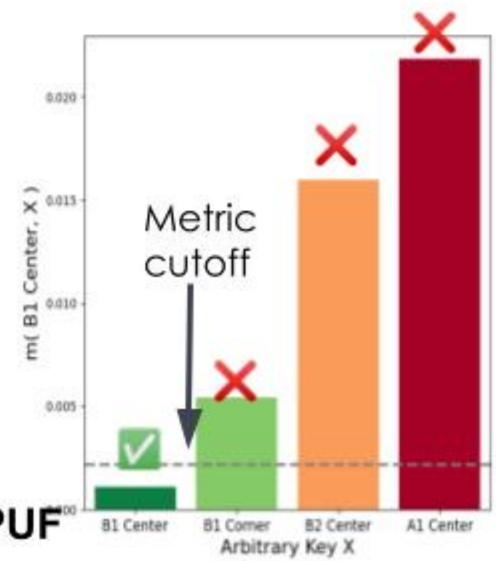
$$\mathbf{m(T_1, T_2)} = \frac{1}{\lambda_2 - \lambda_1}\sqrt{\int_{400nm}^{1000nm} |\mathbf{T_2}(\lambda)) - \mathbf{T_1}(\lambda)|^2\, d\lambda}$$

Raspberry Pi authentication system:

- GUI and driver written in python
- Build up on-board database with known key spectra
- Calculate differences using metric
- Sort matches from lowest to highest
- Key identified if metric difference under cutoff

Results:

- **Keys consistently identified**
  - Each point on chip has unique spectral fingerprint
- Proof-of-concept demonstrated for **CMOS-compatible optical PUF**



TEXAS TECH UNIVERSITY

Autonomous Wind Turbine System

Trey Gloeckler, William Mynatt

EXCELLENCE in SENIOR DESIGN

An Electrical and Computer Engineering Capstone Showcase

Autonomous Wind Turbine System

Trey Gloeckler (CE) and William Mynatt (EE)

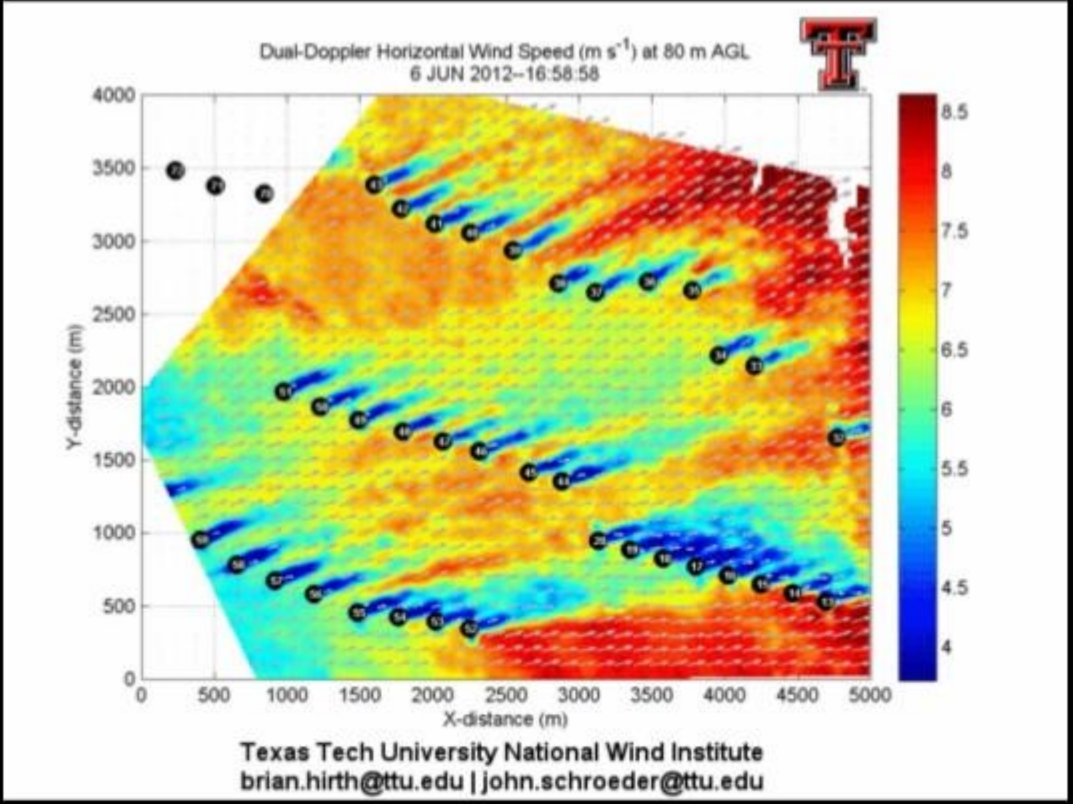
May 20th, 2022

Autonomous Wind Turbine System

Trey Gloeckler (CE) and William Mynatt(EE)

System Goal:

Understand the wake effects and get the best aerodynamics performance of the wind turbine.



Solution:

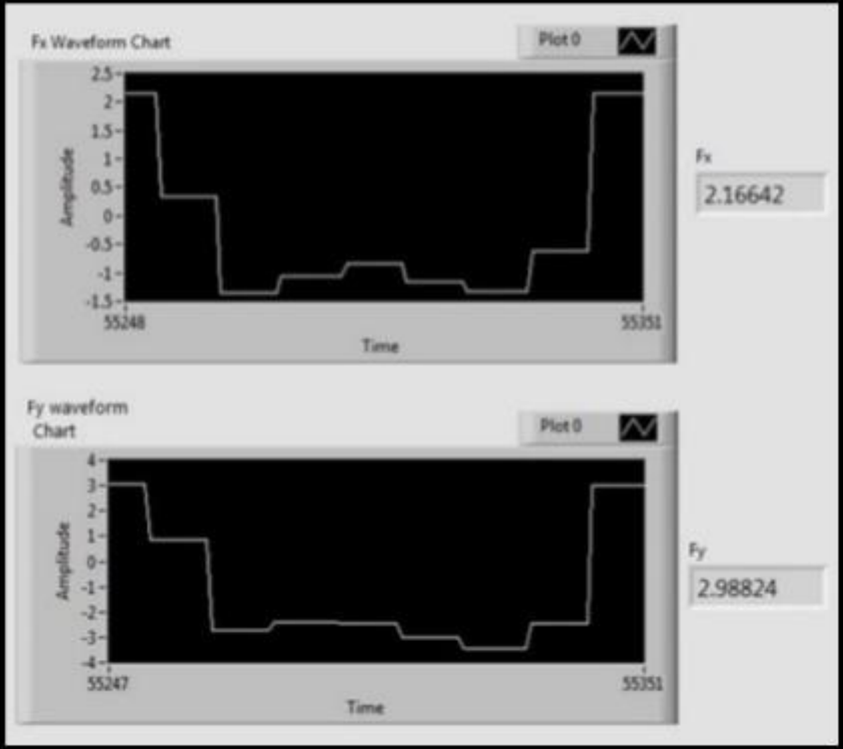
Measure the forces, wind speed and turbine performance and control turbine yaw, rotor speed, and blade pitch.

Autonomous Wind Turbine System

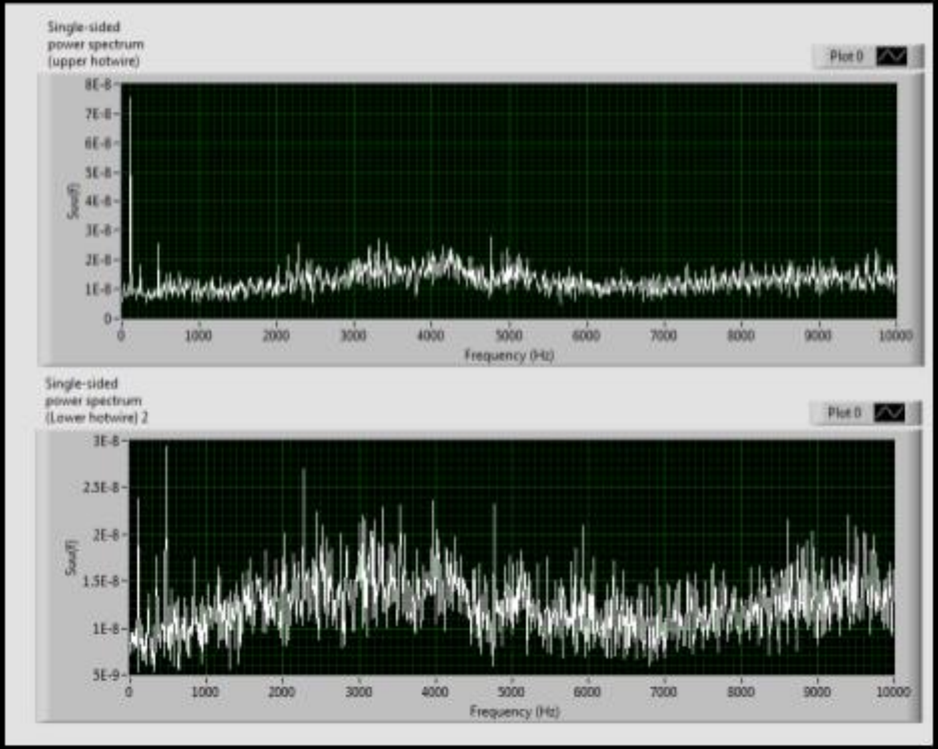
Trey Gloeckler (CE) and William Mynatt(EE)

System Inputs:

Forces Acting on the Turbine Tower

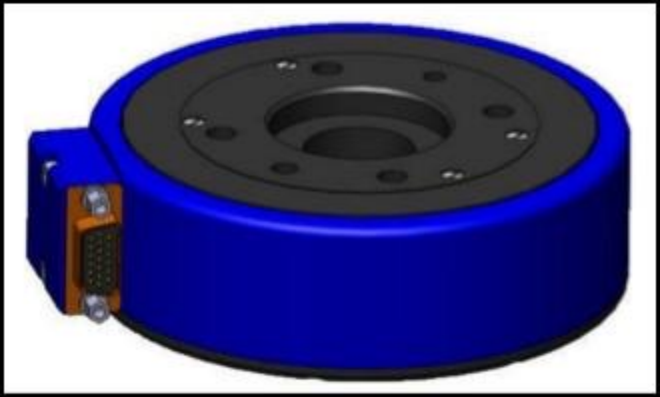


Air Turbulence Created by Turbine Blades

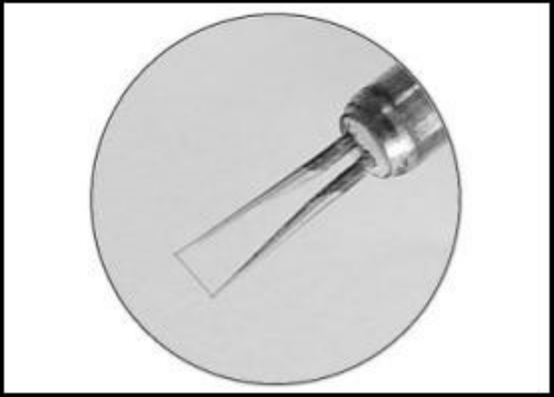


Autonomous Wind Turbine System

Trey Gloeckler (CE) and William Mynatt(EE)



JR3 Force/Torque Transducer



Hot Wire Sensor

Autonomous Wind Turbine System

Trey Gloeckler (CE) and William Mynatt(EE)

System Outputs:

- Turbine Tower Yaw control.
- Blade Pitch Control
- Turbine Speed Control

Zaber Motor Controller

Servo Driven Pitching Mechanism

Advanced Firefighter Mesh Network

Harold Robinson, Nigel Damian-Reyes, John Prosper, Luke Pellegrino,
C. Cherry, Justin Lancaster, Misael Ramos,

EXCELLENCE in SENIOR DESIGN

An Electrical and Computer Engineering Capstone Showcase

ADVANCED FIREFIGHTER MESH NETWORK

HAROLD ROBINSON (EE), NIGEL DAMIAN REYES (CE), LUKE PELLEGRINO (EE), JOHN PROSPER (EE),
CHERRY CHESNYA (CE), MISAEL RAMOS (EE), JUSTIN LANCASTER (EE)

ELECTRICAL & COMPUTER ENGINEERING

UT DALLAS

TOGETHER WE CAN
REDUCE THE CASES OF INJURY OR LOSS OF LIFE TO FIRST RESPONDERS

There has been a strong need in the first responder and firefighting communities for a system that provides real-time status updates of the conditions and hazards within their operating environment.

U.S. Fire Administration (USFA) Reports
102 Firefighter On-Duty Casualties in 2020

- 37 from Stress or Overexertion
- 36 from COVID-19
- 15 from Vehicle Crashes
- 4 from Building Collapse
- 3 Trapped
- 2 Out of Air
- 2 Struck by Debris
- 1 Fall
- 2 Other

This leads to a need for mitigation of potential loss of life due to a lack of situation awareness.

Our solution is to reduce the cases of injury or loss of life to first responders by:

- Making Communication Backbone
- Active Monitoring
- Promote Situational Awareness
- Facilitate Rapid Deployment

ADVANCED FIREFIGHTER MESH NETWORK

HAROLD ROBINSON (EE), NIGEL DAMIAN REYES (CE), LUKE PELLEGRINO (EE), JOHN PROSPER (EE), CHERRY CHESNYA (CE), MISAEL RAMOS (EE), JUSTIN LANCASTER (EE)

HoloLens Enhanced Situational Awareness

Designed to complement existing systems: Bluetooth sensors BioHarness

- *Posture*
- *Temperature*
- *Accelerometer*
- *Heartrate*
- *Respiratory rate*

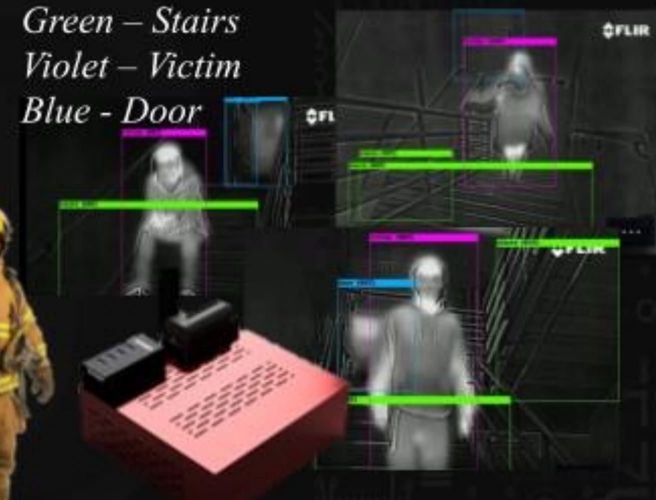
FireFlyMesh:
Internet of Thing applications keeping you and your team connected

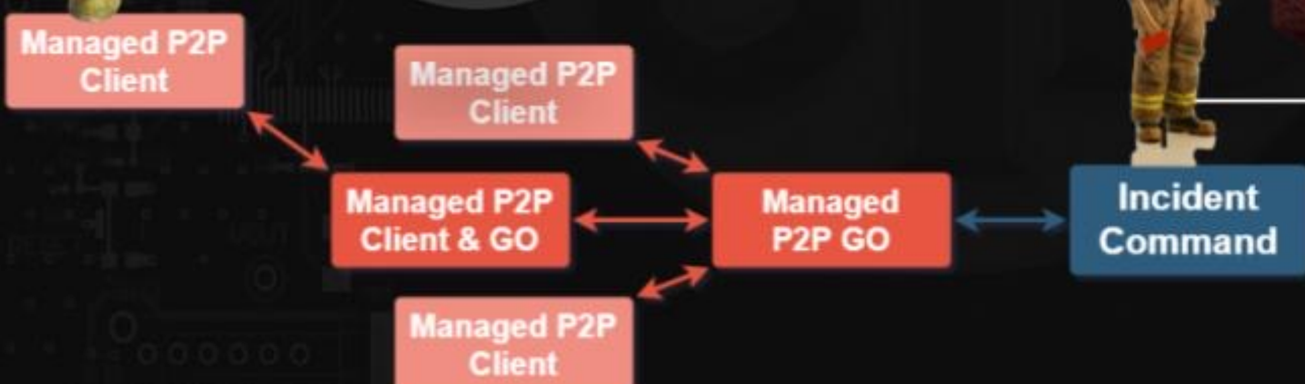
Sister Team

Cyber Firefighter Vision System

HoloLens Processing & Display: Establish a machine learning based object detection application for thermal video feed. Identify Stairs, doors and victims.

Green – Stairs
Violet – Victim
Blue - Door





It gives everyone on scene and off full informational visibility so they can make informed decisions quickly and confidently.

ADVANCED FIREFIGHTER MESH NETWORK

HAROLD ROBINSON (EE), NIGEL DAMIAN REYES (CE), LUKE PELLEGRINO (EE), JOHN PROSPER (EE),
CHERRY CHESNYA (CE), MISAEL RAMOS (EE), JUSTIN LANCASTER (EE)

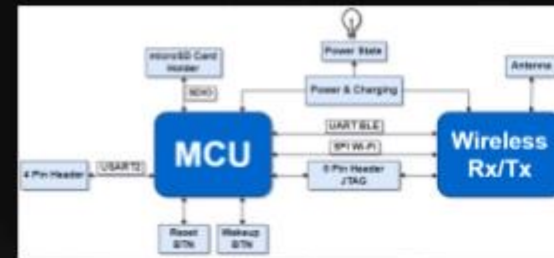
Demonstrated Performance:

- 200 Mbps transfer rate (roughly 24 MB/s) Over Wi-Fi
- 5 Simultaneous Device Connections

Software testing performed on similar development hardware.

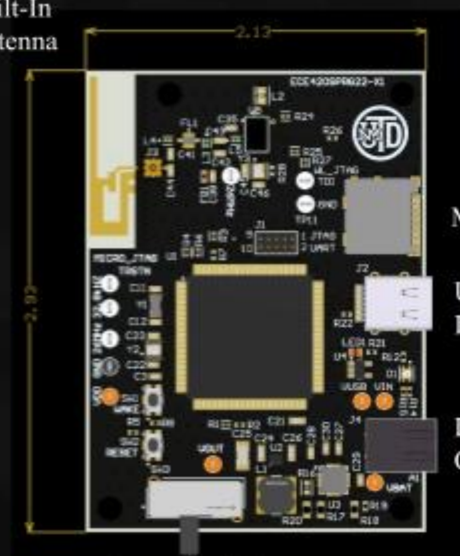
Designed for Manufacturability:

- Power Efficient Build
- Small Form Factor
- Meets IPC Class 3 Standards



Due to budgetary constraints, fabrication is expected to begin Summer 2022.

Built-In Antenna



MicroSD Slot

USB Type C Interface

Li-Ion Battery Connection

Power Switch (Prototype Only)

University of New Mexico

Sponsor: Dr. Eric Hamke

Harold Robinson

Project Manager

Nigel Damian-Reyes

Software Lead

John Prosper

Hardware

Luke Pellegrino

Software/Hardware

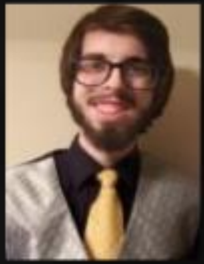
University of Texas at Dallas

Sponsor: Dr. Marco Tacca

Cherry Chesnya

Simulation Lead

Justin Lancastar



Software/Hardware

Misael Ramos

Simulation

University of New Mexico

Sponsor: Dr. Eric Hamke

CYBER FIREFIGHTER VISION TEAM

Qingquan (Kevin) Cui

Project Manager

Josiah Castaneda

Training & Software

Priya Bhakta

Testing & Systems

Ceenu Shaji

Training & Systems

Personal Temperature Regulation Vest

Caleb Broodo, Tung Vu, Aldo Casco, Cordell Messina

EXCELLENCE in SENIOR DESIGN

An Electrical and Computer Engineering Capstone Showcase

Personal Temperature Regulation Vest

Caleb Broodo (EE), Tung Vu (EE), Aldo Casco (EE), Cordell Messina (EE)

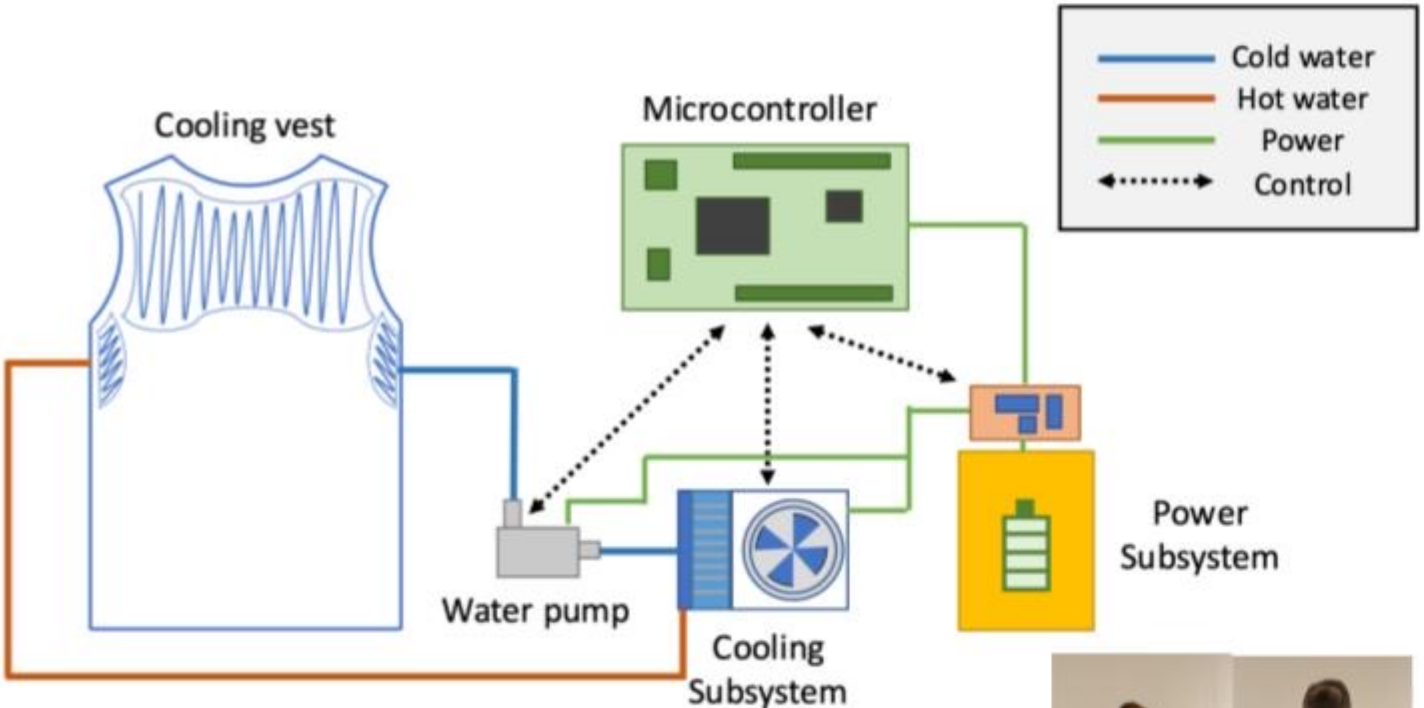
Background

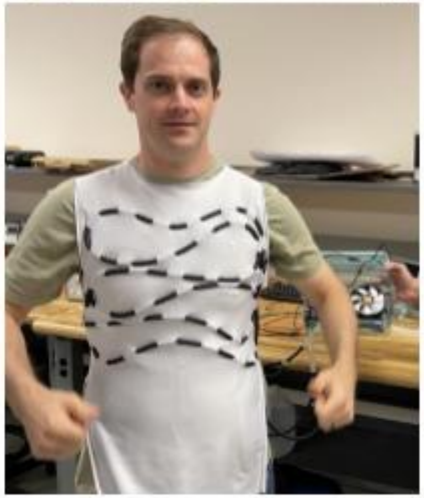
- **Introduction:**
  - More than 2 millions construction workers, landscaping workers in the US
- **Problem:**
  - Occupational heat stress
- **Goal:**
  - Remove trapped core heat
  - Features:
    - Ergonomic, lightweight for laborers
    - Control amount of cooling
- **User analysis**
  - Major occupational hazard is heat
  - Low-cost, easy-to-use, and durable

Personal Temperature Regulation Vest

Caleb Broodo (EE), Tung Vu (EE), Aldo Casco (EE), Cordell Messina (EE)

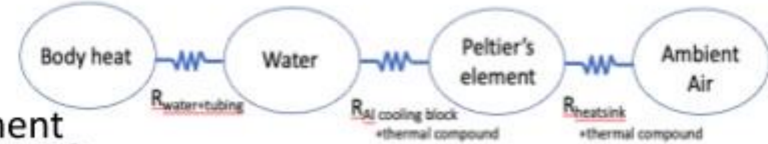
Overview Diagram



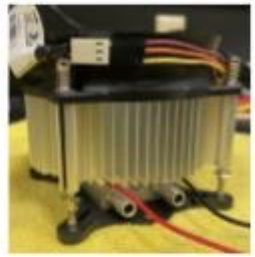


Caleb Broodo (EE), Tung Vu (EE), Aldo Casco (EE), Cordell Messina (EE)

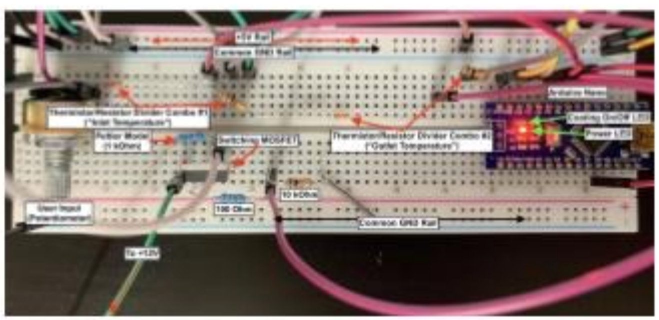
Cooling and Temperature Control

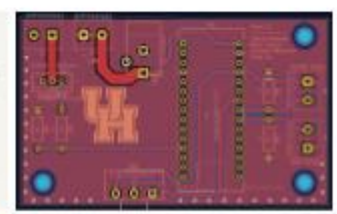


- **Cooling:**
  - Cool the coolant, extract heat from system to environment
  - Components:
    - Water cooling block
    - Peltier's element
    - Heatsink & fan combo
    - Thermal compound



- **Temperature Control:**
  - Take user input and adjust liquid temperature
  - Components:
    - Microcontroller (Arduino Nano)
    - Switching device (MOSFET)
    - Thermistor
    - Potentiometer





Caleb Broodo (EE), Tung Vu (EE), Aldo Casco (EE), Cordell Messina (EE)

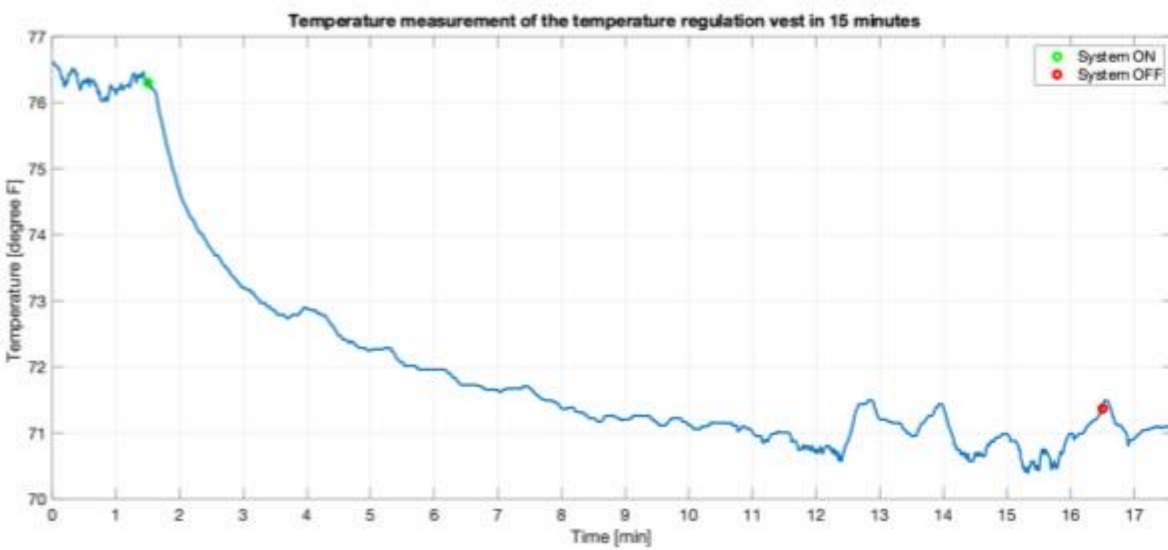
Coolant and Power

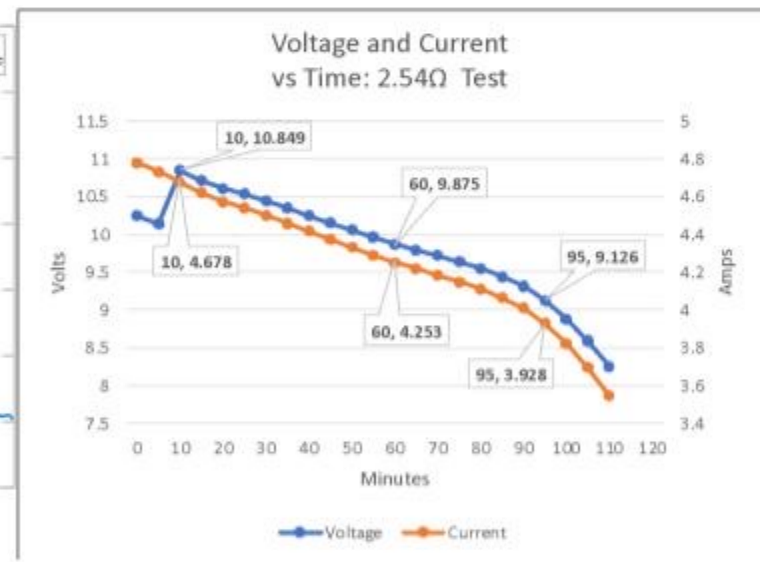
- **Coolant:**
  - To house, move liquid coolant throughout vest
  - <u>Components:</u>
    - Pump
    - Tubing system
- **Power:**
  - Delivery of power to other subsystems
  - Provide necessary operating voltages and currents
  - <u>Components:</u>
    - Battery (12V, 6A max, 135Wh capacity)

Caleb Broodo (EE), Tung Vu (EE), Aldo Casco (EE), Cordell Messina (EE)

Results

- Fully function system
- Lab measurement:
  - 5°F drop in 11 minutes, hold 71°F
  - 1hr 40min run time
- User experience test:
  - Comfortable for outdoor conditions
  - Ergonomic





US Army Advanced Futures Command Cybersecurity Tutor

Javier Arellano, Hazel Mc Kenzie, James Mc Kenzie, Oscar Urbina

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Javier Arellano, Hazel Mc Kenzie, James Mc Kenzie, Oscar Urbina
University of Texas at El Paso
Department of Electrical and Computer Engineering
Senior Design II
Spring 2022

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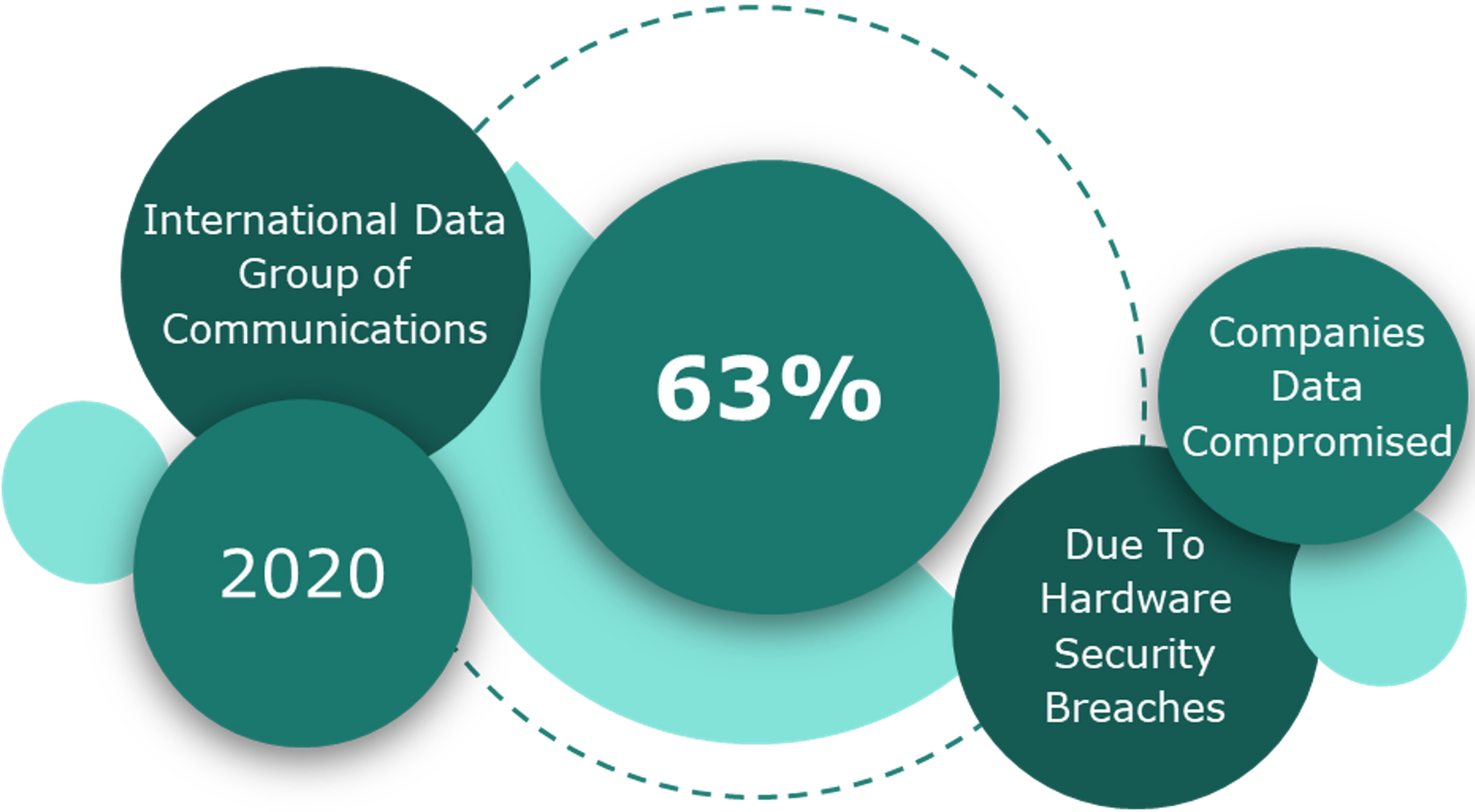

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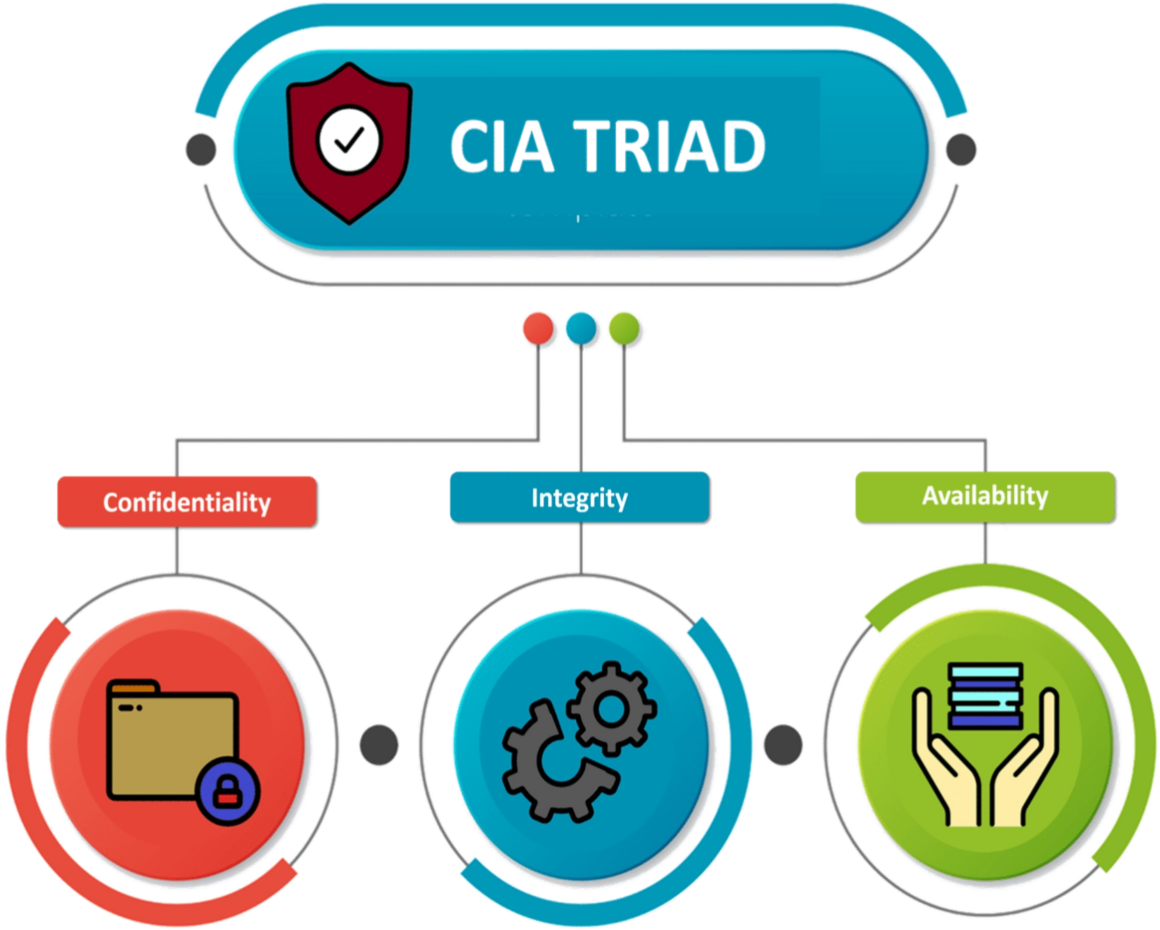
Senior Design II Spring 2022

Develop a cybersecurity tutor for college level, US Army personnel



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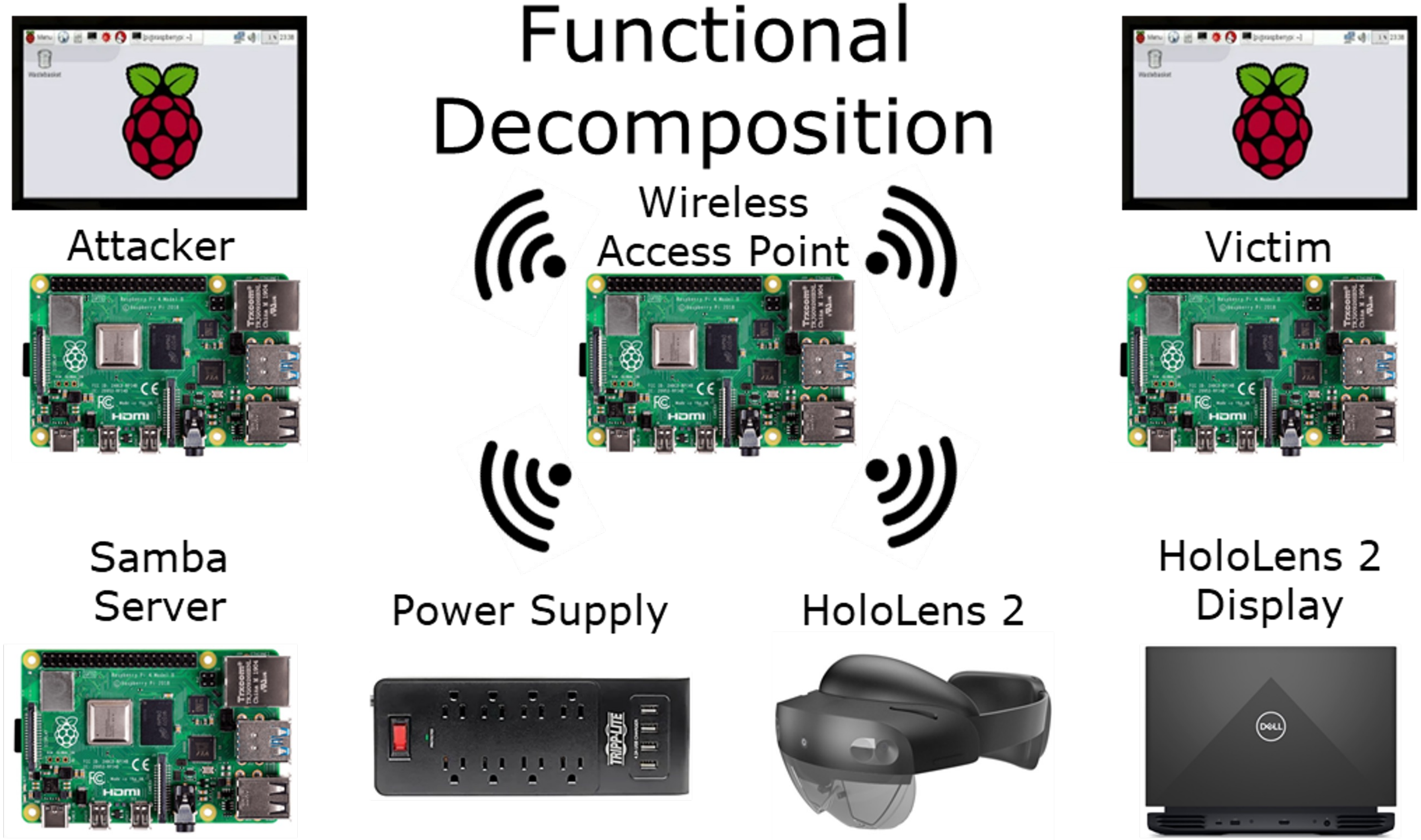
Functional Decomposition



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Department of Electrical and Computer Engineering
Senior Design II Spring 2022

HoloLens 2

THE UNIVERSITY OF TEXAS AT TYLER

Sensor Acquisition Verification/Validation Yield Kit

Nathan McNamara, Devon Wade, Efrain Tavera,
Maxwell Ugbebor, Conrad Fjetland

The SAVVY Kit

Nathan McNamara (EE), Devon Wade (EE),
Efrain Tavera (EE), Maxwell Ugbebor (EE) and Conrad Fjetland (EE)

EXCELLENCE in SENIOR DESIGN

An Electrical and Computer Engineering Capstone Showcase

Sensor Acquisition Verification/Validation Yield Kit

Sponsored by: Trane Technologies

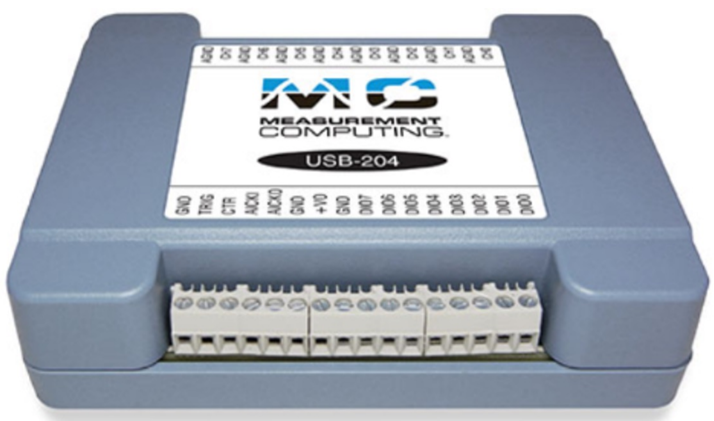
Project Supervisor: Dr. Jounsup Park

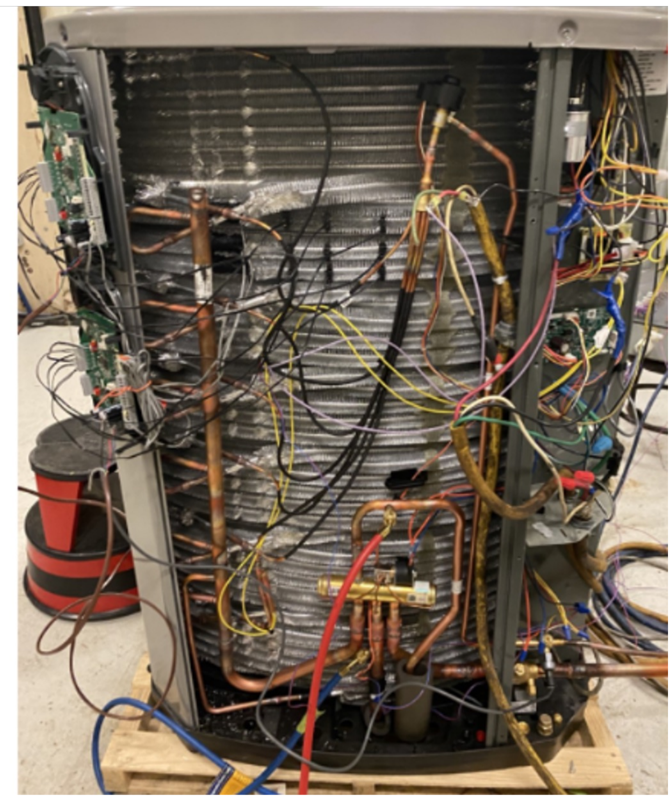
The SAVVY Kit

Nathan McNamara (EE), Devon Wade (EE),
Efrain Tavera (EE), Maxwell Ugbebor (EE) and Conrad Fjetland (EE)

Problem Statement

- Data Acquisition of HVAC Parameters
- Log Temperature and Pressure Data
- Current solution is inadequate
- Requires too much user input and network connection



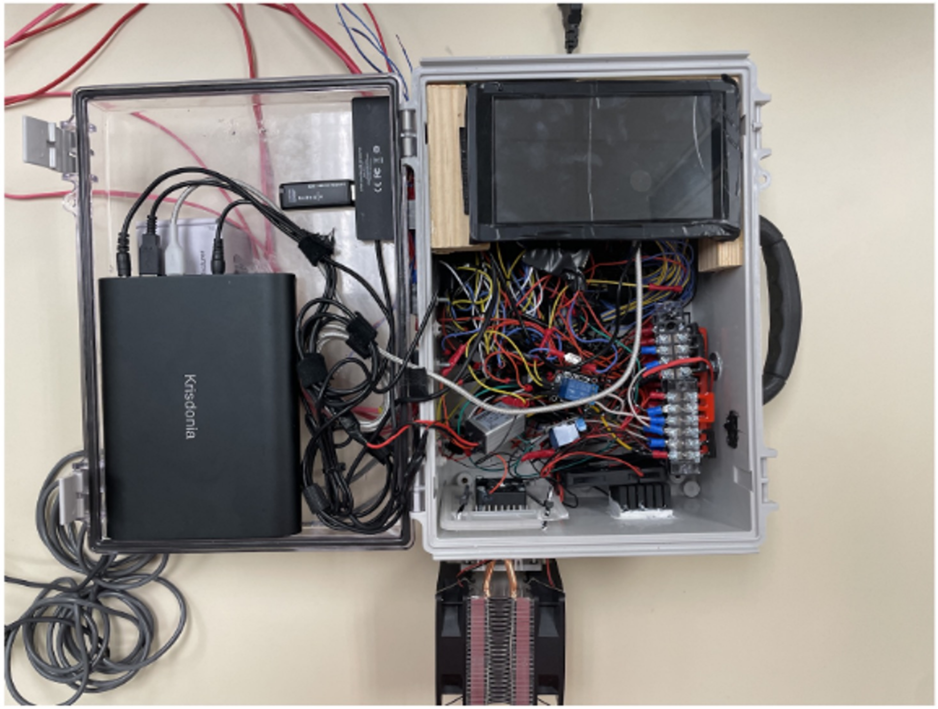


The SAVVY Kit

Nathan McNamara (EE), Devon Wade (EE),
Efrain Tavera (EE), Maxwell Ugbebor (EE) and Conrad Fjetland (EE)

Solution: The SAVVY Kit

- Processing Subsystem
  - Raspberry Pi 4
  - 3 MCC 118 DAQ HAT
  - 2 MCC 134 DAQ HAT
- User Interface
  - 7” Touchscreen
- Power Subsystem
  - 50,000 mAh passthrough battery
- Thermal Management Subsystem
  - Heating and cooling using Peltier technology



Nathan McNamara (EE), Devon Wade (EE),
Efrain Tavera (EE), Maxwell Ugbebor (EE) and Conrad Fjetland (EE)

Functionality and Performance

- **Multi-Sensor Compatibility: 8 Thermistors, 8 Thermocouples, 2 Pressure Sensors**
- **Sampling Rate: 0.033-1 Hz (Sample interval: 1 to 30+ seconds per sample)**
- **Data stored in USB flash drive: 32 GB**
- **Temperature Range: -20 Celsius to 65 Celsius**

SMU | LYLE SCHOOL OF ENGINEERING

Adaptive Irrigation System

Elliot Boesch, Will Egan, Ross Garrett,
Dalia Quezada Campos, Ashley Terrill

EXCELLENCE in SENIOR DESIGN

An Electrical and Computer Engineering Capstone Showcase

Adaptive Irrigation System

SMU Lyle School of Engineering

Elliot Boesch (CPE), Will Egan (EE), Ross Garrett (EE), Dalia Quezada Campos (EE), Ashley Terrill (ME)

Texas Instruments

Background

Water scarcity is becoming a problem in our society as global warming worsens & water usage increase. To tackle this problem, we wanted to emphasize improving how homeowners water their lawns because 30% of household water usage is outdoor water and 50% of this water used is wasted.

Goals

- Affordability to Consumer
- Measure Moisture
- Use Moisture to Water Plants
- Wireless Capability
- Leak Detection
- Online User Control of Sprinklers

Challenges

When building our prototype, some challenges we faced were:

- Finding out that our flow meter was defective from the manufacturer.
- Wi-Fi functionality using TI Launchpads.
- Waterproof capabilities of moisture sensor.
- Appropriately pressure sealing the piping system.
- Trouble shooting water hammering.

SMART SPRINKLER

Approach

Capacitive Moisture Sensor:
Adafruit moisture sensor has I2C interface to the pi and gives a reading from 200-2000

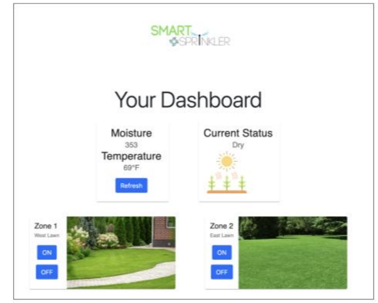
Raspberry Pi:
The raspberry pi collects the soil moisture and flow meter data and communicates to the website

Ultrasonic Transducers:
The cold-water ultrasonic transducer collects data that can be used to calculate water flow rate

TI Ultrasonic Sensing Evaluation Module:
Calculates flow rate from ultrasonic transducer data and communicates this data to the raspberry pi.

Solenoid Water Valves :
Dual solenoid water valves allow separate control of two watering zones with a signal from the Raspberry Pi

Website



Our Tech Stack

LOSANT
Pantry
python
React

Summary

Our adaptive irrigation system is an affordable, user-friendly addition to a manual sprinkler system that helps prevent water waste and ensure lawn health.

- Allows the user to use water more efficiently by letting the system turn off and on sprinklers depending on moisture in the soil.
- Alert the user of any leaks in their sprinklers so it can be shut down through our website, preventing water waste.
- Calculate and show water usage by the system to evaluate water savings and trends.

Acknowledgements

The team appreciates greatly the financial support by Texas Instruments.

We would also like to thank Michael Zwerg, Sal Barraza, and Sreenivasan Koduri's for their valuable technical support and guidance.