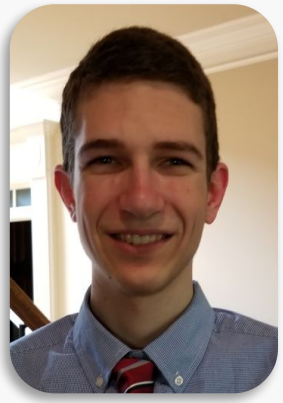

# Capstone Expo: An Optimal Drone End-Effector for Vegetation Pruning

Team Name: Drones for Tree Trimming

April 27th, 2021

Tyler Bryant, Darrell Fambro, Keith Liang, Nikhil Patel, Matthew Ramberger

# Meet the Team



Matthew Ramberger [EE]

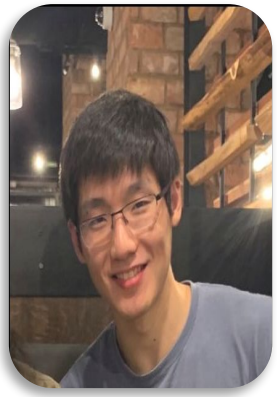
Testing Team Lead

Darrell Fambro [CmpE]

Webmaster

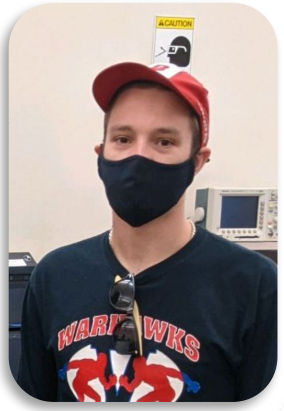
Nikhil Patel [CmpE]

Software Team Lead



Keith Liang [EE]

Hardware Team Lead



Tyler Bryant [EE]

Director of Communications

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# Introduction

- Goal: Design an *optimal* end effector configuration that integrates with a DJI Inspire Drone
  - Optimal: Perform light trimming and pruning of vegetation surrounding power lines
  - Able to withstand repetitive impact with grass and dirt from a height range of 30-50 feet
  - The end effector will attach to a branch and disconnect from the drone, allowing the drone to safely fly away while the cut is made

DJI Inspire 1

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# Motivation

- Implement the use of drones to provide safer and more reliable services to customers
- Florida Power & Light Aerial Intelligent Response (FPLAIR)
  - Oversees all aerial inspections of the company's overhead transmission and distribution facilities
  - Percepto "Drone-in-Box" Solutions to aid in hurricane disaster recovery


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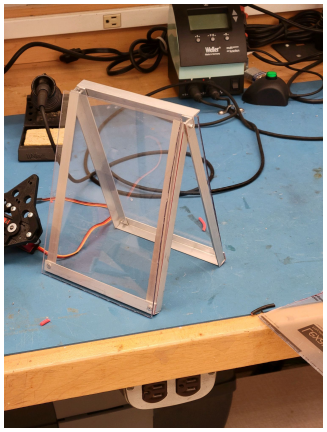
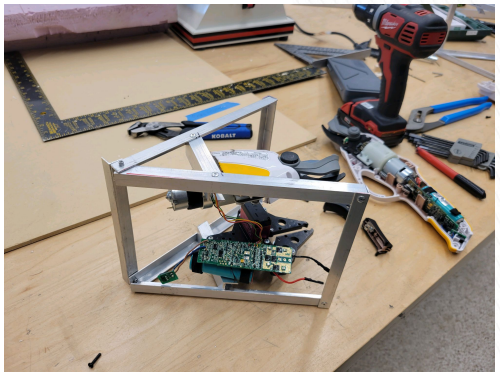
# End-Effector Mechanical Assembly

- Hardware Components
  - L-Shaped aluminum core structure
  - Ryobi BSH-120 Gardening Tool
  - ACTOBOTICS Parallel Gripper Kit
  - Flying Tech Payload Release Mechanism
  - Lexan Polycarbonate Sheets
  - Foam Cushioning



Aluminum Frame with Lexan



Aluminum Frame w/ support bars, cutter, and clamp

Finished End-Effector

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# End-Effector Electrical Systems

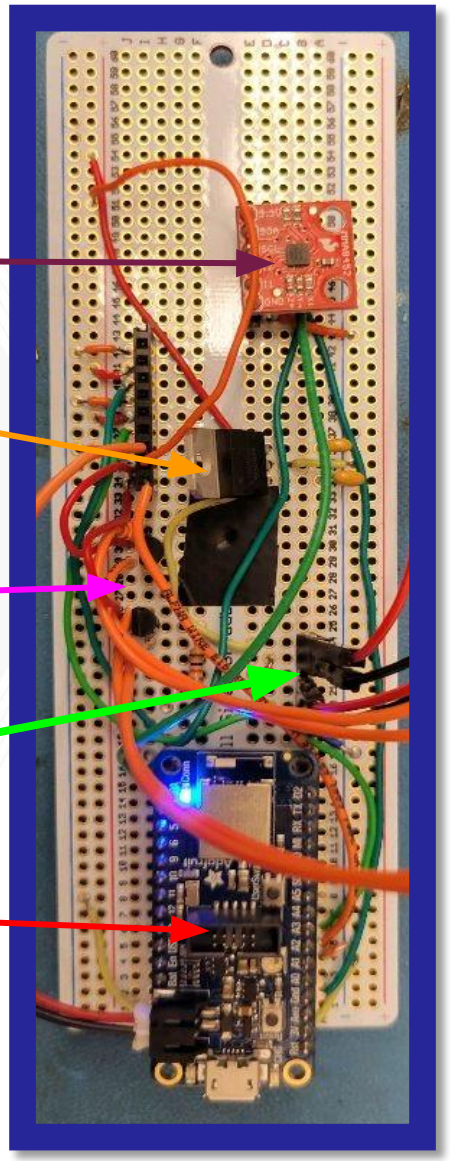
Accelerometer

Voltage Regulator (5V)

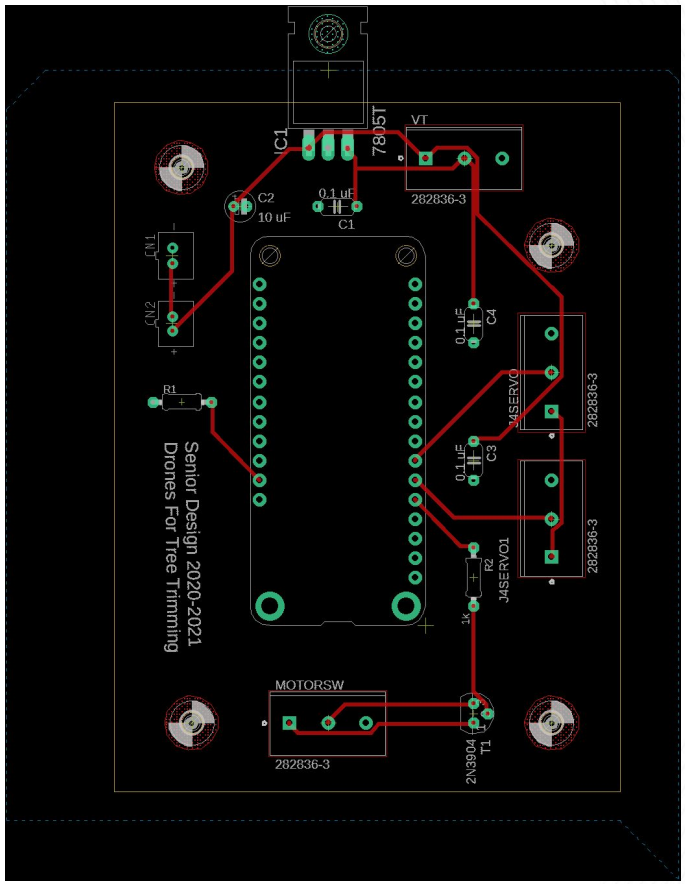
Two NPN BJT Transistors

Battery Terminals

Microprocessor



Soldered Breadboard




PCB Design

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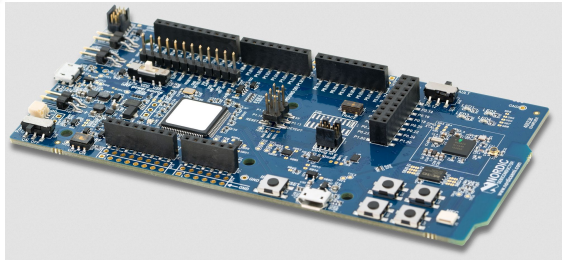
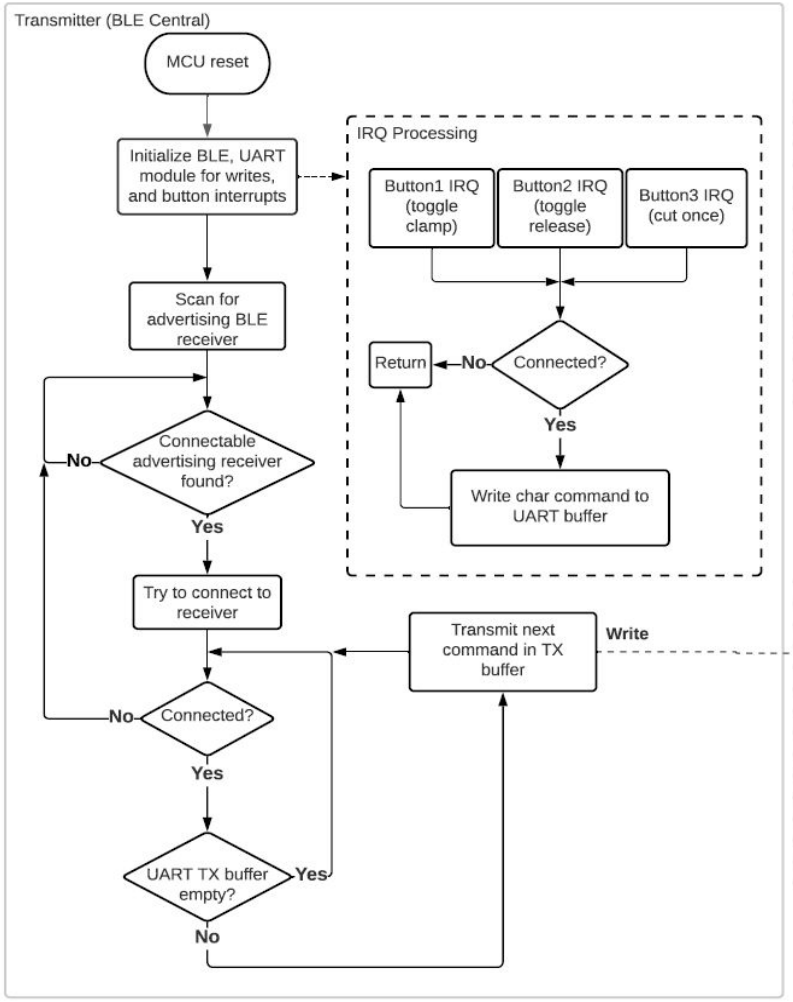
# End-Effector Software Design

- Communications between controller and end-effector are done using UART over bluetooth
  - 2 nRF52840 microcontroller development boards
- The nRF52840 chip has a built-in bluetooth module capable of long ranges (> 200 ft)
- The nRF52840-DK board transmits character based commands to the end-effector's board (i.e. '!C', '!T', '!R')
  - Pressing a button triggers transmission (see right)



nRF52840-DK development board




Transmitting controller software flow diagram

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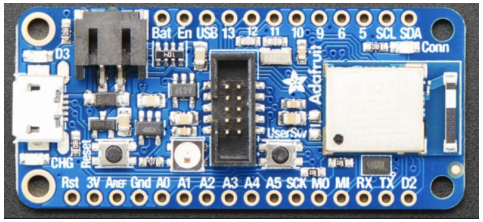
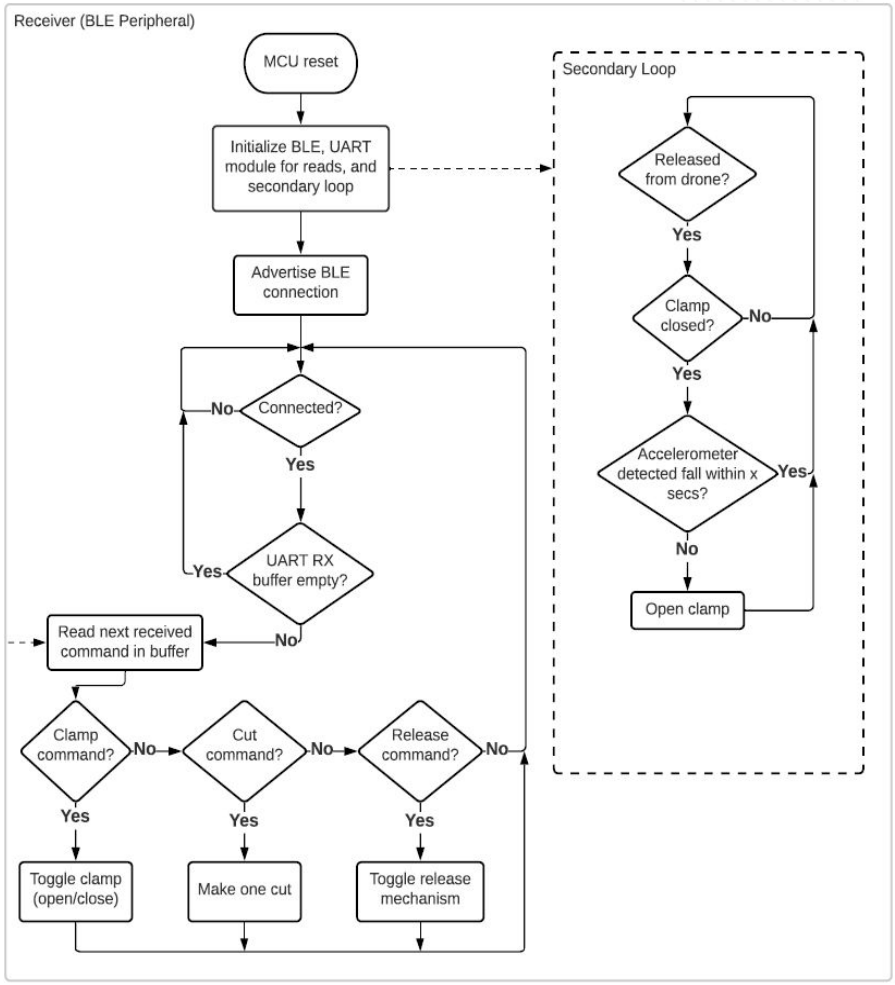
# End-Effector Software Design

- The nRF52840 Feather Express receives commands and parses them
  - Toggles the clamp, cutter, and release accordingly by sending out the appropriate signal on a pin (see right)

- Detects if the end-effector is stuck after being released from the drone using an accelerometer (i.e. in a tree)
  - Releases clamp if no fall detected 30 sec after drone release




nRF52840 Feather Express development board




Receiving controller software flow diagram

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# Drop Test Video

Drop Test #1: ~20 feet

Drop Test #2: ~40 feet

## Results

- Drop test was around 4 lbs - 1.5x our current weight
- Framing easily survived both drops
- Dirt getting inside frame is a problem

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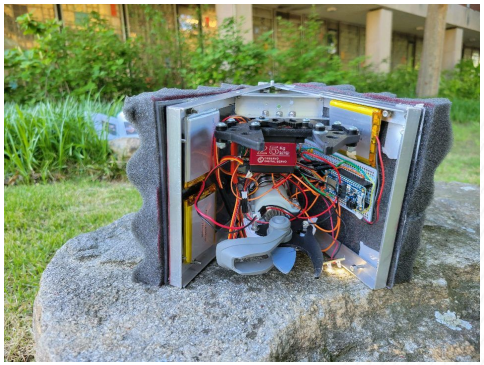
# Testing and Results

- Weight ~ 2.5 pounds
- Signal Range ~ 200-250 feet LOS
- Battery Lifetime ~ 45-60 minutes
- Fall Survival Height ~ Survived 40 Feet
- Cutting Size ~.10” - .40”
  - Inconsistent over .40”



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# Future Steps

- Additional release mechanism for vertical cuts
  - Integrating release mechanisms inside frame
- Upgrading soldered breadboard to printed circuit board
- Increased diameter and power of cut potential
- Adding shock absorbent mounting
- Upgrading to titanium framing
- Upgrading drone to increase payload capacity

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