Bees and RF

Professor Martin and Dr. Howard
Joseph Florentine EE/Physics 2021
Bhargav Singaraju EE 2021
Justin Yu EBHS 2020
The Undergraduate Team

- Bhargav Singaraju: EE 2021
- Joseph Florentine: EE/Physics 2021
The High Schooler

Justin Yu
EBHS 2020
Inspiration and Overview

- RF (Radio Frequency) is everywhere.
- In May 2014 *Anthropogenic electromagnetic noise disrupts magnetic compass orientation in a migratory bird* was published.
  - 1MHz RF interferes with birds finding magnetic north.
- Bees also navigate using the earth’s magnetic field
  - RF consists of Electromagnetic waves
Project Overview

- Design and conduct a study to create specific RF/DC magnetic fields in the proximity to 4 feeders while observing bee presence/interaction at the feeders.
  - All equipment must be weatherproofed to survive field conditions, and overcome resulting challenges:
    - Power limitations
    - Limited access (mandates automation of some degree)
    - Budget constraints
    - Bees
Experiment Setup

Feeder Specifications:

- Raspberry Pi Zero (2)
  - Raspberry Pi Cam V2
- 20Ah 5V battery bank
- 400Hz Buzzers
- Active USB extensions
  - 128GB SD cards
- 2 Liter sugar water jars
Antenna Design:

- Coil is driven off MSP430 with a mosfet
- Initial idea: Solenoid
  - Bees enter clear tube to access feeder
    - Coil is wound around tube
- Final version: Two Dipoles (DC&RF)
  - Under platform (no visibility issues)
  - Reduced power draw
  - Easier to assemble
Third Harmonic (3MHz) is around 25-30dB down. Is it the best sine wave ever? No, but it does the job.
Bee Counting

- Python Image Processing Library (OpenCV)
- Grayscale, threshold, pixel counting (Clumps)
- Issue: Shadows
Bee Counting 2.0

- OpenCV
  - Static and Dynamic
- Ants
- Trees?

![Bees Counted Over Time](image-url)
Footage of the Bees:

From Raspberry Pi:
https://youtu.be/QTCOFtUdneQ

BEEroll of Bees:
https://youtu.be/__YusUmGQ6Q4
Goals for the Rest of Year

- 400 Hz Training
- Track bees
  - Track paths → classify behavior
  - Density (RF)
- Control two feeders with brick pi3
  - EV3 lego motors
- Reinforcing for extra weather proofing
  - Thunderstorms
- Software efficiency
Thank You For Your Time

- Any Questions?
  - Please visit our poster!