Hive Monitoring

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WINLAB | Wireless Information Network Laboratory

Objectives

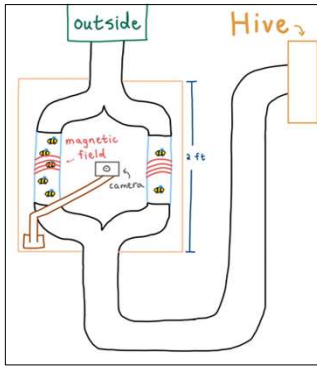**How are changes in the world affecting biological systems?**

➔ We are observing electromagnetic pollution and its effect on biological systems

- Study bees in two different environmental conditions as a model for biological systems
- Conduct an experiment on bees in an artificial "maze" environment containing AC (alternating current) and DC (direct current) electromagnetic fields

- Observe bees in their natural environment using a camera placed inside a beehive to monitor colony activity close up
- Gather additional information about beehive health with the goal of reducing bee mortality

Apparatus Experiment

- Construct a bee apparatus that splits into two paths
- Bees have the option to pass through one of two paths, one having an AC or DC field on
- Record videos of the bees passing through the apparatus for use in machine learning

Machine Learning

- Used video data to train a neural network to predict the state of the magnetic field
- If the AI can accurately predict the state of the magnetic field, this indicates that there are changes in the behavior of the bees
- Utilized the PyTorch machine learning framework
- Modified cropping of the videos

Setup

- Created a bee apparatus consisting of two glass tubes each with a magnetic coil wound around it
- Surrounded apparatus with a removable black box to provide constant lumination from a lamp
- Positioned breadboard above apparatus

- Programmed a Raspberry Pi to control different states of the magnetic fields
- Wrote a program to generate a 1 MHz radio frequency current and set up new coil
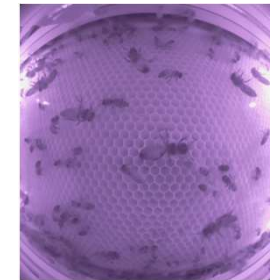
Results

- Generated accuracies suggesting that the AI has found features that allows it to detect the state of the field
- High correlation with time of day indicates that the neural network may be learning the hourly switch of the magnetic field based on the daily routine of the bees
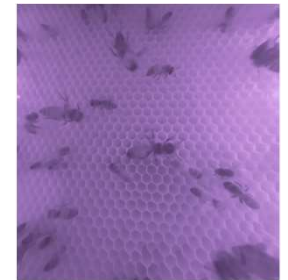

Hive Camera

Deployment:
- 222-degree FOV camera enclosed in a beehive frame
- Positioned IR lights in the corners for even distribution
- Sealed the frame with aluminum tape to isolate the camera from the colony

Video Undistortion:
- Used the OpenCV Camera Calibration library to 'flatten' fisheye-images
- Multithreaded video undistortion code to reduce execution time by over half
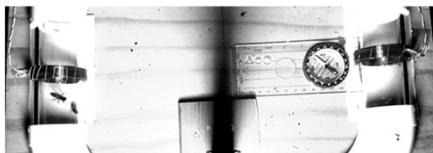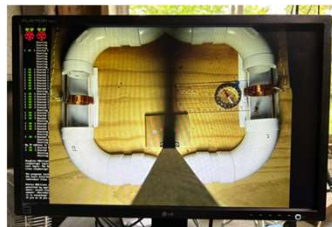

Original   Undistorted

Next Steps

- Randomize the timing of classes when collecting data to avoid temporal correlation
- Run additional apparatus experiments (i.e., AC field in one tube and DC field in the other, alternating fields between tubes)
- Use hive video for future experiments (i.e., counting bees to determine colony health)
- Determine what aspects of behavior are affected by magnetic fields

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