Agricultural Monitoring of Beehive Health

RUTGERS
WINLAB | Wireless Information Network Laboratory

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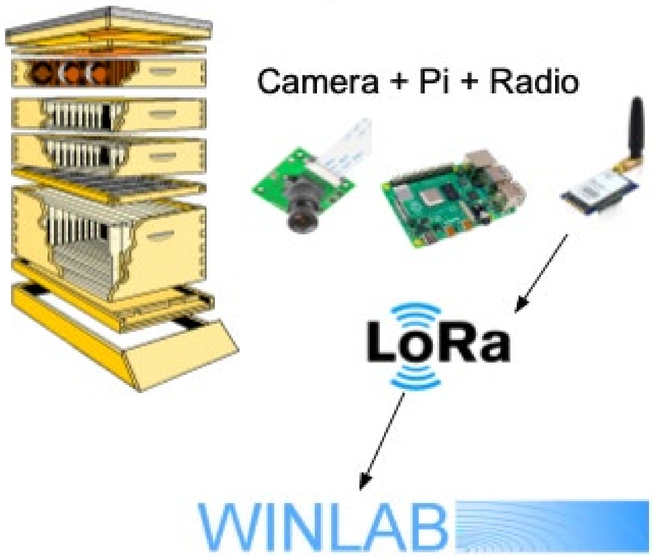
Abstract

- Annual beehive mortality rates have been increasing from 10% to 30%
- An innovative way of monitoring beehive health could help prevent the occurence of colony collapse disorder caused by a significant decline of bee populations
- Our method involves the use of a camera and computer vision to count bees that are exiting/entering the hive for population metrics.

Solar panel + battery

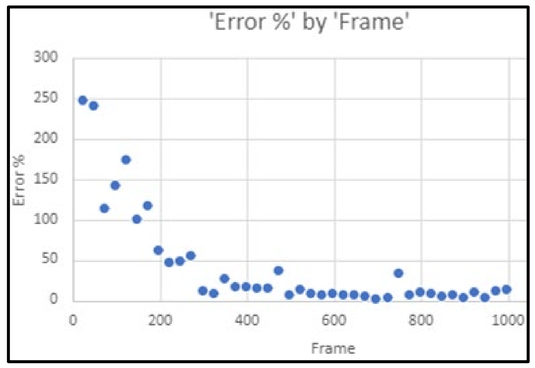


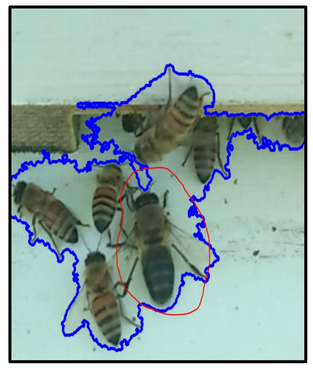
Goal

Our aim was to build a system powered by a battery and solar panel that uses a camera, raspberry pi and LoRa (Long Range) radio. The camera will record the beehive entrance and use computer vision algorithms to count the bees and send the bee count over a mile from the Hort Farm to WINLAB.

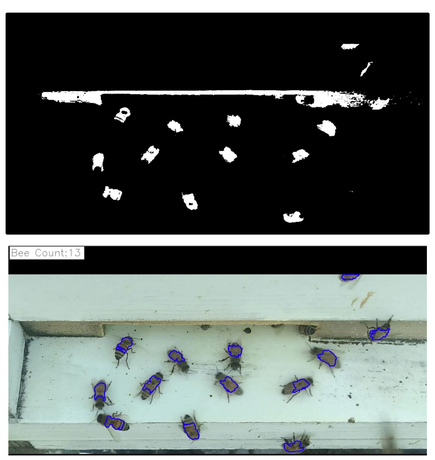
Computer Vision

- Tto count the amount of bees entering/exiting the hive, we tried two different approaches using OpenCV:
- Background Subtraction
  - KNearestNeighbors Algorithm to find moving objects, bees, using Gaussian filter to remove error
  - Accuracy Rate: 92.64%, accuracy increases as frame count increases
  - The method did not account for stationary bees





- Color Hue
  - Chooses pixels in a specific color range
  - We chose the specific ciolor hue values of a bee
  - The background must be a different color than the bees
  - Accuracy rate: 89%. accuracy stays consistent for any frame chosen



The top picture on the left represents the chosen pixels within a specific color range.
The bottom photo is a frame of the live video feed. The white pixels are circled, with the larger area portion removed (specific area range chosen). There is a bee count at the top of the frame.

Sending Data

Using Python, we created a program that combined the computer vision algorithm with the radio configuration, allowing for the module to send the bee count data every five seconds to the other radio module. The Rfm9x module sends the data in the form of bytes using an i2c bus system.

The radio display showcases that the bee count is zero and the number of the packet received is thirty six.

Results/Conclusions

The radio successfully sends the bee count data over the distance of around half a mile. The raspberry pi receives a sufficient amount of power for running the computer vision algorithm. The pi is weatherproofed in a secure box with a clear front. With the counting algorithm displaying high accuracy, the next step implementing the radios at greater height for greater range, or using a relay node while sending data.

Future Work

- Implement audio, humidity, and temperature sensors at hive to monitor hive health
- Implementation and debugging of LoRa over long distances
- Implementation of cloud server to website

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