Individual Bee Identification using Computer Vision

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Who am I?

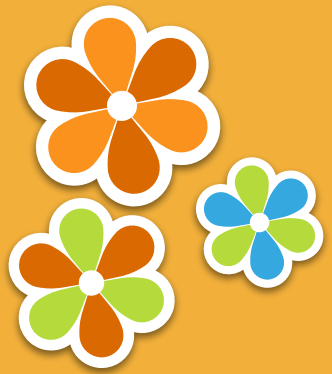
- Applied Data Science, College of IST 2023
- Bucks County, PA
- Free Time: Music (Jazz and Classical)
- Got involved through ENT 222N

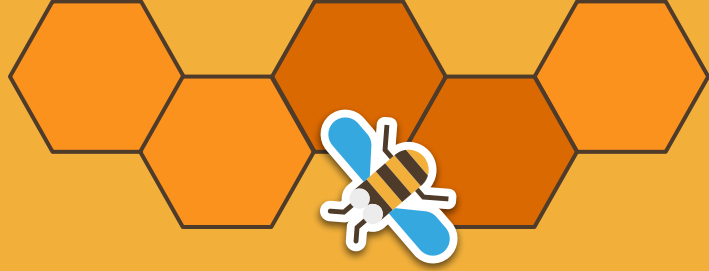
Overview

Method: Tracking Bees with Computer Vision

Current Performance/ Findings

Future Work





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Tracking Bees with Computer Vision

THE PROBLEM

Tracking bees from videos is tedious and time-consuming

Motivation: Discover effects on foraging behavior, health of bee, etc.

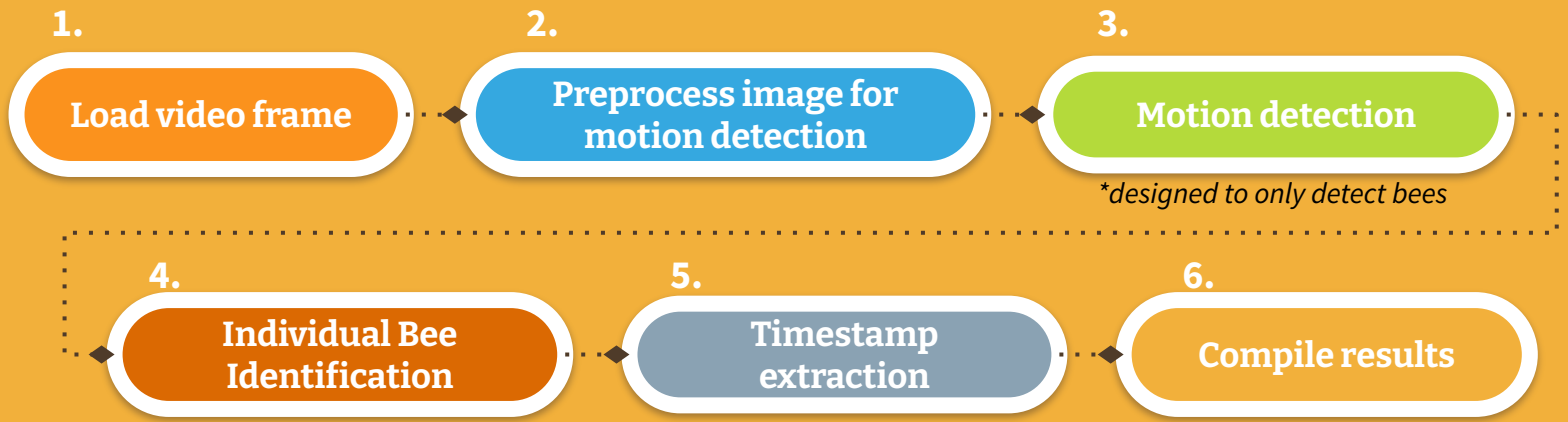
THE SOLUTION

Identify + Track Bees with Computer Vision

How does computer vision help?

- Process each frame of the video to:
  - Identify circles (tubes) in the video
  - Detect motion
  - Associate motion with bees
  - Assign bees to tubes = individual bee identification

Individual Bee Identification Steps



Load video frame

Date	Start Time	End Time
5/14/22	10am	10:59 am
5/14/22	11am	11:59 am
5/14/22	12pm	12:59 pm

Videos Processed

Preprocess image for motion detection

Preprocessing Steps

1. BGR → RGB
2. Convert to grayscale
3. (Slightly) blur image

Motion detection

Contours, small and large

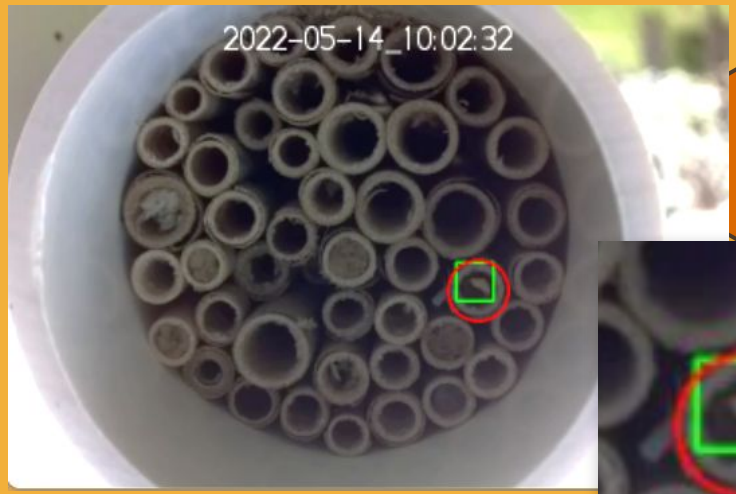
Large contour identified with a bee (green)

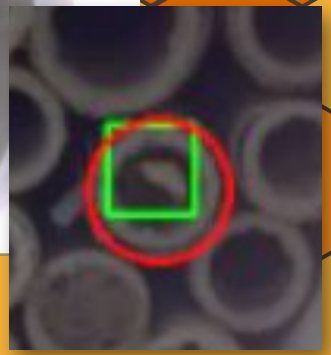
Motion Detection Steps

1. abs(difference between frames)
2. Keep pixels that changed “enough”
3. Calculate groups of pixels (aka “contours”)
4. Remove any contours with area <400 or >1000 pixels

These contours are our potential bees.

Individual Bee Identification



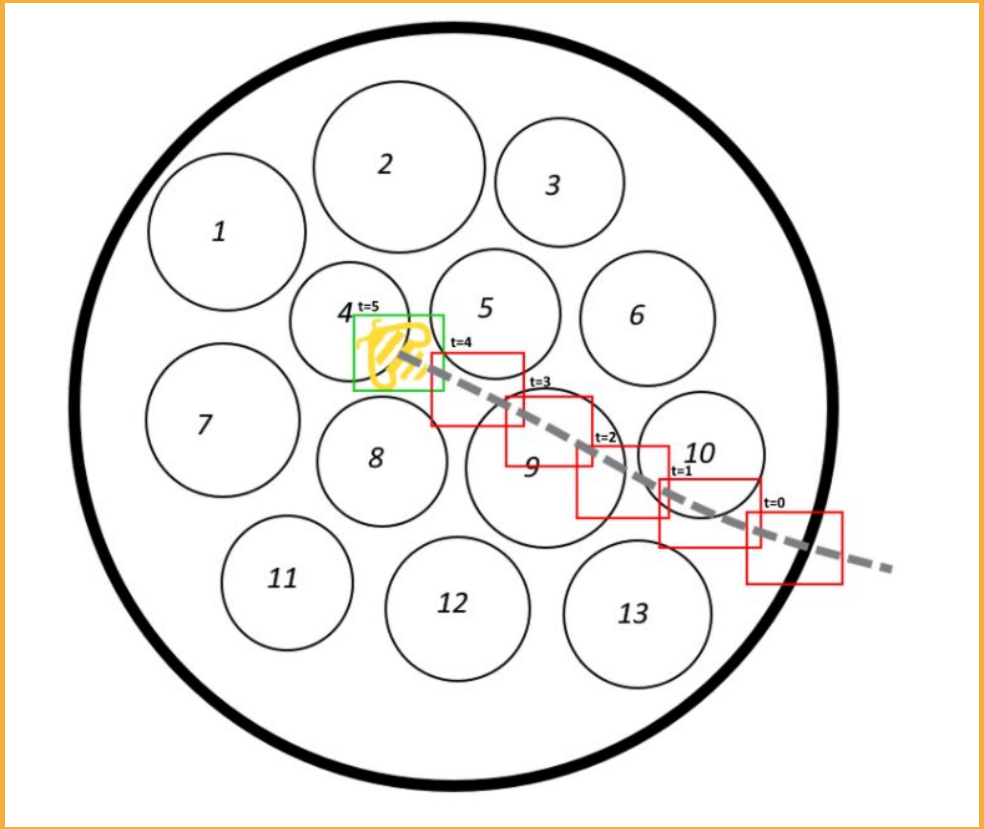


Individual Bee Identification Steps

Based on the assumption that each tube belongs to <u>one</u> bee

1. Assign each tube a number
2. Calculate distance from each tube to contour
3. Assign contour to the number associated with the closest tube

Individual Bee Identification



Contour window technique

Timestamp extraction

Current Timestamp placement

Ideal Timestamp placement

Timestamp Extraction Steps

1. Crop to timestamp bounding box (determined by human)
2. RGB→ grayscale
3. Invert image (so text is black)
4. Add 10 pixels padding around timestamp
5. Apply Optical Character Recognition (OCR) to get timestamp
6. Clean extracted timestamp as necessary

Compile results

Tube Centers with Bee IDs

Detected events

```
Bee ID=28 Tube Hive Coords: [162 334]
Bee ID=29 Tube Hive Coords: [344  48]
Bee ID=30 Tube Hive Coords: [390 310]
Bee ID=31 Tube Hive Coords: [154 134]
Bee ID=32 Tube Hive Coords: [244 392]
Bee ID=33 Tube Hive Coords: [218  66]
Bee ID=34 Tube Hive Coords: [340 246]
Bee ID=35 Tube Hive Coords: [246 112]
Bee ID=36 Tube Hive Coords: [342 430]
Bee ID=37 Tube Hive Coords: [200 368]


Bee ID=22 detected at frame 38/108042.0, Timestamp: 10:00:00
Bee ID=25 detected at frame 38/108042.0, Timestamp: 10:00:00
Bee ID=22 detected at frame 38/108042.0, Timestamp: 10:00:00
Bee ID=25 detected at frame 38/108042.0, Timestamp: 10:00:00
Bee ID=25 detected at frame 40/108042.0, Timestamp: 10:00:54
Bee ID=31 detected at frame 40/108042.0, Timestamp: 10:00:54
Bee ID=25 detected at frame 40/108042.0, Timestamp: 10:00:54
Bee ID=31 detected at frame 40/108042.0, Timestamp: 10:00:54
Bee ID=32 detected at frame 42/108042.0, Timestamp: 10:00:52
Bee ID=37 detected at frame 42/108042.0, Timestamp: 10:00:52
Bee ID=28 detected at frame 42/108042.0, Timestamp: 10:00:52
Bee ID=14 detected at frame 42/108042.0, Timestamp: 10:00:52
Bee ID=2 detected at frame 42/108042.0, Timestamp: 10:00:52
Bee ID=32 detected at frame 42/108042.0, Timestamp: 10:00:52
Bee ID=37 detected at frame 42/108042.0, Timestamp: 10:00:52
Bee ID=28 detected at frame 42/108042.0, Timestamp: 10:00:52
Bee ID=14 detected at frame 42/108042.0, Timestamp: 10:00:52
```

Demo!

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Current Performance/ Findings

TP, FP, Precision Rates

https://personal.psu.edu/gvg5207/bee_demo.html

Bee Identification Precision

Bee ID	Precision (%)
20	86
39	83
8	62
35	62
6	44

We can go to a log entry and know that it will be **THE CORRECT BEE** **19.3%** of the time.
We can go to a log entry and know that it will be **A BEE** **71.0%** of the time.

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Future Work

Future Works

- Compare Kalman Filter to contour window*
- Fine-tune motion detection parameters to reduce FPs
- New hotel setup to simplify the problem

*already started

THANKS!

Do you have any questions?
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