BEE HIVE TRACKING APPLICATION BASED ON AI

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INTRODUCTION

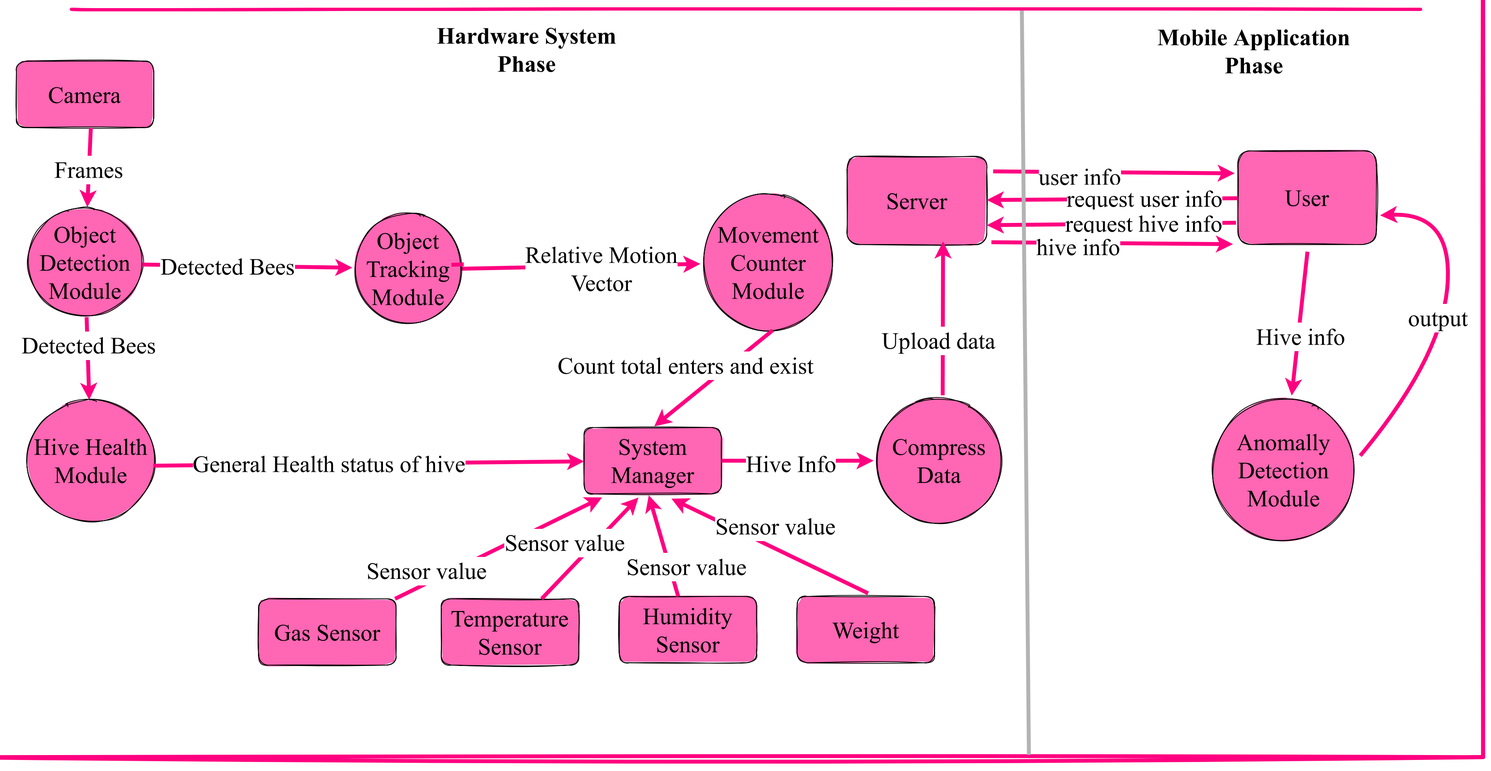
The Problem

Bee populations are decreasing every year due to natural disasters and humans. Fires in the forests, unconscious spraying, weather conditions, wild threats, poor hive management are the main reasons for population decline. Generally, beekeepers cannot determine the reasons for the decrease in the bee population and cannot react quickly or take precautions accordingly.

Approach to the Problem

We decided that an application can be made where beekeepers can manage their hives and put a stop to this decrease in the bee population. We think that artificial intelligence and machine learning technologies used in many fields today can be integrated as a hive control system. In this way, beekeepers will be able to follow their hives and react quickly to emerging threats.

FLOW CHART

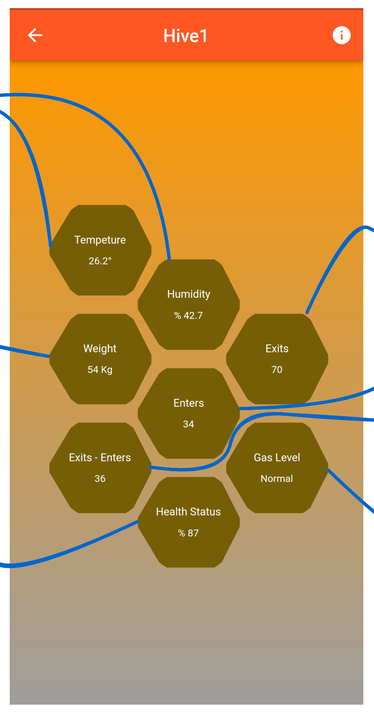


FEATURES

Temperature and Humidity: With these data, the beekeeper can observe whether the temperature and humidity inside the hive are at optimal values and can take the necessary precautions.

Weight: With this data, the beekeeper can follow the weight change of the hive during the honey flow period.

Percentage of Healthy Bees: With this data, the beekeeper can understand whether there is a disease threatening his/her hive and can take the necessary precautions.



Number of Enters and Exits: With these data, the beekeeper can understand that there is a problem in case of sudden bee entry or exit to the hive and can take the necessary precautions.

Gas Level: With this data, the beekeeper can understand in advance a possible fire situation that may threaten their hives and take the necessary precautions as quickly as possible.

Fig. 1, Mobile Application GUI

BEE COUNTER AND BEE HEALTH DETECTION

A real-time object detection algorithm that can detect bees is a prerequisite for predicting the health status of bees and determining the number of entrances and exits. For this, we trained and tested the YOLOv3 algorithm with the data set we created by labeling 4 videos that capture the entrance of the hive in a Github repository [1].

After successfully detecting the bees we implemented object tracking algorithm by using the previous frame as reference. In this method, we calculated the Euclidian distances of the bees between the previous frame and the current frame. Then, using these Euclidian distances, we matched the bees in the previous frame with the bees, they were closest to in the current frame. With this matching, we calculated the motion vector of each bee and were able to detect whether the bee was entering or leaving.

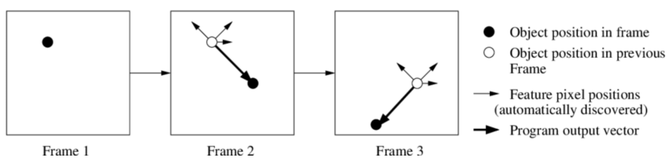


Fig. 5, Object tracking method [2]

In order to predict the health status of bees, we applied the CNN architecture shown in the figure below, and we trained and tested this algorithm with the 'The BeeImage Dataset: Annotated Honey Bee Images' dataset [3]. With this algorithm, we were able to predict the health status of the bees at the entrance of the hive and as a result, we measured the general health status of the hive.

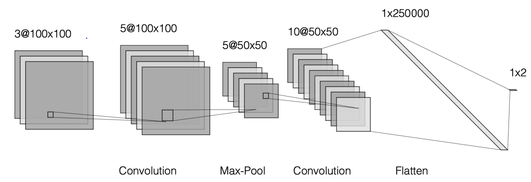


Fig. 6, CNN architecture for predicting health status of the bees

MEASUREMENTS OF TEMPERATURE, HUMIDITY, WEIGHT AND SMOKE VALUES

We used the DHT11 sensor to measure the temperature and humidity values inside the hive.

Fig. 2, DHT11 Sensor

We used the MQ-2 sensor to detect the flammable gas level around the hive.

Fig. 3, MQ-2 Sensor

We used 4 weight sensors and HX711 load cell to measure the weight of the hive.

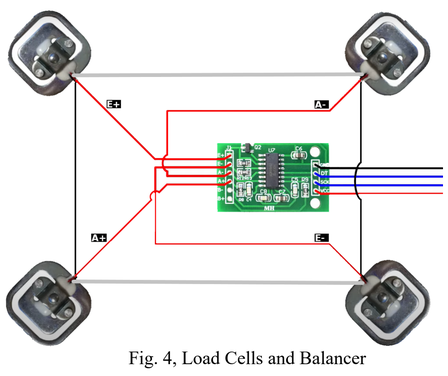


Fig. 4, Load Cells and Balancer

We connected these sensors to Raspberry Pi 3 Model B and sent the read values to the server with the help of socket programming.

EXPERIMENTS & RESULTS

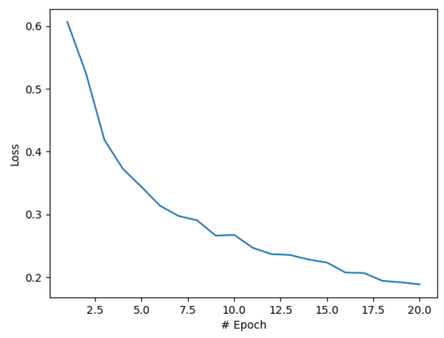


Fig. 7, Training loss vs. epochs of CNN algorithm

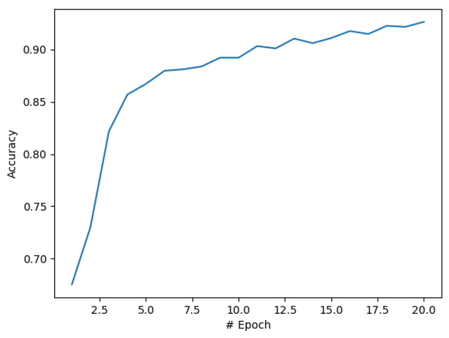


Fig. 8, Training accuracy vs. epochs of CNN algorithm

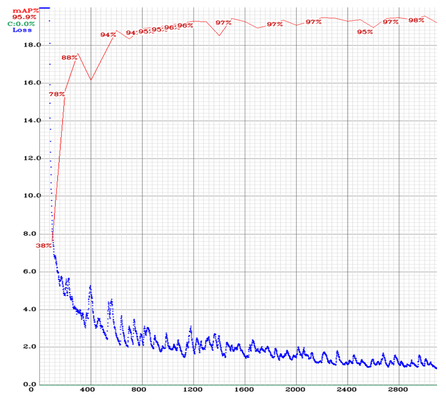


Fig. 9, YOLOv3 mAP and loss metrics

CONCLUSION AND FUTURE WORK

During the field test phase, we received feedbacks from the beekeepers around us that our project will facilitate the control of the hive and taking the necessary actions to increase the efficiency of the bees.

We plan to make our project more scalable in the future and reach investors who invest in digital agriculture.

TECHNOLOGIES USED

Flutter · Firebase · Python · Raspberry Pi · Darknet · Tensorflow

REFERENCES

[1] Carlos Pena Caballero, E-Hive, (Aug 31, 2017), GitHub repository, https://github.com/cpena107/E-hive/tree/master/Data [Online] [Accessed on: November 2, 2021]
[2] Murugavel, M. (2019, April 9). Object Tracking — Referenced with the previous frame using Euclidean distance [Figure]. Medium. https://manivannan-ai.medium.com/object-tracking-referenced-with-the-previous-frame-using-euclidean-distance-49118730051a
[3] Yang, J. (2018, September 17). The BeeImage Dataset: Annotated Honey Bee Images [Apis mellifera with location, date, health, and more labels]. https://www.kaggle.com/jenny18/honey-bee-annotated-images [Online] [Accessed on: October 29, 2021]