Artificial Intelligence in Apiculture

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1. Problem Statement:

The idea that we still rely heavily on bees for much of the food that ends up on our dinner plates in a modern civilization may seem weird, but it is a fact. Bees continue to play a crucial role in food production despite the century and a half of agricultural breakthroughs made by human civilization. The chief reason behind this is "pollination". But as time flows, we can observe the decline in the population of bees.

We can observe bee populations are falling drastically due to loss of habitat, pollution, pesticides, and even several other insects are killing it (such as Hornet). As it continues, there is a chance of food storage in the coming future.

Artificial Intelligence can become a great tool for overcoming downstream the livestock of the bees. The main objective of the project is to build a smart beehive that contains

- Temperature reading
- Humidity reading
- CO_2 sensor
- Monitoring a foreign agent
- Automated devices for harvesting
- Letting the model decide the best outcome

2. Market Need Assessment:

Honey is a great source of antioxidants and flavonoids, which can reduce oxidative stress and other types of inflammation in the body while warding off cancer and heart disease. Additionally, the item even contains antibacterial and antiseptic qualities that aid in wound healing by creating a moist environment and boosting the availability of nutrients to the affected area. These elements have helped the market for the product for home cures to grow. The honey market in India reached a value of INR 21.1 Billion in 2021. Looking forward, IMARC Group expects the market to reach INR 38.3 Billion by 2027, exhibiting a CAGR of 10.31% during 2022-2027. It has also been one of the richest products in exports, during the year 2020-2021, India exported honey of value of nearly 716 Croce's to the rest of the world.

The global market size of natural honey is US$ 8.4 billion and it is projected to reach US$ 10.3 billion by 2025, with an expected CAGR of around 4.8%. Globally 1,779.6 metric tons of honey is produced. China produces almost 28% of the world's honey, followed by Turkey (5.9%), Iran (4.5%), and the US (4.1%). India is the 6th largest producer of honey, accounting for 3.5% of global production. During the last decade, India's exports of honey proliferated from US$ 56.2 million to US$ 100.8 million, experiencing a growth rate of 6.5% per annum, higher than the world's export growth.

As we can observe the market for honey has always been a great bull, which is going to be a dependable hand in the future market and economy of the country.

3. Target Specification and Characterization:

Target specification:

1. Monitoring the livestock
2. Observing the temperature of the bee hive
3. Constantly reading the gases percentage (mainly CO_2)
4. Piping monitoring
5. Mite control
6. Honey harvesting
7. Count the bees
8. Weight of the hives

For achieving the above targets, we need to maintain sensors in the beehive continuously reading the data and for the agent to take the relevant action.

4. External Search:

1) National Beekeeping and Honey Mission (NBHM):

The primary goal of NBHM is to encourage the holistic development of the beekeeping industry for the generation of income and employment for farm and non-farm households, to improve agriculture and horticulture production, and to develop infrastructural facilities, including the establishment of Integrated Beekeeping Development Centers (IBDC)s/CoE, honey testing labs, bee disease diagnostic labs, custom hiring centers, Apitherapy centers, nucleus stock, bee breeders, and other related initiatives

2) Application of a Precision Apiculture System to Monitor Honey Daily Production (Author: Pietro Catania):

The main intention of this paper was to study the main environmental parameters (temperatures, relative humidity, and wind speed) correlated with honey production and allowed it to manage the hive in an intelligent mode.

Link: [Click Here](#)

5. Benchmarking alternate products:

1) BeeToxAI: An artificial intelligence-based web app to assess the acute toxicity of chemicals to honey bees. They predict the lethal dose of pesticides for a plant, which doesn't the honey bee health rate.

2) We4bee: A German application, which provides AI solutions for improving the growth rate of bees.

6. Applicable Patents:

1) System having a beehive based on the internet of things and a management method. (Patent Specification No. KR101736288B1)

2) Beehive monitoring system (Patent Specification No. US20170079249A1)

3) Communication and control systems and methods for monitoring information about a plurality of beehives.

7. Applicable Regulations:

The Honey Bee Health Task Force has identified seven priority areas for funding, though other areas will be considered as well.

1) Effects of pathogens and pests on honey bee behavior, physiology, and/or colony health; including the development of novel methods to mitigate these effects.
2) Effects of nutrition on pest, pathogen, and disease incidence.
3) Effects of pesticides on pests, pathogens, and disease incidence.
4) Effects of parasite and pathogen shared between bee species.
5) Development of approaches for genetic stock improvement of honey bee populations to enhance resistance to pathogens and parasites.
6) Effects of climate or environmental variables on honey bee pests, pathogens, and disease incidence.
7) The development of diagnostics or indicators for the presence of pests, pathogens, and diseases that affect honey bee health.

8. Applicable Constraints:

As a smart beehive is a compact box, we don't need much space. The required hardware components are:

- Camera
- Sensors and hardware devices(for harvesting)
- System for data analysis

9. Business Opportunity:

- Using Artificial Intelligence, we play a crucial role in making beehives more smart, productive, and precise.
- At the same time, building these smart beehives creates a huge employment rate for different sectors.
- By using smart beehives, is going to reduce human effort on a greater scale.

10. Concept Development:

- Artificial Intelligence for remote data analysis of the current scenario of the hives. As the data is continuously monitored as stored, we can identify different data patterns across time, which will help find out the best attribute values for a better output.
- An auto harvesting of honey without the help of a human. Hives will be coated with wax, which acts as a shield for the honey. For obtaining the honey, we need to chop off the wax layer and extract it.
- It can identify the different flies, milts, and other agents, which disturb the bees (mostly kill them) and alert the user regarding the issue.
- With the help of the in-built camera we can also check for the insects on the wax if any are present and can detect them.

o By maintaining everything, we can expect a great product in return.

o The most important of all is protecting the species from the outside environment and feeding them.

11. Final Product Prototype with Schematic Diagram:
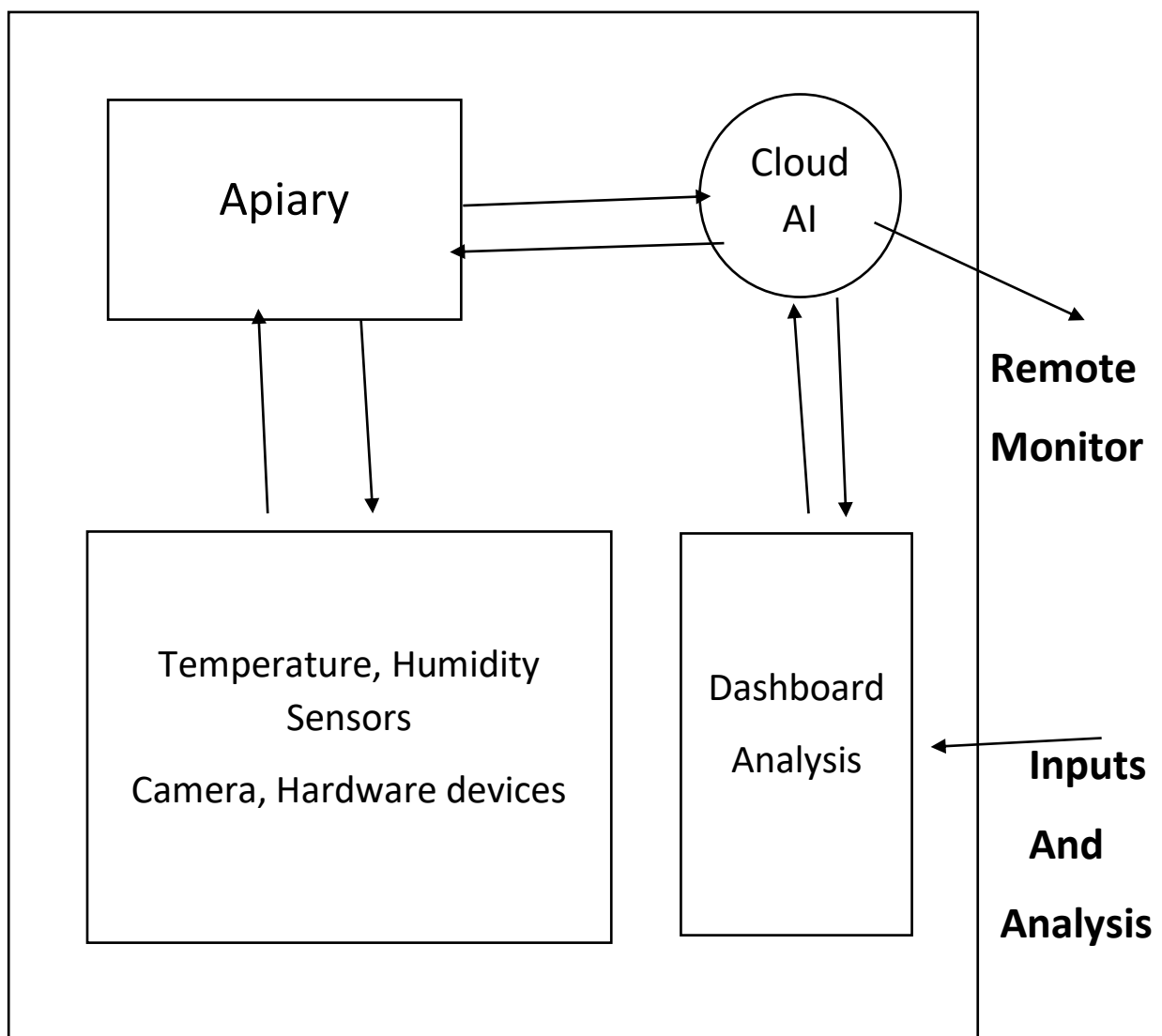
12. Product details

- How does it work?

The final prototype collects real-time data by using the sensors (temperature, humidity, etc...). For maintaining the foreign agents out of the beehives, we are going to use computer vision to detection of the fly. If any fly other than a bee appears, it could send a warning message to the users. Using CNN models, we can achieve a good amount of information regarding the image. We are going to build a model based on the readings obtained from the sensors, which can be made to act on its activities based on the values.

- Data Sources

Most of the time, we collect real-time data with the help of sensors. After collecting sufficient information, we can build our deep learning model, and later on, we can replace the new data with the older or we can continue as it is built.

- Algorithms, frameworks, and software needed

- o Knowledge of deep learning
- o Different architectural knowledge of CNN
- o Knowledge of Computer Vision
- o Knowledge of system design

- Team required to develop.

- o With in-depth knowledge of CNN and other object detection techniques, the team should

be made of curious people on learning the new technologies.

o The profession with knowledge of deep learning and IoT devices.

- What does it cost?

The cost may vary between 5000/- to 9000/- as most of the budget is for buying the hardware components camera, and sensors.

13. Conclusion:

By implementing the project we can ensure the following things:

o protection of the bees
o implementing the self-automated facilities
o producing good quality honey
o improves the market size
o automating the harvesting process
o model deciding the actions based on the sensor values
o maintaining a custom dataset for future references