



The visit to the apiary was very eye-opening and provided invaluable insights for our project. Dan explained to us in detail the whole process involved in beekeeping, from the installation of hives, the inspection to the harvesting.

In our analysis, here's how the project would fit into the picture:

- 1. Remote and Real-time monitoring of the hives:** Dan explained that once a month, someone would go to the hives and do an inspection.
Having the sensors recording the temperature, humidity, sound and weight placed in the hive would be giving insights into what is happening at any point in time. The data that is recorded from the hives would be displayed on a dashboard on any smart device in the form of graphs, charts and other data visualization tools and would enable one to have the data in real time.
If, for instance, the temperature rises exceedingly high to degrees that are unsuitable for the bees, a notification alert would be sent to the mobile device and will enable the desired action to be taken, such as placing the cover that regulates the temperature within the hive.
- 2. Data-driven harvesting precision:** Dan told us that the harvesting times are determined mainly by looking at the capping on the beehives.
Along with this observational method, the harvesting time can be told by analyzing the graph with data collected from the weight sensor. This could be when the curve plateaus or flattens after a gradual increase over time.

The sounds produced inside the hive are also an indicator on the best times to carry out the harvesting activity. For example, it is not recommended to carry out harvesting when the bees produce a frequency of sound that shows their agitation or when they are unusually silent.

- 3. Insights into presence of pests and intrusions:** along with measures to prevent ants and other pests from infesting the hive and feeding on the honey such as having oil on the stands, the data from the sound and the weight sensors can be valuable in detection. Bees produce a different frequency of sound when feeling agitated and under 'attack', either by a human, animal or insect. When such happens, a beekeeper can get a notification on the mobile device to indicate intrusion.

Dan had raised the question of how we'll tell what sound indicates which occurrence in a hive or whether there's simply a normal random change in the weight. Machine learning will, in this case, be used to filter out the sounds that are produced in the hives in various occasions so as to prevent false alarms.

The weight will be a player in giving alerts when a sudden, abnormal increase in weight occurs, such as when a honey badger gets on top of the hive or shifts the hive a bit.

Dan also raised the question of having foreign objects in the hive, explaining that the bees use propolis to cover unwanted materials in the hive. We're brainstorming on finding a way of covering the sensors in the hive and making them to be a part of the hive as much as possible so as to prevent the sensors from being covered with propolis and failing to gather data.

Overall, the focus of our project is to reduce unwarranted intrusion and disturbance of the beehive by having the sensors and data analytics tell what is happening. The notifications alert the beekeeper whenever an anomaly occurs and when the need to be physically present at the hive arises.

