Apiary Assistant: Hive Monitoring Solution

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Abstract

Beekeeping is a daunting hobby for beginners and even those experienced to undertake. Assuming responsibility for thousands of tiny lives and contributing to the slowing of the species' decline is a difficult task, especially when considering the bees' survival can be so easily jeopardized by things as trivial as weather, mites, temperature or other predators who crave the precious honey they produce and we consume. Thus, it is essential for beekeepers to periodically open their hives to assess the conditions within and respond quickly and accordingly to potential problems. This process which is referred to as a hive-dive is typically performed as seldom as the beekeeper's skill allows in order minimize interference or possible harm to the hive ecosystem, and bees within. Not checking enough, however, can also be just as detrimental and lead to worse problems such as colony collapse.

Our project addresses the hobbyist beekeepers and is a scalable IoT based application for small-site beehive monitoring and stands out from others as it is modularly compatible with both medium and deep apiary boxes with non-permanent, easy installation and is capable of being placed where any ordinary frame would lay. Our solution is a sensor-to-screen project that monitors conditions inside the hive and provides data to beekeepers over the internet so that they can track their hive's conditions and activity from anywhere and therefore make more informed decisions while disturbing the ecosystem of their colonies less frequently.

By utilizing an embedded "Smart Frame" design which houses a variety of sensors, we will be able to provide beekeepers data from the inside of their hives as well as provide web

based visualization of data trends for temperature, humidity, and sound of their colonies. Our Smart frame will mimic a traditional honey-bearing frame in size and shape but will instead be a sensor bearing frame consisting of temperature sensors, a humidity sensor, and a microphone to measure audio. All of which will be integrated with an ESP32 microcontroller and protected from comb and propolis accumulation.

The flow of our system is as follows. The ESP32 microcontroller takes the sensor data periodically throughout the day. It will record 5 second audio samples every two hours, and measure temperature and humidity every hour, resulting in 12 audio samples and 24 temperature and humidity samples per day. These samples will be transmitted over a ZigBee transceiver via the 2.4 GHz band to a module inside the beekeeper's home. The home module will consist of another microcontroller connected to another 2.4 GHz transceiver to receive the data and relay it via I2C communication to a single-board computer (Raspberry Pi) that acts as a gateway device to upload samples to an online database. The home module is to be connected to a person's home router and requires very minimal setup since it will be hard-wired with an ethernet cable. Once the data is stored in a database, it will then be accessible and visualized for the beekeeper's interpretation over a mobile app. The users app will provide graphs of temperature and humidity, as well as a graph of present frequencies within the hive for each 5 second recording. The recording can be played back for the beekeepers and data samples can be requested at any time by the beekeeper with the push of a button. With our database allowing at least a year's worth of data to store and look back on, and a frame's autonomy of 10 days battery life the Apiary Assistant effectively helps beekeepers reduce interactions with their hives while providing data critical to their survival.