Smart Hive

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Executive Summary

- Support for Bee Population
- Mesh Network Data Accumulation
- Website for Beekeepers

Problem Statement

Motivation

- Produce a low-cost sensor network
- Use sensor networks data
- The network will be automated

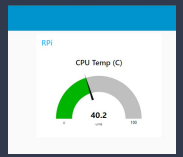
Needs

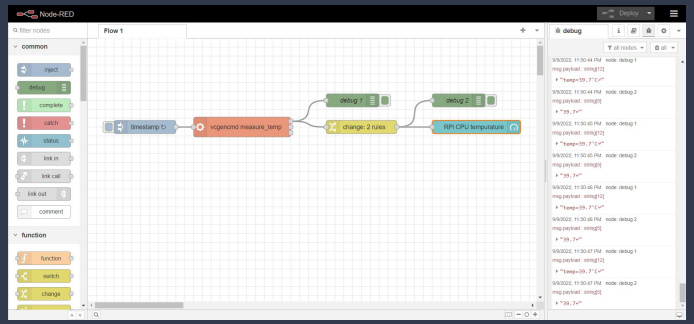
- Device must measure key parameters such as temperature, humidity, C02, weight, and illumination levels of the hive
- Wirelessly connected to Wi-Fi or be able to access data remotely
- Low-cost and automated or require minimal tampering

Market and Application Review

- An application of our smart hive that would appeal to the market is having a significant impact
- Beekeepers visit beehives on a weekly to monthly basis
- Beekeepers lose almost half of their bee colonies each year
- Smart Hive will allow for precise monitoring and treatment to improve colony survival rates

Approach





Server

BeeBox

Smart Frame

Alternatives?

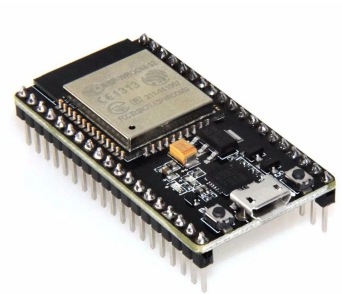
- Server
- Beebox
- SmartFrame
- Alternative sensors

Server

- Cloud-based solution or microcontrollers for Kubernetes
- MERN stack or HTTP server via python script

BeeBox

- Microcontrollers such as an ESP32, Beaglebone Black, or Raspberry pi zero
- Will need to transmit data schema and read information from sensors

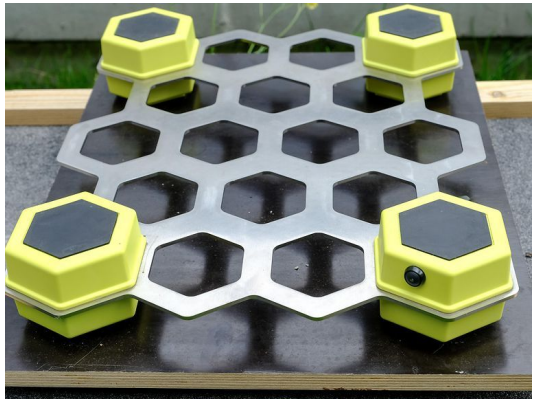


SmartFrame

- GPIO or microcontrollers on frames
- Beebox would make frames more expensive

Alternative Sensors

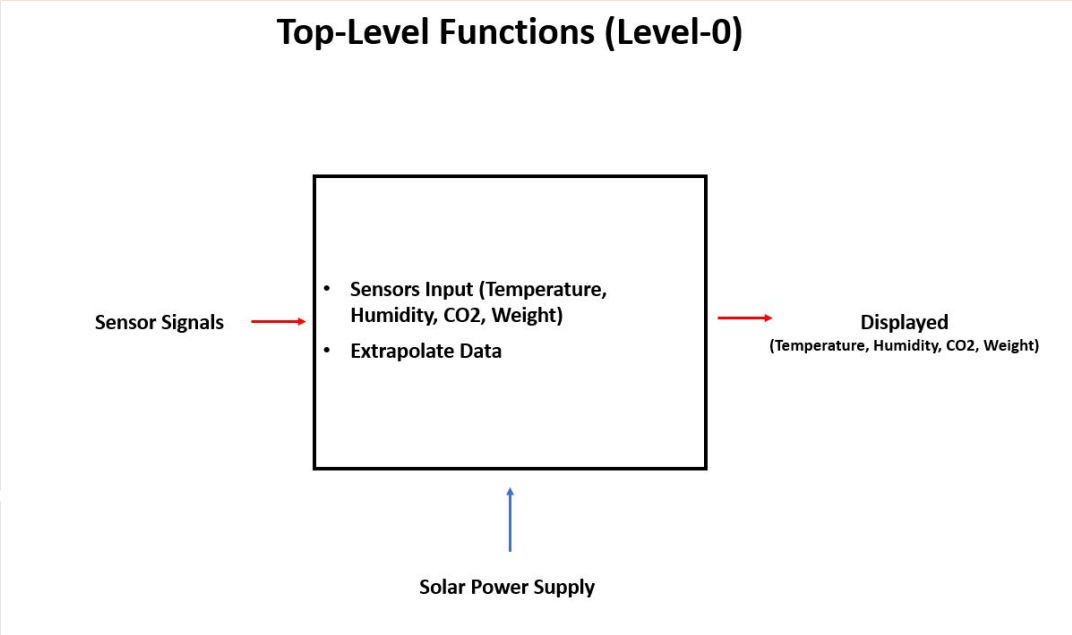
- Weight Sensors was requested by the customer
- Add to the cost of a low-cost solution



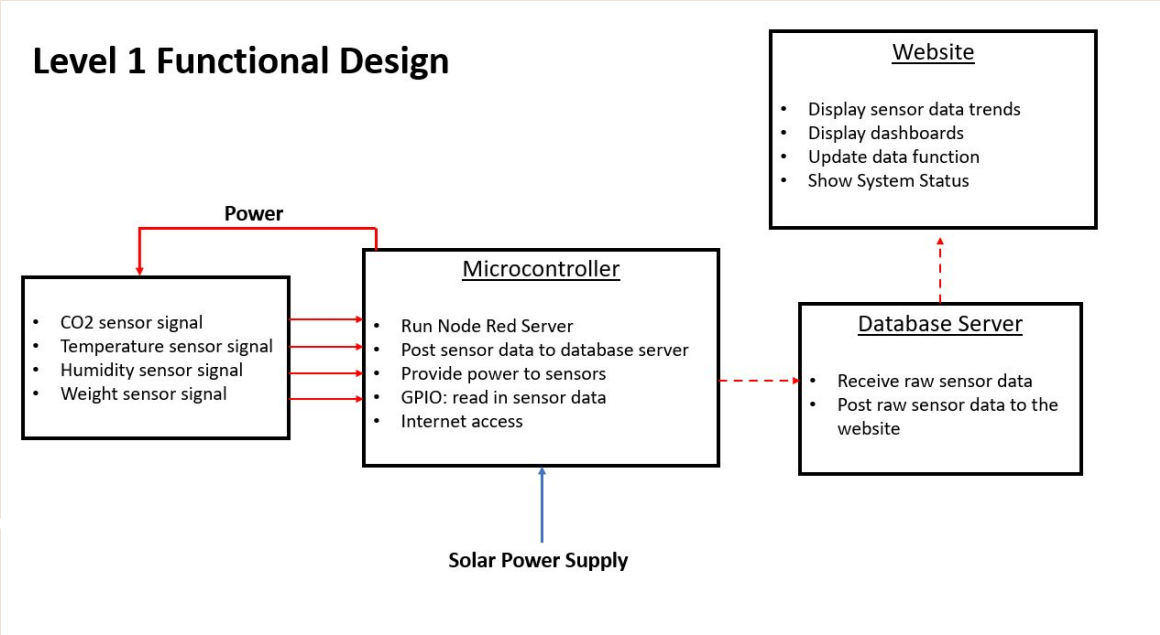
System Design

Functional Decomposition

Top-Level Functions: Level-0

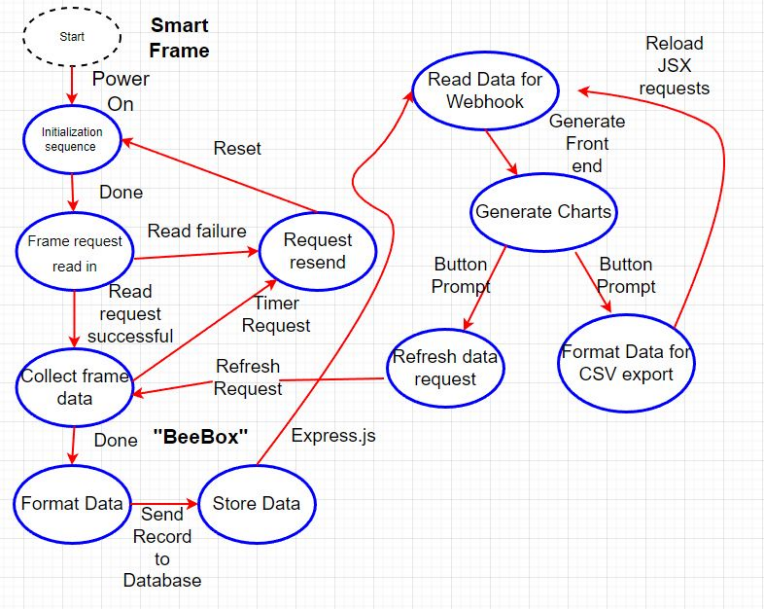


Functional Design: Level-1



System

- Raspberry Pi
- 5v Power supply
- 26 ¾” solar panel
- Node Red
- MongoDB



Weight

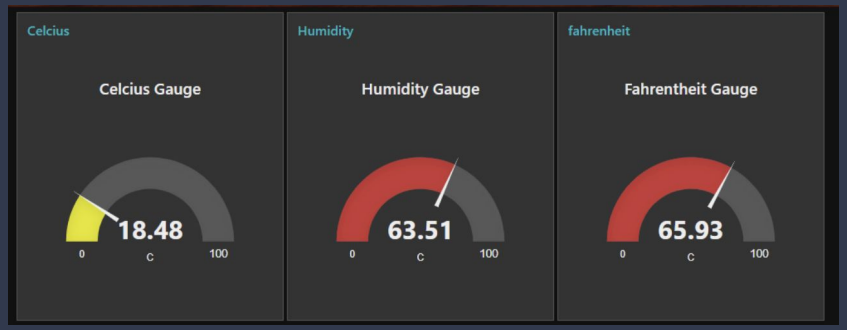
- Monitoring the weight of a beehive gives beekeepers an indication of the start and stop of nectar flow
- Sudden drop in weight can suggest that the bee colony has swarmed
  - Hive itself has been unusually affected by external factors and needs to be seen
- Comparing weight between the hives gives the beekeeper a sense of productivity

Temperature

- Alerts beekeepers to dangerous conditions within the hive including excessive heat
- Indicated that the hive needs to be moved or properly ventilated
- Low heat indicates that the hive needs to be insulated from cold water

C02

- Levels allow beekeepers to better ventilate their hives
- Bees can tolerate higher levels of c02 than humans
- High levels can still kill them



Humidity

- Honey production within an excessive amount of humidity can be dangerous to bee colonies
- High humidity levels alert beekeepers that moisture build-up is occurring
- Better ventilation and water removal is needed.

Illumination

- Light is an important indicator of potential threats to a beehive, including a swarm
- Sensors will indicate what light levels are healthy and not
- Levels can pick up on threats to a hive that other sensors may not indicate

Preliminary Experimental Plan

Experiments

Experiment #1

Testing if sensors work with our microcontroller (Raspberry Pi), and are accurate compared to readings we receive with measuring tools within a certain percentage

Experiment #2

Testing if our database receives and transmits data to our online tool reliably over many trials and circumstances – introducing hazards

Preliminary Project Plan

1. Interfacing sensors with microcontroller
2. Sending sensor data to the database using Node-RED
3. Implementing the database server with MongoDB
4. Developing our online tool for displaying data, sending data from server to website

Potential Problems

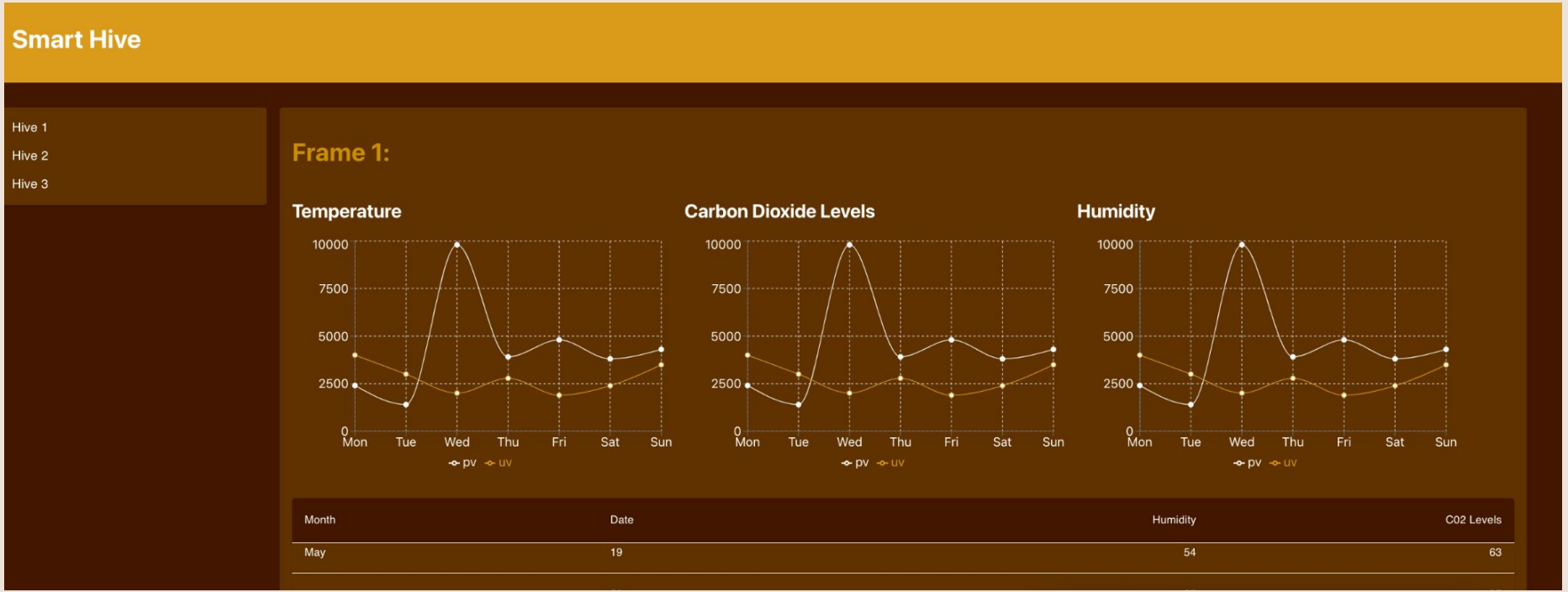
Connectivity

Weather Conditions

Power consumption

Website lag hosting front end and back end concurrently

Website Demo



The End.

Thank you!

References

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[2] E. NTAWUZUMUNSI and S. KUMARAN, "Design and Implementation of Smart Bees Hiving & Monitoring System," *2019 IST-Africa Week Conference (IST-Africa)*, 2019, pp. 1-9, doi: 10.23919/ISTAFRICA.2019.8764856.

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