Smart Hive

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Smart hive FS: Dr. N. Peixoto Design and deploy a multi-sensor framework that is wirelessly connected to Mason’s wifi and automatically uploads log files with temperature, CO2, weight, and illumination data from beehives. This project is intended to support Mason’s beehive project. This project may be sponsored by the Patriot Green Fund.

1.

Project Requirements

Requirements (Part 1 of 2)

- Our motivation in advancing the Smart Hive project is to produce a low-cost sensor network to monitor honey bees' health
- Future proofing/low troubleshooting this project is essential to keeping long term success for the end user
- Beehives and sensors must be in stable condition and protected with plastic mesh
- Plastic shall be used in order to maintain a cheaper and safer environment for the bees
- Device must have key parameters such as temperature, humidity, and Carbon Dioxide (Co2)

Requirements (Part 2 of 2)

- Bee Hives must have minimal light to avoid key disturbances and properly monitor the health of each hive
- Sensors will be located at the bottom of each hive to allow bee hives to build in size and show strength
- Smart Hives must be monitored 24/7 to keep beekeepers alert as soon as disturbance occurs
- Smart Hives will allow more precise monitoring and treatment and will improve colony survival rates

$200
Maximum Budget Per Frame

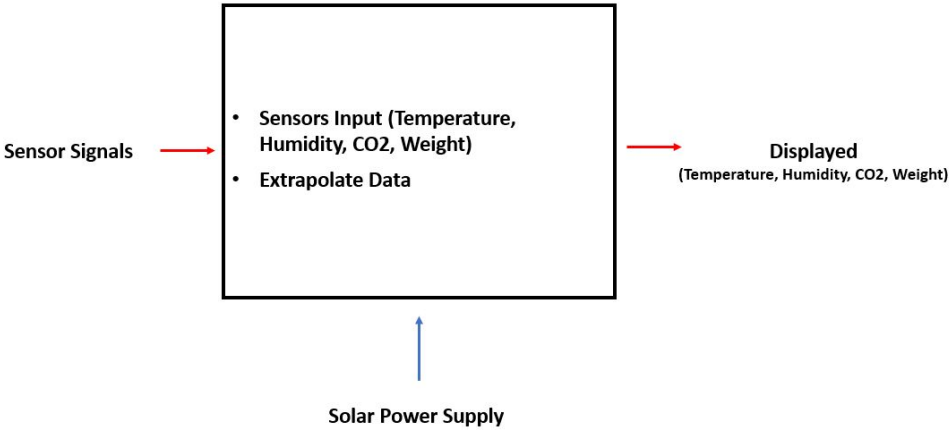
Accessible to 13-year-old
User manual is included in deliverables

⅜”
The amount of inches we have of gap space between the components

2.
Design Architecture

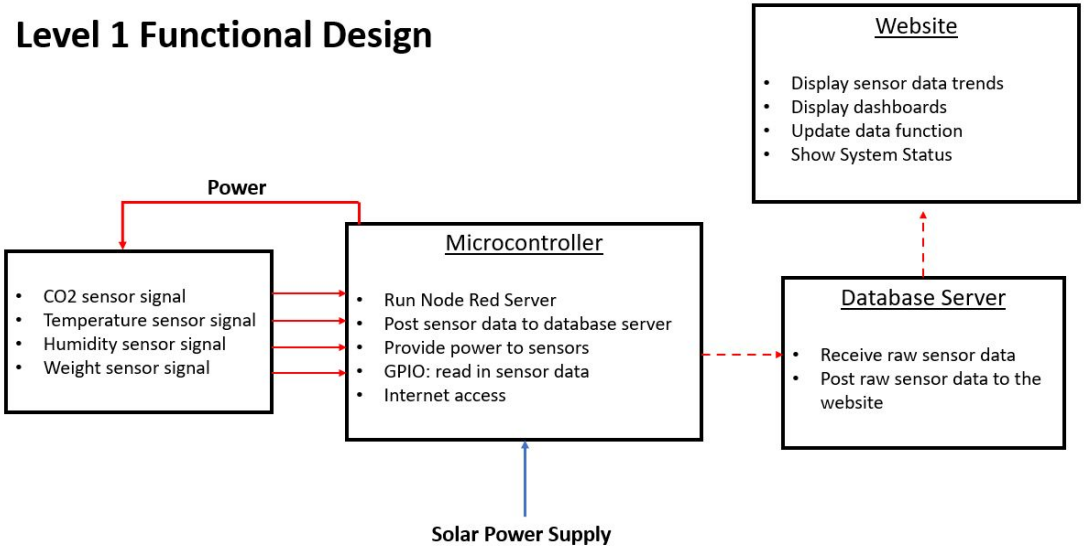
Level 0

Top-Level Functions (Level-0)



Level 1

Level 1 Functional Design



3.
Background

Background

Our approach to this solution involves a series of microcontrollers which connect together to create a small internet of things. One of these microcontrollers will be inserted into each hive to be monitored and the other will be used as a database in order to store information onto the website for the user to access.

- Raspberry Pi
  - 5v Power supply
  - 26 ¾” solar panel
  - Communicate with physical server
- Node Red
  - Live feed dashboard
  - Easily modifiable codebase
- MongoDB
  - Database for mapping

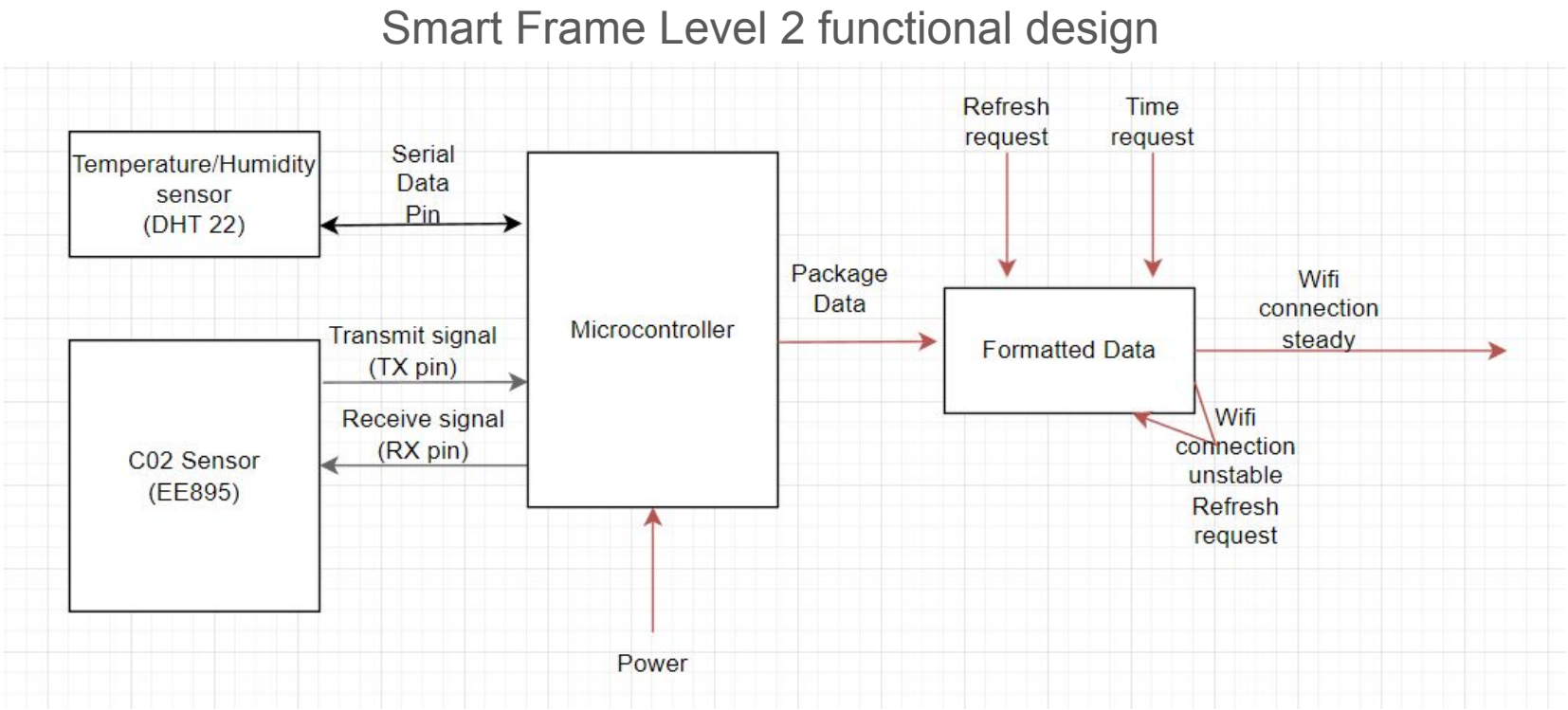
Good to Know

	Temperature	Humidity	CO2
Ideal Range	**93°-97°F**	**90-95%**	**0.10-4.25%**
Number of Sensors per hive	**6**	**1-6**	**1**

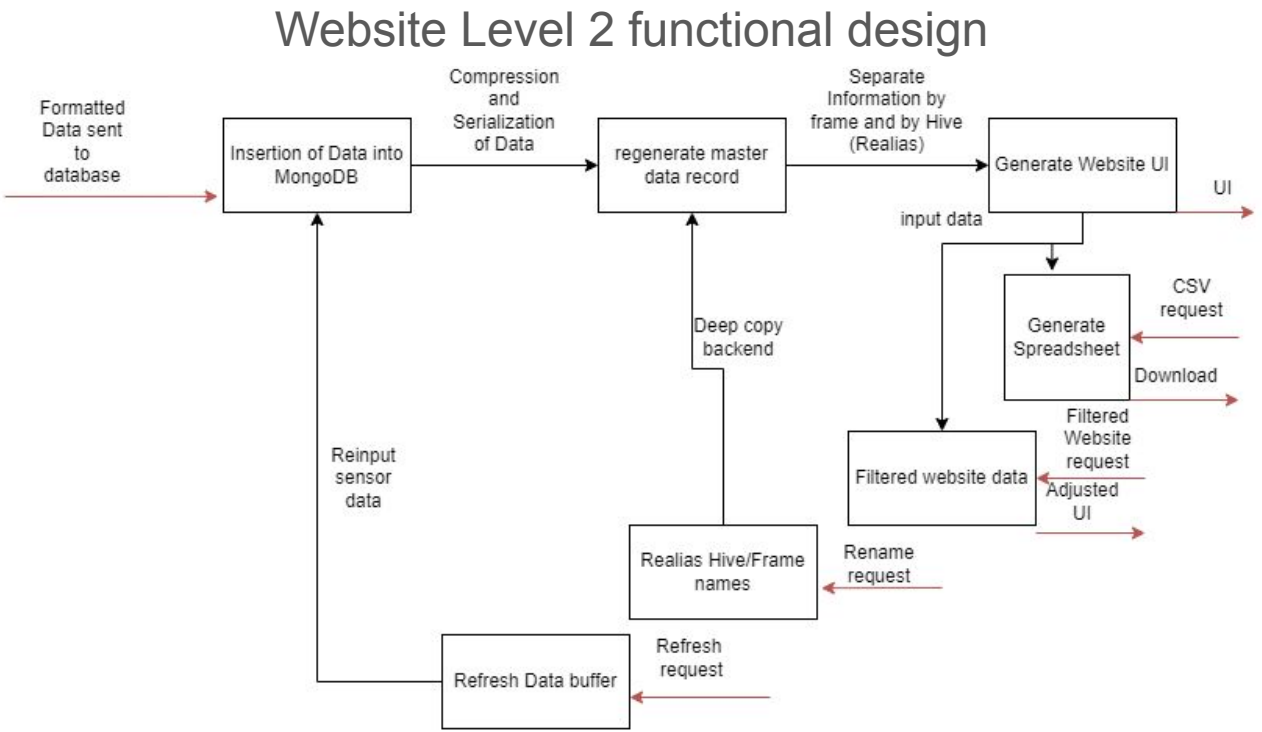
*Humidity and Temperature were surveyed by the customer

4.
Design

Level 2

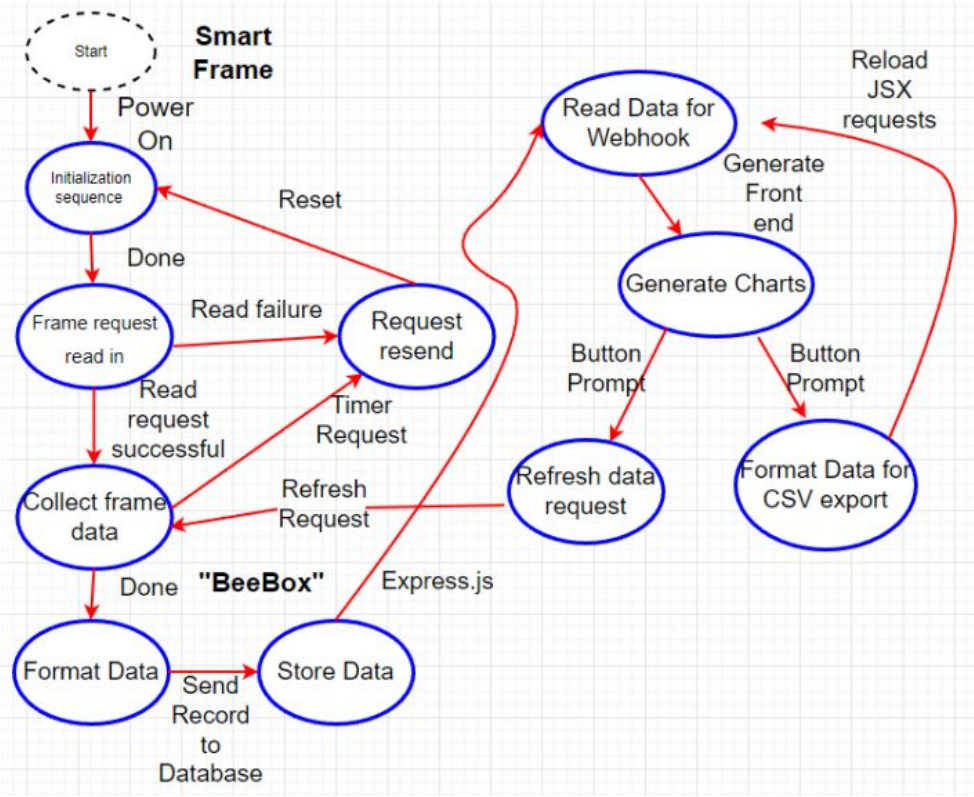

Smart Frame Level 2 functional design
Temperature/Humidity sensor (DHT 22)
Serial Data Pin
Microcontroller
Refresh request
Time request
Package Data
Formatted Data
Wifi connection steady
Transmit signal (TX pin)
Receive signal (RX pin)
C02 Sensor (EE895)
Wifi connection unstable
Refresh request
Power

Level 2

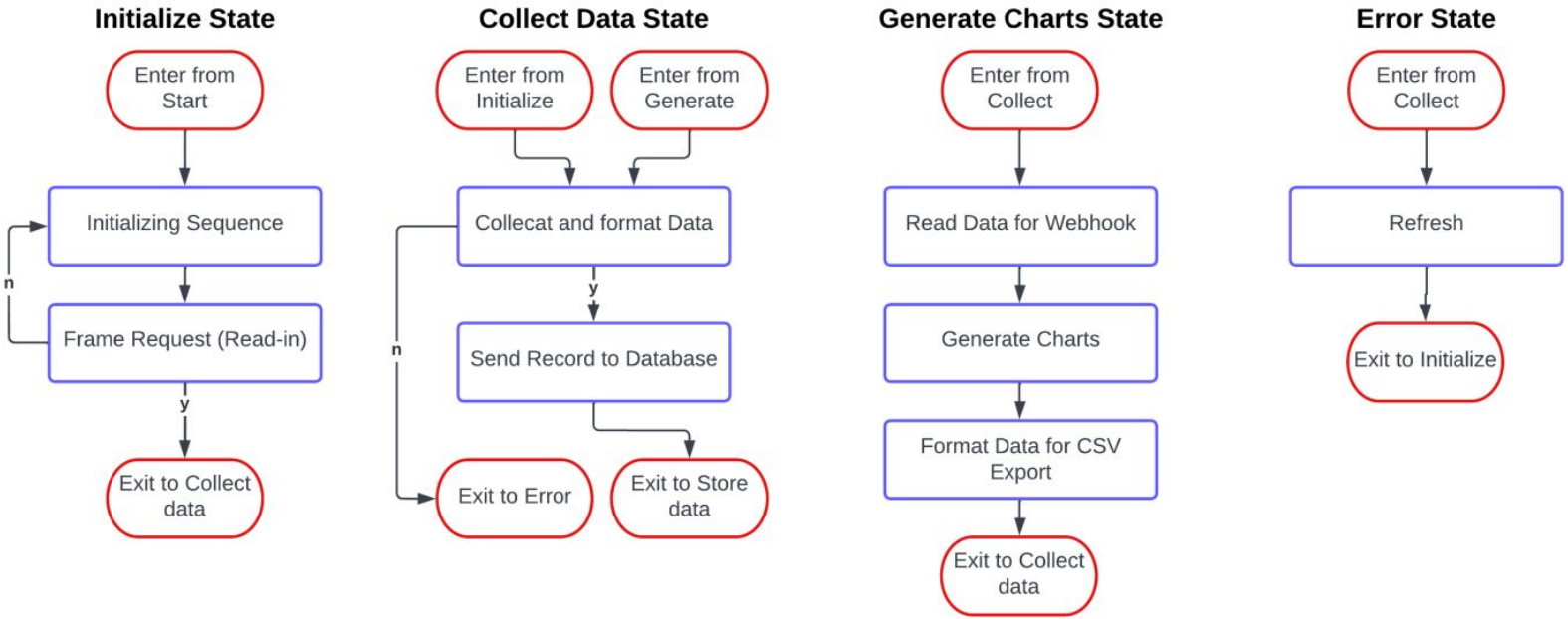

Website Level 2 functional design
Formatted Data sent to database
Insertion of Data into MongoDB
Compression and Serialization of Data
regenerate master data record
Separate Information by frame and by Hive (Realias)
Generate Website UI
UI
input data
Generate Spreadsheet
CSV request
Download
Deep copy backend
Reinput sensor data
Filtered website data
Filtered Website request
Adjusted UI
Realias Hive/Frame names
Rename request
Refresh Data buffer
Refresh request

5.
System models

Generic Flowchart



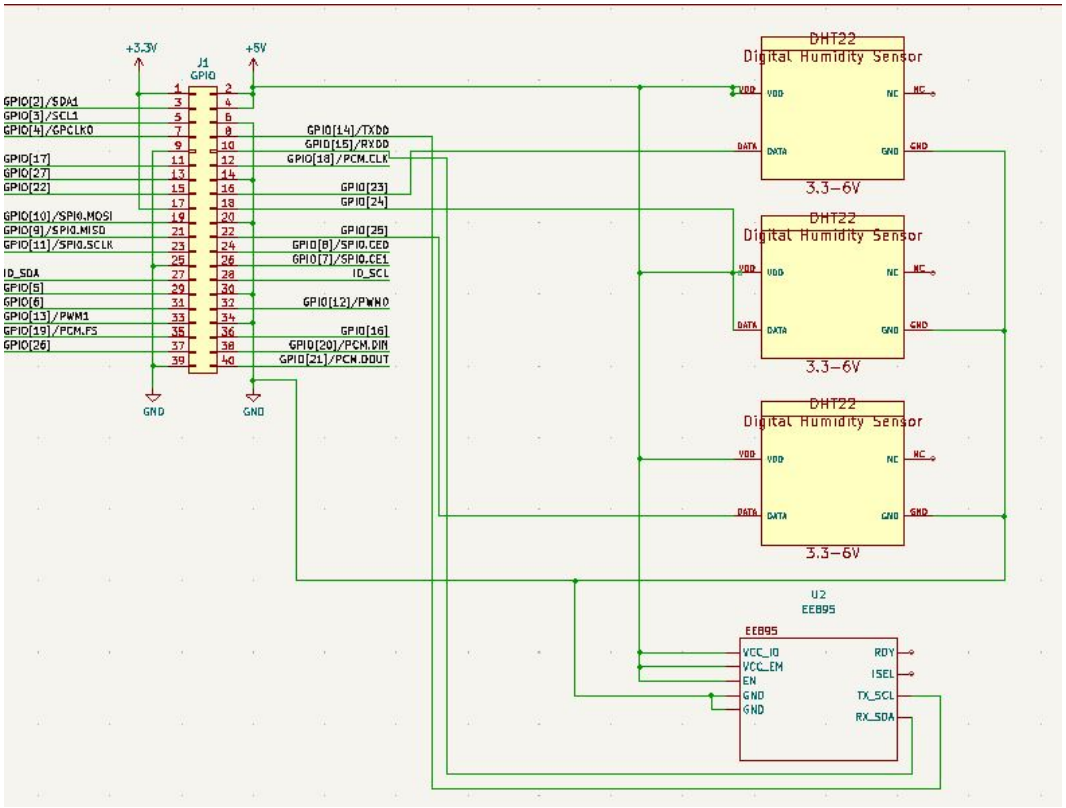
Other flow diagrams:



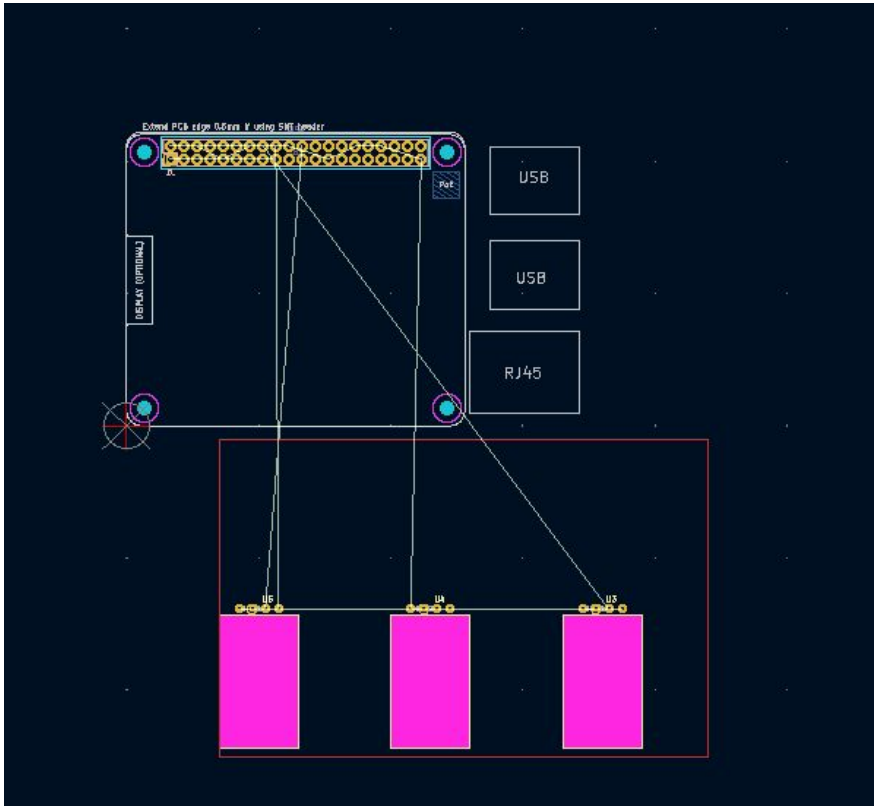
6.

Schematics & Parts Selection

Generic Schematic (Kicad symbolic with C02 sensor)



KiCad footprint for the smarthive (no C02 sensor)



Sensor Decision matrix

Temperature Sensor:

	Weight ->	9	10	5	2	10	
Part Number:		Cost	Durability	Size	Digital/Analog	Accuracy	Final Rank
DHT22		9	6	9	10	9	43
DS18B20		10	3	7	10	8	38
DHT11		9	6	9	10	7	41
LM35		6	4	9	5	10	34

Humidity Sensor:

	Weight ->	9	10	5	2	10	
Part Number:		Cost	Durability	Size	Digital/Analog	Accuracy	Final Rank
BME280		5	6	9	10	7	37
SHT40		6	7	10	10	8	41
DHT22		9	6	9	10	9	43
DHT11		9	6	9	10	8	42

Weight Sensor:

	Weight ->	9	10	5	2	10	
Part Number:		Cost	Durability	Size	Digital/Analog	Accuracy	Final Rank
HX711		7	7	9	5	10	38
H26R0		7	5	10	5	8	35
MF02A-N-221-A01		8	3	8	0	8	27

CO2 Sensor:

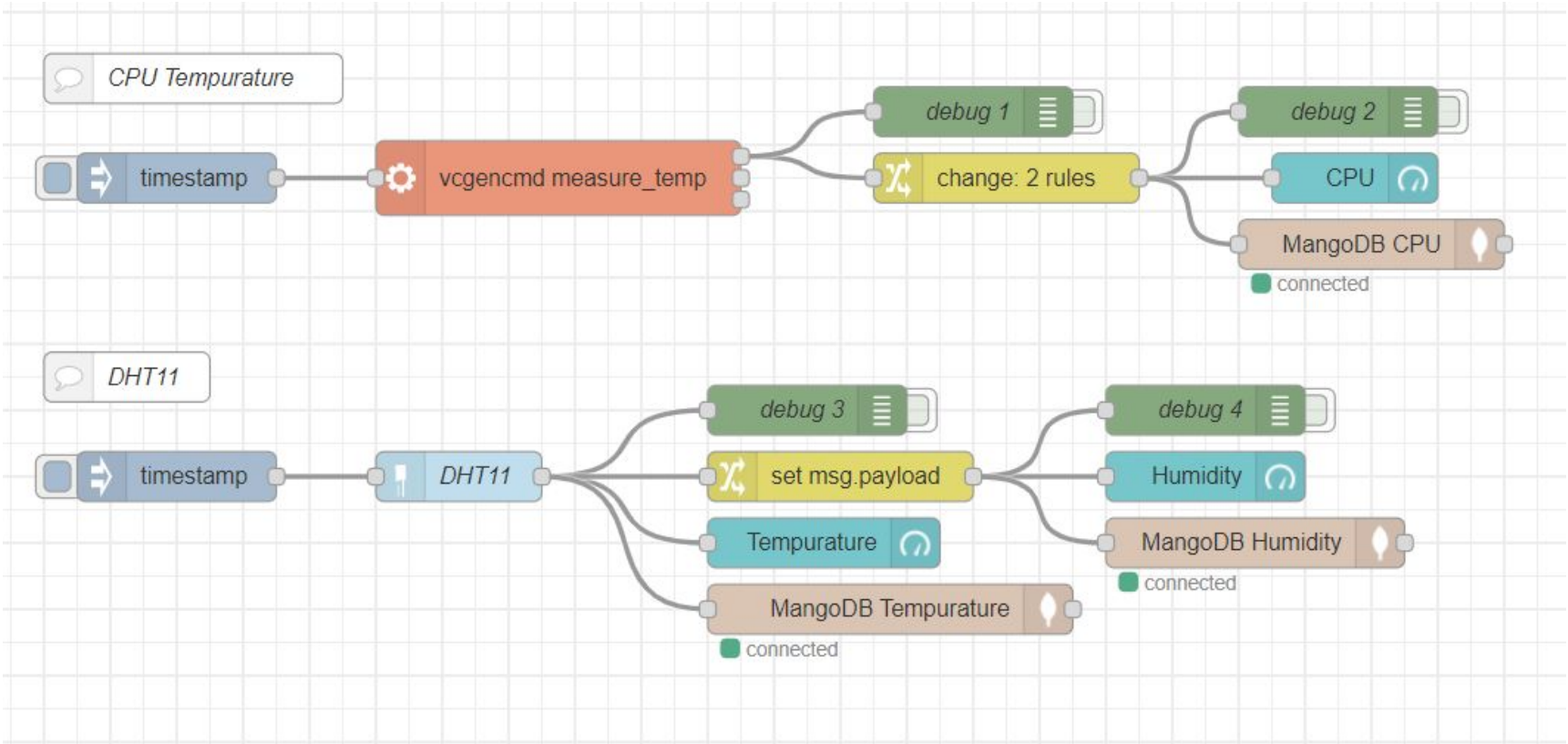
	Weight ->	9	10	5	2	10	
Part Number:		Cost	Durability	Size	Digital/Analog	Accuracy	Final Rank
K30		4	5	7	10	8	34
SCD30		6	5	7	10	8	36
EE895		5	6	8	10	9	38
CCS811		7	4	8	5	7	31

7.

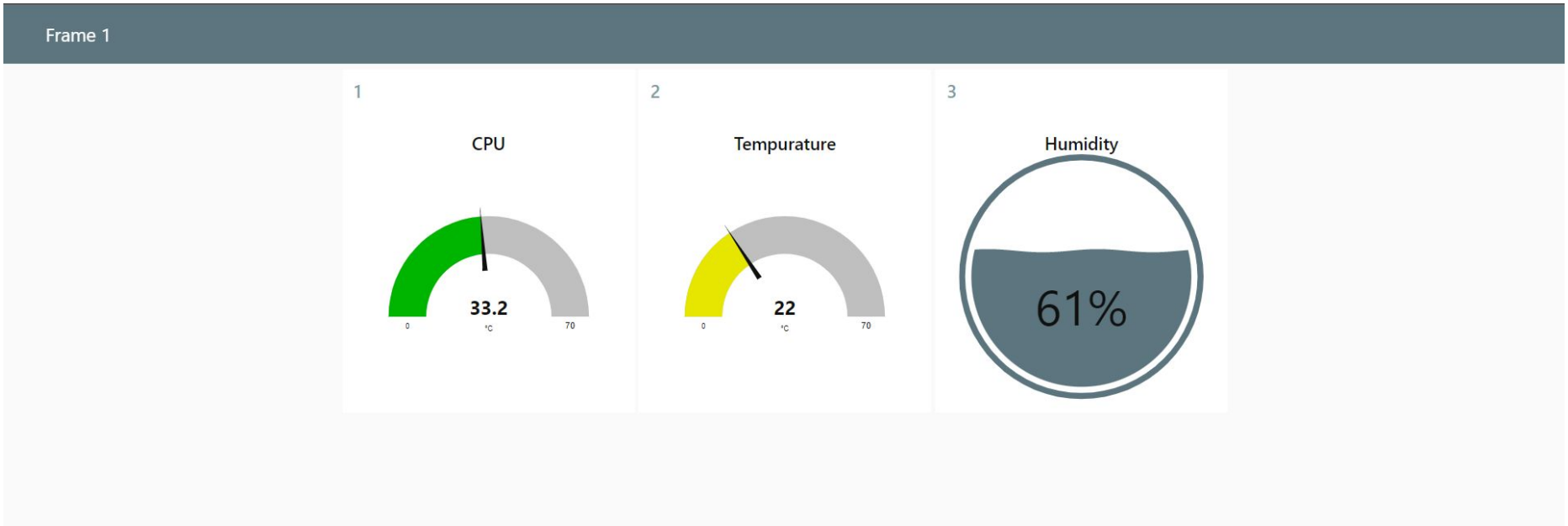
Prototypes

Website Prototype

NODE-RED sensor Prototype



NODE-RED live sensor feed dashboard prototype



8.

Project challenges

Propolis

Bees produce a wax-like substance referred to as propolis. This has been known to damage circuits which go unprotected. The project must contain a safe substance the bees will not interfere with in order to protect the circuits.

Connectivity

The second largest issue is the connectivity between the database and the smart frames. If the wifi were to stop working and it were not accounted for, we could lose major portions of the data without backup

Weather

Components can be damaged by the weather and can also cause water damage. Our components must be protected in order to maintain a longer lifetime in the hive as well as provide more accurate data.

9.

Tasks to be done

Experiments we have completed and yet to complete

Experiments completed:

- NODE-RED GPIO Connectivity
- MERN stack running concurrently on same server
- MongoDB postman unit tests
- Rechart.js/Software flow test
- Schematic footprints
- Temperature sample gathering
- Humidity sample gathering
- Dimensions gathering

Experiments to be completed:

- Circuit propolis
- MongoDB to Node-Red
- Durability with generic printed circuit boards
- Measured smart frame boards in the hive
- Wifi Connectivity throughout day
- General port forwarding of the connection