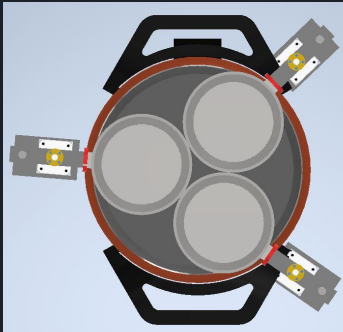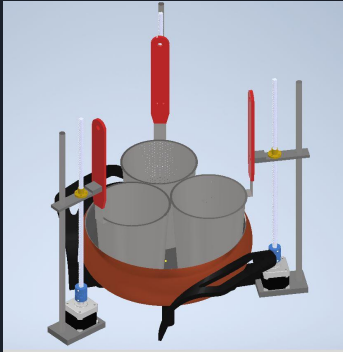# Team E5: Hot Pot Bot Design Review

Christina Chi (cchi1), Isabel Basow (ibasow), Shane Oh (shaneo)

Application Area and Solution Approach

Hot Pot Bot is a system that makes hot pot easier and safer
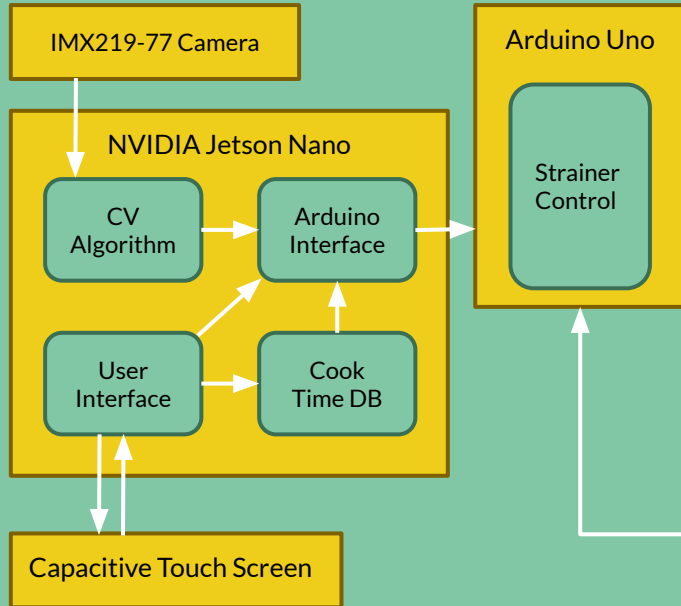
- Prevents the over and undercooking of hot pot
  - DB of ingredient cook times
  - Motorized strainers actuate based on cook time
  - Strainers allow easy retrieval without losing food in the broth
  - LEDs convey strainer status
- CV categorizes ingredients as they are dropped into the strainers
  - No contact with food
  - Users can arrange and move ingredient platters arbitrarily
  - Does not interfere with socialization
- UI on touchscreen
  - Users can quickly adjust cook time to preference
  - Occasionally correct categorization errors
- Powered by wall outlet
  - User already has access to outlet for hot pot

Computer Vision Algorithm
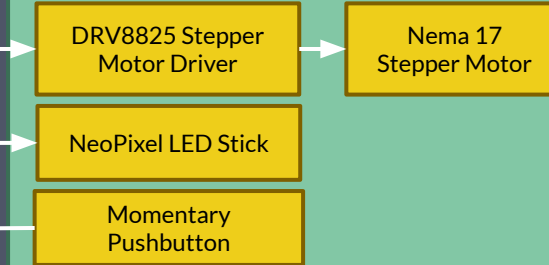
Crop video to strainer region

- Camera location predetermined on control tower
- Pot and strainer locations known

Isolate foreground

- Blur frame
- Background subtraction using MOG2
- Reduce noise with morphology open

Create multiple versions of foreground

- Thresholded
- HSV colorspace

Blob detection

Overall strainer contents classified by majority rule

- Assuming multiple pieces dropped in at a time

On threshold

low circularity

high circularity

On HSV

H = brown
S = mid
V = mid

H = green
S = high
V = high

H = red
S = high
V = high

Strainer States

READY
Strainer above pot with no food

LEDs green

CV detects food put in & temp. = 100°C ±5°C

LOADING
Strainer above pot, food being put in

LEDs animated

5 sec. window for dropping in more food

CAUTION
Strainer moving

LEDs flashing

Strainer fully lowered

COOKING
Strainer in pot with food

LEDs red

Food timer done

Button pushed

COLLECT
Strainer above pot with food

LEDs yellow

Strainer fully raised
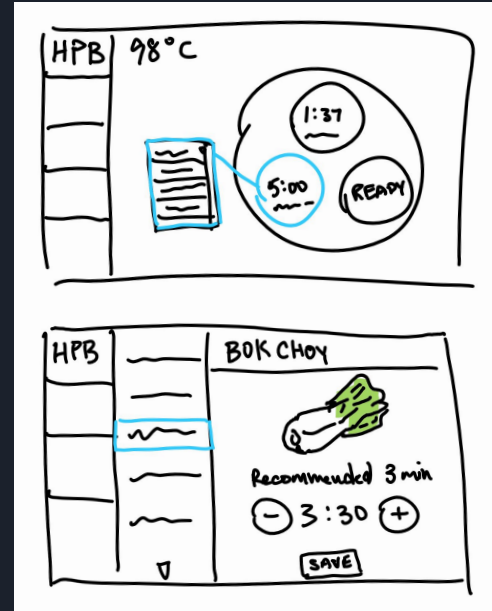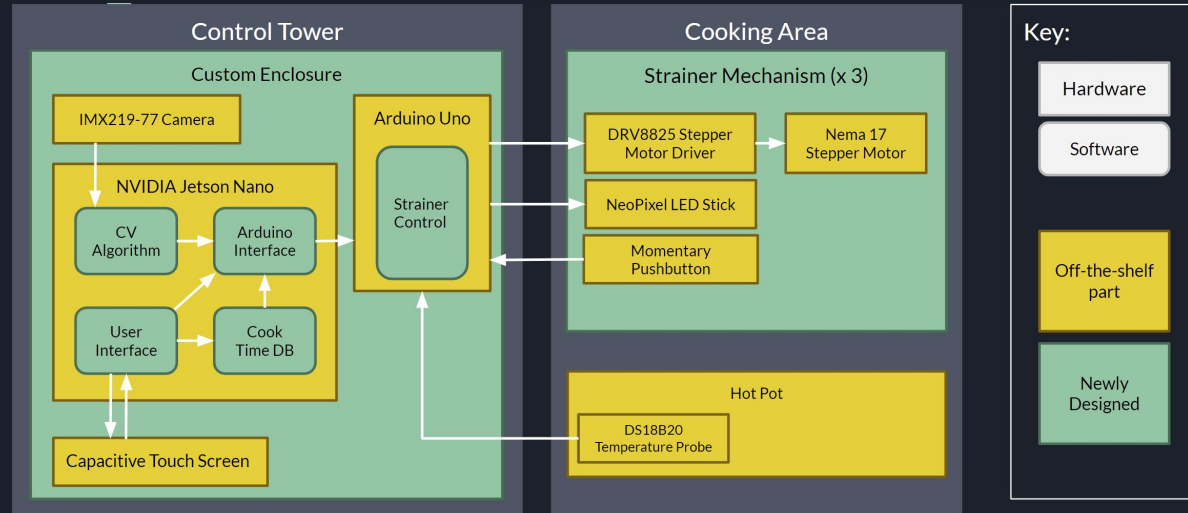
User Interface

- Located on control tower
- Controlled through touchscreen
- Displays strainers and their states
- Displays currently cooking ingredients
  - User can tap strainer and select correct ingredient in case of categorization error
- Access to cook time DB
  - Can add or subtract to preferred time

Implementation Plan

- Off-the-shelf electronic components
- Custom designed mechanical parts and enclosures
- Custom designed software and interfaces
  - Downloading existing OpenCV libraries for use in newly designed algorithm

Control Tower

Custom Enclosure

IMX219-77 Camera

NVIDIA Jetson Nano

- CV Algorithm
- Arduino Interface
- User Interface
- Cook Time DB

Capacitive Touch Screen

Arduino Uno

Strainer Control

Cooking Area

Strainer Mechanism (x 3)

- DRV8825 Stepper Motor Driver
- Nema 17 Stepper Motor
- NeoPixel LED Stick
- Momentary Pushbutton

Hot Pot

DS18B20 Temperature Probe

Key:

- Hardware
- Software
- Off-the-shelf part
- Newly Designed

Metrics and Validation

| Feature	Test Inputs/Method	Test Outputs	Success metric
CV accuracy and speed	Test set of foods dropped into pot	Confusion matrix and code benchmarking	≥80% accurate (individual) ≥95% accurate (strainer) <5 sec per classification (strainer)
Strainer speed	Food being dropped in and cooking	Time for strainer to fully lift up and down	Strainer drops <5 sec after classified, Strainer lifts <5 sec after done cooking
LED response time	Button push, food being dropped, cook timer trigger	Time until LED changes color and state	LED changes state <1 sec
UI response time	Tapping on the UI	Time until response	≤0.1 sec for all functions
User experience	Unaffiliated users perform setup and cleanup with minimal provided instructions	Time to complete setup Time to complete cleanup	<5 minutes to set up <5 minutes to disassemble
Durability over meal	Run system for 1.5 hours during hot pot meal	Response times and accuracy of above components measured every 15 min.	<5% decline in accuracy and speed throughout the meal

Risk Factors and Unknowns

Scenario	Risk Mitigation	Worst Case	Cost
CV doesn't recognize ingredients	- Limit ingredients to visually different foods - Have footage of backup ingredients to swap in - Allow for categorization error corrections in the UI	Food selection done completely through touch screen without CV	User experience significantly worsens
Steam blocks camera	Place camera at an angle, not directly above hot pot	Include fan on control tower	- Need redesign of control tower - Additional integration work
Components damaged by heat or moisture	- Position components with ample space from pot - Create waterproof casings - Reserve budget + slack time for obtaining replacements	Repurchase components and use thermal insulation	- Time and money - Need redesign to include insulation - Additional integration work

Schedule

Work Distribution:

- Christina
  - CV
  - Jetson Nano interfacing
- Shane
  - Strainer Design
  - Control Tower
  - UI
- Isabel
  - Arduino interfacing
  - Motors and LEDs connection
- Everyone
  - Integration and testing
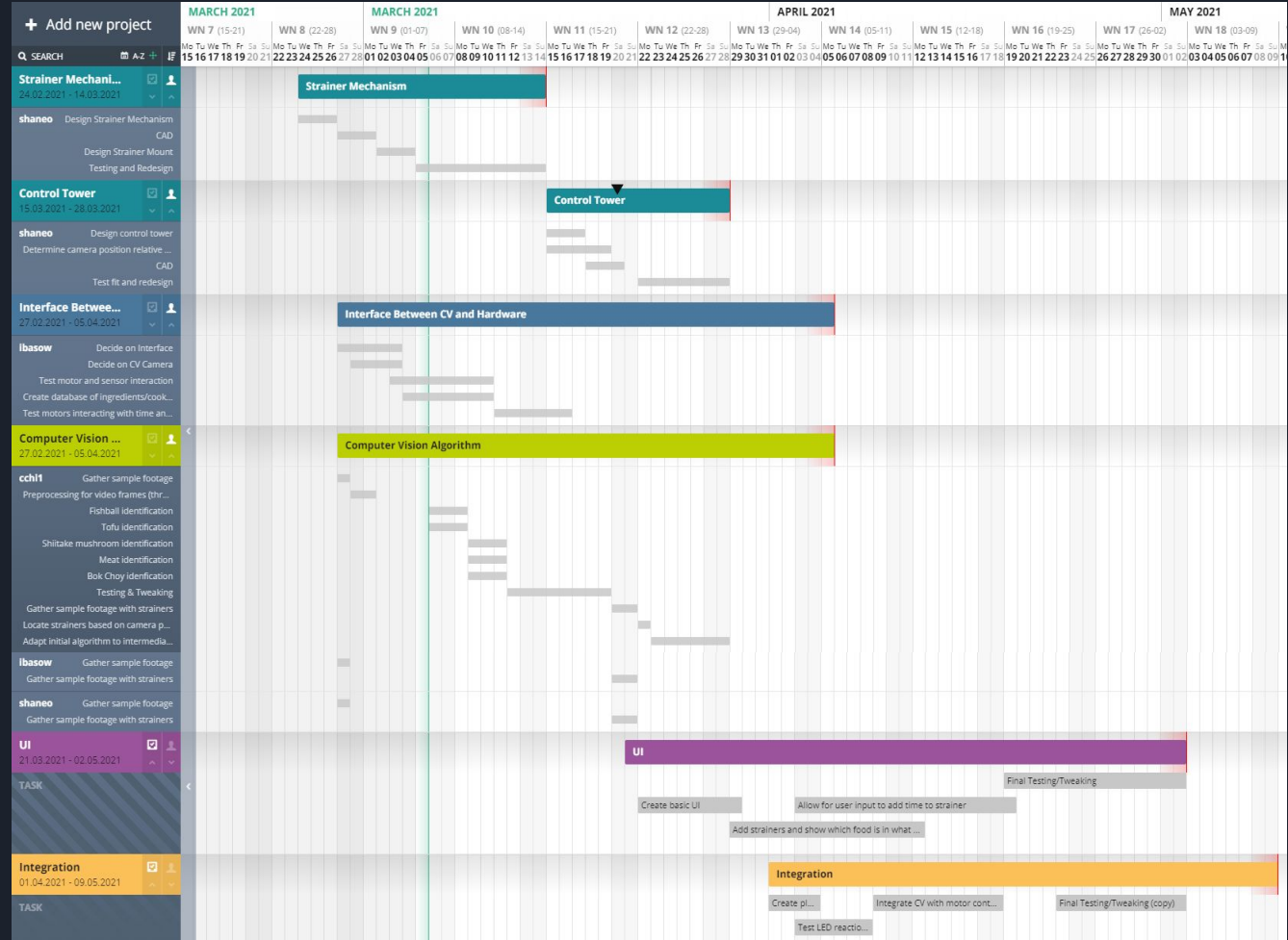
Conclusion

We are excited to create Hot Pot Bot!

- Building:
  - All major parts ordered and arriving within week
  - Strainer mechanism CAD model finished
- Developing:
  - Initial CV dataset collected
  - Background subtraction working
  - Ingredient recognition promising
- So far on schedule
  - Team Hot Pot Bot is on the dot!