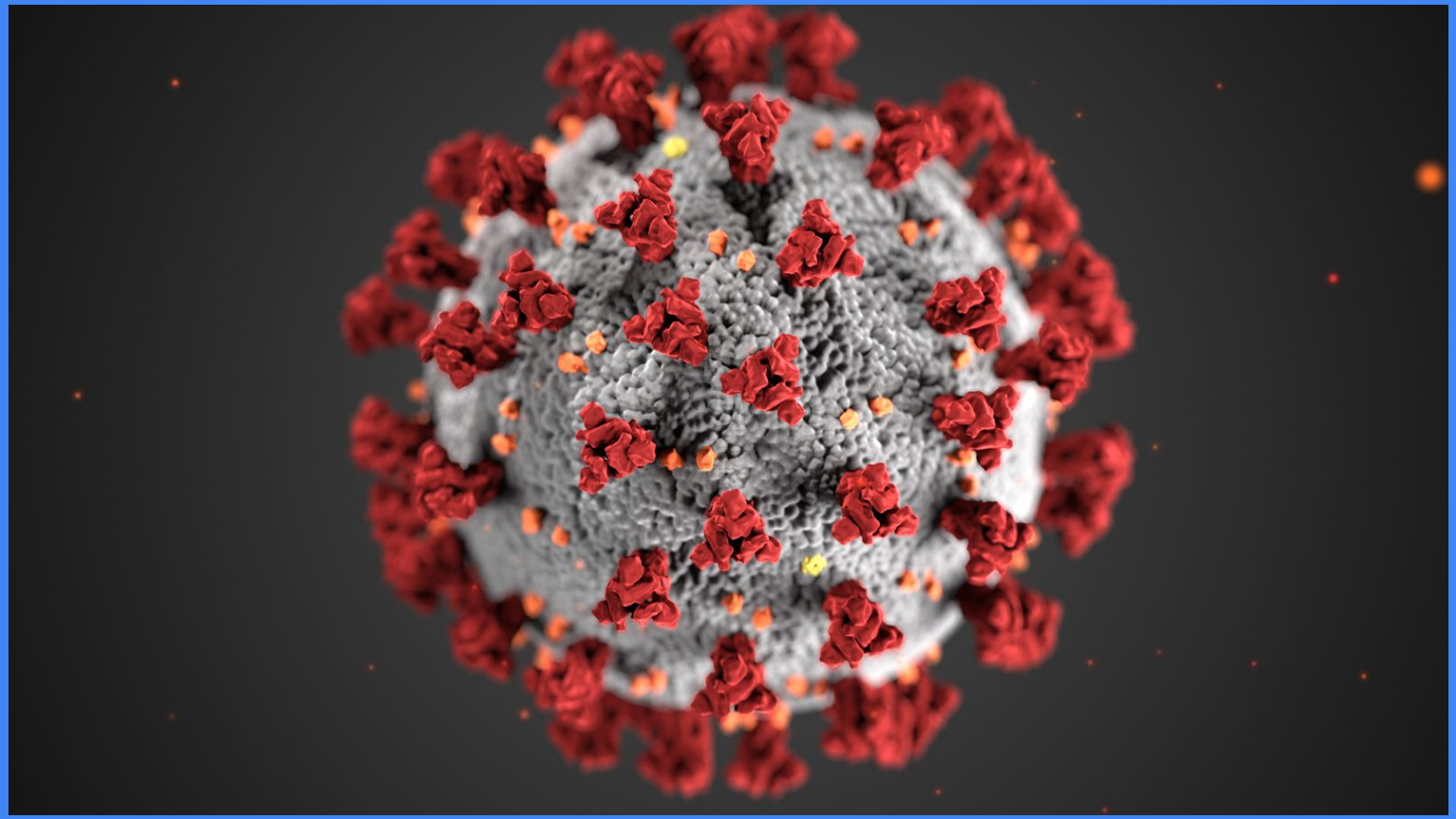
COVID Screening Checkpoint

Capstone Group 3
Ammar Alvi, Neel Khatri, Xavier D’Souza
Advisor: Dr. Abdul Bais

Past Year

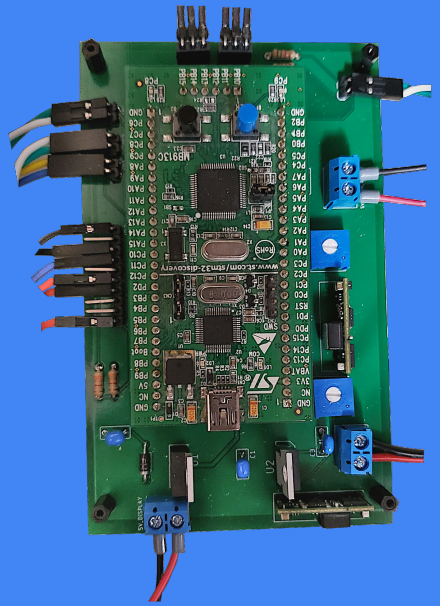


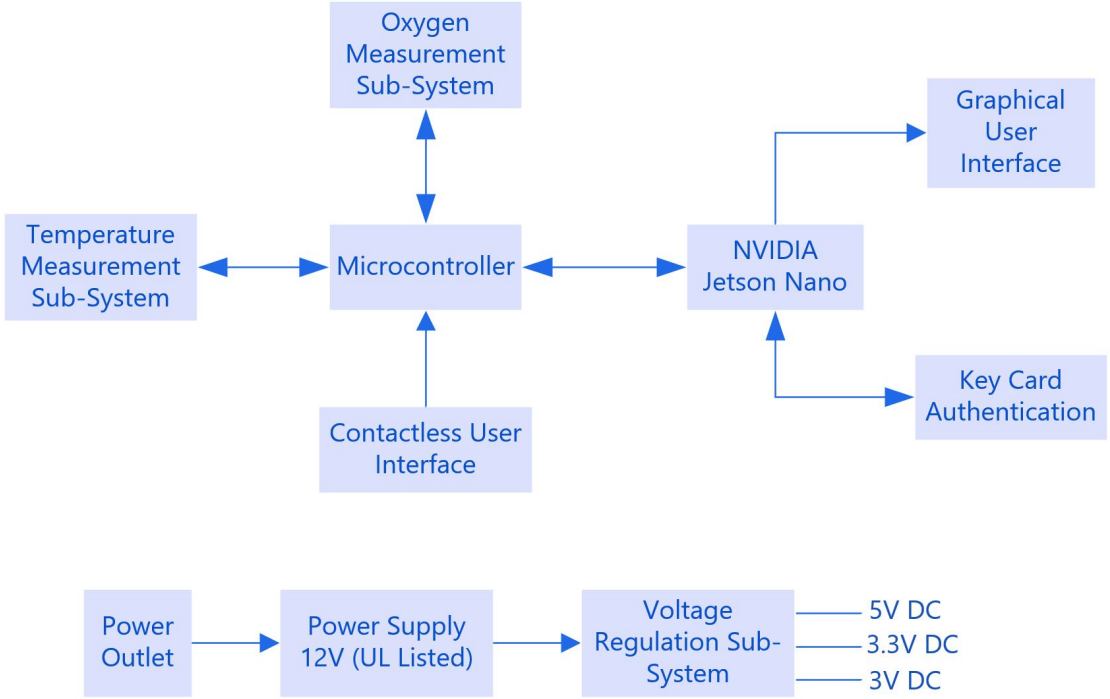
https://www.fda.gov/food/food-safety-during-emergencies/food-safety-and-coronavirus-disease-2019-covid-19

Agenda

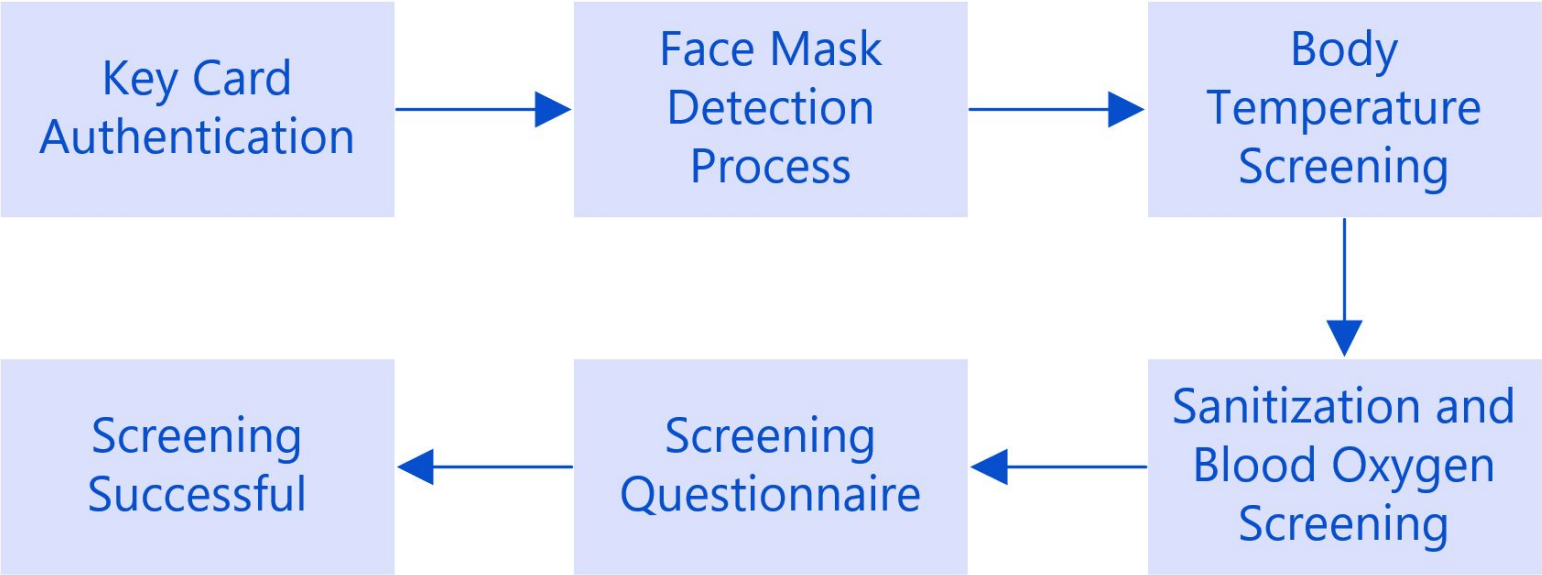
1. System Block Diagrams
2. Individual Component/Subsystem Descriptions
3. Enclosure Design
4. Safety and Ethical Considerations
5. Future Development
6. Demo Video
7. Questions

System Block Diagram



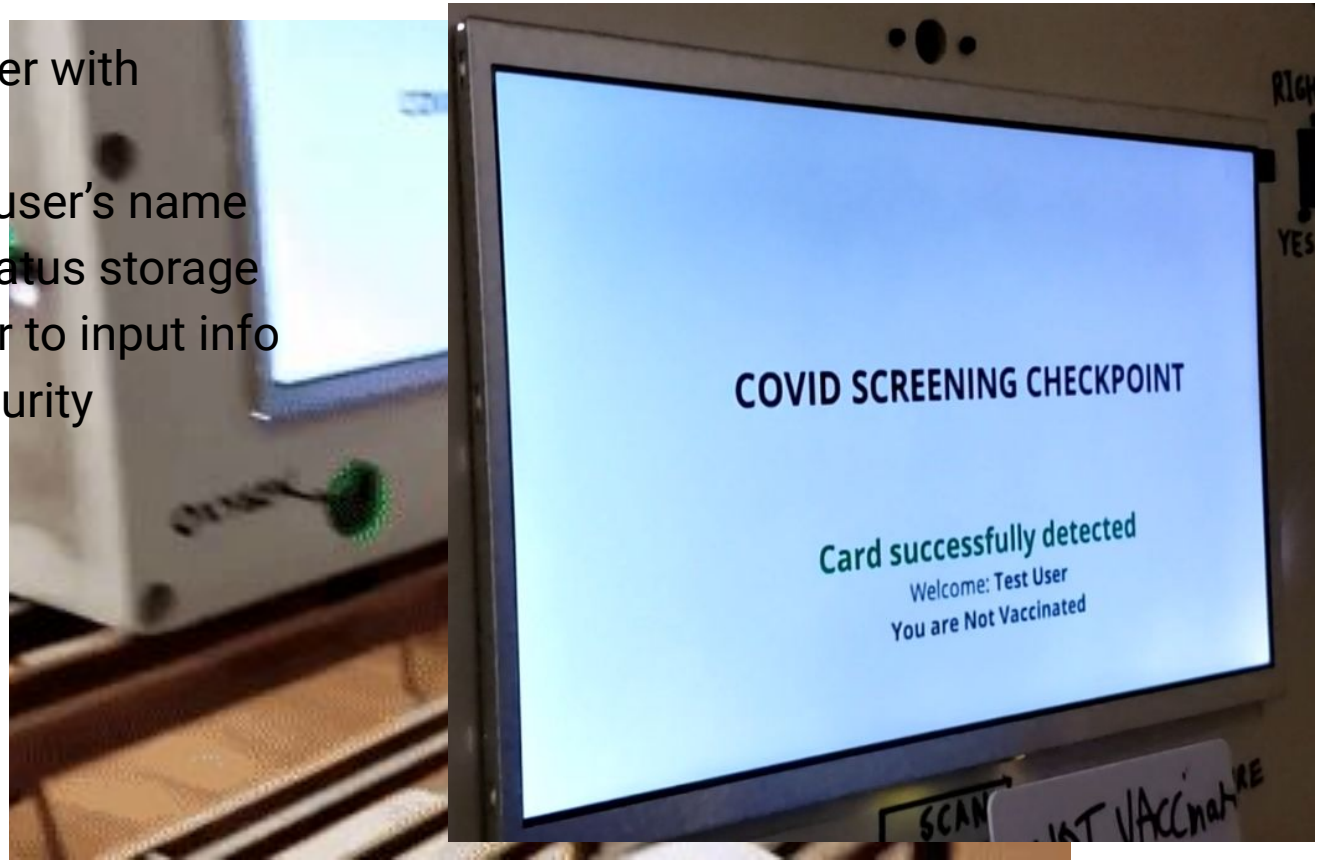


Sequence of Operation



User Authentication

- NFC/RFID Controller with unique Key Cards
- SQL Database for user’s name and vaccination status storage
- QR Code Generator to input info
- Validation and Security

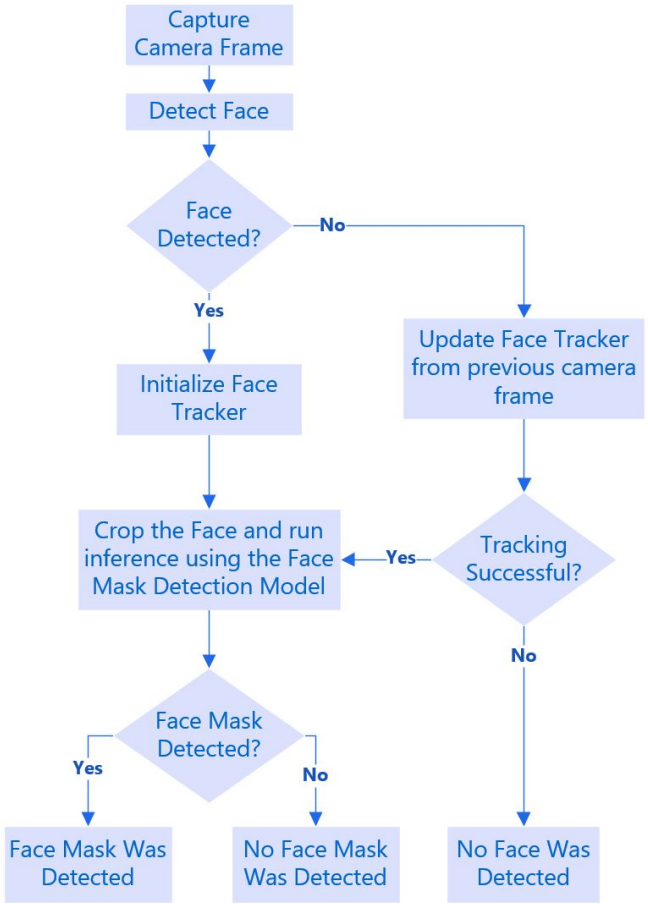


Contactless User Interface

- Two Infrared Proximity Sensors (Left and Right side)
- User simply hovers their hand over it to make a selection (Simple UI Navigation)

Face Mask Detection Process

- Used **Face Detector** to detect user's face
- Track the user's face from previous camera frame if face not detected
  - Ensures face detection stability
- Crop the Face Region in the camera frame and run inference using **Face Mask Detection Model**

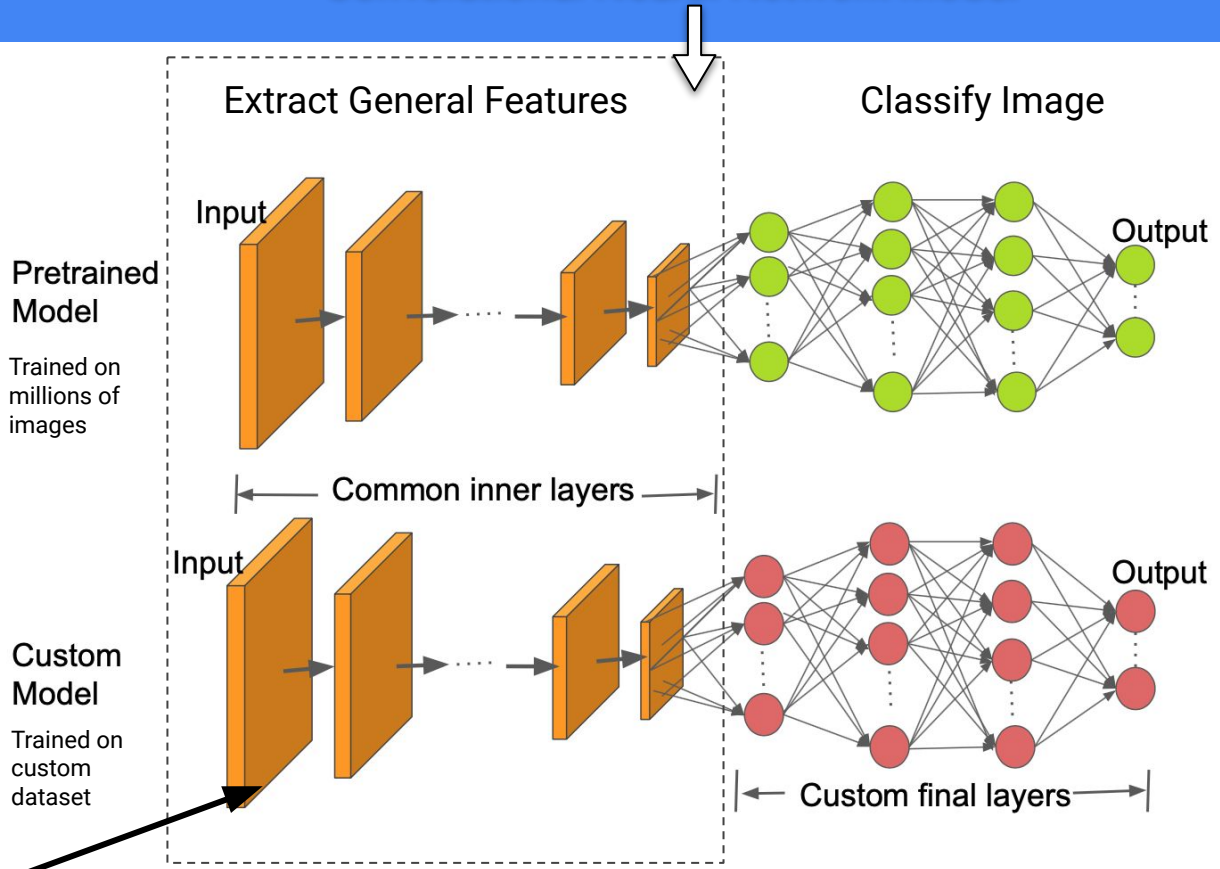


Transfer Learning

Convolutional Neural Network Model

Transfer Learning Steps:

- Select pre-trained model
- Replace its final layers
- Re-train model on our custom dataset
- Run inference

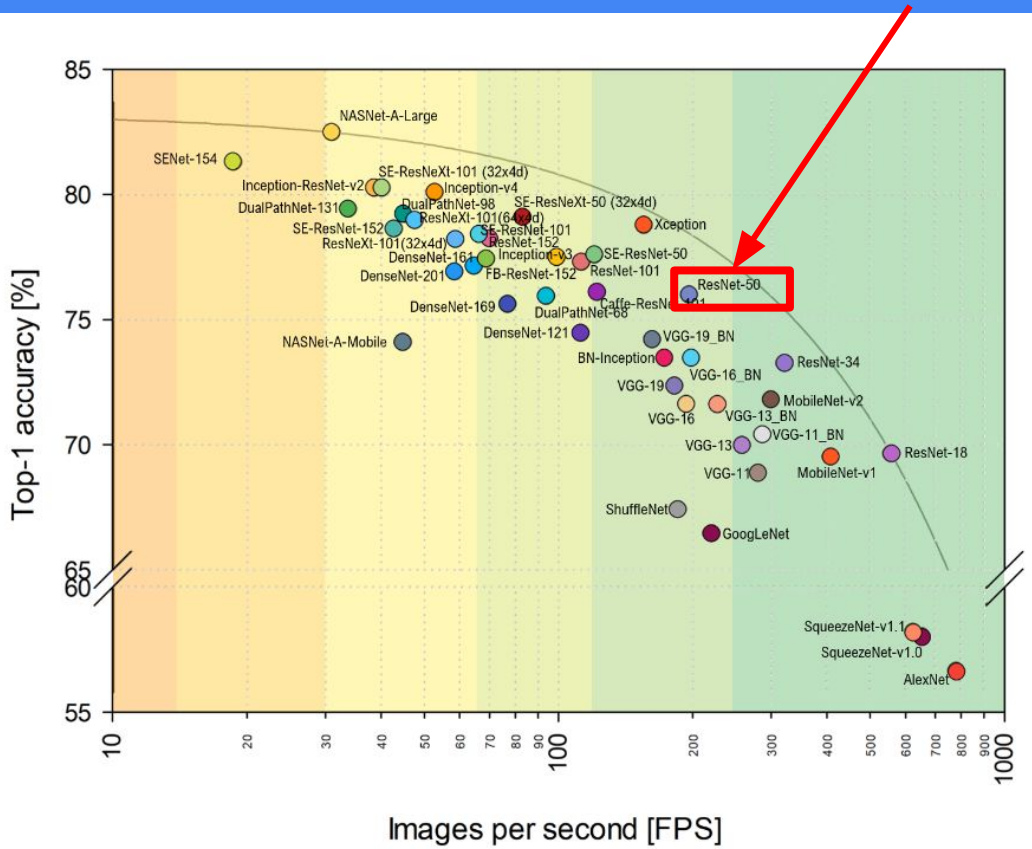


Frozen during training

Source: https://learnopencv.com/image-classification-using-transfer-learning-in-pytorch/

Pre-Trained Model Selection

- Chose ResNet-50 pre-trained model
- Provides a good balance between accuracy and speed



Source: S. Bianco, R. Cadene, L. Celona and P. Napoletano, "Benchmark Analysis of Representative Deep Neural Network Architectures," in *IEEE Access*, vol. 6, pp. 64270-64277, 2018,

Face Mask Detection Model Training Dataset

Dataset Sources:
github.com//MaskedFace-Net
github.com/NVlacabanibs/ffhq-dataset
www.kaggle.com/andrewmvd/face-mask-detection

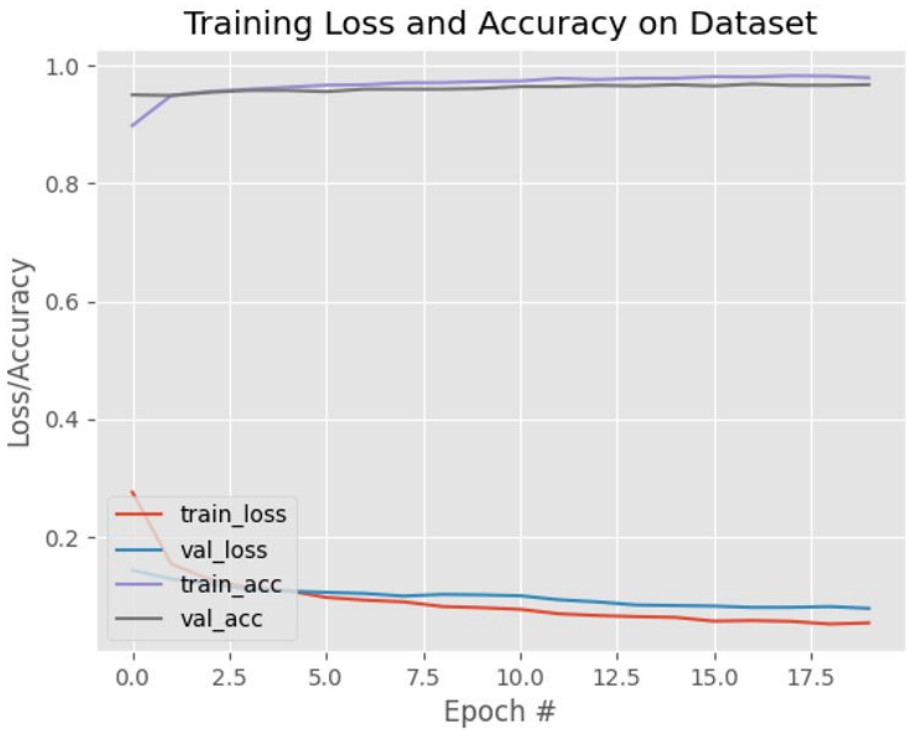
People Wearing Face Mask

People Not/Incorrectly Wearing Face Mask

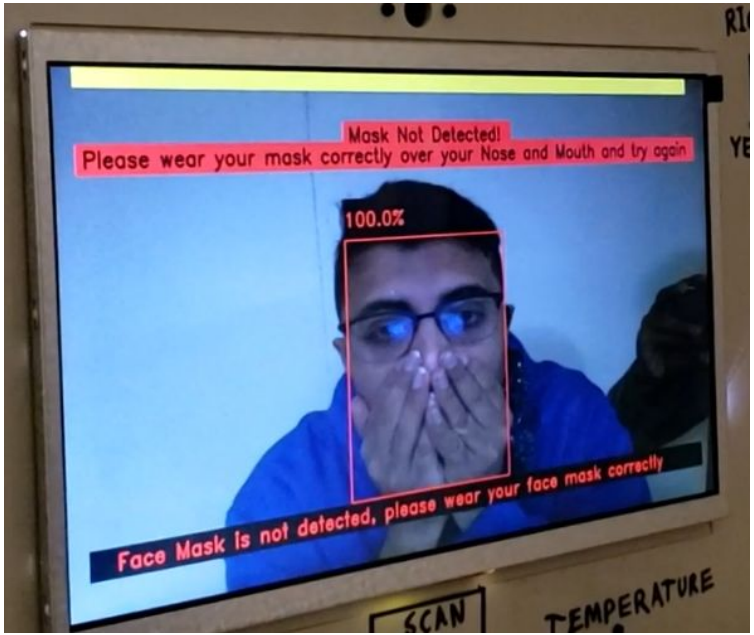
Face Mask Detection Model Training Results

Trained using Keras (open-source API)

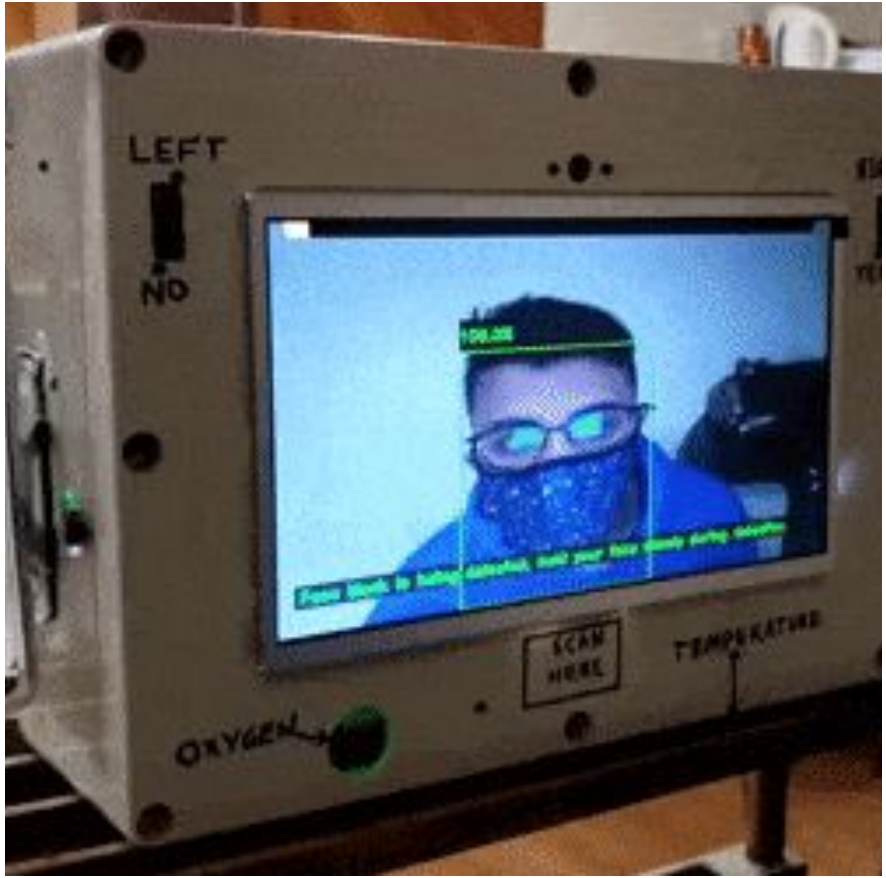
Training/Validation Accuracy achieved >90%

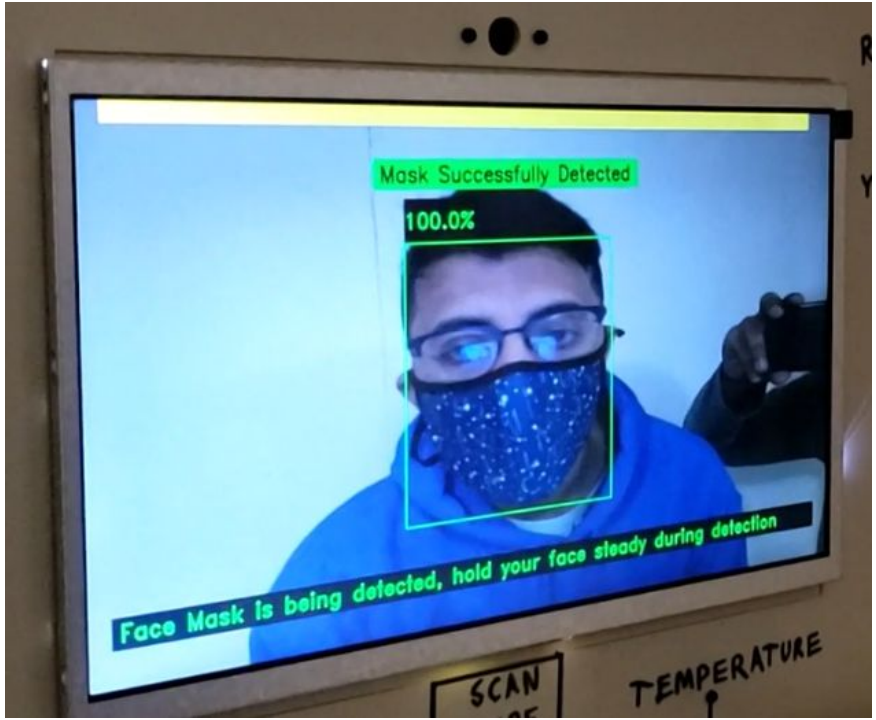


Face Mask Detection (Mouth Covered by Hand)



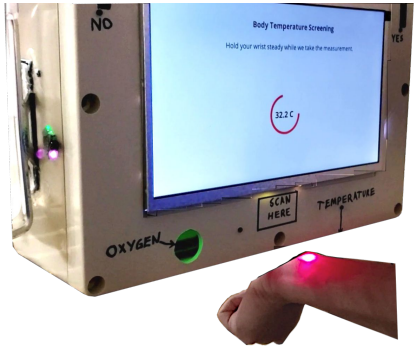
Face Mask Detection (Successful Detection)





Infrared Temperature Sensor

- Guided with a red 5mV laser
- Reads temperatures from the wrist
- 37°C trigger threshold set within our code
- “Wrist measurement is more stable than forehead measurement... ”(Chen et al., 2020).



https://os.mbed.com/components/MLX90614-I2C-Infrared-Thermometer/

Chen, G., Xie, J., Dai, G., Zheng, P., Hu, X., Lu, H., Xu, L., Chen, X., & Chen, X. (2020). Validity of Wrist and Forehead Temperature in Temperature Screening in the General Population During the Outbreak of 2019 Novel Coronavirus: a prospective real-world study.
https://doi.org/10.1101/2020.03.02.20030148

Infrared Temperature Sensor Cont.

- Raw Readings are given in Kelvin * 50
- Significant of Field of View(bottom left) and Accuracy(right)
- No Impact from skin color

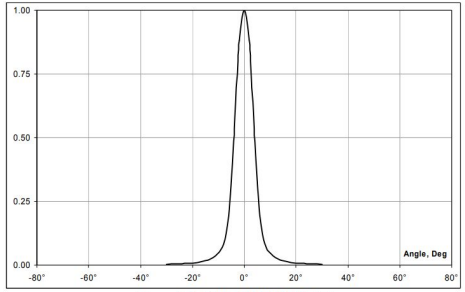


Figure 25: FOV of MLX90614xCF

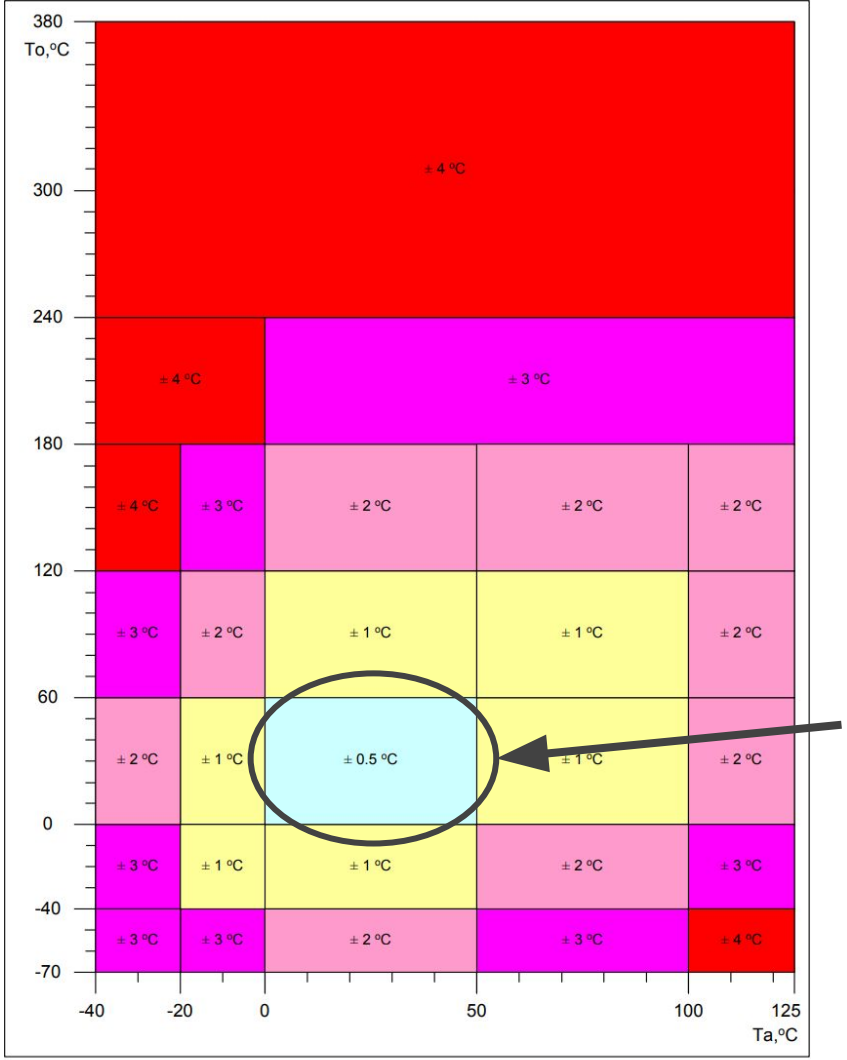
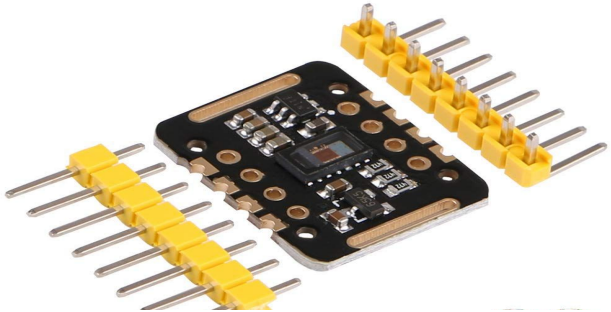


Figure 19: Preliminary accuracy of MLX90614 (Ta,To)

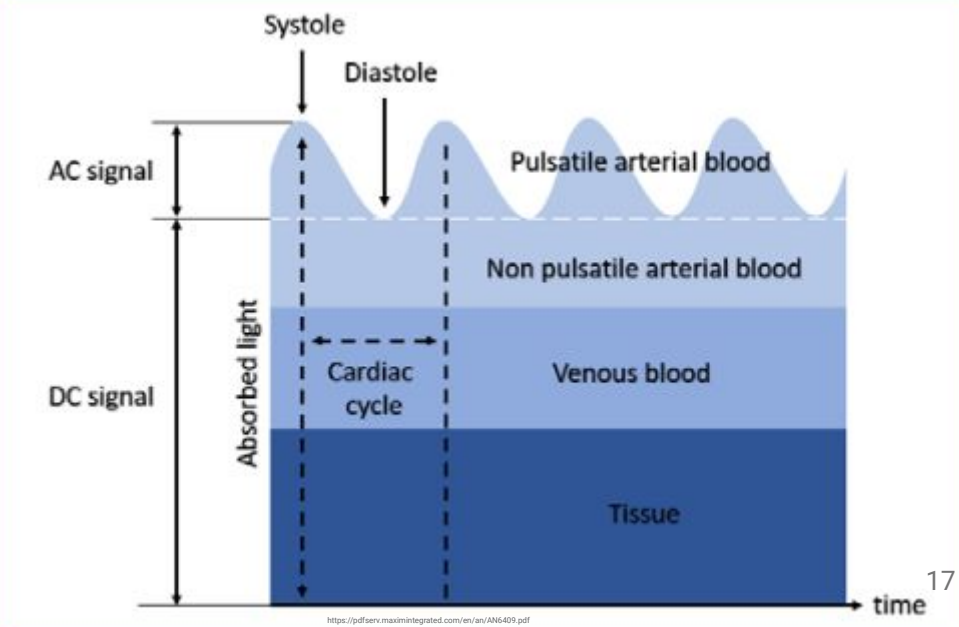
Both pictures from:
https://www.sparkfun.com/datasheets/Sensors/Temperature/SEN-09570-datasheet-3901090614M005.pdf

Blood Oxygen Level Sensor

- Reflective Pulse Oximetry
- Set threshold detection to <95%

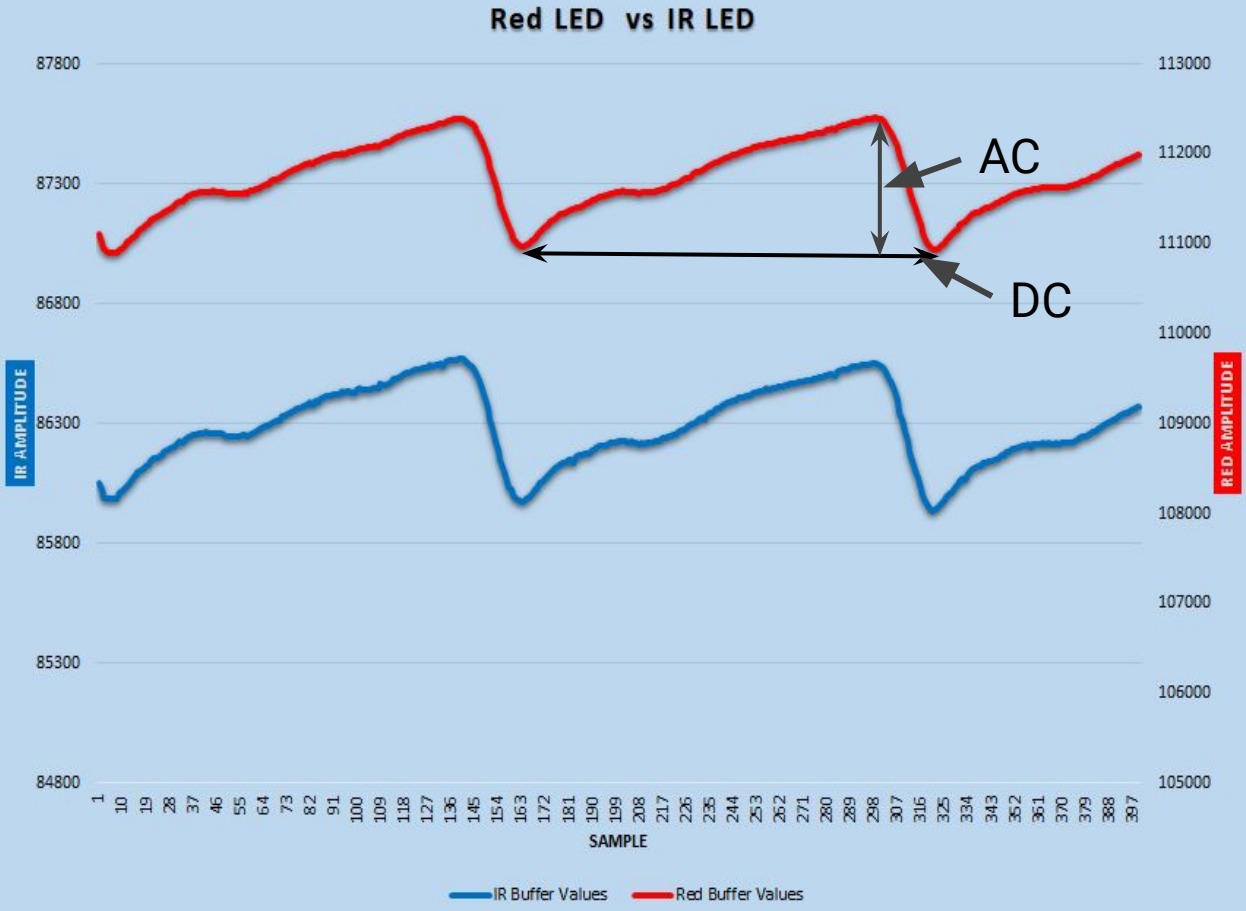


https://os.mbed.com/components/MLX90614-I2C-Infrared-Thermometer/



https://pdfserv.maximintegrated.com/en/an/AN6409.pdf

Blood Oxygen Level Sensor Cont.



$$R = \frac{\frac{ACred}{DCred}}{\frac{ACinfrared}{DCinfrared}}$$

$$SpO_2 = 104 - 17R$$

Expected Results: 95-100%

Actual Results: 20-100%

https://pdfserv.maximintegrated.com/en/an/AN6409.pdf

Sanitization System

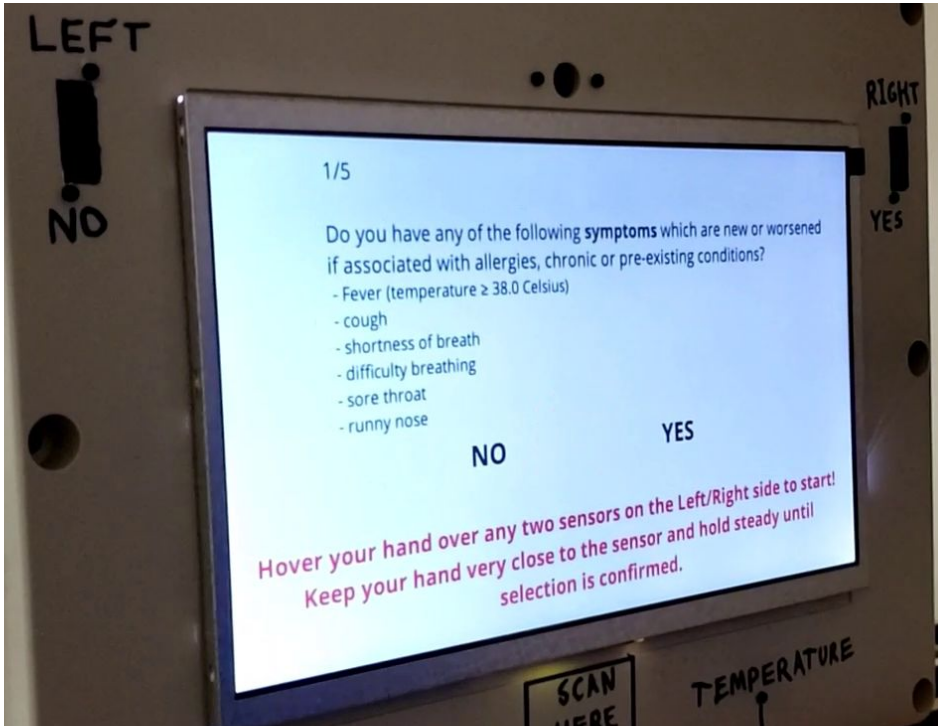
- Submersible pump with a motor driver
- Dispenses approximately 3 ml of sanitizer
- Added for contact portion of device

Graphical User Interface

- 10.1 Inch TFT LCD Display
- GTK Library Used
- Clear Font with appropriate size
- Red progress circle when making selection
  - Makes it more interactable

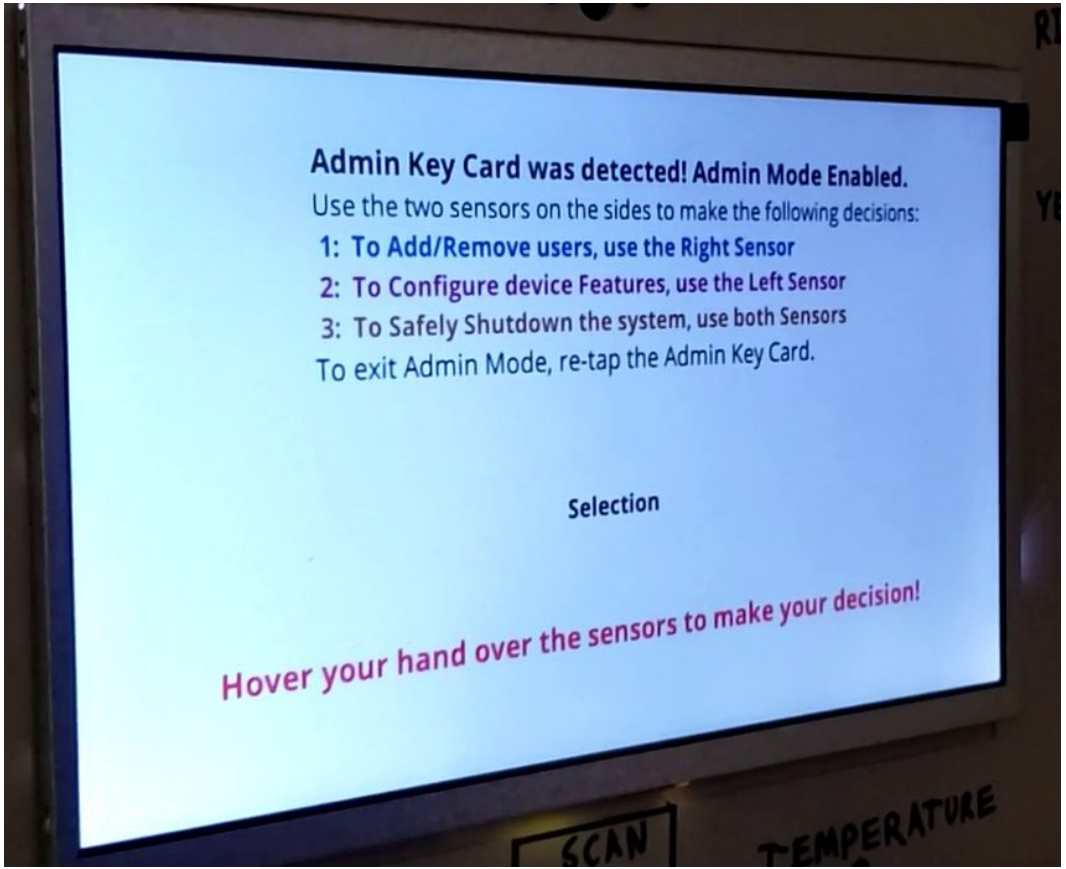
COVID Screening Questionnaire

- Cycles through 5 COVID Screening questions
- Questions derived from Alberta Health Services: Daily Fit For Work Questionnaire
- Entry denied if answer incorrectly to any of the question



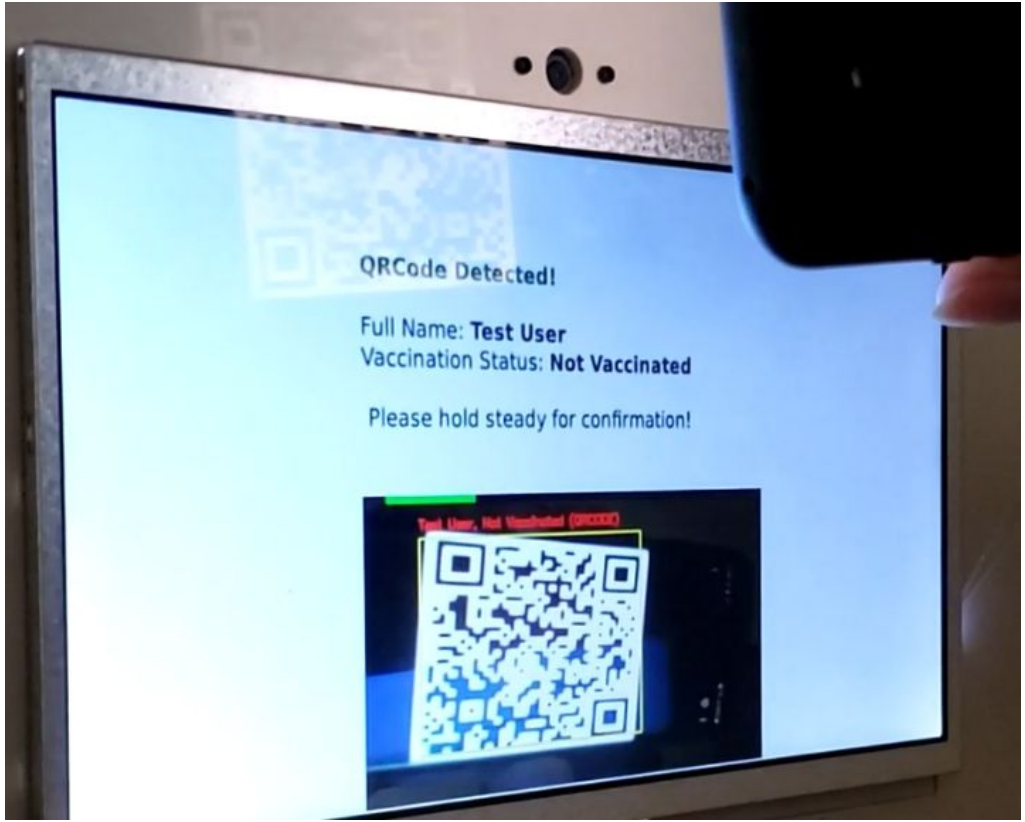
Implemented Admin Privileges

- Accessible using a specific Admin Key Card
- It allows the admin to:
  - Add or Remove Users
  - Enable or Disable specific features on the device (temperature, oxygen, etc)
  - Shutdown the system

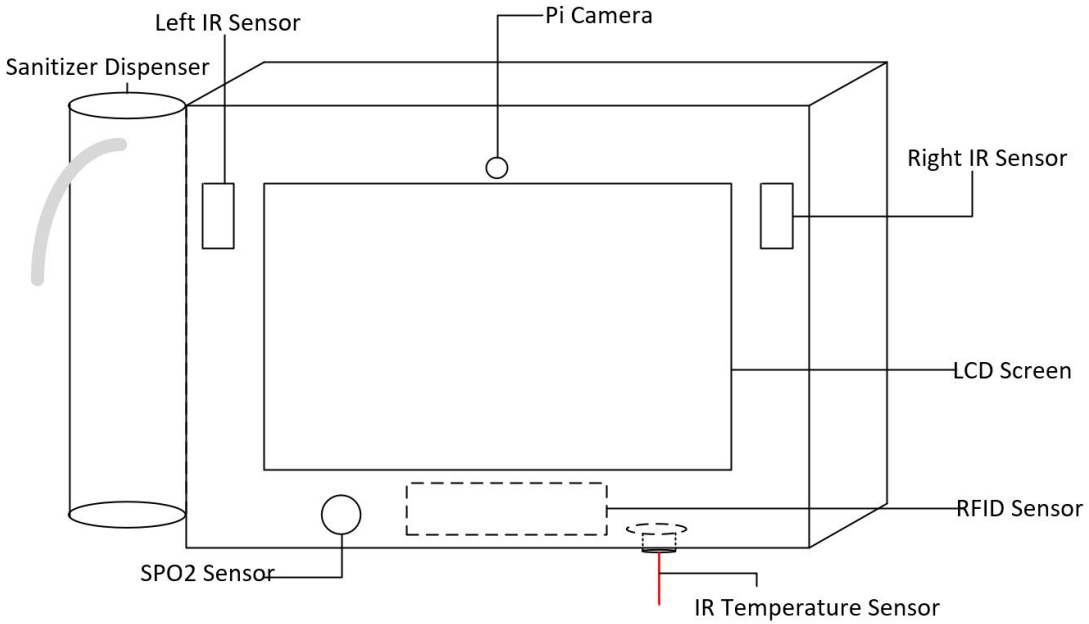


Adding User's Name

- Contactless
- Use QR-Code to encode user's name and vaccination status
- Information registered into local Sqlite3 database



Enclosure Design



Safety Considerations

- UL Listed 12V Power Supply
- Sanitization system integration VS UVC lighting for SP02 Sensor
- Laser guide and IR temperature sensor orientation

Ethical Considerations

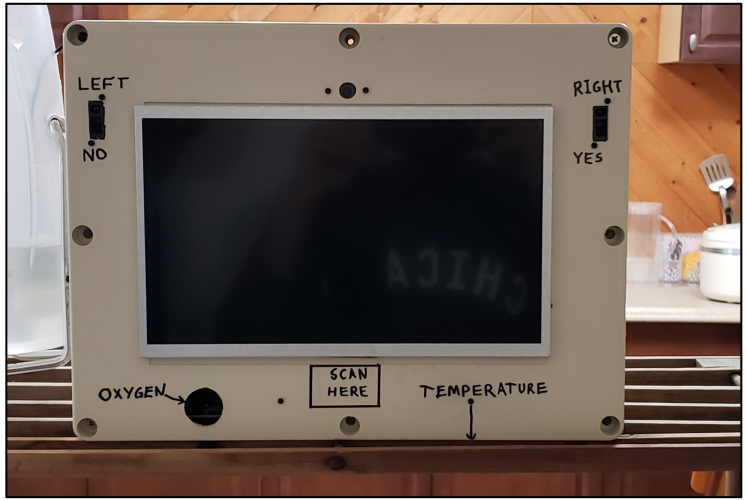
- No storage of user face data
- Everything done on local device

Future Development

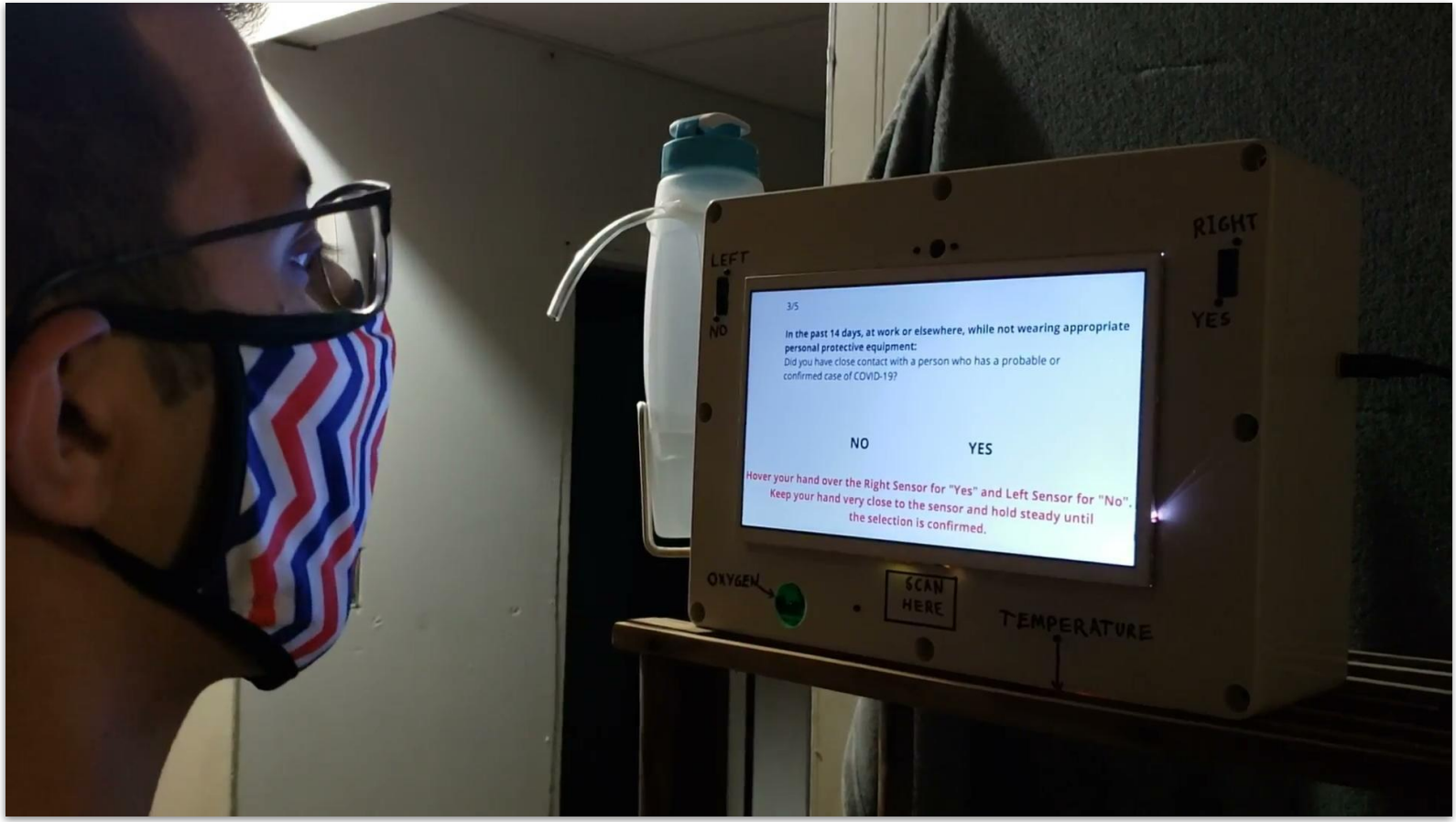
- Add an “ask for help” option
- Enhance User Interaction Experience
  - Use audio to guide the user
  - LEDs above sensors which activate when hovered over
- Sanitization & SpO2 Redesign
  - Solenoid plunger design
  - Transmissive pulse oximetry & algorithm update
- Output Relay

In Summary...

LEFT
NO
RIGHT
We will ask a series of daily screening Questions to protect from exposure during the COVID-19 pandemic and provide a safe environment
The screening questionnaire is only meant as an aid and cannot diagnose you. Consult a health care provider if you have medical questions.
START
Hover your hand over any two sensors on the Left/Right side to start! Keep your hand very close to the sensor and hold steady until selection is confirmed.
SCAN HERE
TEMPERATURE
OXYGEN


LEFT
NO
RIGHT
YES
SCAN HERE
OXYGEN
TEMPERATURE

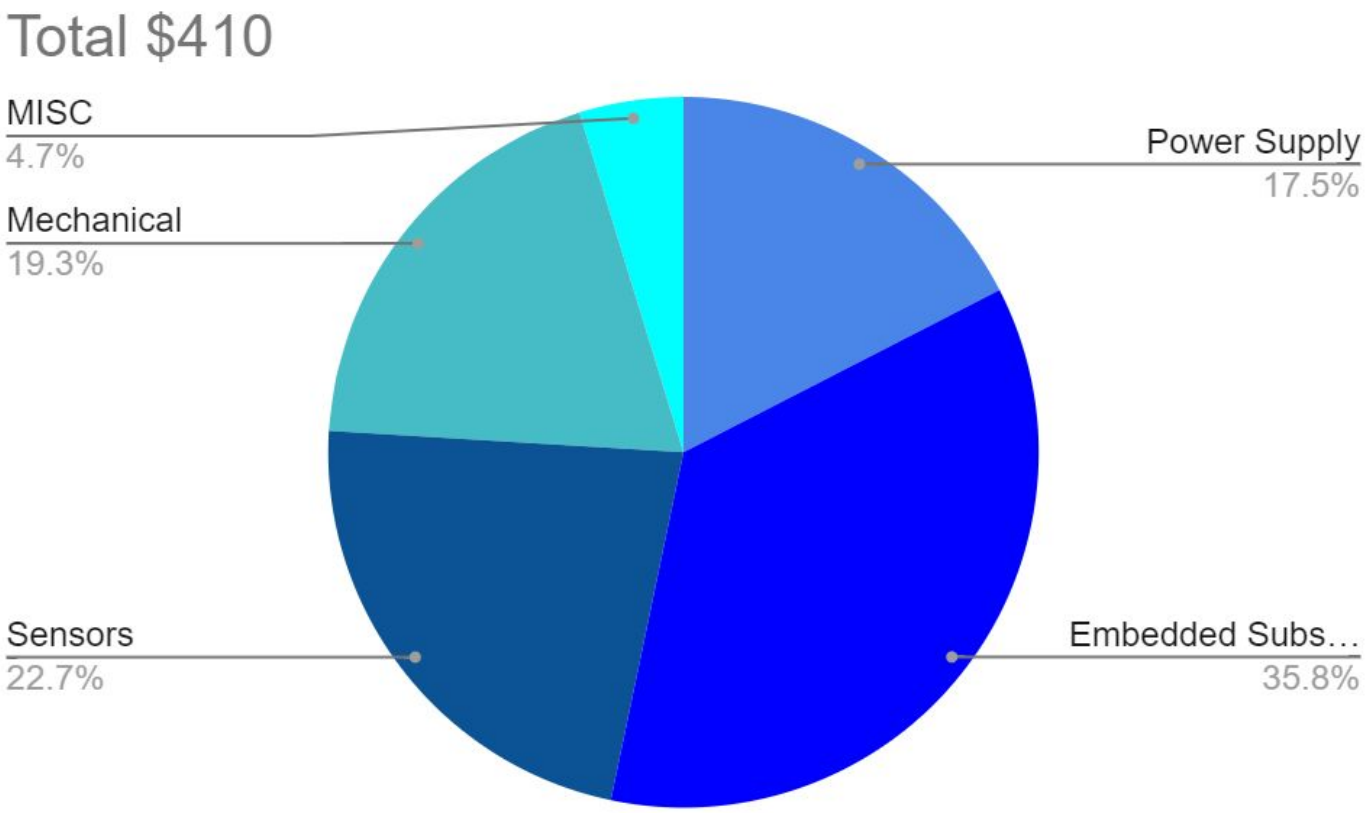
Demonstration Video



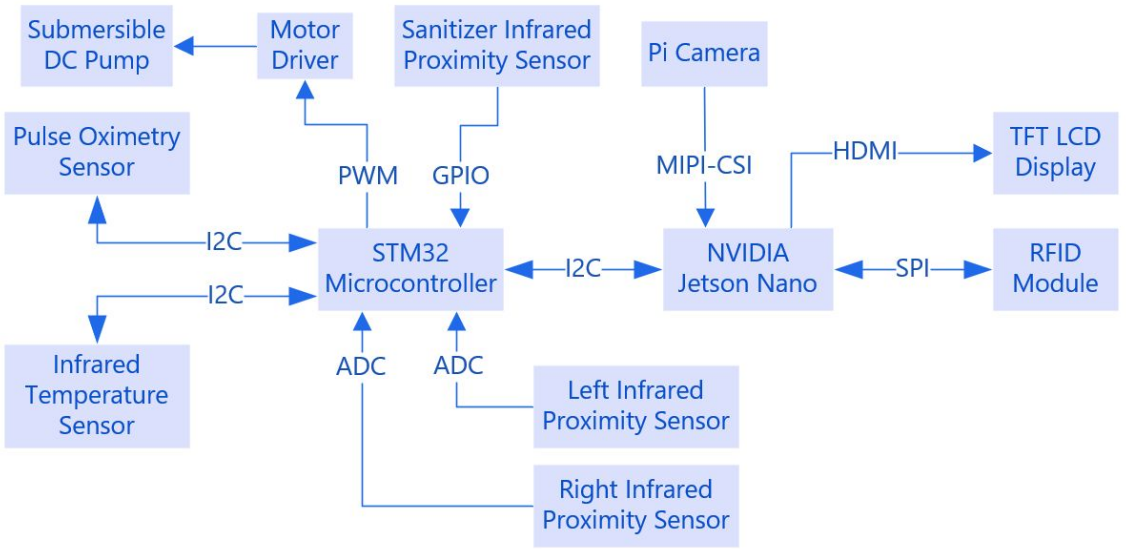
Thanks!

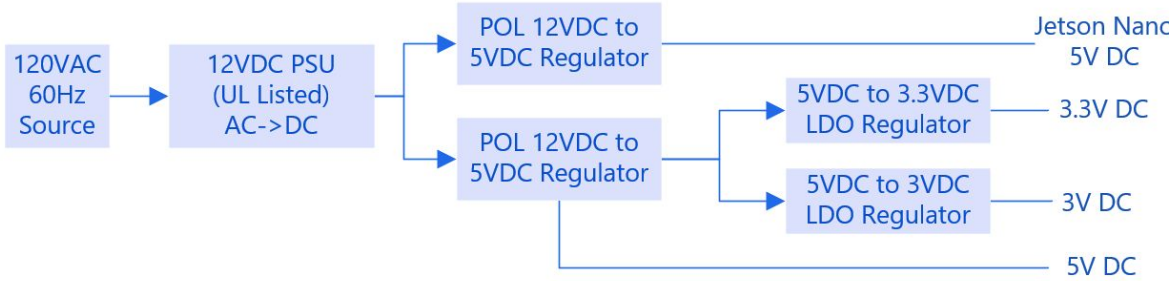
Questions

Cost Breakdown

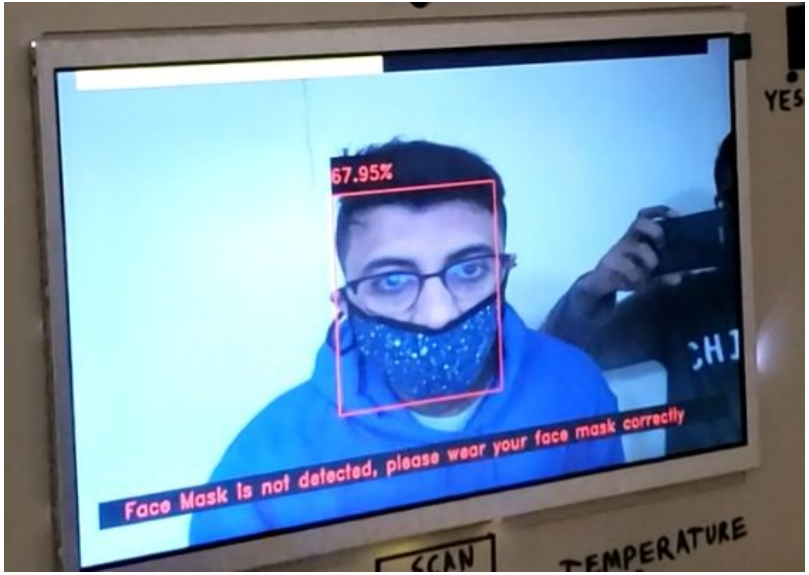


Detailed Block Diagram





Problem Statement

“With the ongoing pandemic we want a way to screen individuals at entrances for common COVID symptoms, and ensure face mask compliance while reducing person-to-person exposure during the screening process.”

Face Mask Detection (Incorrectly Worn Mask)