

The logo for Carnegie Mellon University, featuring a dark blue background with a grid of colorful lines (red, green, yellow, blue) forming a diamond pattern.

**Carnegie
Mellon
University**

Team E7: IntelliRack

Doreen Valmyr, Ryan Lin, Surafel Tsadik



Use Case

Large event attendees check in personal items due to declutter or for security concerns before attending the event

Problems:

- Attendants needed
- Time-consuming
- Disorganization

We plan on automating the process of item/coat checking with a facial recognition system that interfaces with a physical hardware item stand



Use Case Requirements

Facial Recognition:

- Detect faces within 0.5 meters
- Detect faces within 5 seconds
- 95% accuracy for detecting faces within 0.5 meters
 - This does not apply to users passing by

Item deposit/retrieval:

- Detect an item has been added or removed within 1 second
- Once user face has been matched, display user's item position with LED lights within 1 second

Item/Coat Stand Integrity:

- Be able to handle weights of 25 pounds on each hook and worse case 150 pounds on the entire stand



Technical Challenges

Component 1: Rack (Hardware)

- Building coat/item stand from scratch
- No experience in woodworking
- Attachment and integrity of sensors and actuators
- Robust to handle rotation of upper rack and defined weight limit of 25 pounds per hook and 150 pounds total

Mitigation:

- Limit item type on rack (just coats vs backpacks)
- If weight detected is over threshold pounds, flash LED red



Technical Challenges

Component 2: Web Application (Software)

- Creating an intuitive and smart UI
- Fast but secure with retrieving user facial data
- Effectively communicating with hardware systems

Mitigation:

- Keep all logic on Arduino and rely on it to process and information and control components



Technical Challenges

Component 3: Facial Recognition

- Ensure fast and accurate recognition for improvement of user experience
- Privacy concerns with facial data storing

Mitigation:

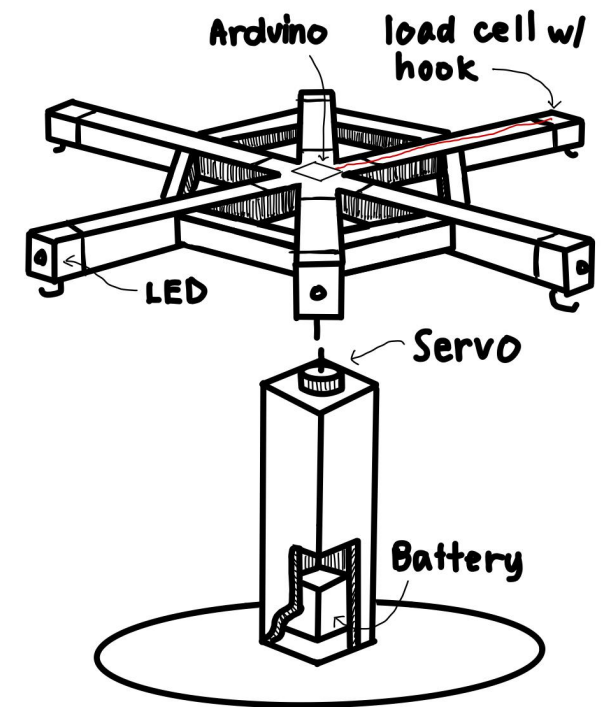
- Handle user authentication with OAuth or QR code

Solution Approach

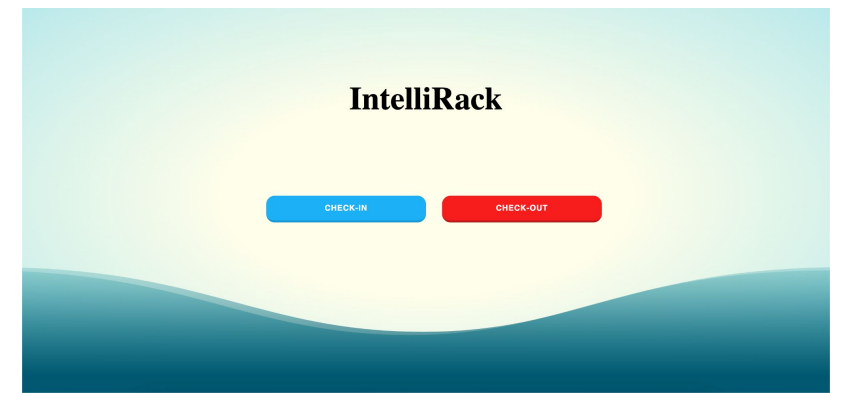
Component 1: Rack (Hardware)

Building physical rack/stand with:

- **Wood** - lightweight and strong
- **Load cells** with **hooks** - weight detection
- **LEDs** - Notify users of open hook
- **Arduino** - Ease of use, interfacing with components
- **RF transceiver module** - Communication between components
- **Large Servo** - Strong enough to rotate rack
- **6V+ Battery** - Power life/consumption



Solution Approach



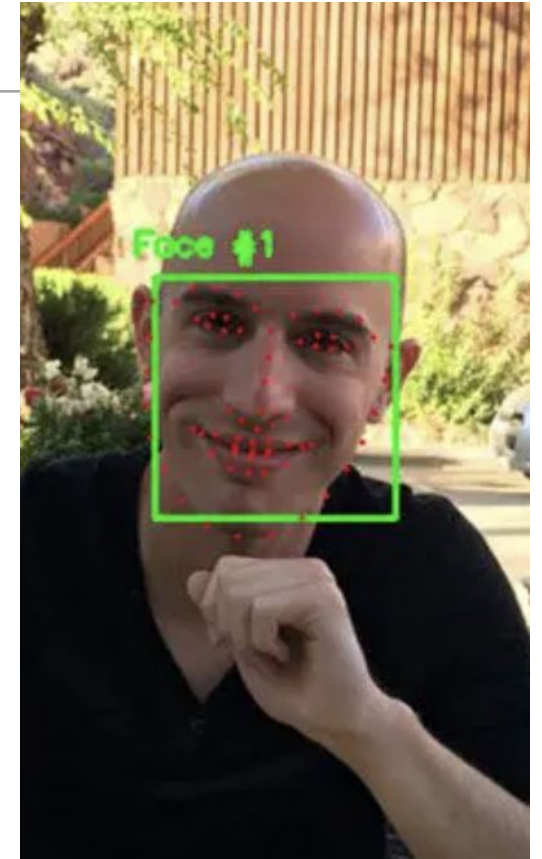
Component 2: Web Interface (Software)

- Using Django to program a local webapp
 - More complex web framework for facial recognition, most experience with Django over other frameworks
- That communicates with small arduino through serial port

Solution Approach

Component 3: Facial Recognition

- Camera specifications:
 - At least 2K
 - 30 fps
- Looking for tools/libraries with specifications:
 - Pre-trained models for face detection
 - Accurate and fast detection





Testing and Verification

Detect faces within 0.5 meters, within 5 seconds, with 95% accuracy:

- Recognition Time: Different starting areas, distances
- Accuracy Test: Different/Similar faces

Detect item placement/removal and display item position within 1 second:

- LED notifies user where to place item

Handle weights up to 25 lbs/hook, 150 lbs total on rack:

- Weight Test: Varying weights, weight imbalances



Tasks and Division of Labor

Construction and electronics of item stand - Ryan and Doreen

Lead on app UI - Surafel (support from Ryan and Doreen)

Research and deployment of facial recognition - Team Effort

Schedule

