IntelliRack

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Product Pitch

Large event attendees often choose to check their coats with dedicated coat check attendants, allowing them to fully enjoy the event without the burden of bulky personal items. This storing and retrieval process, typically time-consuming, involves attendees handing over their coats to the attendants and receiving a corresponding ticket for identification. During retrieval, attendants must sift through numerous customer items, slowing down the process and inconveniencing customers. Additionally, attendees may misplace their tickets, leading to a lengthy and challenging item retrieval process. The purpose of our project is to automate this process, improving item search through automation. Therefore, the main components of this project will include a **user-friendly web application, face detection capabilities, and a physical rack**.

To automate the coat check process effectively, our system must achieve specific requirements. This includes facial detection and recognition within **0.5 meters**, **95%** accuracy, and item deposit/retrieval detection within 1 second. Additionally, the system should indicate hook positions within **7 seconds** and support up to **20 pounds** on each of **6 hooks**, with a maximum load of **120 pounds**.

System Architecture

The system is comprised of 3 main component:

1. **Wep Application/Software System**: A user is able to scan in their face to check in or check out items. From, the web interface, admins can see logs of who is currently checked in.
2. **Facial Recognition**: Obtains facial landmarks and computes facial embeddings to determine which action a user is attempting to perform.
3. **Item Stand**: Assigns users positions to store their items. Detects if a weight has been placed by polling on load cells and rotates to users' assigned positions.

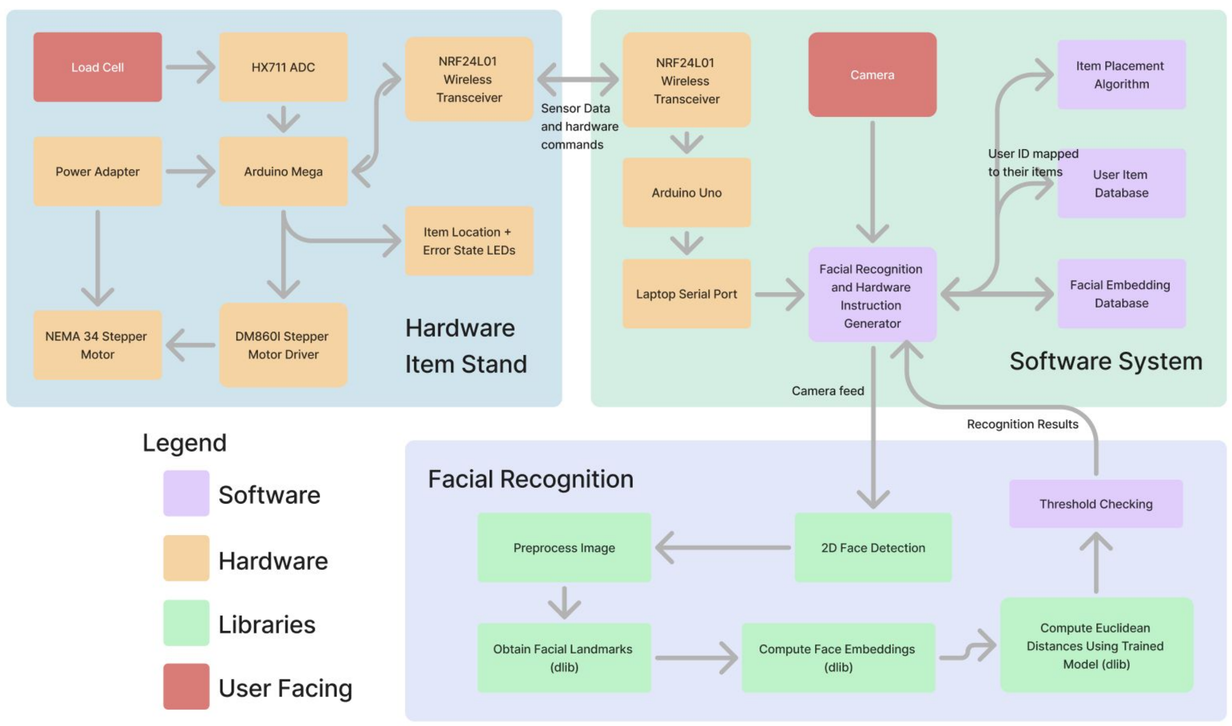

Figure 1: System Block Diagram

Conclusions & Additional Information

Our system helps streamline the coat-checking process at large events. The integration of a facial recognition system with an electronically controlled coat rack creates autonomy that improves the efficiency of the previously time-consuming and manual process. The system has exceeded our requirements, as the main features and an additional security alert system have been implemented. As a team, we have learned woodworking, laser cutting, how to use various hardware components, and the basics of implementing facial recognition. In the future, this project could be expanded in scope, allowing more than 6 users to check in their items. Additionally, multiple racks can be used together, allowing for more users.

https://course.ece.cmu.edu/~ece500/projects/s24-teame7/

System Description

Web Application:

- Users scan their face. Instructions are displayed, indicating when users can take certain actions.
- Admins have a log page to see currently checked in users or manually communicate with the rack in the case of system breakages (not likely).

Facial Recognition:

- Recognize users by comparing facial landmarks.

Hardware:

- Rotates to a user's assigned hook position.
- Alert when attackers attempt to steal belongings from the stand.
- Communicates with web app about process, whether success or failure.

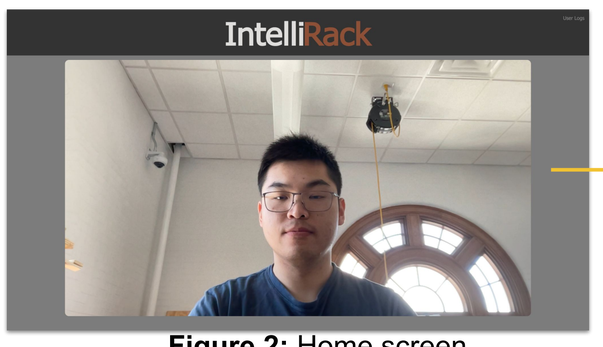

Figure 2: Home screen displaying camera feed

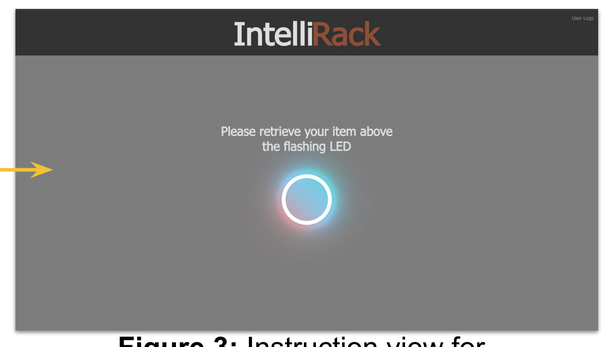

Figure 3: Instruction view for check-in/check-out guidance.

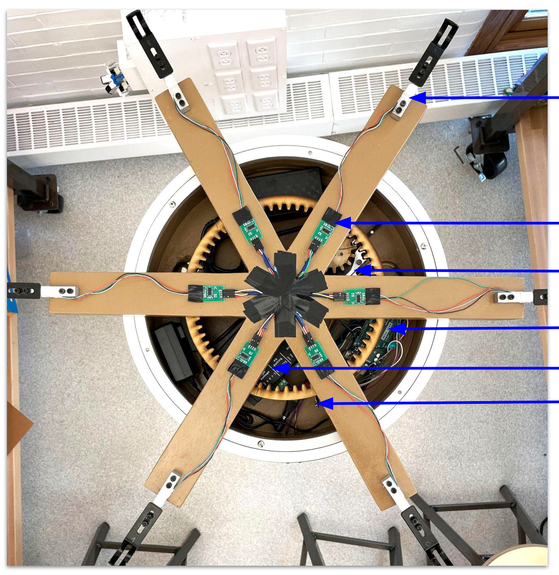

Figure 4: Item Stand

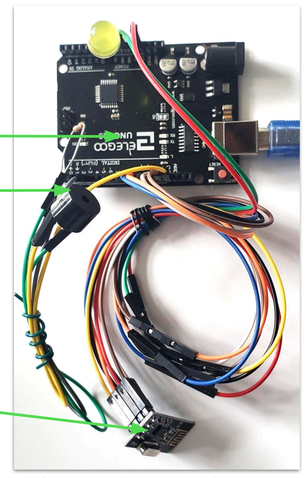

Figure 5: Arduino Uno connected to computer with running application

System Evaluation

Three main test types:

1. **Facial Recognition**: Only recognize users within 0.5 m of camera with accuracy of 95%.
2. **Timing for item deposit/retrieval**: Detect weight changes within 1 second. Users can place/pick up items within 7 seconds of recognition.
3. **Stand Integrity**: Support max 120 lbs across 6 hooks. Verify motor can rotate max load. Ensure no wood cracking or hook breakage.

Metric	Target	Result
Recognition range	0.5 m	**Passed**
Time to recognize users	<5 s	**<1 s**
Facial recognition accuracy	>95%	**98%**
Detection of item removal/addition	<1 s	**608 ms**
Display user position on rack quickly	<7 s	**Max: 6.36 s**
Support high weight on each hook	20 lbs	**20 lbs**

Table 1: Test Results

Raspberry Pi	**Arduino**
• Higher computational power: could be used to run facial recognition • More complex to configure	• Precise hardware control • Limited processing power
face_recognition Library	**SVM Classifier**
• Pre-trained models • Limited customization	• Effective in high-dimensional spaces • Computationally expensive

Table 2: Trade-Offs