



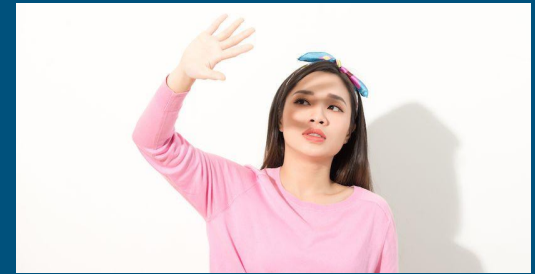
B.L.I.N.D.S.

Blocking Light IN Domestic Spaces

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Use Case



- You are sitting in front of computer working/watching something and the sun moves and shines directly on your face breaking your train of thought/enjoyment of whatever you are watching.
- Direct sunlight bothers people
 - Obstructs vision
 - Negatively affects visual comfort, eye health, and productivity ¹
- But: Completely eliminating natural light negatively impacts a person's mood and mental health ²
- Our project:
 - Top down bottom up blinds that roll upwards and downwards depending on whether sunlight from the window hits the person in a room, to maximize sunlight but minimize the amount of light that hits a person in rest
 - Motors will adjust the blinds to prevent sunlight from reaching a person's face

1. Boyce, Peter R. "Review: The Impact of Light in Buildings on Human Health." *Indoor and Built Environment*, vol. 19, no. 1, Feb. 2010, pp. 8–20, 10.1177/1420326x09358028.
2. Shishegar, N, and M Boubekri. "Natural Light and Productivity: Analyzing the Impacts of Daylighting on Students' and Workers' Health and Alertness." *International Journal of Advances in Chemical Engineering and Biological Sciences*, vol. 3, no. 1, 21 May 2016, 10.15242/ijacebs.ae0416104.

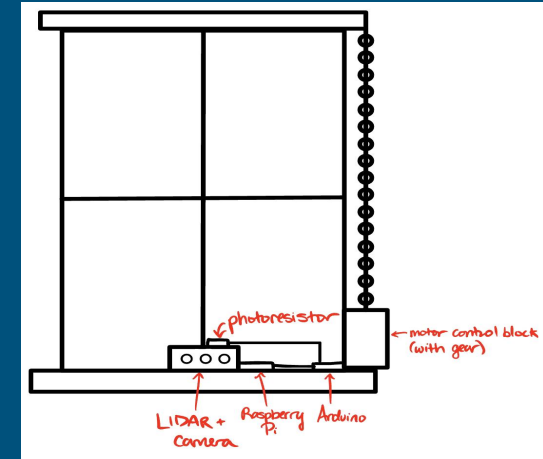
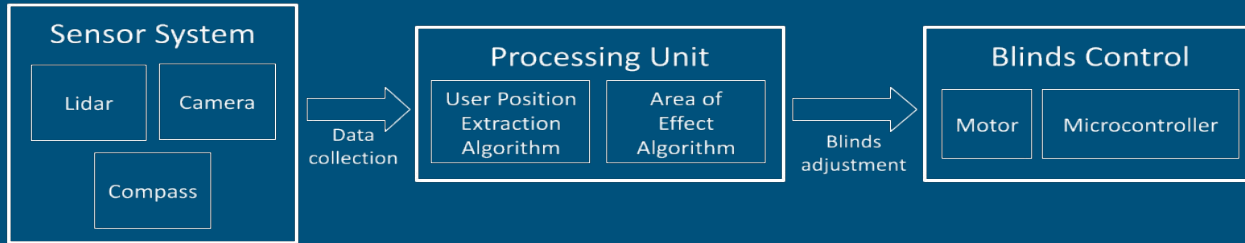
Use Case Requirements

- Ability to detect a person in a 300 ft² space
 - The size of an average bedroom in the US
- Physical latency should be under 60s
 - Commercial motor controlled blinds also take roughly the same amount of time
- Feedback latency of blinds \approx 10s
 - Popular face detection methods take under a second to detect faces
 - Small survey on college students said they would be startled if blinds are constantly moving, and would rather the blinds wait to determine if a person is planning on staying in one place before adjusting (wait duration no longer than 10 seconds)
- Accuracy \geq 90%
 - Error defined as lack of adjustment or error in adjustment calculation
 - Small survey on college students asked about maximum error rate they would tolerate

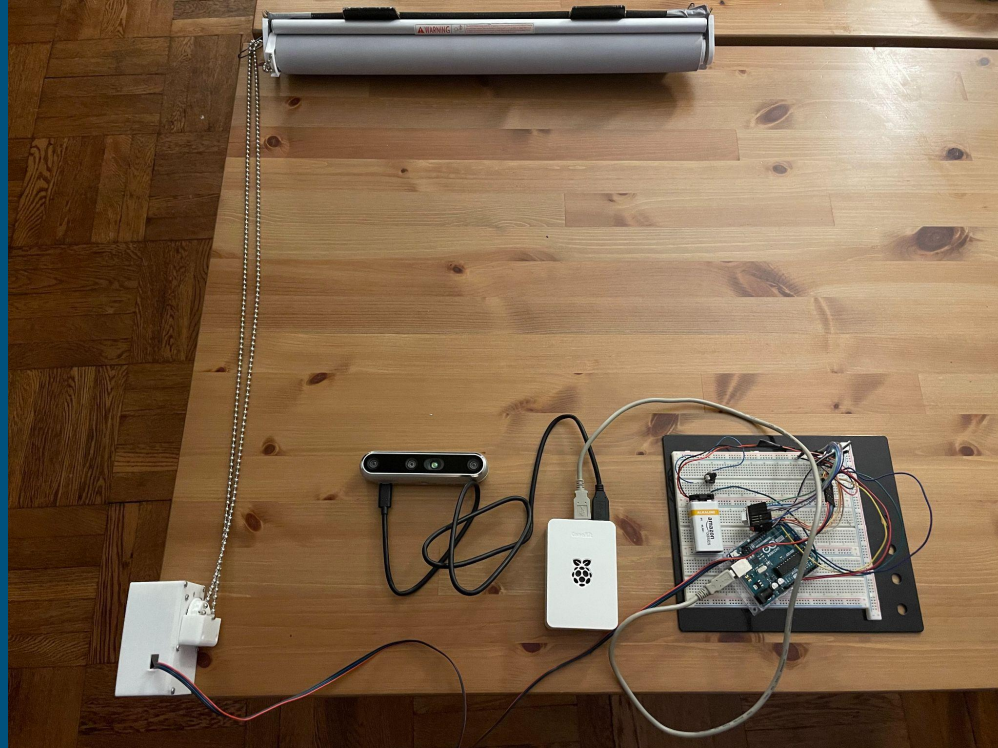
Solution Approach

- Sensor System
- Processing System
 - User Position Extraction
 - Light Area of Effect Algo
 - Sun Position API
- Blinds Control

- Ethical Considerations: Data is processed on-device so PII is securely handled and disposed of without being sent to Cloud or third parties



Complete Solution



Test, Verification, and Validation

User Position Extraction	300 ft ² room	Size of an average bedroom in the US
	≥90% Accuracy	To reach overall accuracy requirements
LAOE	≥90% Accuracy	To reach overall accuracy requirements
Physical Latency	60s	Compete with commercial products
Feedback latency	≈10s	People would be startled if blinds were constantly moving
Overall Accuracy	≥90% Accuracy	Results of small survey

Test, Verification, and Validation

	Requirement:	Result:
User Position Extraction	300 ft ² room	5m x 8m (430 ft ²)
	≥90% Accuracy	87% for verticality, 85% for depth, and 94% for height (88.7% average)
LAOE	≥90% Accuracy	Average of 96.93% accurate results for the location of the LAOE prism and intersection

Test, Verification, and Validation

	Requirement:	Result:
Physical Latency	60s	~58.6s
Feedback latency	≈10s	~1.9s
Overall Accuracy	≥90% Accuracy	90%

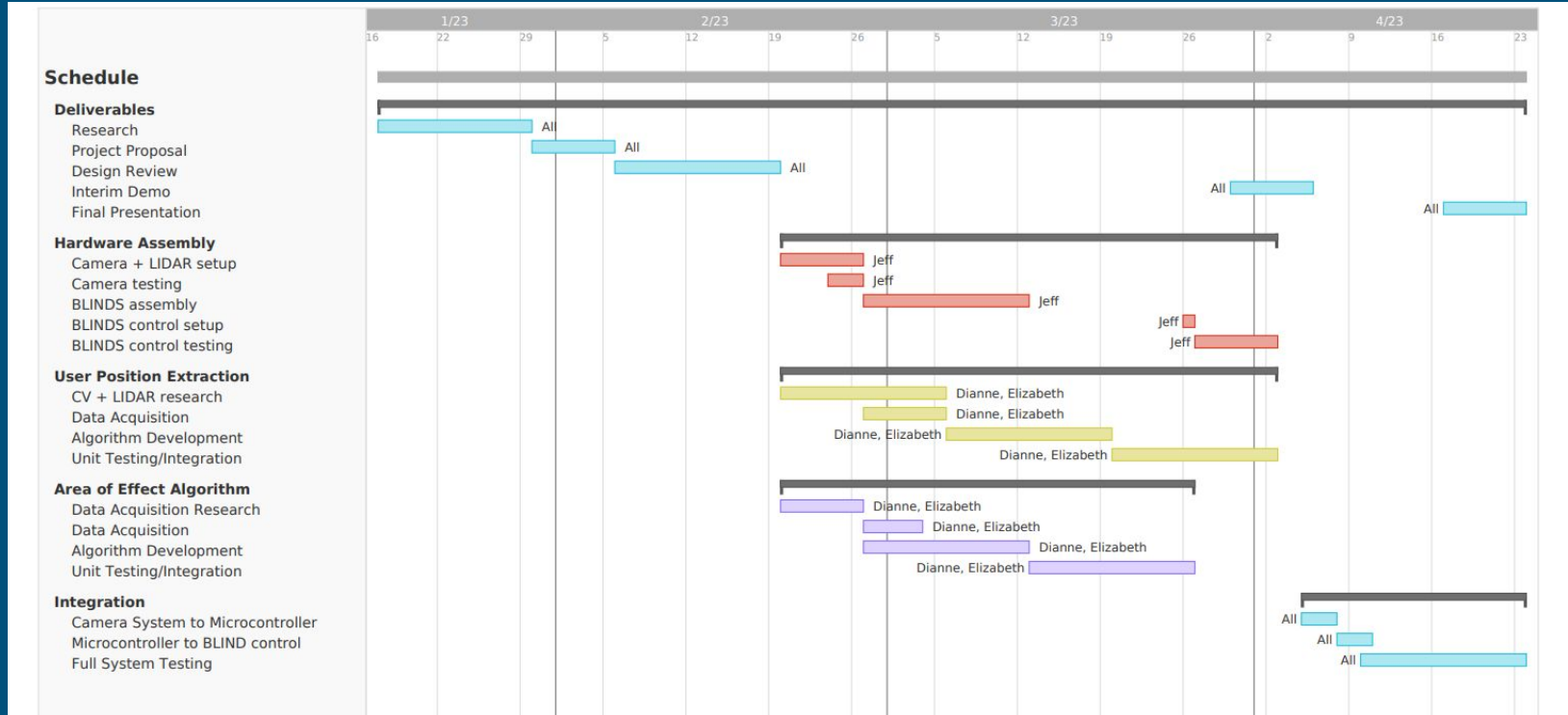
Design Tradeoffs (Hardware)

- Motor:
 - Motor speed
 - Pros: Faster motor speed allows the blind to move faster, reducing physical latency
 - Cons: Increases inconsistency and noise
- Sensor:
 - Removed magnetometer
 - Pros: reduce cost
 - Cons: Window Orientation must be manually inputted by installer

Design Tradeoffs (Software)

- LAOE tradeoffs:
 - Sun sensor/sundial
 - Pros: Helps us determine whether or not sunlight is being blocked from the window in some way
 - Cons: Expensive, device placement issues, lack of accuracy
 - Sun API
 - Pros: Accurate azimuth and altitude values, cheap
 - Cons: Cannot determine blocked state
- User Position Extraction tradeoffs:
 - Triangulation using multiple cameras
 - CNNs
 - Bluetooth Beacons
 - Haar Cascades

Project Management



Next Steps/Remaining Work

- Final report
- Final poster
- Preparing for demo (building fake window frame, setting up light, etc)