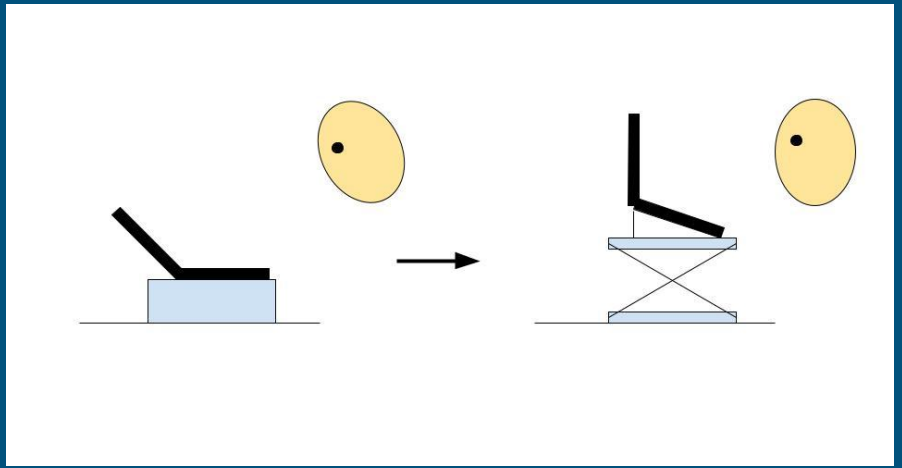
Uses Case Review

Problem: Laptops are not **ergonomic** and most computer stands require **manual** adjustment

Solution: a computer stand that automatically **lifts** and **angles** your laptop

- Also detects slouches
- Limits eye fatigue
- Displays posture progress



Quantitative Design Requirements

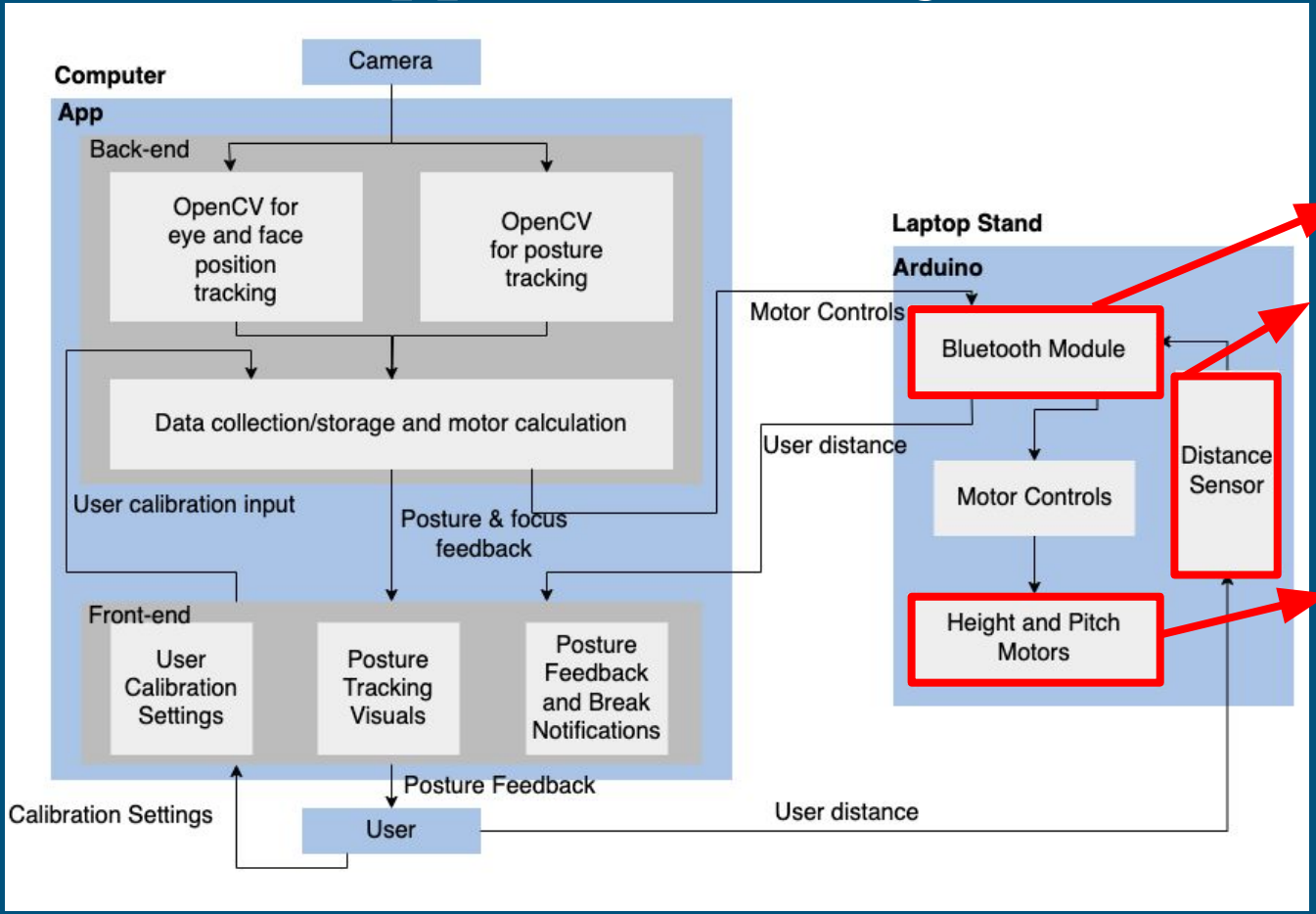
User Interface

- User can angle screen of PC to arbitrary angle
- Device weight < 4 lbs
- Device battery lasts 8 hrs
- Notifications for slouching and eye fatigue
- Progress tracking through GUI

Height & Angle Adjustment

- Stand lifts up to 12 in
- Stand angles PC up to 45 deg
- Max angle error < 5 degrees
- Max height error < 3 inches
- Slouch detection within 1 sec
- Ideal height reached < 5 sec

Solution Approach Changes



Revisions:

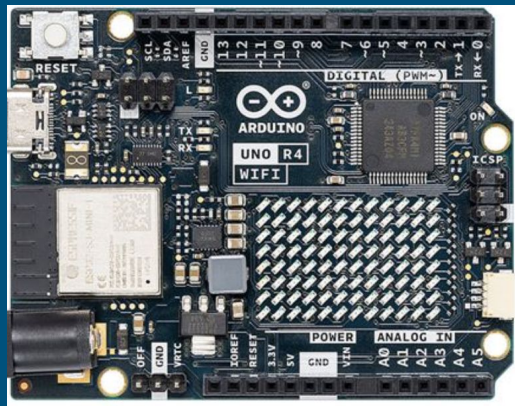
Serial Communication

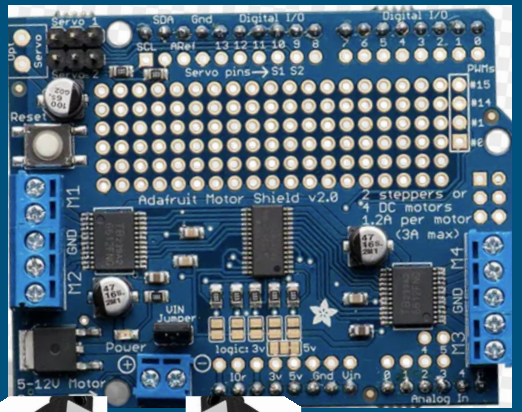
Removed

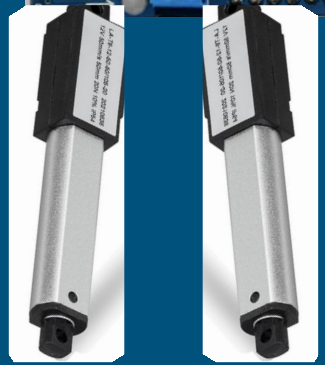
Exchanged for a Nema 17 with gearbox

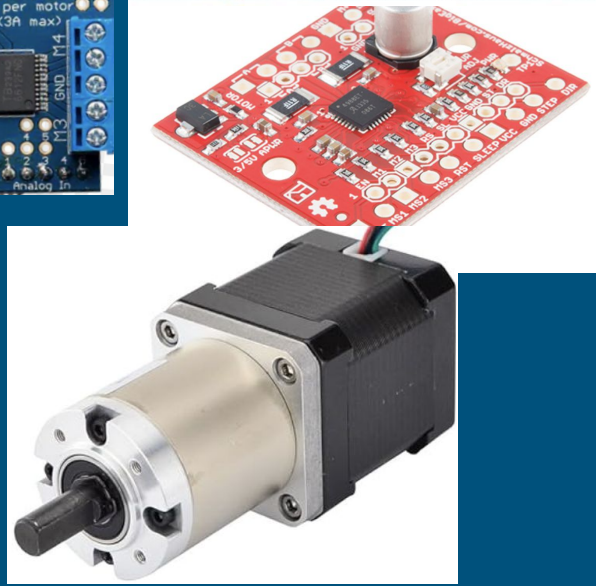
Complete Solution: Hardware

- Linear actuators are connected to an Adafruit Motor Shield V2
- Stepper motor is connected to a Big Easy Driver
- Arduino is connected to the laptop serially
- Shield and driver both use 12v power source

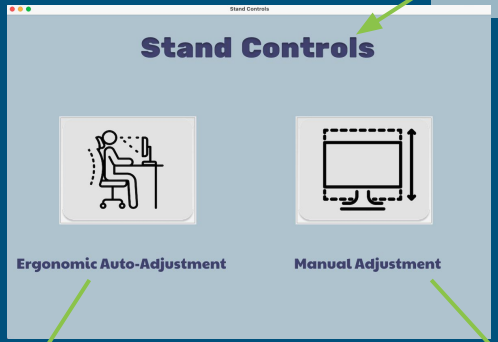


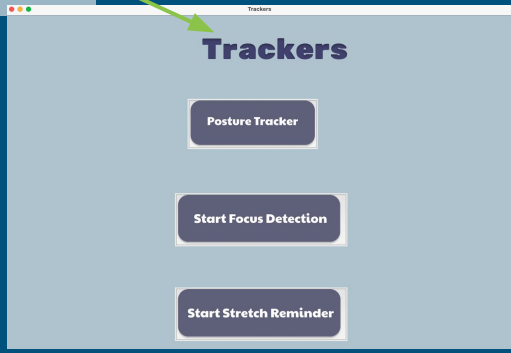


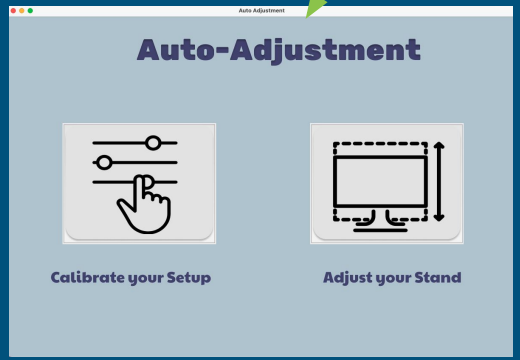


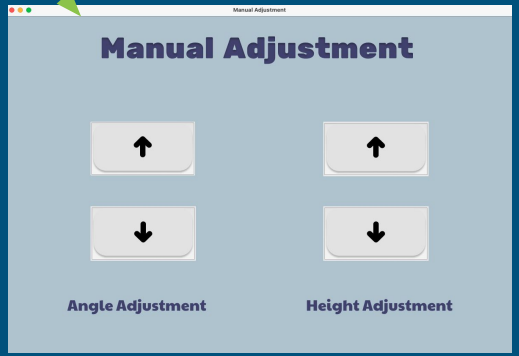


Complete Solution: GUI









Ethical Considerations

- We aim to help people fix their posture and prevent eye strain while using their laptops.
- Researched the optimal height and angle of a screen, as well as how long a person should be looking at a screen.
- We appropriately balanced the device to prevent it from harming the user.

Design Tradeoffs

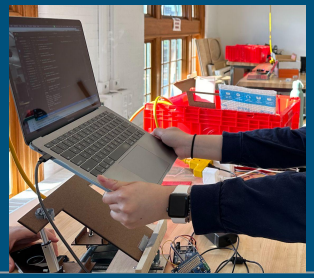
	Benefits	Drawbacks
High Torque Gearboxes 51:1 VS. 14:1	Stand requires 4.4 Nm of torque to lift. 14:1 gearbox only provides 3.0 Nm. Higher torque = higher range of motion.	Using the gearbox means that the motor will achieve less rotations per second, slowing down calibration.
Linear Actuators placed below the top plate	Can use linear actuators with greater change in distance without increasing the starting angle.	More complex mechanical design that must be able to support the weight of a laptop.
Neural Network-based posture detection	Rich decision boundary in neural nets means that a wide variety of poses can be classified.	Harder to set up, requires diverse training data.

Demo Solution

- Using the app, the user will be calibrate the stand to the appropriate angle and height.

- Once calibrated, the user will exit the app and receive notifications about their posture.

Height and Angle Accuracy



Metrics	Test	Results
Average Height Error	Use the height and angle adjustment process until “ideal” height and angle are reached.	0.95 inches (distance from center of the screen to user’s eyeline)
Average Angle Error	Use the height and angle adjustment process until “ideal” height and angle are reached.	2.44 degrees (angle between screen and vertical)
Average Calibration Time	Use the GUI to calibrate different user’s facial landmarks.	6.7 seconds
Average Adjustment Time	Opening laptop to varying angles, running the automatic angle adjustment, then manually increasing height.	33.56 seconds

Requirements and Results:

Requirement	Metric	Results
Height Range	Stand lifts up to 12 in	Met, up to 12 inches
Height Accuracy	Max height error < 3 inches	Met, 0.95 inches
Angle Accuracy	Max angle error < 5 degrees	Met, 2.44 degrees
Angle range	Stand angles PC up to 45 deg	Met, up to 60 degrees
Speed	Ideal height reached < 5 sec	Not met, 33.56 seconds

Posture Detection

- Uses mix of shoulder and face landmarks
- Captures “ideal” landmark positions, then measures deviation
- If user strays too far from the ideal landmark positions, warning notification

Project Management:

Category	Task Title		Task Owner
Slack	** slack **	Not started	Everyone
Course	Choose materials/parts to purchase	Done	Everyone
Course	Order materials	Done	Everyone
ML/CV	Learn OpenCV for Eye/Face tracking	Done	Olivia
Software	Integrate camera with OpenCV	Done	Olivia
ML/CV	OpenCV facial landmark tracking	Done	Olivia
Software	Python for facial landmark analysis	Done	Olivia
Software	Motor position computation	Done	Olivia
Software	Test for height/angle computations	Done	Olivia
Slack			
ML/CV	Learn OpenCV for Posture Detection	Done	Sebastian
Software	Integrate camera with OpenCV	Done	Sebastian
ML/CV	OpenCV posture recognition	Done	Sebastian
ML/CV	Categorize posture types	Done	Sebastian
Software	Posture recognition data computation	In progress	Sebastian
Software	Testing for posture recognition	In progress	Sebastian
Hardware	Research about stand	Done	Sebastian
Slack			
Mechan…	Choose stand's raising mechanism	Done	Everyone
Mechan…	Design/create stand's angle mechanism	Done	Mary Rose
Mechan…	Design/create laptop holding mechanism	Done	Mary Rose
Firmware	Code for motor control via Arduino	In progress	Mary Rose
Mechan…	Put together stand	Done	Sebastian
Slack	** slack **		
Firmware	Motor arduino code	Done	Mary Rose
Hardware	Test motor controls	In progress	MR & S
Firmware	Code for bluetooth	Done	Mary Rose
Firmware	Test bluetooth	Done	Mary Rose
Software	Serial communication: PC -> Arduino	Done	Mary Rose
Software	Testing for Serial communication	Done	Mary Rose
Firmware	Serial connection: Arduino -> PC	Done	Mary Rose
Integrat…	Integrate bluetooth with python	Not started	Mary Rose
Firmware	Code for linear actuators	Done	Mary Rose
Firmware	Test code for linear actuators	Done	MR & S
Slack	** slack **		
Software	Develop basic GUI functionality	Done	Olivia
Software	Refine GUI for user experience	In progress	Olivia
Software	Create application package	Not started	Olivia
Slack	** slack **		
Software	Python for eye tracking/focus detection	Done	Olivia
Integrat…	User testing	In progress	Everyone
Integrat…	Incorporate changes	In progress	Everyone
Integrat…	User interface testing	Not started	Everyone
Integrat…	Incorporate changes	Not started	Everyone