

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 B0: AutoErasing

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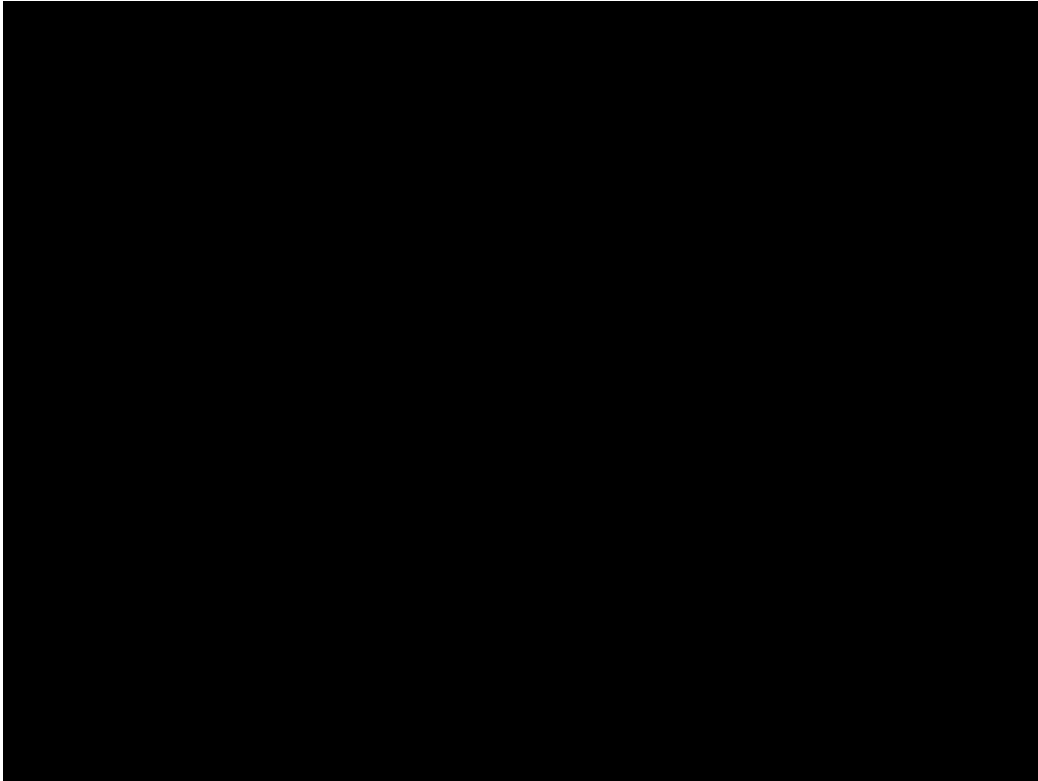
Use-case Requirements

- **Use Case:**
 - Provide unlimited virtual space on whiteboard
- **Solution:**
 - **Virtual Board System** with automated board erasing
 - From a web application, users can **erase** the board using motor-driven erasers upon instruction, **take picture** of the board using camera, and **project** the pictures back to the board using a projector

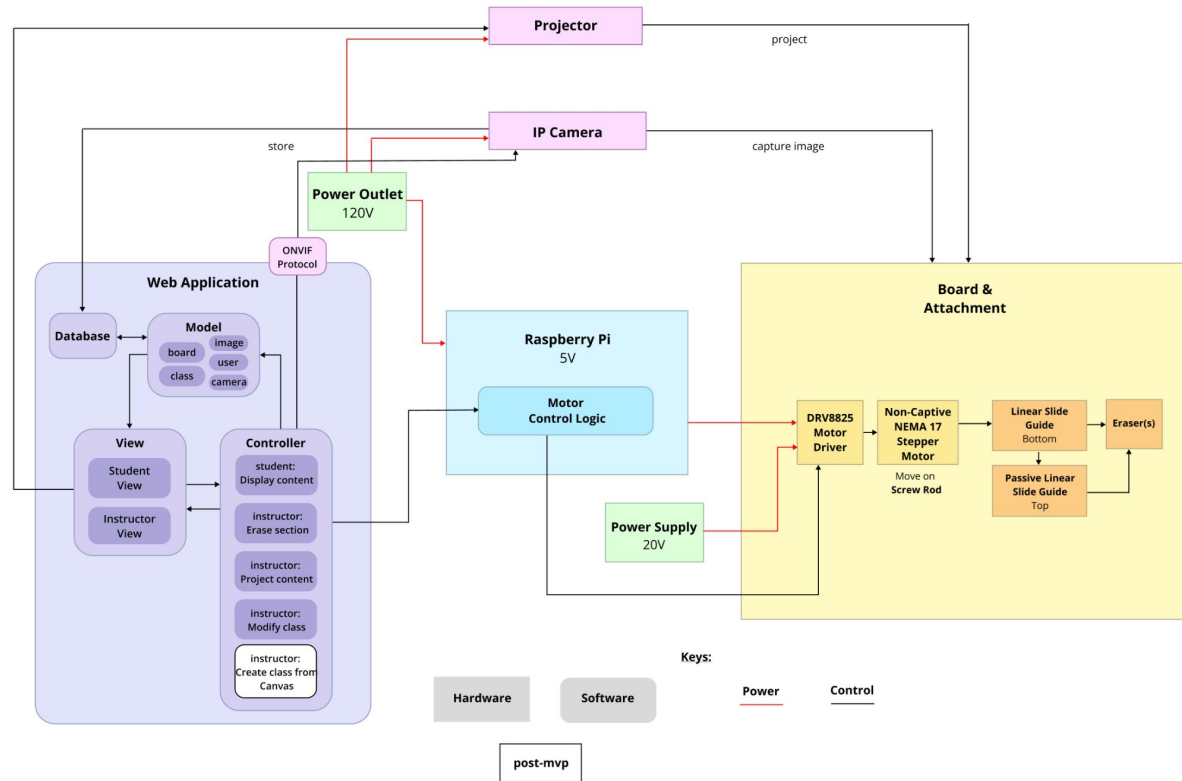
Design Requirements

Case	Requirements
Latency - Erasing	Erasing a 30''x 15'' area of board takes less than 45s
Latency - Image	Captured image should be displayed in < 3s
Website User Experience	~1 min to learn how to use the website
Accessibility	< \$200 (excluding the board and eraser)
Power Consumption	Peak power should be < 70W (power of laptop)

Complete Solution



Solution Approach



Solution Approach

Difference since design report:

- **Remove solenoid** from our design, erase the entire board instead of erasing parts of the board
- Instead of using motor with wheels, **use a non-captive stepper motor spinning on a screw rod** to move the erasers
- Include the **projector** so instructors can project the images back
- Use a **power supply** instead of battery to supply the voltage required by the motor driver more stably

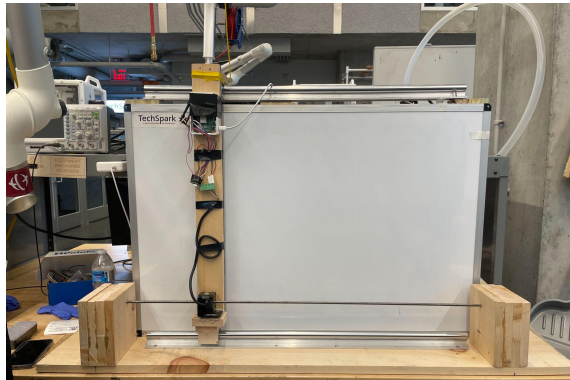


Ethics Consideration

- **Safety:**
 - **Issue:** Mechanical part hurts instructor
 - **Solution: Wood blocks** to support the board and the top slides; **screw** to stabilize mechanical system; add **protection case**
- **Privacy:**
 - **Issue:** The web application being hacked, and class information disclosed
 - **Solution: Sanitize** users input; add a **CSRF token**

Test, Verification and Validation

Requirement	Metrics	Actual Performance
Power Consumption	Peak power should be < 70 W (laptop average power)	19.65W for motor + 7W for RPi + 24W for camera



Test, Verification and Validation

Requirement	Metrics	Result
Latency - Erasing	Erasing a 30"x 15" area of board takes less than 45s	50s
Latency - Image Capturing	Captured image should be displayed in < 3s	1.3s

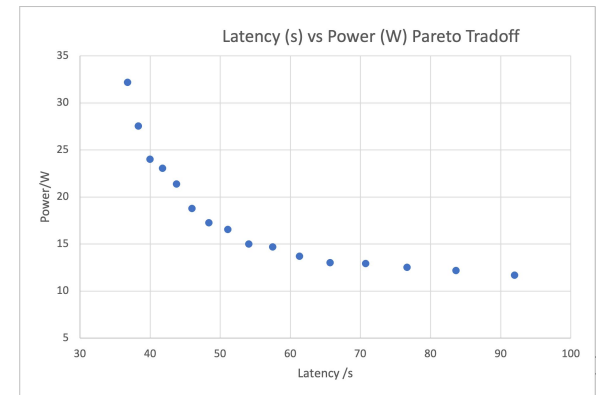
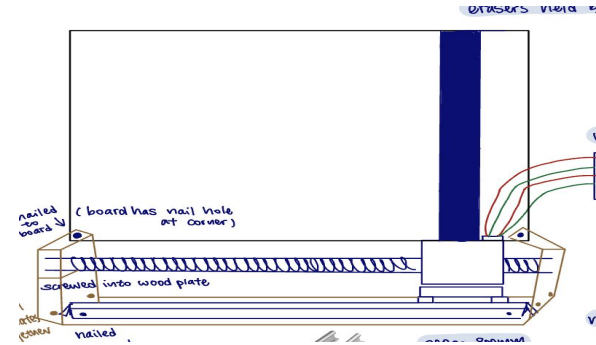
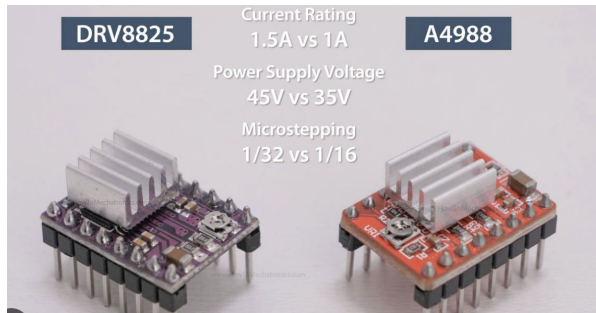
Test, Verification and Validation

Requirement	Metrics	Result
Website User Experience Testing	~1 min to complete all the required actions	~45s for instructor, ~7s for student
Overall User Testing	~67% of users report no significant latency & erasing and image capturing works well & website easy to use	3 users out of 3 respond with standard response

Test, Verification and Validation

Trade-offs

- Erasing cleanness VS. motor speed
- Erasing latency VS. power
- A4988 VS. DRV8825
- Screw rod VS. Wheels



Project Management

