AutoErasing

B0: Wenqi Deng, Jiayi Wang, Xiaoyu Chai
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Electrical and Computer Engineering Department
Carnegie Mellon University

Product Pitch

In classroom scenarios, instructors often need to erase the boards repeatedly during lectures due to the limited space of the physical boards. Our product is designed to address this issue: it provides unlimited virtual space on whiteboard for instructors by automatically taking pictures of the whiteboard content and allowing instructors to project it back later.

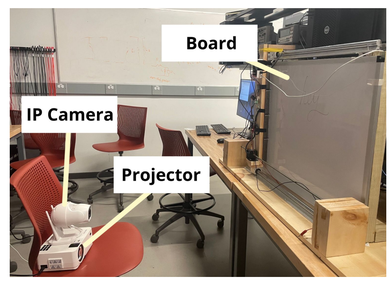
In order to meet the use cases identified above, our product achieves the following requirements:

- After **automatic erasing**, the board is **ready for next iteration of writing** without further erasing
- **Board erasing**, **image uploading and projection,** and **interaction with web application** have **no significant latency**
- The entire system is **no more power-consuming** than a laptop
- The product is **easy to navigate** and **use**

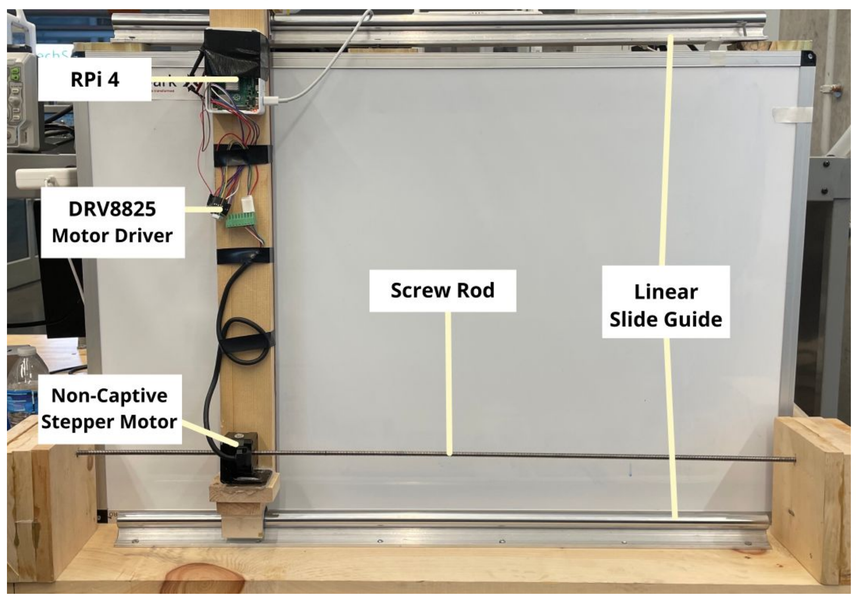
System Description

Our virtual board system consists of a **web application**, a **Raspberry Pi**, a **non-captive stepper motor** spinning on a screw rod, an **IP camera**, and a **projector**. The web application functions as the main interface for users to interact with the rest of the system. Instructors can command the system to erase the board using motor-driven erasers, take pictures of the board using the IP camera and store the pictures in its database, and project the pictures back to the board using the projector; and students can view class images taken before. The Raspberry Pi serves as a microcontroller that listens to the instructions from the web application, and outputs signals through GPIO pins to a DRV8825 motor driver which controls the movement of the non-captive stepper motor, which drives the erasers and sliding blocks on the linear slide guide to erase the board.

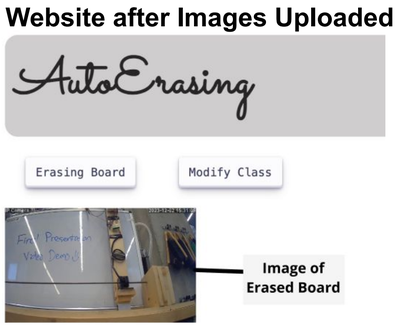
Side View of Board Setup w/ IP Camera and Projector



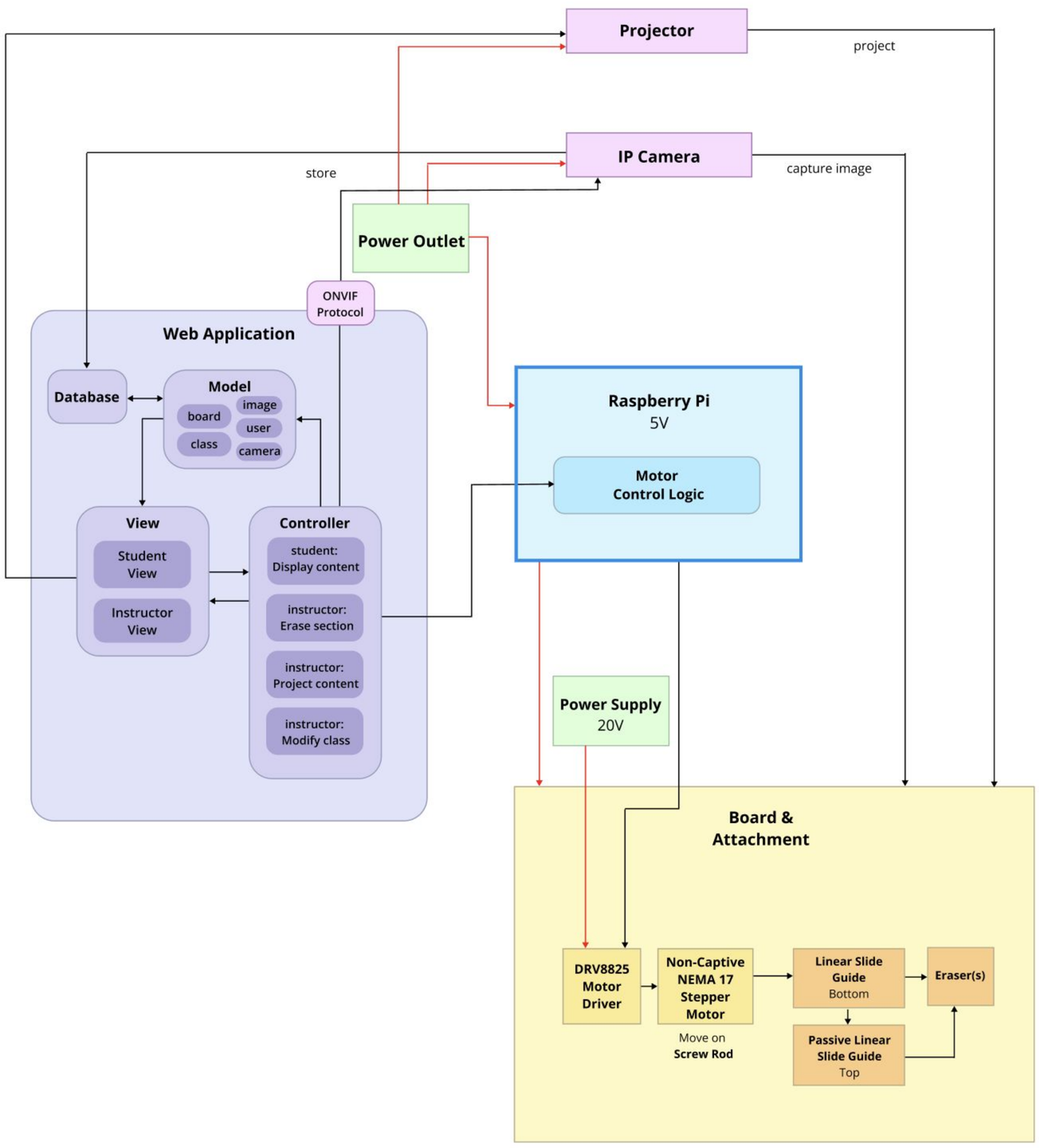
Physical Attachments on Board



Website after Images Uploaded



System Architecture



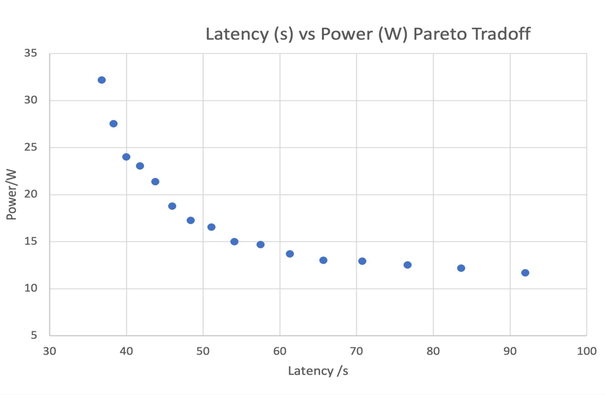
System Evaluation

Table of Validations, Metrics, and Results

Test	Requirement	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 less than **3s**	**1.3s**
Power Consumption	Peak power consumption should be less than **70 W**	19.65W for motor + 7W for RPi + 24W for camera = **50.65W**
Website User Experience	About **1 min** to complete all the required actions	About **45s** for instructor, **7s** for student
Overall User Test	More than **67%** of users report no significant latency, and system has satisfactory functionalities and easy to use	**67%** respond with satisfying response, while the rest indicates latency in erasing

We made several trade-offs between different design requirements. The first trade-off lies between erasing cleanness and erasing speed, In order to fully clean the board, we need sufficient pressure on erasers, which in turn provides friction to motor movement and caps motor maximum speed. The second trade-off is between power consumption and latency, as the motor requires more current when running at high speed. Also, there is a trade-off between the motor drivers. We picked DRV8825 which has a higher current rating and maximum voltage, which allows us to achieve higher speed than the cheap A4988 motor driver.

Graph of Pareto Trade-off Between Erasing Latency and Erasing Power Consumption



Conclusions & Additional Information

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https://course.ece.cmu.edu/~ece500/projects/f23-teamb0/

Overall, we are confident that our virtual board system will bring convenience to instructors and students in a classroom setting with the ability to reference erased board content and automate the board erasing process, aligning seamlessly with our envisioned goals. Potential extensions involve transitioning to a screw rod with a larger pitch size to optimize the erasing speed. However, since we have successfully developed a fully functioning prototype, future work can easily progress once the compatible components are identified.

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