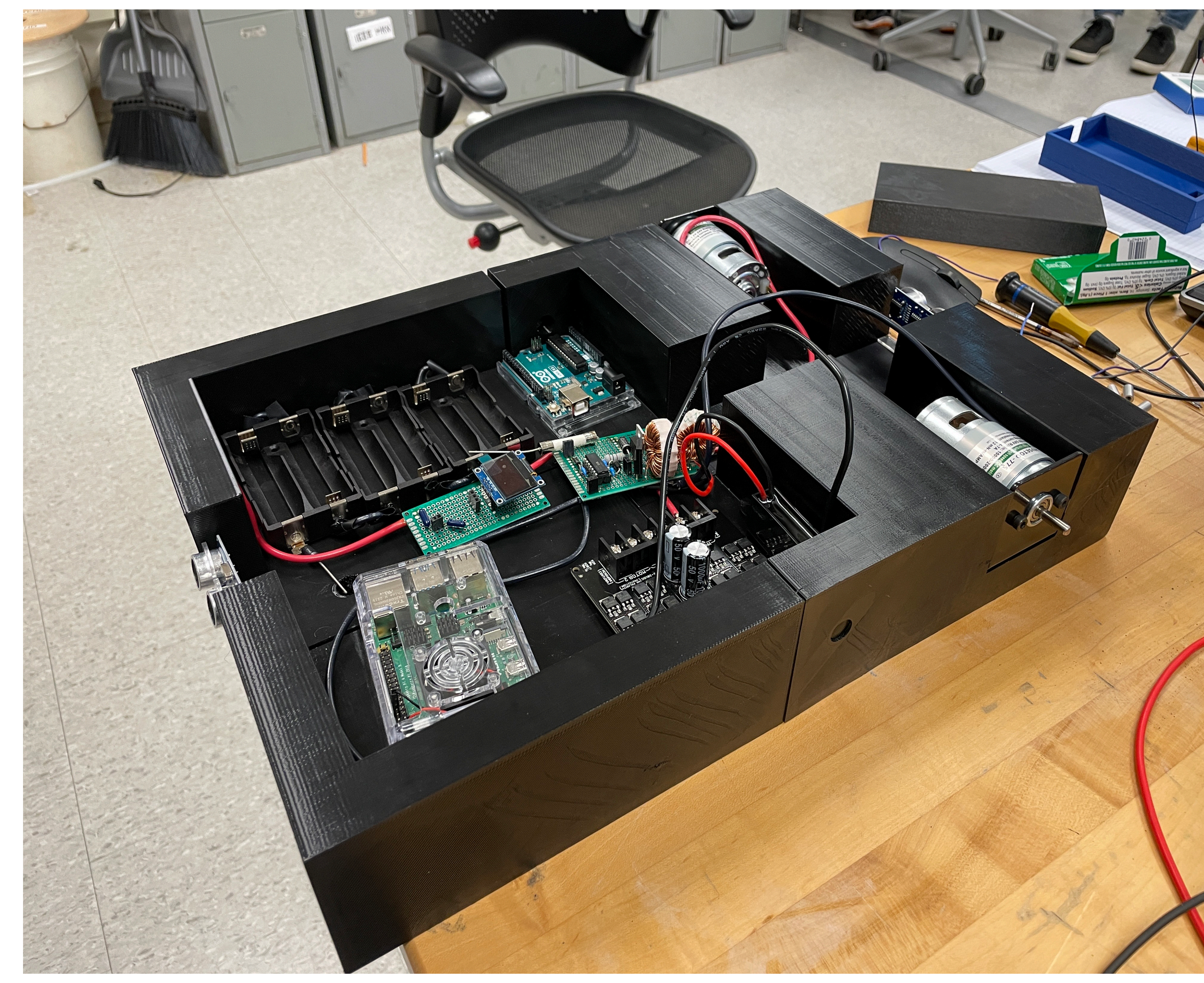
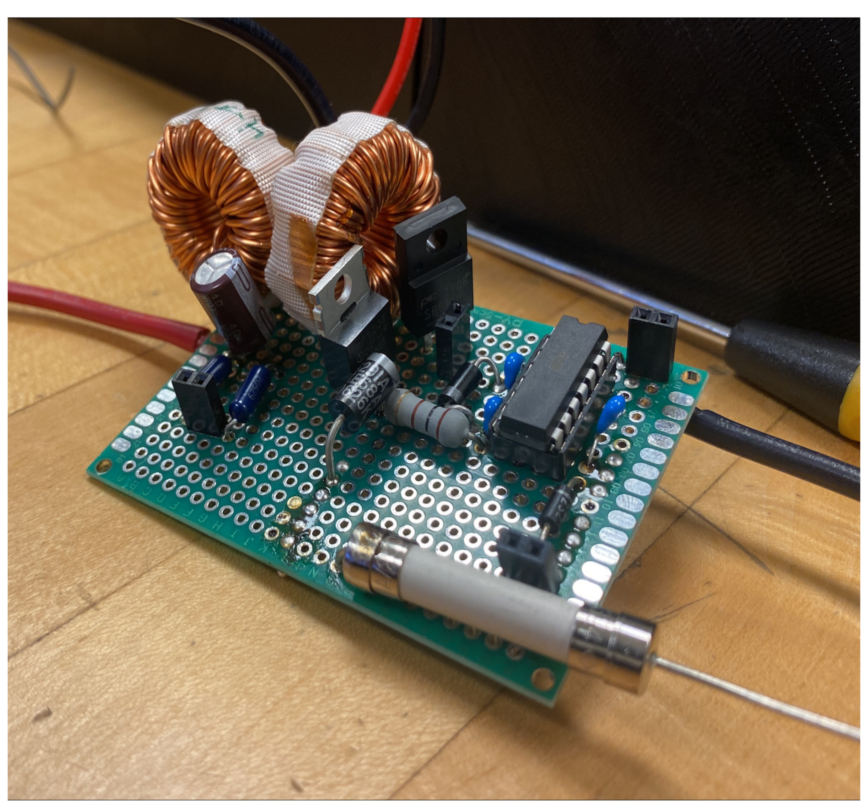
Shadow Cart

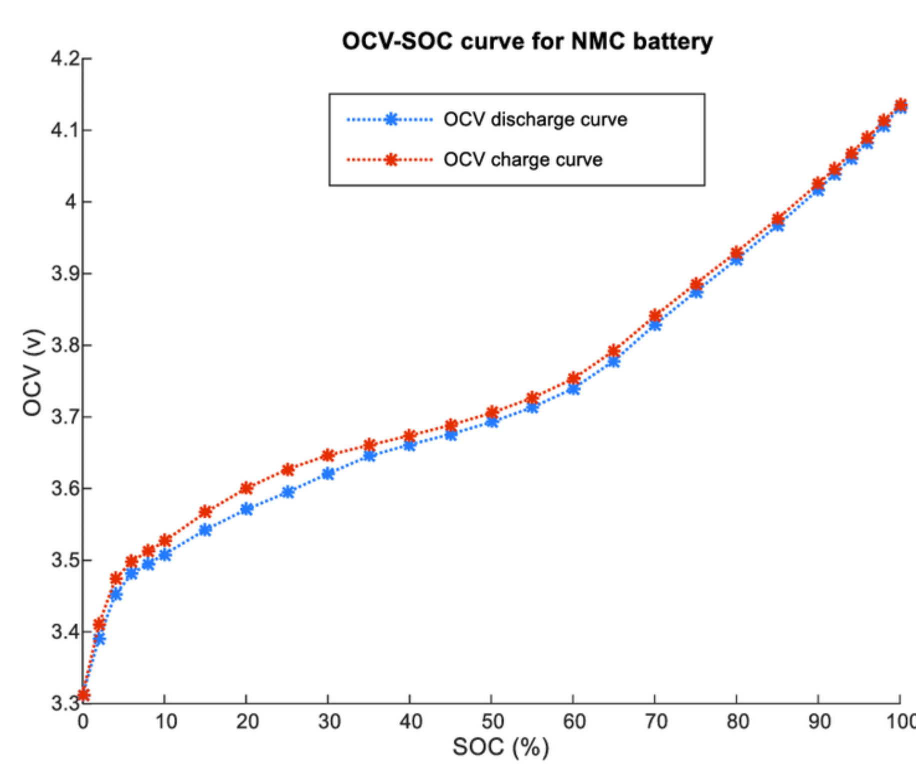
Kyle Anderson, Blake Conner, Brandon Nakamura

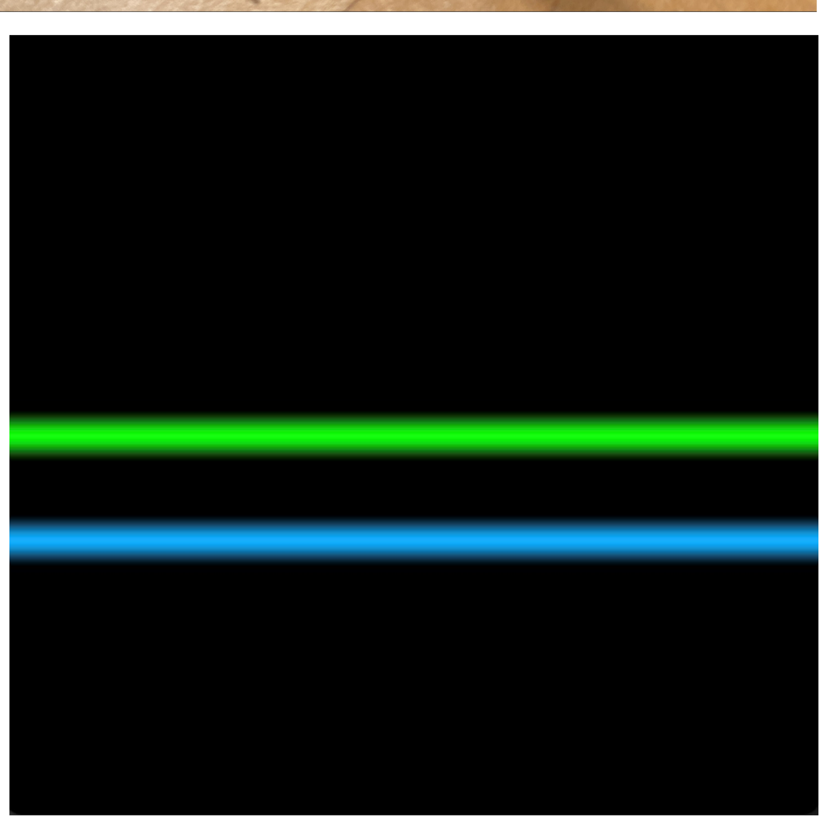
ander766@wwu.edu, connerb4@wwu.edu, nakamub@wwu.edu

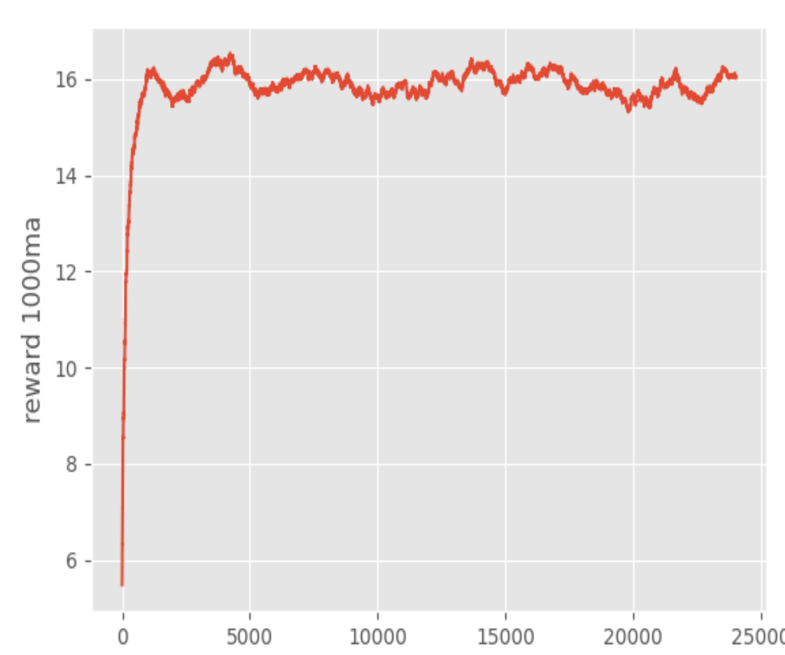
Abstract: Our project is to design an **AI-driven** vehicle that will follow a user, allowing the user to store items in an area on the top, essentially creating a cart-like experience. To track the user's location, the user will hold a phone that transmits a **Bluetooth signal** to the cart. The AI will use the signal strength to determine the user's proximity. Additionally, ultrasonic sensors in front and behind the cart will provide information to the AI, helping it detect obstacles for safety. As for powering the cart a battery bank composed of **lithium-ion batteries** will be used. The power is regulated through a custom **buck converter** which lowers the voltage coming from the batteries. The buck converter is controlled using an Arduino that calculates how much power the batteries have left and maintains a constant voltage. That converted power then enters a motor driver which powers the cart's motors





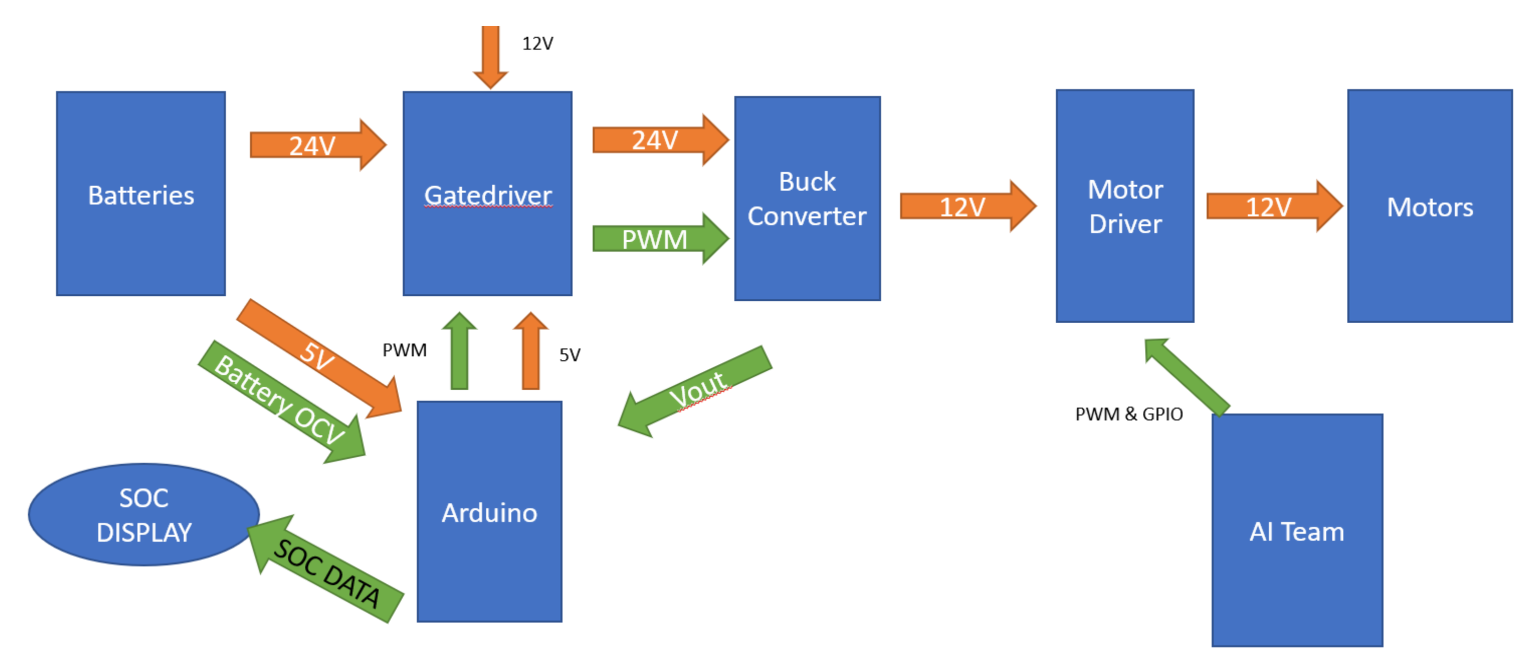






Motivation:

We wanted to create something using AI learning that could help people. We are fascinated by how AI can find shortcuts to achieve goals, so we aim to develop a device that can do that.



Artificial Intelligence:

We aim to create an AI that can learn how to drive using a **reinforcement learning** (RL) algorithm called **Q-learning**. By using RL, the AI can learn from an increasing amount of data as we add more sensors. To enhance our AI, we can expand the Q-table to include more dimensions, accommodating each new sensor and potential movement.

Q-learning:

It is a reinforcement learning algorithm that iteratively calculates the value of potential actions in each state to determine **optimal behavior**. It does this by maintaining a **Q-table**, which stores the calculated values and learns the best one to take based on the highest valued option it has. The algorithm then chooses the action with the highest value from the Q-table, thereby aiming to maximize the cumulative reward over time.

Power:

The system is powered by a battery pack made of 21700 lithium-ion cells, arranged in 6 series for a nominal voltage of 23V. This voltage is reduced to 12V for the motor driver, which powers and controls the motors individually, using a buck converter.

The buck converter reduces the voltage by using a PWM signal to "chop" the power, then smooths it out with inductors and capacitors. An Arduino measures the output voltage and adjusts the PWM duty cycle to maintain the desired voltage. Increasing the duty cycle raises the output voltage, and decreasing it lowers the voltage. This method, called voltage mode control, adapts to the motors' varying load due to changes in speed, direction, and resistance (e.g., when climbing a hill).

SOC: the Arduino will also be calculating the SOC (Capacity remaining in a battery). in this case it will measure the voltage of the batteries in reference to an OCV/SOC curve

Summary of Results:

On the power side we were able to regulate the voltage out of the buck converter to 12V through voltage control. When turning on and off the motors the system would take roughly a second or so to adapt to the change in load.

Conclusion

We are able to build a working cart that can drive itself around but only in a straight line. If we were given more time and a bigger budget, things we would want to add/change would be:

Have a microcomputer with AoA (angle of arrival) so that we know what direction the user is in a 2D environment