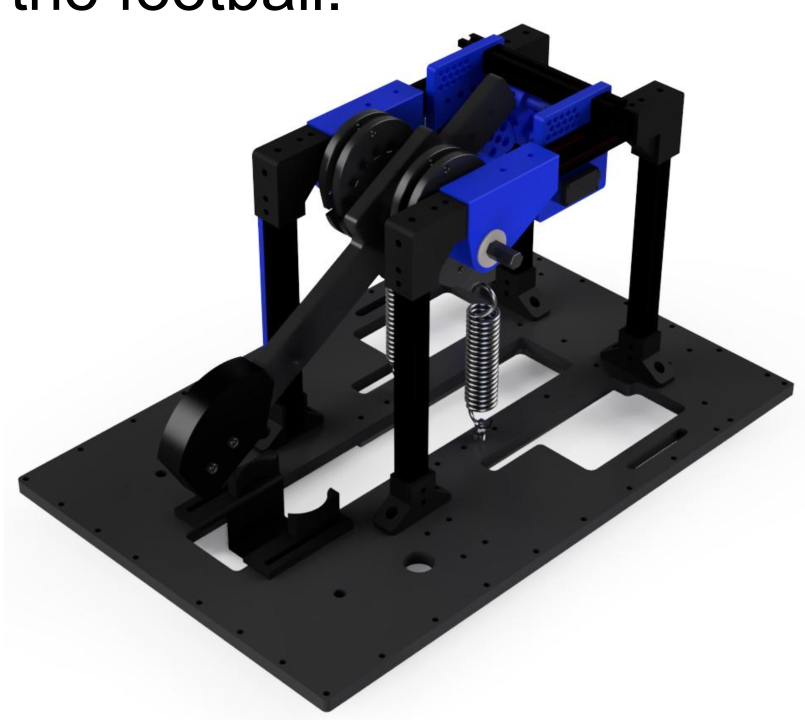
ROBOTIC FOOTBALL

Brayden Amoroso (MechE), Caden Daffron (CpE), Nathan Del Guanto (MechE), Shane Wood (CpE)

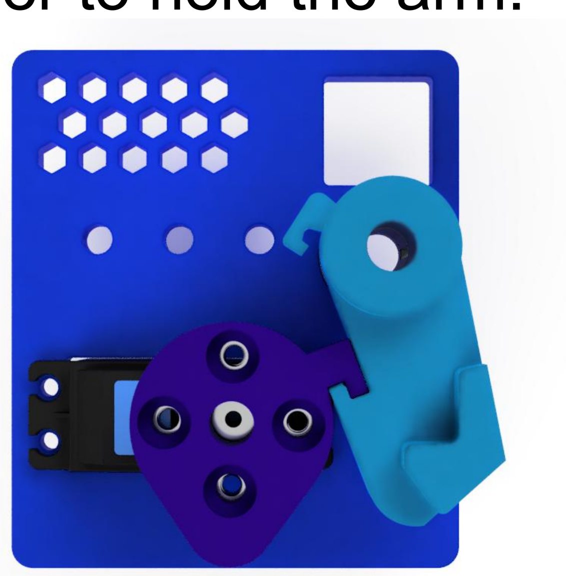
Advisor: Dr. Sean Carroll

Kicking Mechanism

The robot utilizes stored mechanical energy to kick the football. This is accomplished using a spring, rope, and pulley. This system is mirrored on each side of the kicking leg. As the kicking leg is moved backwards into position, this rotates the pulley, putting the two springs in parallel into tension. Once the leg is released, the built-up tension causes the leg to swing through and strike the football.



A latching mechanism is needed to safely and securely hold the kicking leg in place and release it when directed. Utilizing two servo motors, the team created a cam and follower mechanism, improving the mechanical advantage by 1.75 times. As the cam rotates counter-clockwise, it unhooks from the latch component, pushing it away, releasing the leg. This mechanism does not require power to hold the arm.

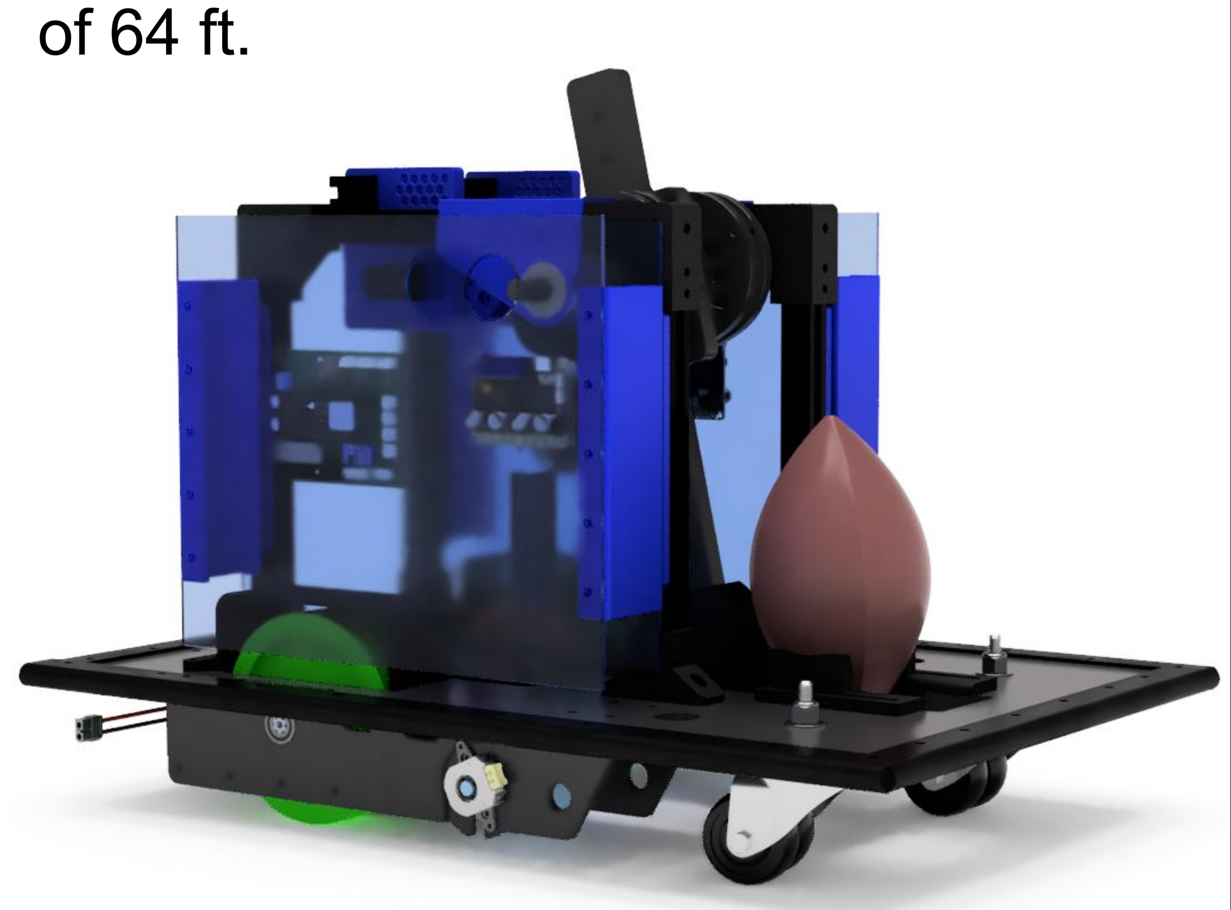


Drivetrain

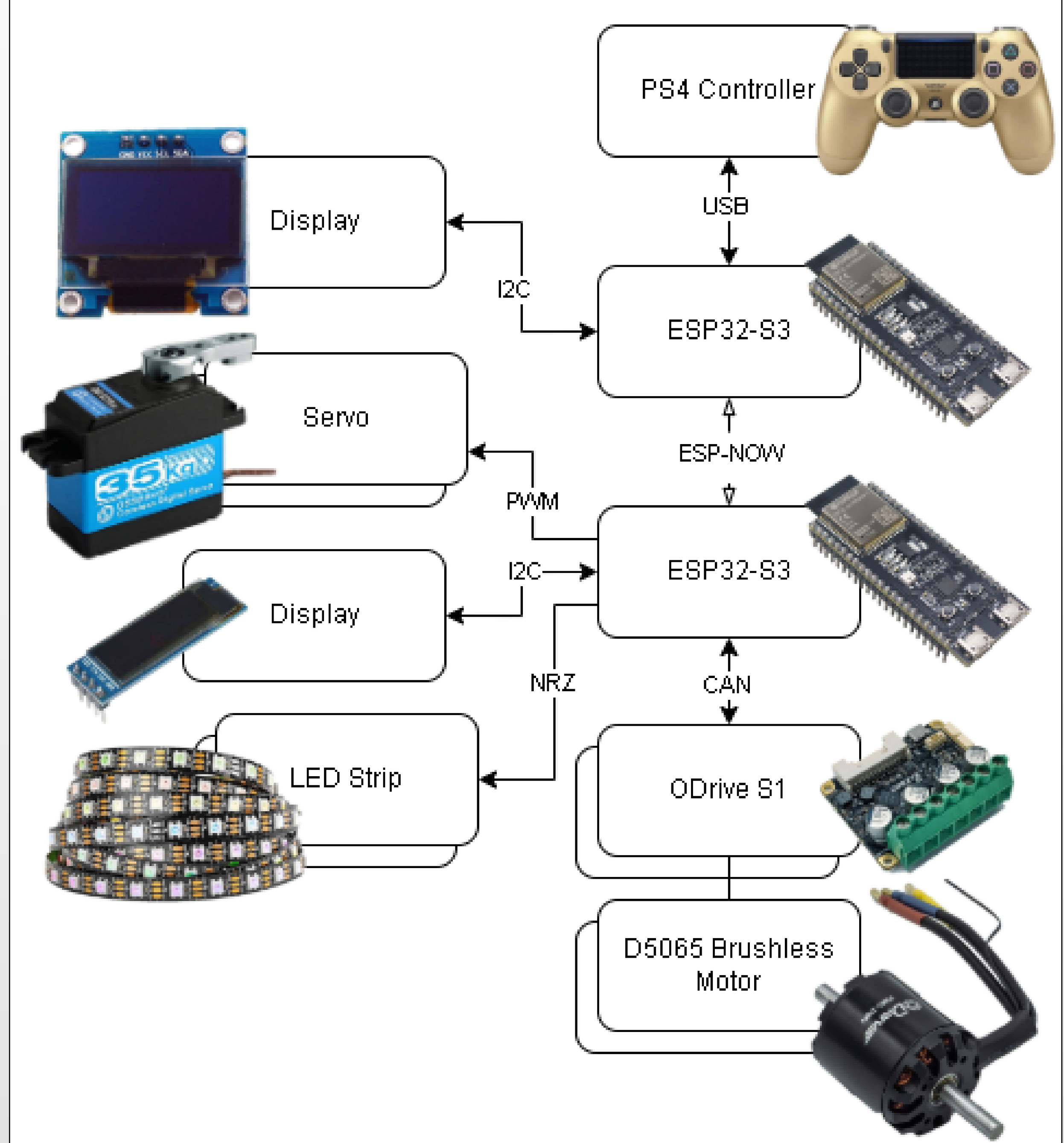
Some of the robots on the team utilize swerve drives and tank drives. These are for agility and strength, respectively. However, the kicker robot will need more precise control over its movement. It will utilize front wheel tank drive with two caster wheels located near the back of the robot. This allows for more controlled movement when aiming. Additionally, the front wheels will be belt driven with a drive ratio of 4:1 for added torque.

Kicker Robot CAD Model

The three previously discussed sections were combined to form the full kicker robot. Also shown below are the side panels which contain the electrical components and the football placement. We can successfully kick a 50 ft field goal, and can kick a maximum distance of 64 ft.



Kicker Electronics



Specifications

- <50 ms wireless latency
- 100 ft wireless communication distance
- Safety mechanism in case of error
- Battery kill switch

Software Information

- ESP-IDF, the framework made by the designer of the microcontroller
- FreeRTOS, with the goal of reducing latency between the controller and the robot

Other Information

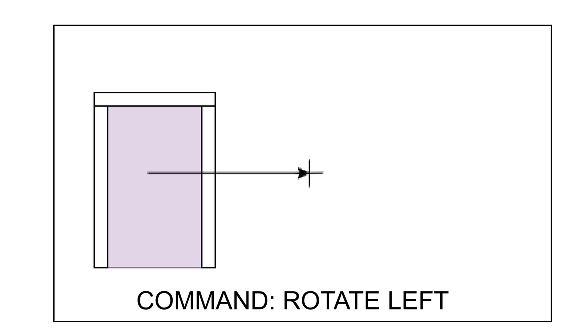
- CAN bus: reliable 2 wire differential communication method
- System voltage of 25.2 – 22.2V
- ESP-NOW is based on 2.4 Ghz, and is also maintained by Espressif

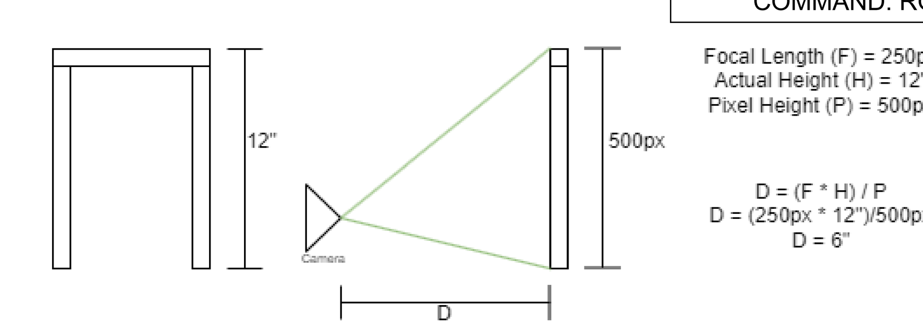
Receiver Tracking

Because the robots are driven from the sideline, lining up the quarterback and receiver robots for a pass and judging the correct distance is often quite difficult for human drivers.

Our proposed solution is to implement computer vision to allow the quarterback to autonomously detect the receiver, aim, and determine range. We will put reflective tape in a known pattern on the receiver, and by shining a bright LED in its general direction, we can use a camera to capture the reflected light.

With this image, we can algorithmically detect the shape of the reflective tape in the frame. If the shape is not centered in the frame, the robot can autonomously rotate and re-check until it is aimed correctly.





Additionally, this vision system is able to estimate the distance from the camera to the receiver. Because the size of the reflective tape shape is known, we can use the focal length of the camera, the pixel measurement of the shape, and the actual dimensions of the shape to calculate the distance. This is useful for determining the power with which to pass.

Hardware:

- Orange Raspberry Pi 5 (8GB)
- Logitech C270 Webcam
- Cree XLamp Near-IR LED