

Receiver

The receiver is designed to catch and retain a running or throwing pass from the quarterback. The team went through 3 design iterations before coming to the finalized design.

Table 1. Receiver Mechanism Bill of Materials

Item	Quantity	Dimension	Price
Nuts and Bolts	24	M6 Variety	\$2.24
Zip Ties	15	8"	\$0.90
Curtain	1	70"W x 71"H	\$9.98
PETG Filament	1	1 kg	\$24.99
PVC to ABS Cement	1	4 oz can	\$8.40
PVC Pipe	2	1-1/2" x 5' Sch 40	\$14.38
Swerve Base Plate	1	Personalized	\$4.46
			\$65.35

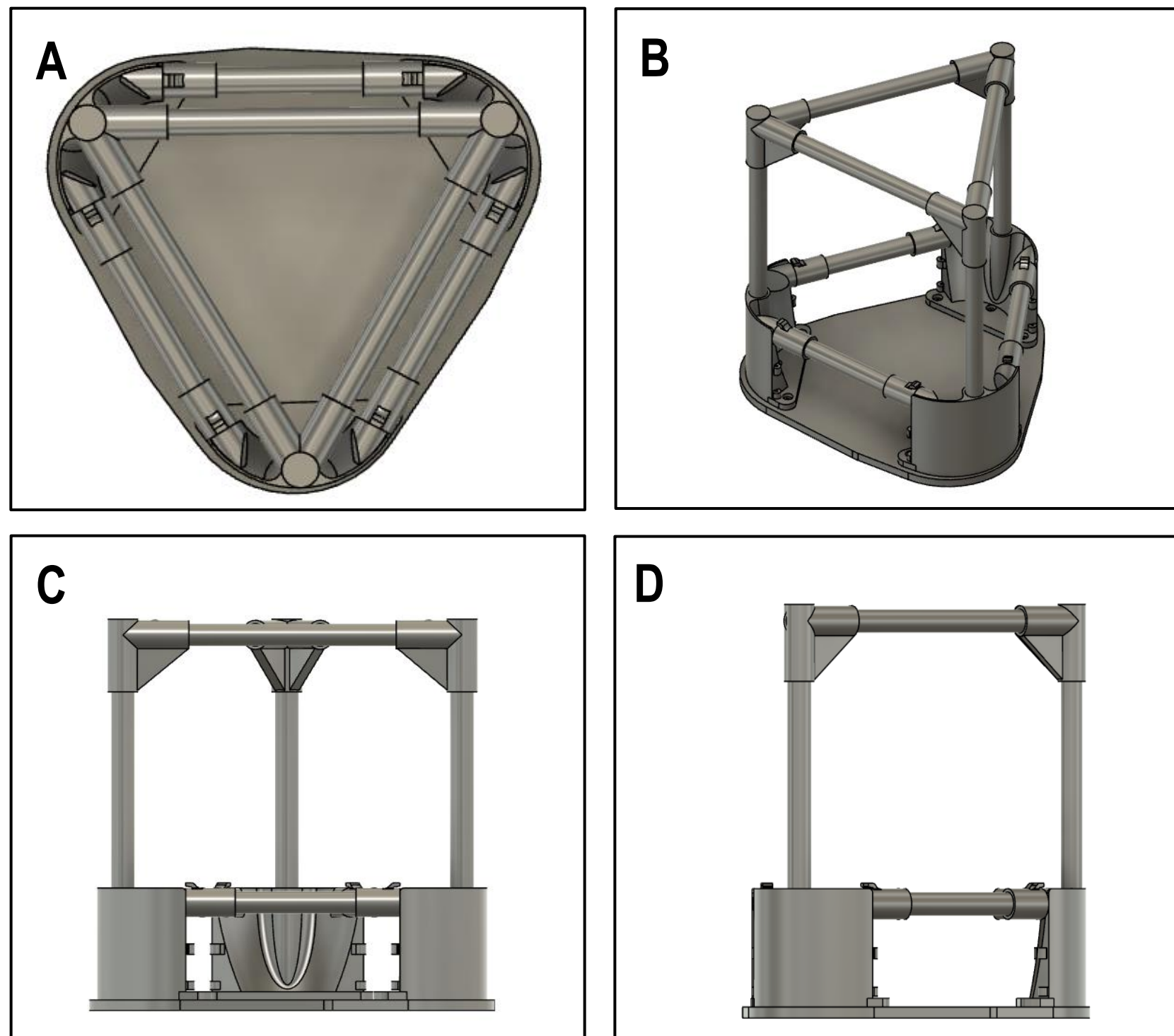


Figure 1. [A] Receiver Top View [B] Receiver Isometric View
[C] Receiver Front View [D] Receiver Side View



Figure 2. Assembled Receiver Mechanism

The final design of the receiver consists of three main posts that lock into the top plate and hold the PVC pipes in between them. Atop the PVC pipes are shower curtains that act as a resistance barrier for the football to push through and allow for a more confined catch of the football.

Quarterback

The main purpose of the quarterback is to consistently launch a football to a receiver for a throwing pass or running pass. The team went through 3 design iterations.

Table 2. QB Mechanism Bill of Materials

Item	Quantity	Dimension	Price
Nuts and Bolts	6	M6 Variety	\$0.60
Nuts and Bolts	10	5mm	\$3.00
Servo Motor	1	9g	\$2.00
Filament	2	2 kg	\$41.74
Stepper Motor (2A)	1	5 mm Shaft	\$13.99
Flywheels	2	4 7/8 in	\$10.00
Wheel Hub	1	T81 Hub 5mm shaft	\$18.00
Swerve Base Plate	1	Personalized	\$4.46
O-Drive Motor	2	Dual Shaft Motor 330KV	\$59.00
Stepper Motor (1.5A)	2	5 mm Shaft	\$28.80
Nuts and Bolts	36	3 mm	\$9.78
Logic Control PCB	1	Personalized	\$81.31
Stepper Control PCB	2	Personalized	\$90.88
Brushless Motor Drivers	2	Personalized	\$298.00
			\$661.56

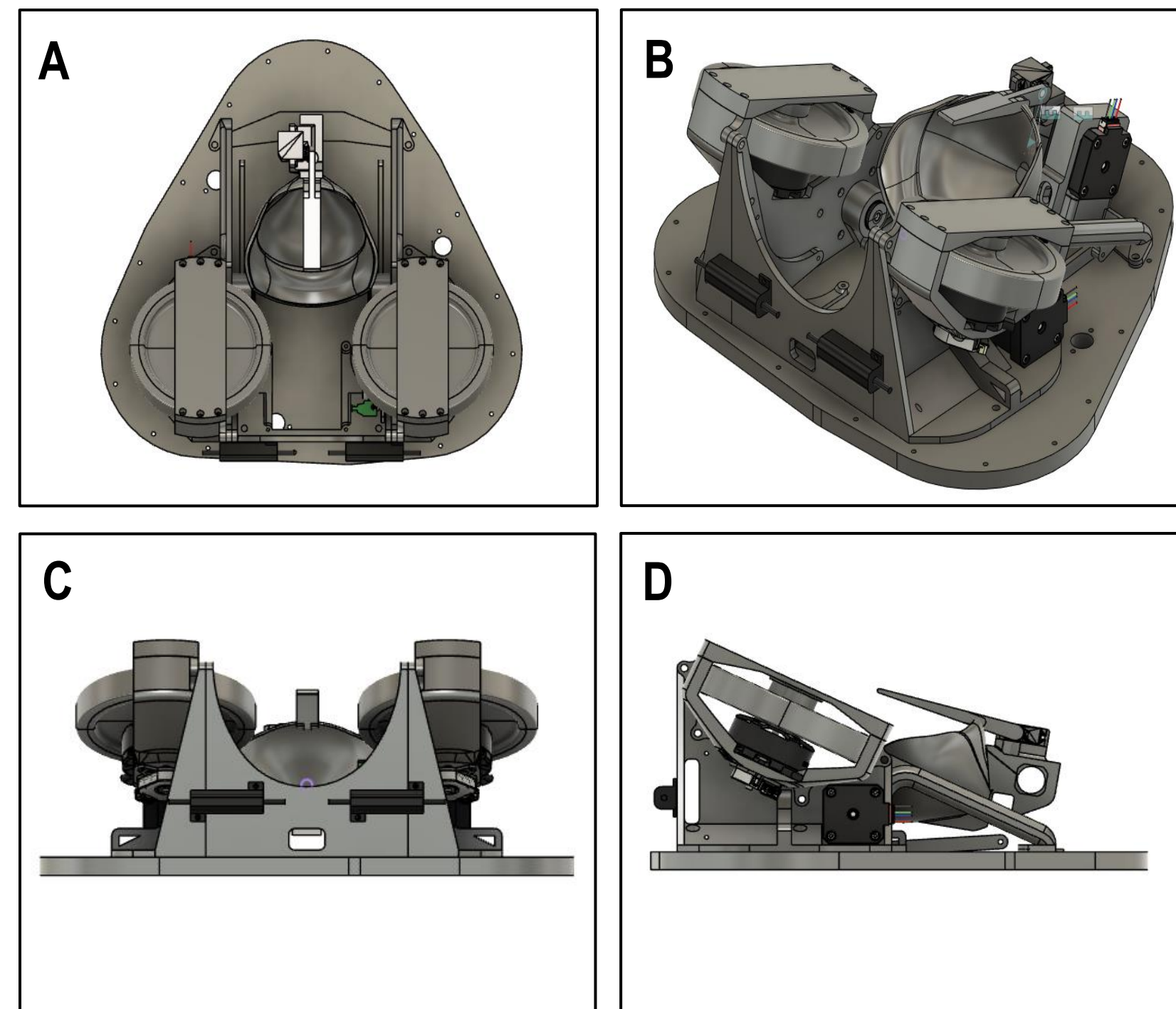


Figure 3. [A] QB Top View [B] QB Isometric View
[C] QB Front View [D] QB Side View



Figure 4. Assembled Quarterback Mechanism

The final design of the quarterback consists of two brushless motors controlling flywheels, two stepper motors controlling the linear motion of the scoop, a stepper motor to change the angle of the scoop, and a servo motor to secure the football.

Center

The center is designed to hold the football at the beginning of the play and then immediately pass it to the quarterback. The team went through 4 design iterations before finalizing the design.

Table 3. Center Mechanism Bill of Materials

Item	Quantity	Dimension	Price
Nuts and Bolts	1	M6 Variety	\$2.99
Nuts and Bolts	1	M3-0.5 x 12 mm	\$2.24
PETG Filament	1	1 kg	\$24.99
T81 Aluminum Shaft Hub	2	8 mm	\$9.00
Lineman Base Plate	1	Personalized	\$19.04
O-Drive Motor	1	Dual Shaft Motor - D5065 270KV	\$89.00
Brushless Motor Drivers	1	Odrive S1	\$149.00
Servo Motor	1	9g Micro Servo Motor	\$2.00
Bearing	1	5 mm x 10 mm x 4 mm	\$0.84
Bearing	2	8 mm x 22 mm x 7 mm	\$1.10
Aluminum T-Slotted Rod	1	20 mm x 20 mm	\$14.31
Steel Shaft	1	5 mm x 50 mm	\$0.76
Steel Shaft	1	8 mm x 100 mm	\$2.00
			\$317.26

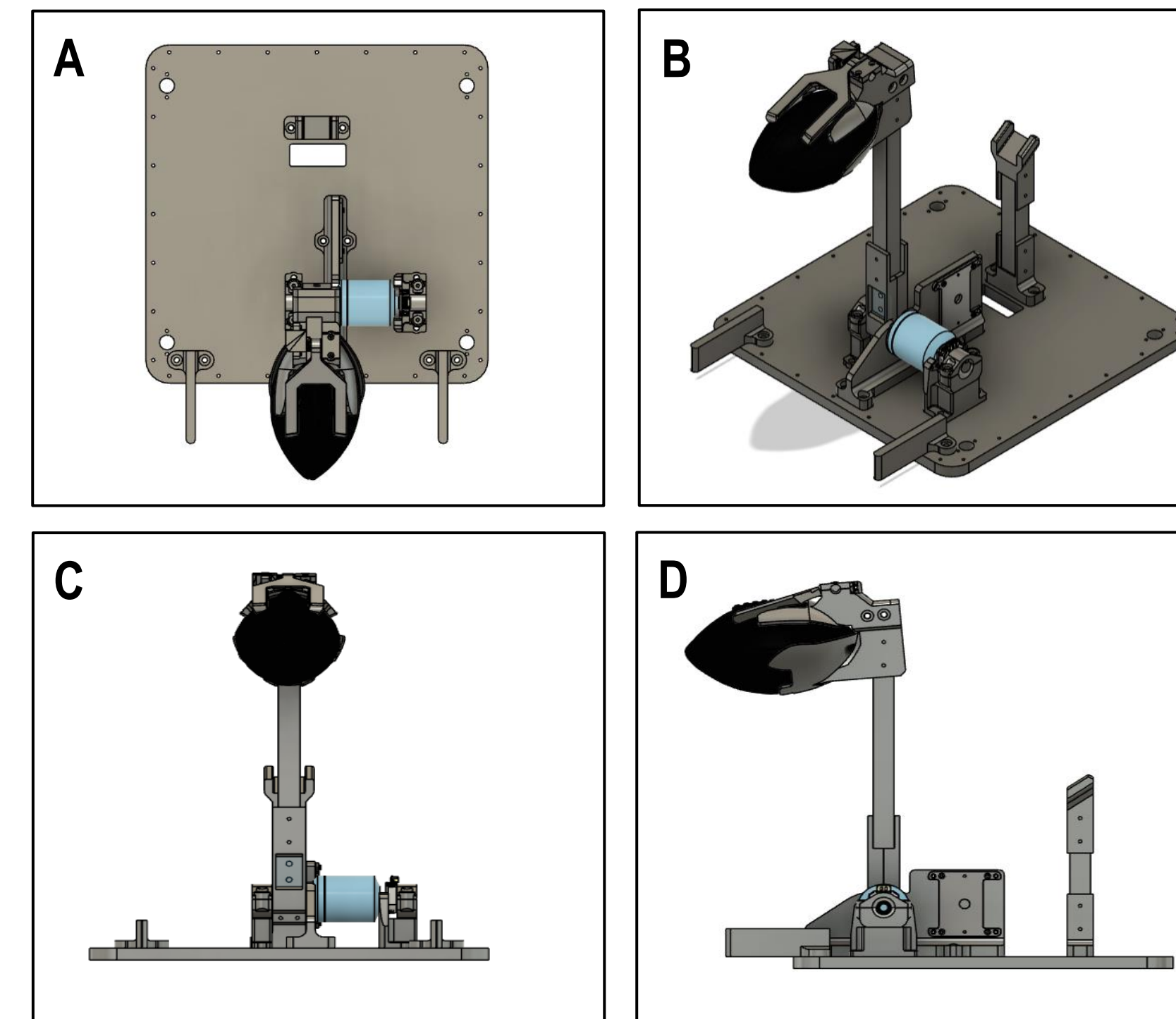


Figure 5. [A] Center Top View [B] Center Isometric View
[C] Center Front View [D] Center Side View



Figure 6. Assembled Center Mechanism

The final design of the center consists of a brushless motor to move the arm back and forth between its desired positions, and a servo on top to clamp and release the football at its different orientations.

Control

Both the QB and receiver use a swerve drive mechanism to allow them to be more agile than a conventional tank drive robot.

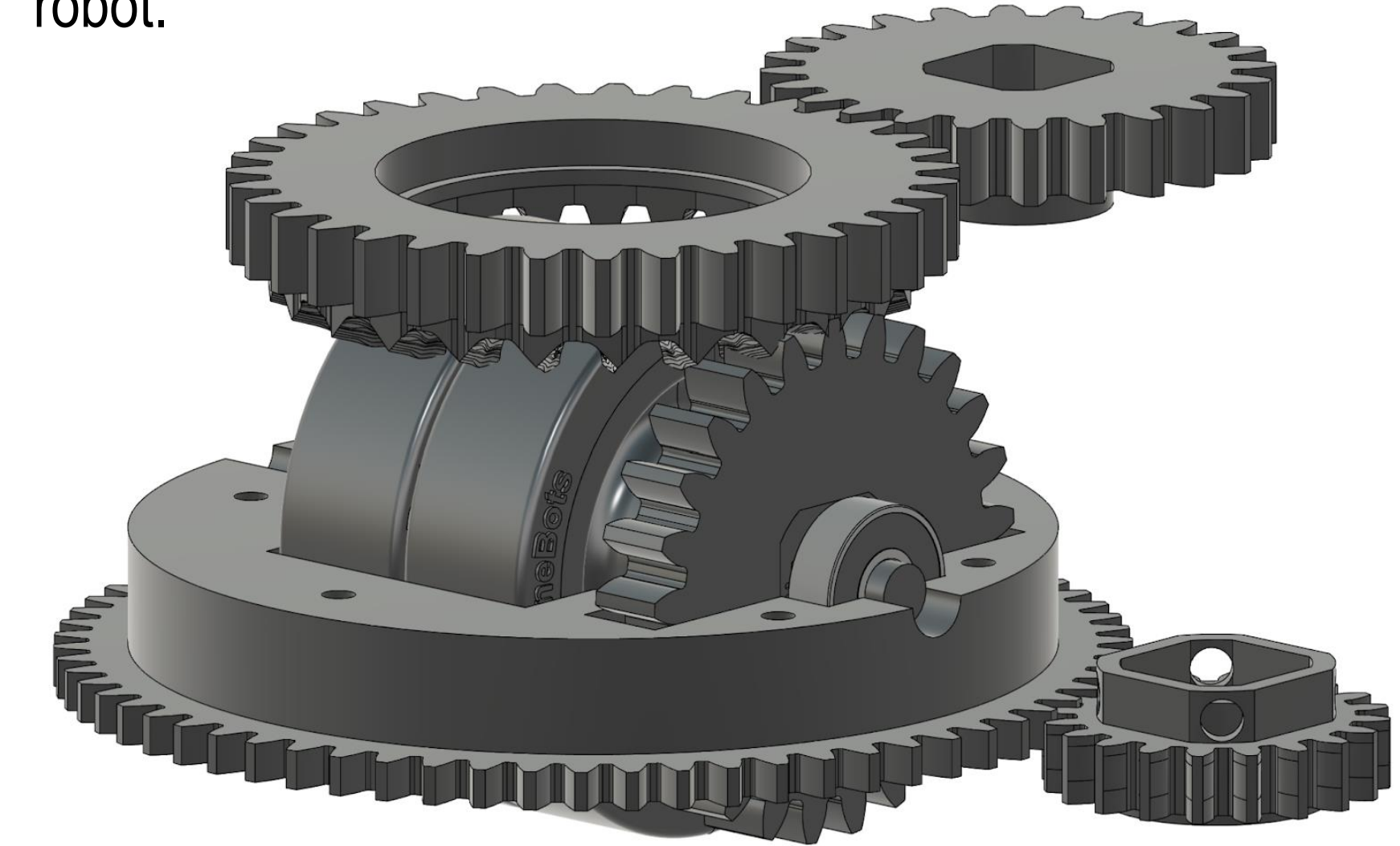


Figure 7. Swerve Drive Gear Train

To control the complex swerve drive mechanism a fairly complicated electrical system is needed.

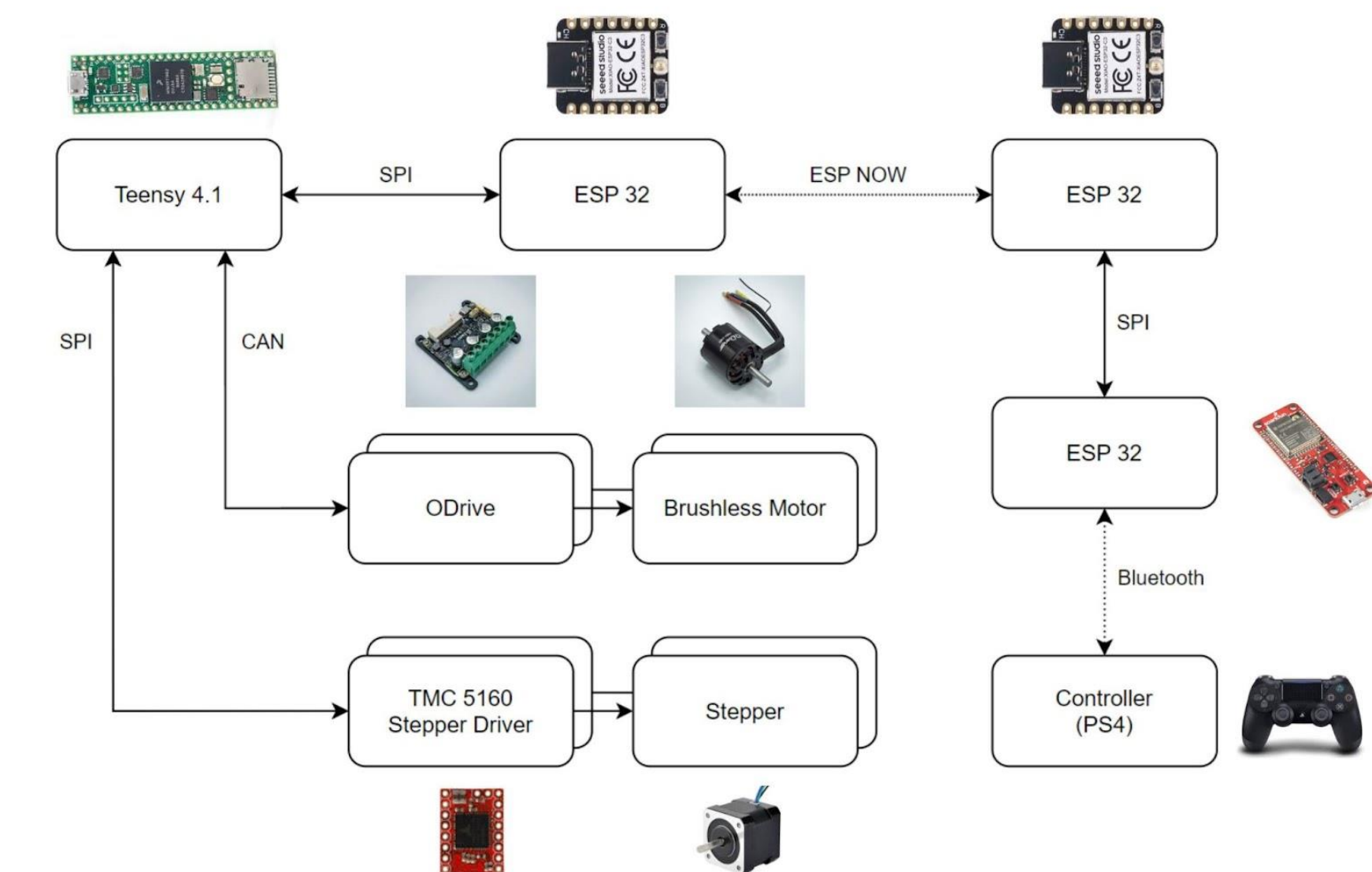


Figure 8. Swerve Electrical Diagram

To control the additional mechanisms on the center and quarterback robots, state machines are used.

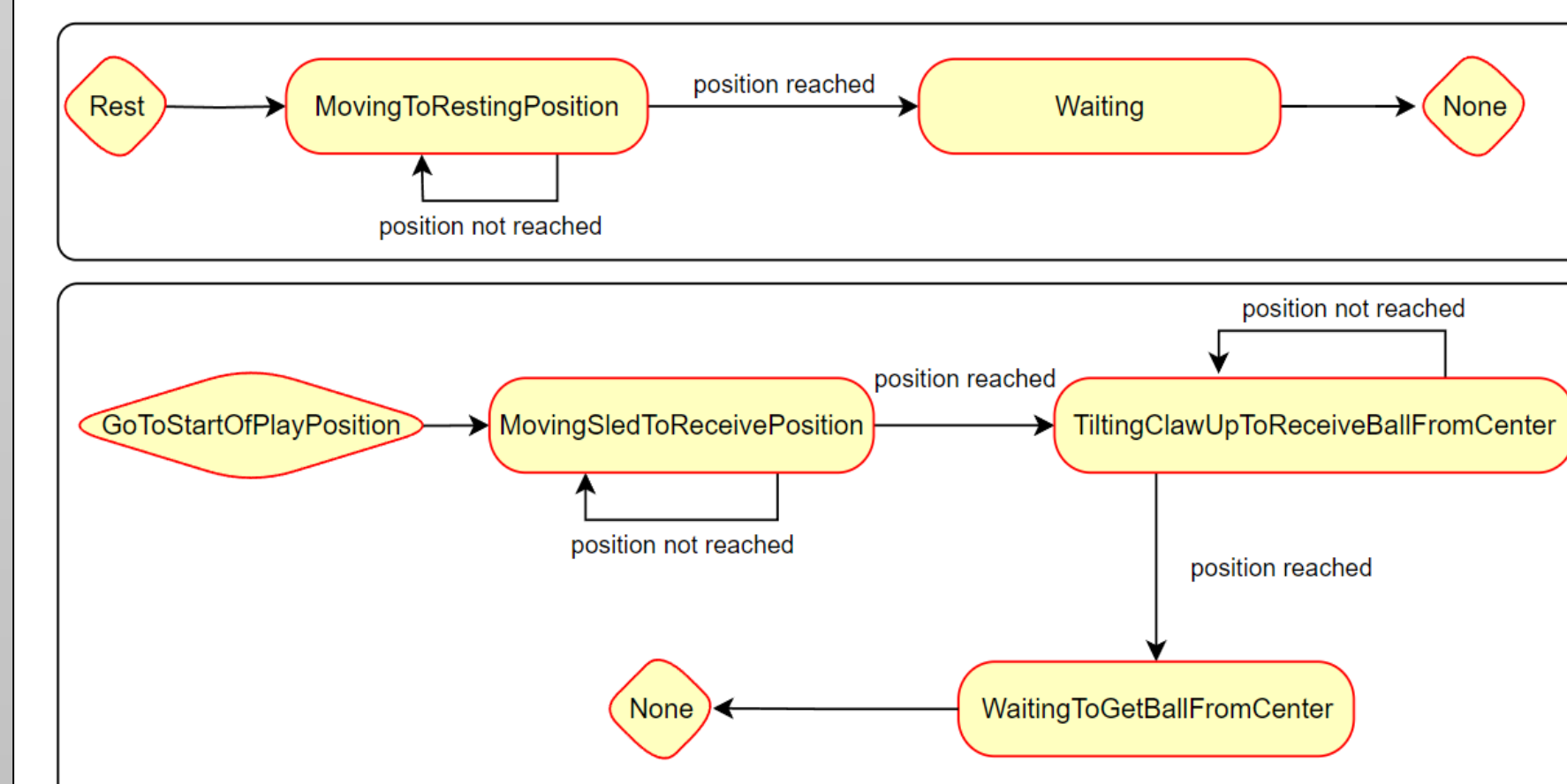


Figure 9. Control State Machines