*Brendan and the Jo(h)nathans* NERF turret was the term project for the second mechatronics class at Cal Poly. The goal of this turret was to use closed-loop motor control and a thermal camera to detect a target, aim, and fire a foam dart automatically.

A white and grey machine

Description automatically generated with medium confidence

Figure 1. CAD model of gun, motors, and geartrain. Thermal camera, bearing, and baseplate not shown.

The main panning axis is driven by a Pololu #4743 12V DC motor with a 50:1 gearbox. Because the gear ratio is slowing down the motor’s rotation to 60 rpm, a 90o bevel gear train with a 1:1 ratio was chosen to avoid reducing the speed further. Worm gears were considered because of their avoidance of backwards driving, but bevel gears were chosen over worm gears because worm gear sets could not be found in a 1:1 ratio.

A grey metal object with a square object

Description automatically generated

Figure 2. CAD isolation of bevel geartrain.

Bevel gears were selected to place the motor close to the table datum while not interfering with the gun’s panning axis. Due to the distance between the bearing and the top bevel gear, runout in the bearing is magnified. This limited the achievable accuracy of our PI controller. A future improvement would be to use a more precise bearing, or a motor with a smaller gear reduction to decrease the pinion diameter and bring the gear closer to the bearing and reduce the runout.

Imprecision in the gear and bearing made position calibration difficult as well. Before each duel, the gun was referenced against a square to start from a repeatable point.

With each weekly lab assignment, pieces of code were written, and hardware was implemented building up to the term project. The main pieces are as follows: motor controller, including driving the DC motor and reading its encoder, tuning the closed-loop proportional and integral gains, cooperative multitasking to drive two motors simultaneously, and finally configuring the thermal camera using inter-integrated circuit (I2C). All software documentation can be found at INSERT DOXYGEN HTML LINK .

A NERF Stryfe gun was modified to have its flywheels turned on from software, and the trigger was pulled by a servo to push darts into the flywheels.