Automatic Nerf Sentry Turret

Kaleb Poley, Michael Watson, Jarrett Reese, Jesse Matthews, Dhairya Mishra
Advisor: Andrea Mitofsky, PhD
Trine University
One University Avenue, Angola, Indiana 46703

Trine University
Electrical and Computer Engineering

Introduction:

As technology is slowly becoming more a part of children's daily lives, our team decided to introduce a new aspect of technology to the already exciting world of nerf. The automatic Nerf sentry turret is an inexpensive, compact, child safe, and exciting toy that brings the wonders of autonomous technology to the household. This project can give kids (and maybe parents) the opportunity to learn about remote connections and software-to-hardware communication.

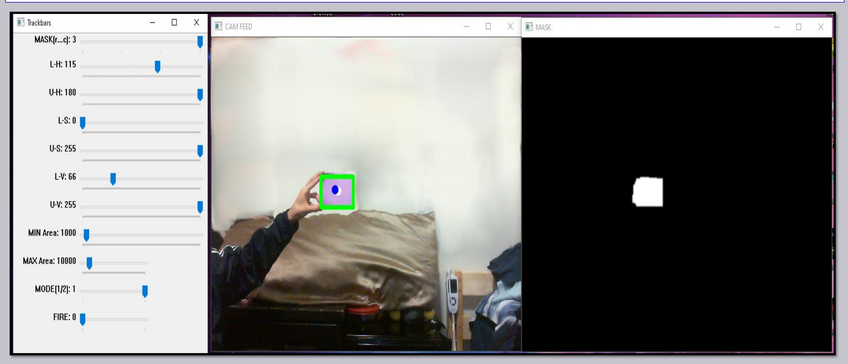

Figure 4: Shows the interface that users are greeted with when launching the script. They are the Trackbar Settings, Cam Feed and Mask respectively.

Custom Software:

By virtue of the software and hardware decision made, the turret is able to autonomously find and track the calibrated/chosen target, intelligently predict its movement and meet the target with a predictive foam dart burst to intercept it. Furthermore, it has the ability to be remotely operated and setup provide that the Raspberry Pi which is the brain of the operation can connect to the internet. 'Threading', a software concept involving division of load and processing power was also used in order to overcome the hardware limitations of the our economical processor.

Testing:

Full integration tests were done towards our scope of at least hitting a target over different situations. These are our results:

Test 1: Hitting a target walking at 3 mph at 10 feet away parallel to the gun – **Result**: (Success) Target hit 4 times.

Test 2: Hitting a target walking at 3 mph at 5 feet away parallel to the gun – **Result**: (Success) Target was hit 3 times.

Test 3: Hitting a target walking at 3 mph at 10 feet away walking at a 45° angle until 10 feet away – **Result**: (Success) Target was hit 5 times

Test 4: Hitting a target walking at 3 mph at 5 feet away walking at a 45° angle until 10 feet away – **Result**: (Success) Target was hit 1 time.

Test 5: Hitting a target walking directly towards the camera from the middle of the frame – **Result**: (Success) Target was hit 5 times.

Test 6: Hitting a target walking directly towards the camera from the left side of the frame (90° FOV) -- **Result**: (Success) Target was hit 5 times.

Test 7: Hitting a target walking directly towards the camera from the right side of the frame (90° FOV) -- **Result**: (Success) Target was hit once.

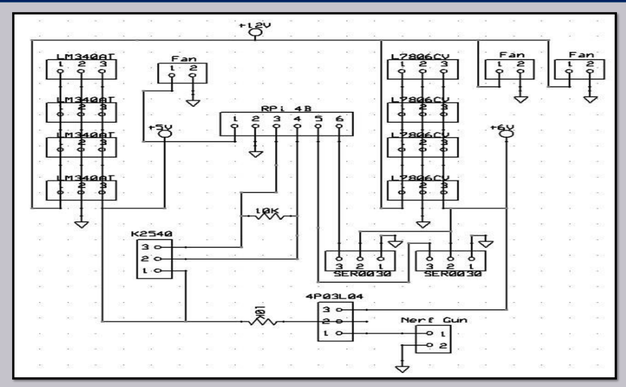

Figure 1: Shows the entire circuit, showing all connections and (if applicable) component marking number.

Components and Design:

- For our programing and computing needs, we utilized a raspberry pi 4B (basically a small, single board computer)
- To power all the electrical components, we used a 120V to 12V power supply with a 10 amp current limit
- Utilizing feedback servos, we were able to move the gun up, down, left, and right based on video feed from the camera as well as custom made prediction functions
- Our team used a 25 round drum combined with a belt fed, motor controlled nerf gun to fire the darts
- 3 fans are used, 2 for cooling the components within the box and one for cooling the motor connected to movement in the up and down direction.
- A 180 degree field of view camera was used in connection with our raspberry pi to detect targets within a 90 degree range
- A custom made wooden box and stand was used to support all of the parts as well as the nerf gun itself.

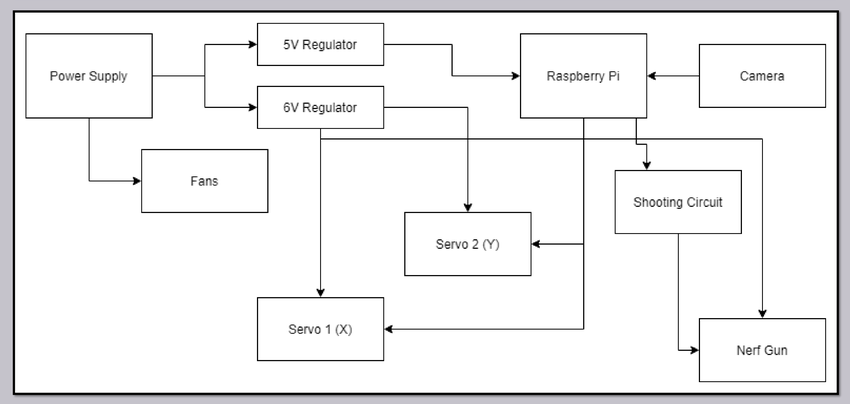

Figure 3: A block diagram of the whole system. The power supply provides 12V to 2 fans and 5V and 6V volt regulators. The 6V regulators powers 2 servos and the Nerf Gun while the 5V regulators power the Raspberry Pi. The camera sends data to the Pi, gets processes, and then the Pi then sends data to the servos and the Nerf gun firing circuit.

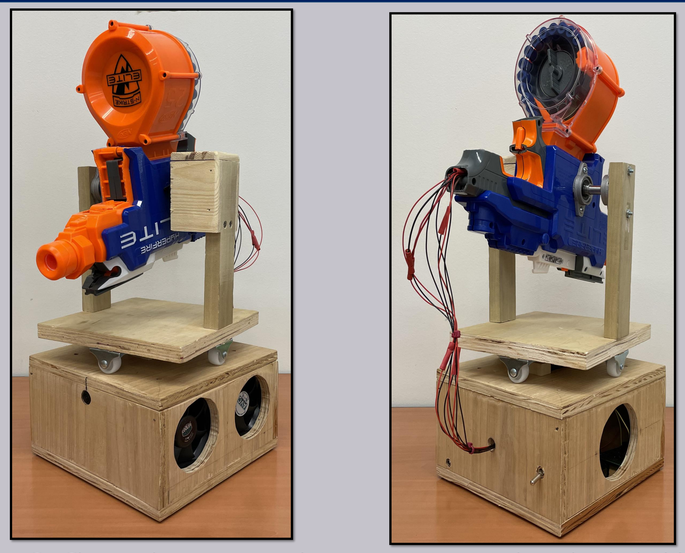

Figure 2: Shows the turret on the servo mounts. The wheels hold up the gun and X servo mount, with the Y servo mount underneath. The X servo is inside the wooden box to the right of the gun.

Conclusion:

Our team has created a fully working autonomous Nerf gun turret that can recognize and shoot a (2x1 ft) colored target at 5 to 10 feet away. Currently is can track red, green, and blue targets as well as a profile that can be set manually. It has a 90 degree FOV and can operate autonomously and only needs to be reloaded. The turret has a hit rate of around 24% (5/21) at 10 feet walking at a speed of 3 mph. As seen in the testing, 100% of the 8 scope tests were successful in hitting the target at least one time. Although this may not be the best accuracy, it fits well within the agreed upon specifications. This can be improved upon by more calibration and testing.

Future Work:

The following are ideas to further improve the Autonomous Nerf Turret:

- Improving the mounting between the servos and turret brackets
- Create more color profiles under different lighting conditions
- Creating a faster way to setup the system
- Create a proper fan shielding
- Do more testing/calibration for accuracy at longer ranges
- Streamline the code to make it process faster
- Better temperature management
- More inputs to the prediction code for better accuracy

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