

# Target Detection With Neural Network Hardware

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**Customer:** Dr. Catherine Schuman - Oak Ridge National Laboratory



<http://goo.gl/forms/OrG6065Ya>

## Design Task

The goal of this research project was to test the targeting capabilities of IBM’s Neurosynaptic Evaluation System using the built-in TrueNorth neurosynaptic chip. Using off-chip training routines, we can build a neural network that is able to detect the coordinates of a target within a camera’s field of vision. The results of these training routines will be a configuration file to be loaded onto the TrueNorth chip.

Once fully connected, real-time images are captured via a Raspberry Pi subsystem and stored in a LMDB database. An OpenCV algorithm on the RPi returns coordinates which must be translated into real motor positions. Software moves the motors to their appropriate positions. When they’ve reached their final destinations, a fire signal is sent to the launcher and a Nerf dart is fired at the target, hitting with a success rate of about 80%.

## Solution Approach

- TrueNorth board programmed with a neural network configuration built from training sets, plus a Rasp.
- A Raspberry Pi connected to a USB camera captures images.
- Nerf Swarmfire model gun was modified to accept direct electronic signals.
- Two Vex 393 motors to form the actuators for the yaw and pitch of the launcher.
- A platform base to mount the motors and launcher, fit to pivot the launcher about its center of gravity.
- The launcher will use an external power supply converting 120V AC wall output to approximately 5V DC for the motors.

## Implementation



**Figure:** Kevin demonstrating the launcher’s tracking and firing capabilities  
A Nerf Swarmfire blaster has been mounted on a 3D-printed launching platform to form the main structure of the turret, with two Vex motors used to control the pitch and the yaw. A USB camera has been mounted on top of the gun.

The turret is programmed to target an external red target by first detecting the target, spending several seconds attaining an accurate assessment, and then firing. Either a TrueNorth emulator or IBM's TrueNorth board itself, trained with Caffe, is used to calculate this.

## Results of Testing and Evaluation

- 20 full integration tests of the system have been completed:
- Fifteen tests were full successes (the target was hit near the center)
  - Three tests were partial successes (the target was hit nearer the edge)
  - Two tests were failures (the target was not hit, but was close)
  - Zero tests were complete failures (the target was not hit, and was not close at all)
- Unfortunately, we were never able to get TrueNorth classifying images properly, due to difficulties using IBM’s available software packages.

## Team Member Assignments and Contributions:

- Garrett, as our team lead, was responsible for organizing and submitting many documents. Luke helped in a secondary leadership position in this respect.
- Garrett completed Caffe installation and worked with interfacing TrueNorth's GPIO.
- Shawn, Kevin, Luke, and Hollis helped construct the LMDB datasets and the original image recognition algorithms, as well as some mathematical calculations.
- Nick and Jalen were the electric engineer experts of the team, while Kevin spearheaded GPIO and motor control on the Raspberry Pi with Nick and Shawn's help in particular.

## References and Acknowledgments

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