

Project Squirrel

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Client: Bob Thompson Advisor: Dr. Gary Tuttle

Introduction

Problem

- Our client Bob has a problem with squirrels chewing on his deck and destroying it.
- A barking dog and other loud noises is not enough to scare the squirrels
- Bob wants a new solution to scare the squirrels.

Solution

- We will build a turret system that will launch ping pong balls at the squirrels

Design Requirements

Functional Requirements

The device should start tracking and targeting squirrels as soon as it is powered on. The product should launch a projectile that will scare squirrels off the deck without damaging the house. The device should be able to attach to the deck without damaging it.

Non-functional Requirements

The device should be low in cost, and be produced within the budget provided for the course. The device should be autonomous and require minimal manual intervention. The device should be simple enough that it can be reproduced and scaled to multiple devices that cover an entire deck. The product should operate for long periods of time without maintenance

Operating Environment

The design was made to be built on an outdoor porch. It should be resistant to snow, wind, rain, and small animals.

Intended Users and Uses

- Anyone who has squirrel problems
- Could also be easily re-trained to target other pests besides squirrels such as rabbits

Design Approach

Concept Sketches



Four-bar launching mechanism



Targeting mechanism



Targeting Assembly

Block Diagram

Training Pipeline

Gather data to train the model

- Took 400 pictures of squirrels and then downloaded an extra 200 images from the internet.
- Annotated the images with bounding boxes around the squirrels and converted the box data to a csv file.

Use the pre-trained model to train our own custom model

- The pre-trained model is already very capable of useful detections, such as lines and shapes.
- Remove the final layers from the pre-trained network that are used for classifying irrelevant objects.
- Transfer the remaining network to our custom model.

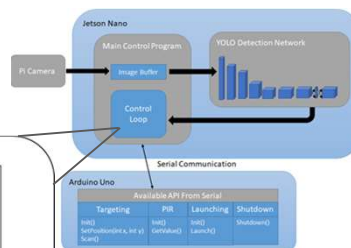
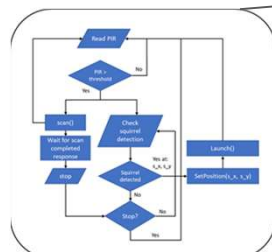
Find a pre-trained model similar to our goal

- Used "Tiny-Yolo", a small, pre-trained model that can detect a few objects like people, cats, and dogs.

Finish training the model

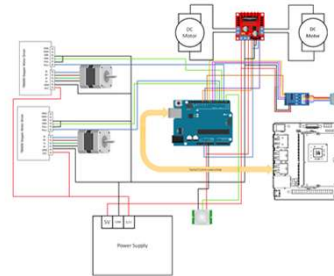
- Train our transferred network on the 600 annotated squirrel images.
- The final model and its weights are saved and ready to be used for detection.

System Architecture



Technical Details

Schematic



Software Libraries

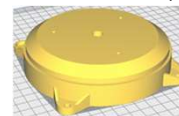
- Jetson SDK
- RPIO
- Python Programming
- Tensorflow
- Arduino IDE

CAD Modeling

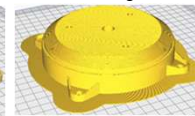
- Autodesk Inventor
- Gimbal design by Fhuable from Thingiverse
- Fritzing (schematic drawing tool)
- Cura

3D Printing

- # of parts: 27
- Total print time of successful prints: 167 hours
- Average print time of only successful prints: 6.3 hours
- Est. amount of plastic used: 1.4kg



Model of base Part



Sliced model with raft (25 hr print time)



Printed

Testing

Functional Testing Results

Passing = █ Failed = █ Mixed = █ No Test = █

Test ID	Subsystem				
	Targeting	Launching	Reeling	Vision	Power
S1	█	█	█	█	█
S2	█	█	█	█	█
S3	█	█	█	█	█
S4	█	█	█	█	█
S5	█	█	█	█	█
S6	█	█	█	█	█
H1	█	█	█	█	█
H2	█	█	█	█	█
H3	█	█	█	█	█
H4	█	█	█	█	█

Testing Breakdown				
Unit	Acceptance	Integration	Systems	Total Tests
20	8	8	4	40
50%	20%	20%	10%	100%

Testing Environment

- Code for Targeting and Launching System was tested in an indoor environment
- Tested on target arduino with motors attached.

Testing Strategy

- We used primarily unit testing to test our components
- Once integration is completed we will use integration, acceptance, and systems test to verify performance

Project Resources

Part	Quantity	Cost
Jetson	1	\$99
StepD-01	1	\$14.95
PI Camera	1	\$29.33
Nano Power Supply	1	\$7.50
SSD 64 GB	1	\$14.99
Nema 17 Steppers	2	\$27.98
DC Motors	2	\$13.78
L298N H-Bridge	1	\$5.99
TB6600 Driver	2	\$23.98
6" Power Cord	1	\$6.16
3D-printing plastic	2	\$40
Casing	1	\$15
Power Supply	1	\$20.77
Wiring	1	\$20
Arduino	1	\$15
Total		\$354

Citations

J. Redmon, S. Divvala, R. Girshick and A. Farhadi, "You Only Look Once: Unified, Real-Time Object Detection," 2016 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), Las Vegas, NV, 2016, pp. 779-788, doi: 10.1109/CVPR.2016.91.