Smart Squirrel Proof Bird Feeder

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Introduction

- Interactable bird feeder

- Actively repel squirrels and load food to birds

Objective

- Squirrels are enemies of backyard birders. Bird food stealer, cause damage to houses.

- Squirrels can hear ultrasound and use it as alarm call, but human and birds can't hear ultrasound.

- Increase the interaction between bird lovers and birds.

High-Level Requirements

- The bird feeder must perform real time object detection to distinguish squirrels and birds.

- The feeder machine must load reasonable amount of food to each bird.

- The repel system must be able to expel squirrels when the food is loaded for the birds. The system should at least significantly decrease the time that squirrels try to approach to the feeder.
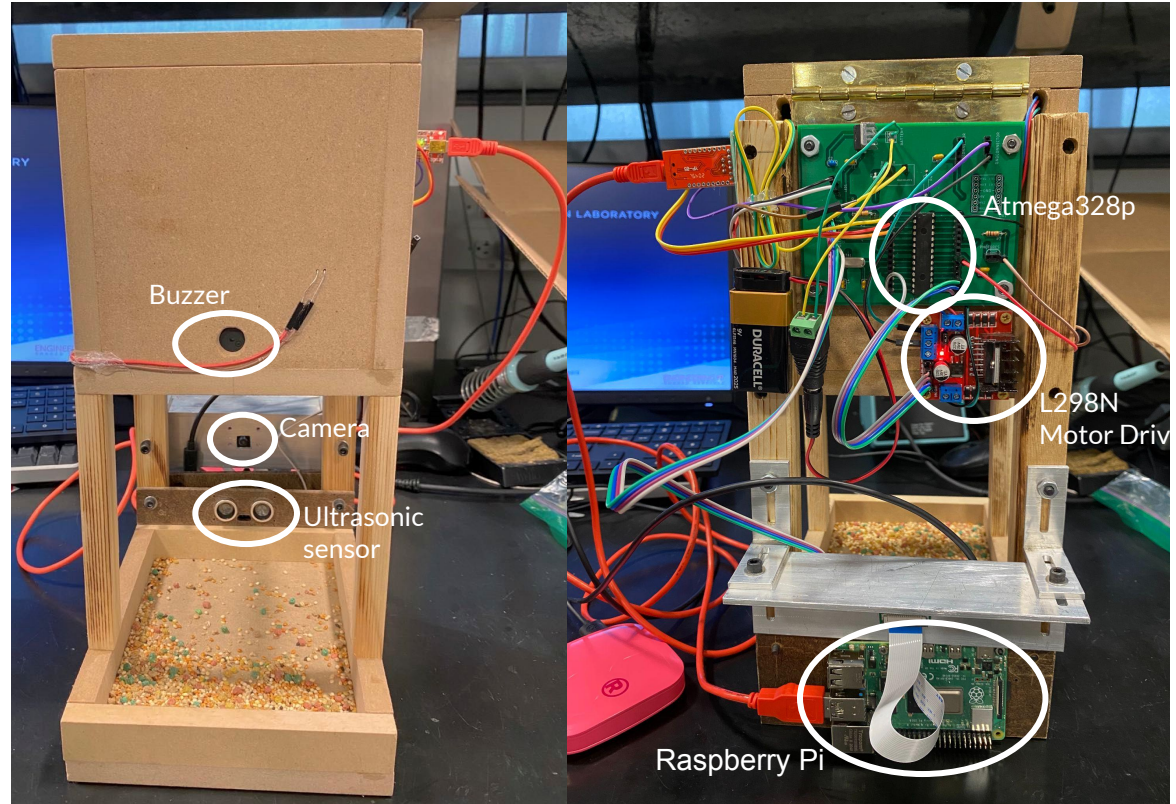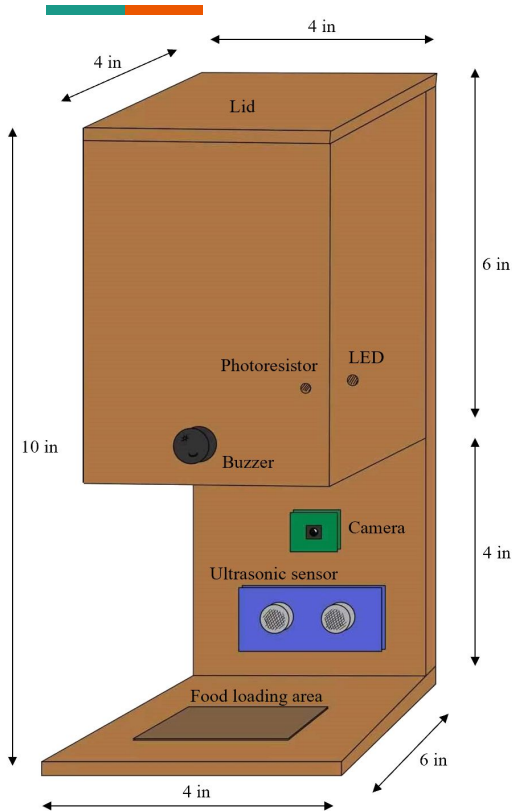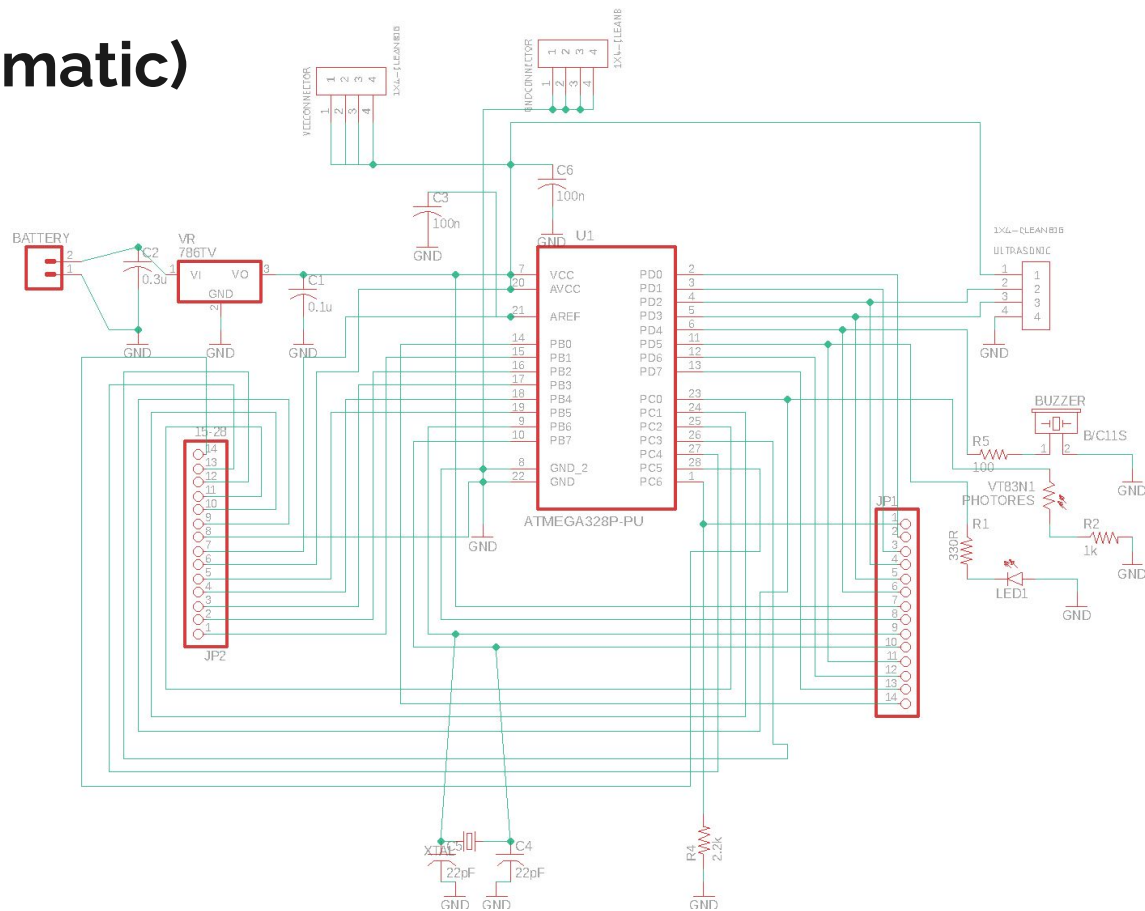
Block Diagram

Flowchart
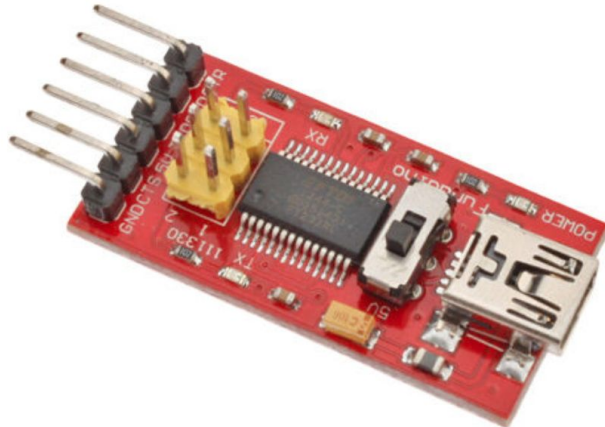
Design

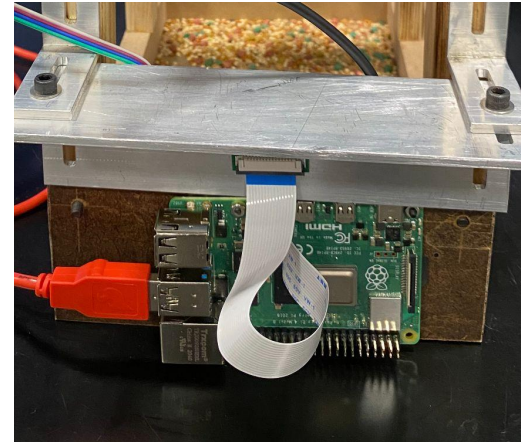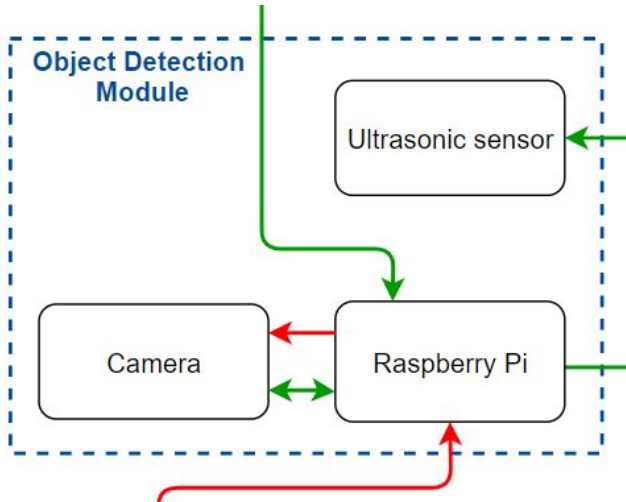# Design (Schematic)
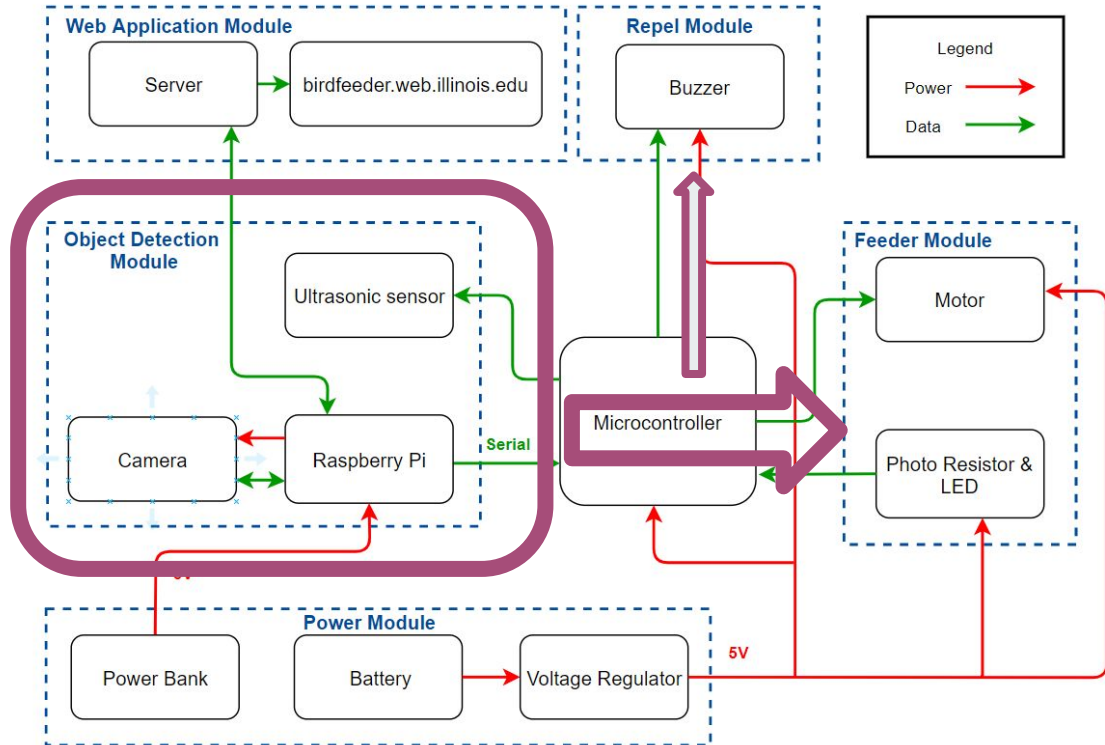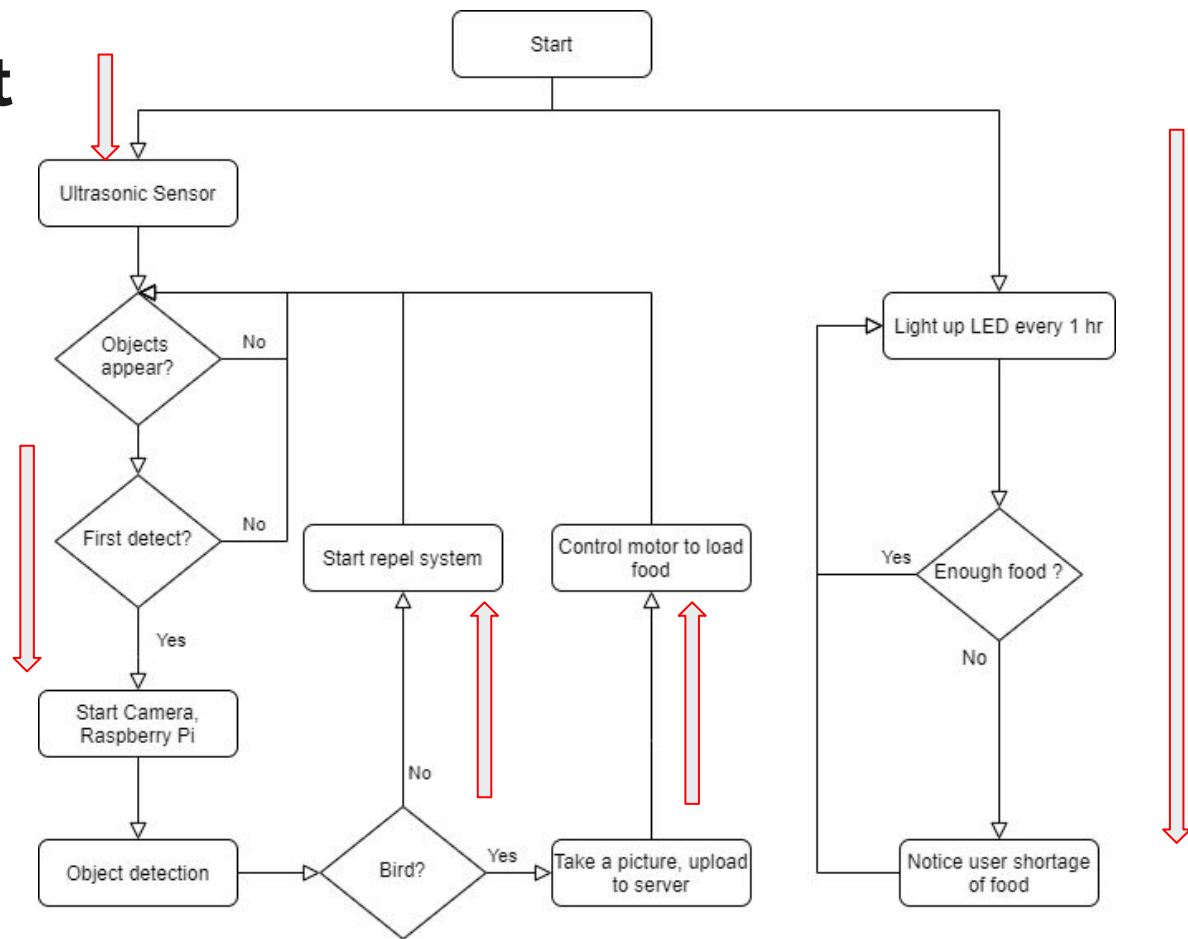
Control Module

- Serial communication between Atmega328p and Raspberry Pi

- Ultrasonic sensor detect---> Atmega328p sends signal to Pi

- Pi runs the object detection -->Pi sends result to Atmega328p

Object Detection Module

Distinguish Squirrels and birds in real time.

- Raspberry Pi 4 2GB
- Pi Camera
- Ultrasonic Sensor

Training Model

- Bird_Squirrel
- SSD mobilenet V2
- 400 images (birds and squirrels)
- 14000 steps
- mAP: 0.969 (0.50 IOU)

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Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.738
Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.970
Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.866
Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = -1.000
Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.500
Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.756
Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.744
Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.774
Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.789
Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = -1.000
Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.500
Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.806
INFO:tensorflow:Eval metrics at step 14000
I0502 17:39:57.868854  3232 model_lib_v2.py:975] Eval metrics at step 14000
INFO:tensorflow:        + DetectionBoxes_Precision/mAP: 0.737946
I0502 17:39:57.877852  3232 model_lib_v2.py:978]        + DetectionBoxes_Precision/mAP: 0.737946
INFO:tensorflow:        + DetectionBoxes_Precision/mAP@.50IOU: 0.969556
I0502 17:39:57.880851  3232 model_lib_v2.py:978]        + DetectionBoxes_Precision/mAP@.50IOU: 0.969556
INFO:tensorflow:        + DetectionBoxes_Precision/mAP@.75IOU: 0.865568
I0502 17:39:57.881854  3232 model_lib_v2.py:978]        + DetectionBoxes_Precision/mAP@.75IOU: 0.865568
INFO:tensorflow:        + DetectionBoxes_Precision/mAP (small): -1.000000
I0502 17:39:57.883854  3232 model_lib_v2.py:978]        + DetectionBoxes_Precision/mAP (small): -1.000000
INFO:tensorflow:        + DetectionBoxes_Precision/mAP (medium): 0.500000
I0502 17:39:57.885854  3232 model_lib_v2.py:978]        + DetectionBoxes_Precision/mAP (medium): 0.500000
INFO:tensorflow:        + DetectionBoxes_Precision/mAP (large): 0.755693
I0502 17:39:57.888857  3232 model_lib_v2.py:978]        + DetectionBoxes_Precision/mAP (large): 0.755693
INFO:tensorflow:        + DetectionBoxes_Recall/AR@1: 0.744048
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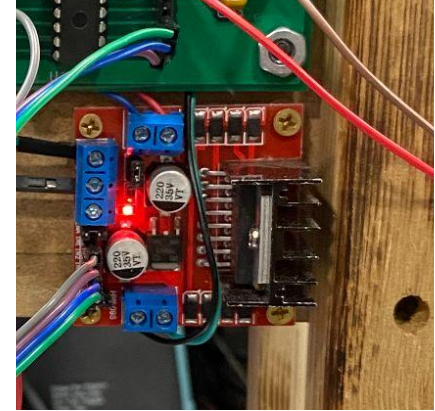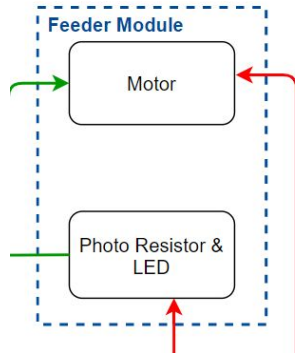Loss/total_loss
tag: Loss/total_loss

Model (tflite model)

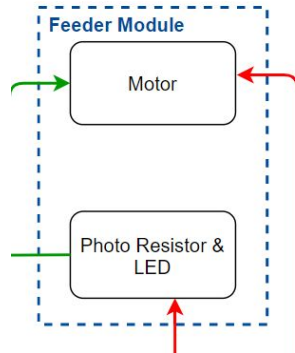| Model	Quantization	Time to process one image (s)	Accuracy (240 images)
Bird Squirrel	None	1.9	0.8958
Bird Squirrel	Dynamic Range Quantization	1.4	0.9
Bird Squirrel Raccoon	Full Integer Quantization	0.26	0.9167

Feeder Module

Food dispenser

- L298N motor driver
- Stepper motor
- Rotating fan-shape plate

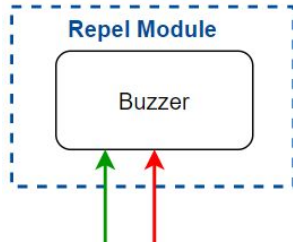# Feeder Module

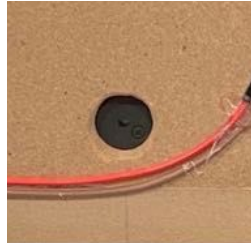Food storage detector

- LED
- Photoresistor

Repel Module

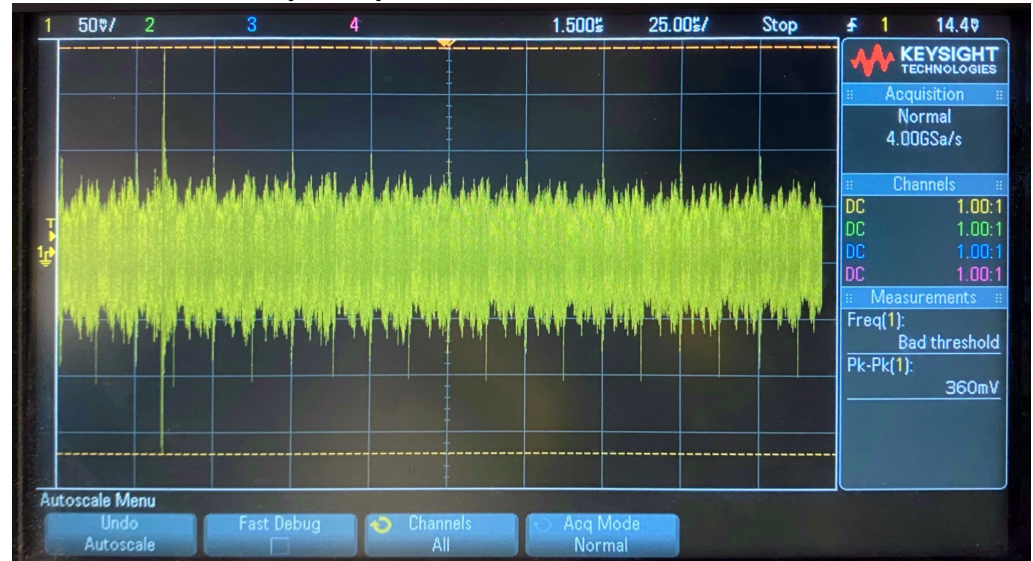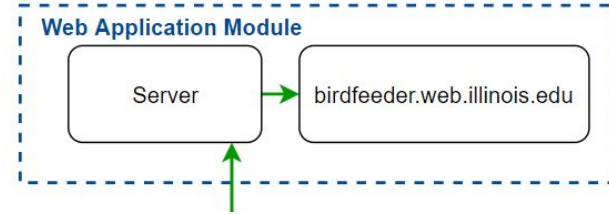Repelling squirrels by ultrasound

- Passive electromagnetic buzzer

Web App Module

Web Application Module

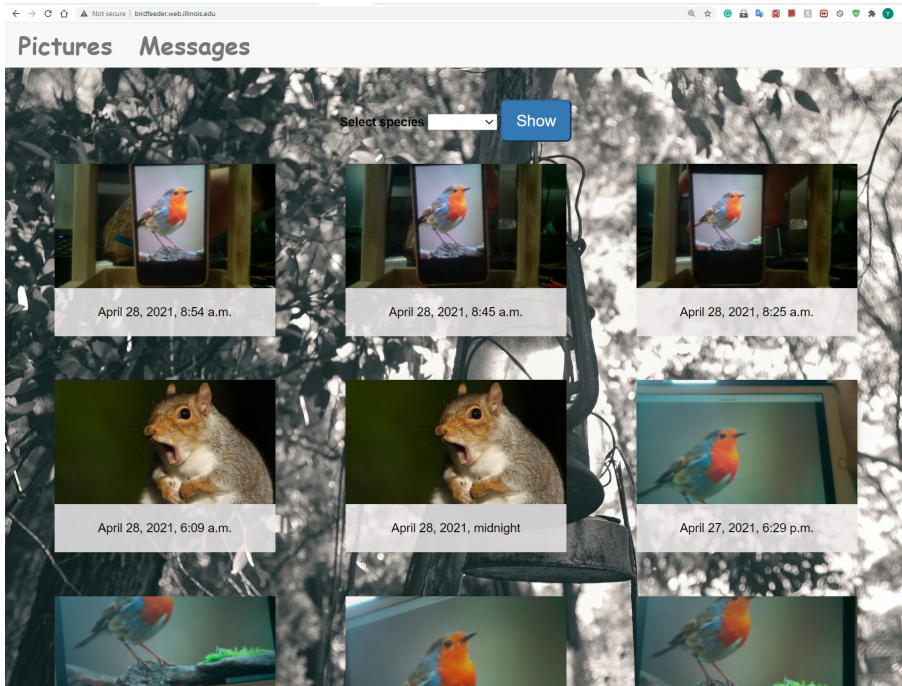Server → birdfeeder.web.illinois.edu
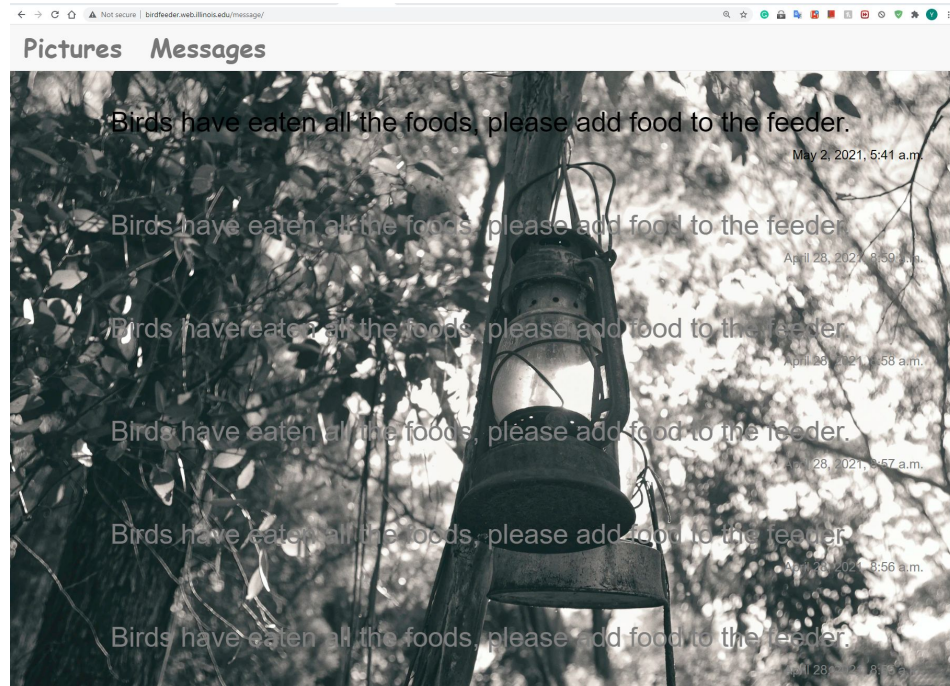
Imgur API, SSH access

cPanel, mySQL, django

Web App Module

Pictures

Messages

Power Module
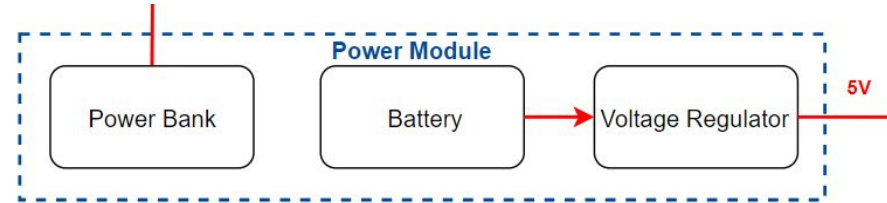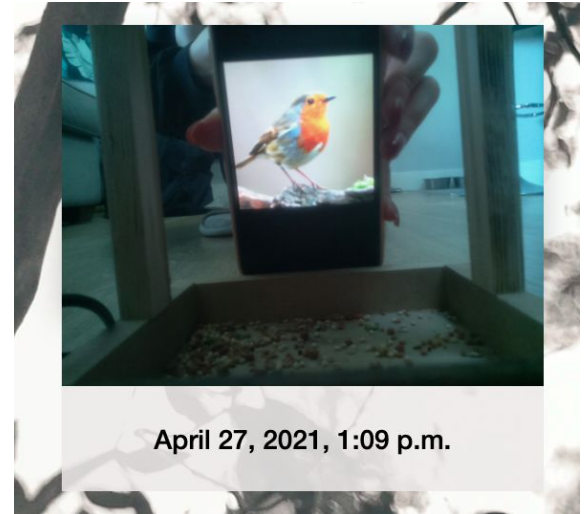

Power Module

- 30 hours for microcontroller based on 10 birds/hour

- Larger power bank for longer time running raspberry pi

Component	Operating Voltage	Operating Current
Ultrasonic Sensor	DC 5V	15 mA
LED	DC 5V	15 mA
Motor	DC 5V	~700 mA
Buzzer	DC 5V	~10 mA
Raspberry Pi	5V	500mA~1.2A
Total		1235mA~1935A

Video Demonstration

April 27, 2021, 1:09 p.m.

Future Work

- Test the repel module with real squirrels.

- Test the bird feeder outdoor.

- Try to lower the power cost.

- Add solar panel to the feeder.

- More functionality with raspberry pi (sleep mode, shutdown during night)