

Smart Squirrel Proof Bird Feeder

Project Proposal

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1 Introduction

1.1 Objective and Background

Squirrels are the “enemy” of backyard birders. Even though squirrels are cute, bird lovers detest them to appear in their gardens. They don’t just want to share the bird food, but they can take all of them. Their amazing athletic ability, voracious appetite and ability to chew through almost everything makes them unstoppable in the backyard. According to the National Pest Management Association, squirrels are considered to be pests. They are threats to the electrical wires and telephone lines outdoors. They can also invade into houses for food and warm shelters [1]. Bird feeders are one of the main food sources that attract squirrels to visit people’s backyard. The main goal of this project is to keep squirrels away from bird feeders and provide a peaceful and enjoyable environment in the backyards for the birders.

To solve this problem, we plan to build a smart bird feeder with a camera compatible as well as a smartphone application. The camera will first distinguish bird and squirrel by machine learning algorithm with pre-studied pictures. Other sensors such as pressure sensors can also be used to support the bird feeder to distinguish squirrels. After the identification, the feeder machine will either automatically load a reasonable amount of bird food based on its weight or prevent squirrels from stealing bird food. The feeders also have a repelling system to decrease squirrels’ interests to steal food. Researcher Jackson and his fellows from University of Toledo, Ohio, claimed in their study that their study objects, two fox squirrels have a hearing range between 113 Hz to 49 kHz at a level of 60 dB sound-pressure level [2]. Ultrasonic also works as an alarm call among squirrels by another study in University of Manitoba, Canada [3]. By comparison, human and birds have a similar hearing range. Both are most sensitive from 1 kHz to 4 kHz. Therefore, ultrasonic does not have any effect on birds. In addition, when the food is almost eaten up, the feeder will notify people to refill the food on the app. To please the backyard birders, we can also create an additional feature of taking birds’ pictures when birds are eating in front of the bird feeder.

Our solution is an innovation to the existing products, combining the smart squirrel bird feeder and innovation of squirrel proof techniques. The squirrel repellent bird feeders that sell currently passively prevent squirrels from taking the bird food, and squirrels are smart enough to beat the feeders. According to the youtuber Mark Rober, squirrels managed to overcome all the squirrel proof bird feeders he tested [4]. There are some effective squirrel proof bird feeders which have a lot of limitations. Our smart squirrel proof bird feeders design to actively provide food for only birds. The feeder also provides smart features such as taking pictures and notice.

1.2 High-level Requirements List

- The object detection module will first capture the image of bird and send it through the WiFi module to process via machine learning algorithm. Once it is identified, it will send back the signal to feeder system.
- The feeder machine needs to take the signal transmitted from object detection as input to decide either load the food or not. The mechanical switch will be triggered after receiving the signal of identifying as a bird and load reasonable amount of food.
- The repel system will generate ultrasonic waves that are above the audible frequency range, usually above 20,000 Hz, to repel squirrels.

2 Design

2.1 Block Diagram

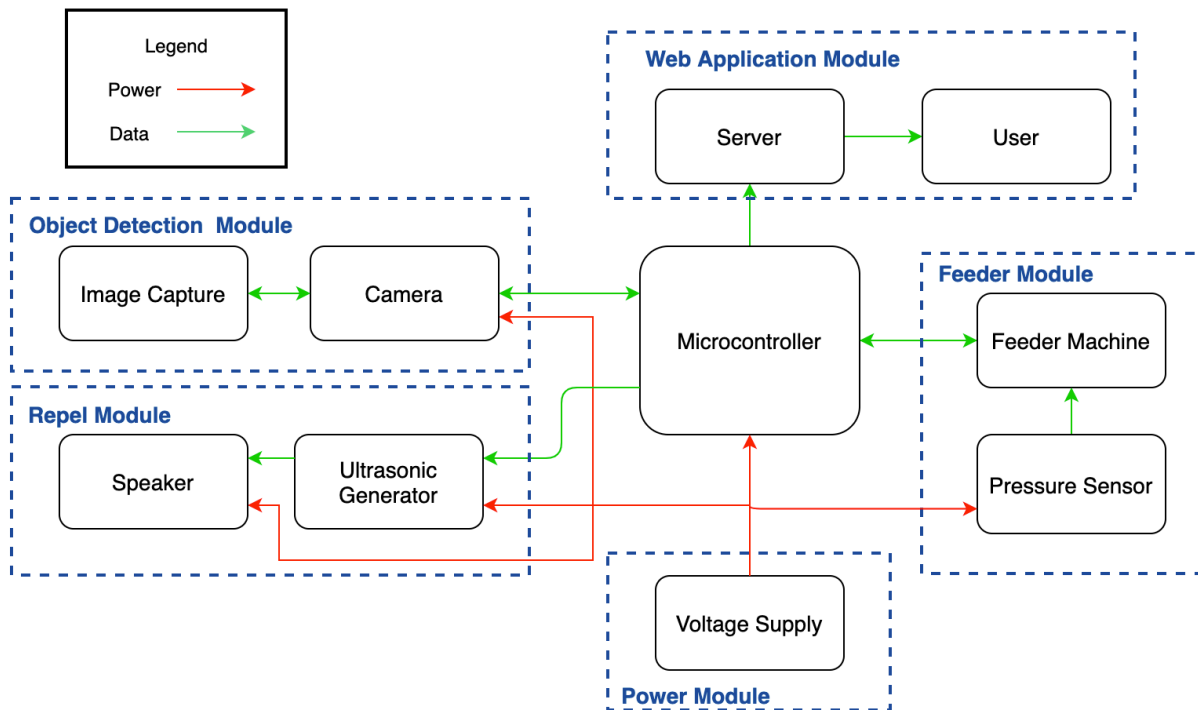


Figure 1: Bird Feeder Block Diagram

2.2 Function Overview

2.2.1 Repel Unit

- The repel module is implemented with a ultrasonic generator to generate ultrasound above 20,000 Hz to repel squirrels.

2.2.2 Object Detection Unit

- A Web camera is used to capture objects.

- Tensorflow Lite will be used to implement the deep learning models. Identifying squirrels and birds is rather a lightweight job, so Tensorflow Lite should be enough and runs faster than Tensorflow framework.

2.2.3 Web Application Unit

- The web application Unit contains a WIFI module that connect the hardware and the user interface.
- The web app works as a user interface of the bird feeder. The birds' pictures would store in the database and the notice of lack of bird food would also appear on the web app.

2.2.4 Feeder Unit

- The feeder module will take input signal from object detection module via microcontroller and decide to either load food or not through mechanical switches.
- The pressure sensor will be able to detect if the feeder need reload food and send the signal back to notify the user via web application module.

2.2.5 Power Unit

- AC/DC adaptor will be used to power the microcontroller and camera connected.
- There will be a 5V battery which will power the ultrasonic sensor and weight sensor for repelling squirrels and detect weight of food in feeder.

2.3 Risk Analysis

One of the most challenging part of this project is the repelling subsystem. Repelling module is the key to prevent squirrels from stealing birds food once the feeder loads food to birds. Our current plan is to use ultrasonic to repel squirrels. However, there is no research on how useful is the ultrasonic squirrel repellent device, since squirrels may eventually get used to the ultrasonic around the bird feeder. Thus, we plan to emit ultrasonic with various frequency discontinuously, for instance, use ultrasonic to keep squirrel away when birds are eating, or when the camera detects squirrels. Experiments on the repelling module are required to show how effective this feature is. The component is considered to be valuable if the number of squirrels appearing near the feeder decreases.

3 Ethics and Safety

There are several concerns to the safety and ethics in the project which need to be further addressed. For the safety concerns, improper ways of using and storing batteries can cause fire or explosion hazard. The damage may occur when the temperatures are too high (e.g., above 130°F) or too low (below freezing 32°F)[5]. The bird feeder, as an outdoor electrical device, could be damaged by the moisture in extreme weather which can lead to short-circuits. We are responsible for notifying the users of the potential consequences and send out the instruction and correct implementation for this product, which is complying with IEEE Code of Ethics[6].

For ethical issues, we will mainly focus on implementing the security for the web application module to ensure the privacy of users. We will keep the data confidential and reliable by avoiding illegal transmission of the data and clarifying the retention and disposal periods for the information[7].

References

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