Goose Chaperone

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Project Design

Introduction

Problem Statement

- Canadian geese nesting on private property
- Destroying property, harming humans

Our Tasks

- Build autonomous robot
- Oust geese from selected area

https://www.buzzfeed.com/sarahaspler/you-win-some-you-goose-some

Requirements

Functional

- Robot must have sensor(s) capable of recognizing geese
- Robot must be able to aggregate data from multiple sensors and act accordingly
- Robot must be capable of movement via motorized wheels

Non-Functional

- Software implementation platform-independent and scalable where possible
- Abide by relevant laws

Constraints

- Total cost of robot may not exceed $400

Similar Products

Goose Guardian

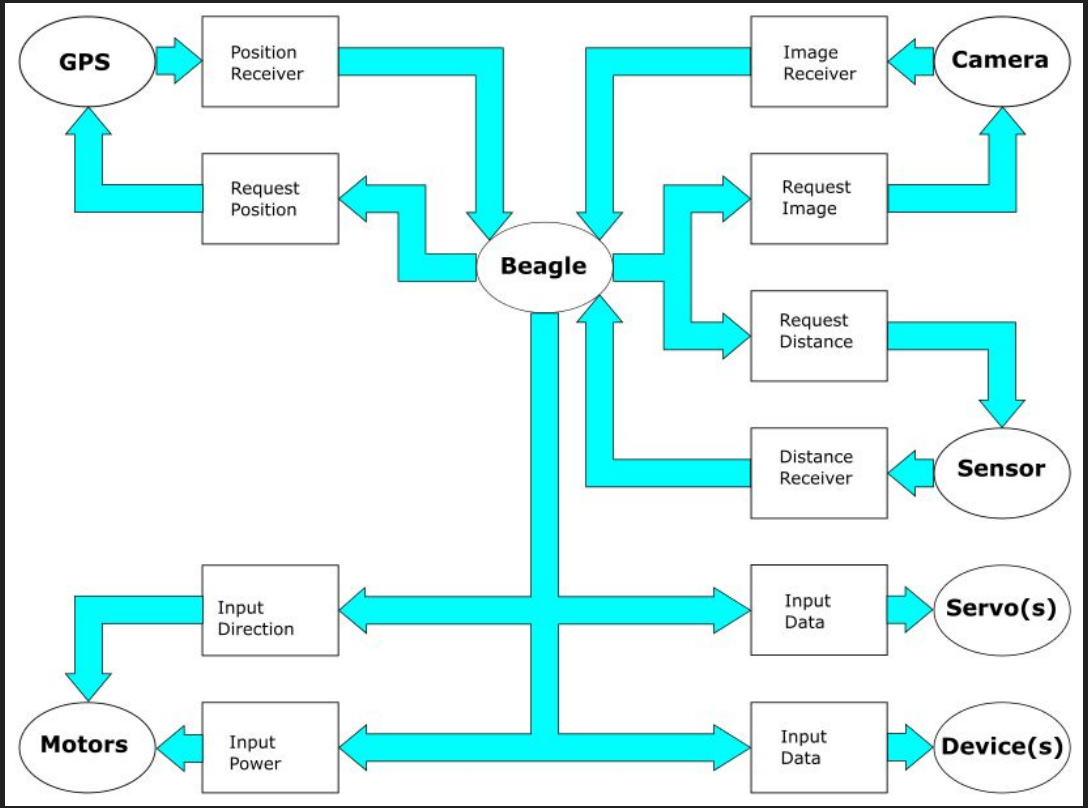
- Equipped with camera for goose recognition but does not move

SMP Bird Control Robots

- Very similar in functionality and design
    - Different models come with different deterences

System Components

Logical Relationships



Structural Integrity

Summary

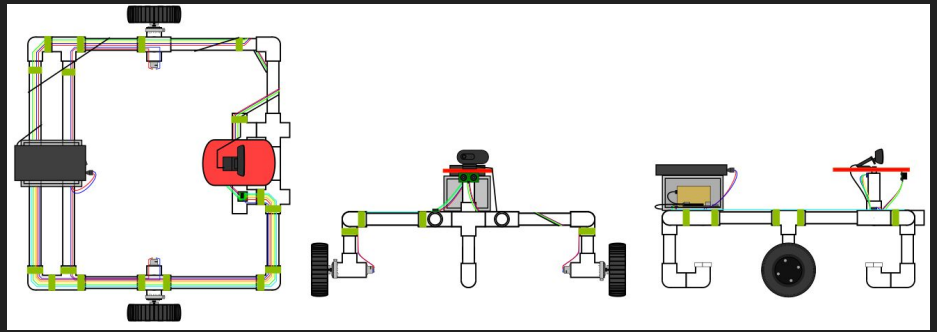
- PVC 1” solid core
- Platform for
  - Stepper Motor
  - Camera
  - Sensor
- Batteries and Controller
- Left and Right Wheels
- Elbow PVCs Balancer

Function

1. Durable/Resistant
2. Front View
3. Fewer Back Attack
4. Almost Perfect Rotations
5. Balance and Lesser Friction

Issues

- Exposed Wires
- Weak connectivity weaken certain components



Movement System

Summary

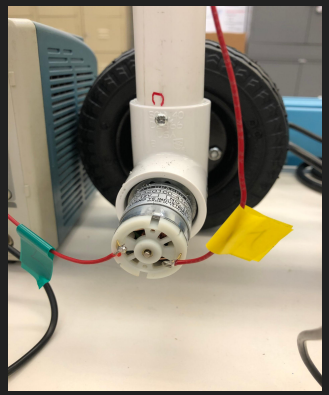
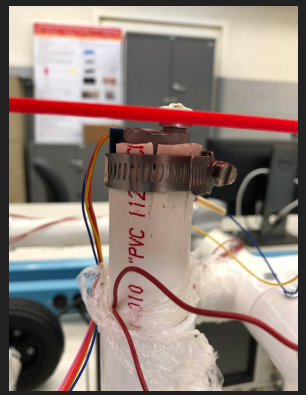
- Single 5V Stepper Motor
  - Hold Vision Platform
- Two 12V Brushed Motors
  - Wheel Operations
- 12.6V/3A Power Source

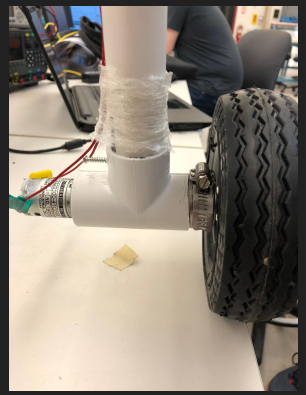
Function

1. Swivel camera, distance sensor left and right
2. Allow robot forward, reverse, and turning movement

Issues

- Brushed motors work, yet it cannot move model
  - Improper physical or electrical connection, motors too weak, faulty PWM chips


Distance Detection

Summary

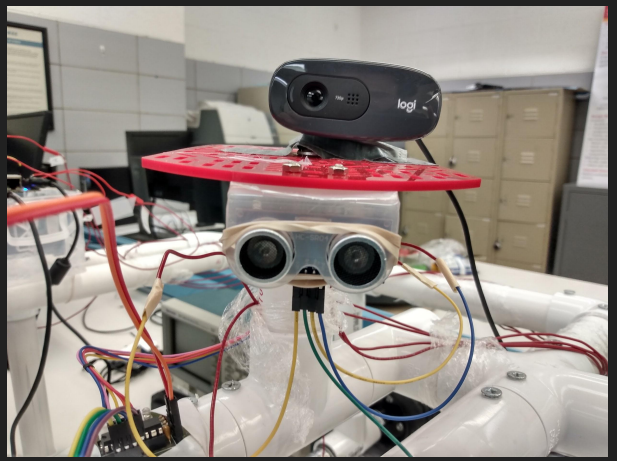
- Ultrasonic distance sensor
  - Object and distance detection
- Beaglebone as power source

Function

1. Warn bot's mainloop when approaching objects
2. Allow bot to move to a specified distance away from an object

Issues

- None



Vision System

Summary

- Logitech Camera
- Tensorflow and OpenCV
  - Tensorflow identifies targets
  - OpenCV controls camera and visualizes detections during testing
- Swiveled by stepper motor
- Captures and analyzes around 10 images per second

Function

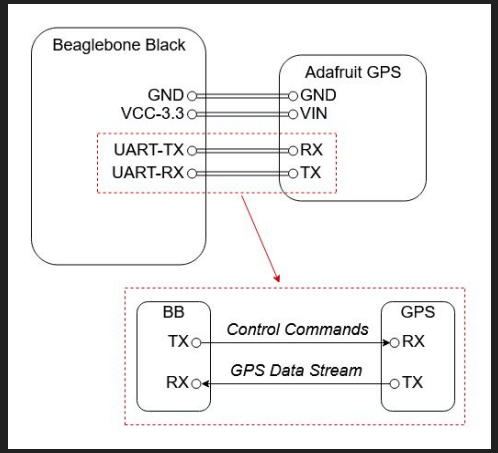
1. Primary: Geese detection
2. Secondary: People detection
3. Rotation for wider coverage
4. Provide detection results for bot logic

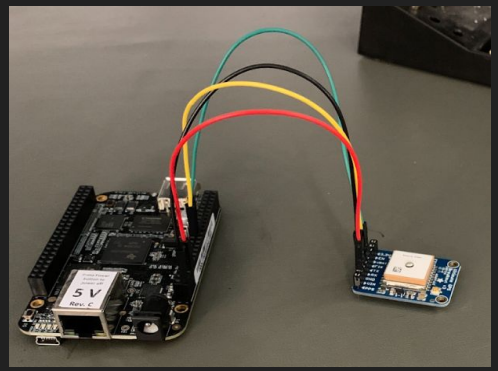
Issues

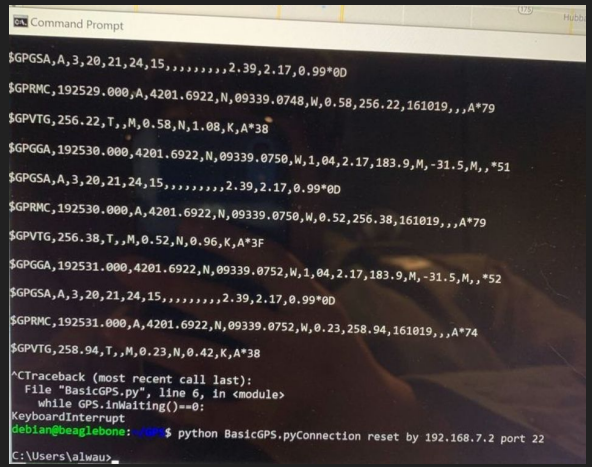
- Currently only supports goose and human detection in code, does not reliably detect sand traps and water hazards

Navigational System

- GPS Module- Adafruit Breakout GPS
  - Low power, 10 HZ updates.
- Python Script
  - Gets raw data from GPS module
  - Data is sent through UART on Beaglebone
  - Data is then parsed for use in program
- Issues
  - GPS can only get a fix outside
  - Insufficient time to combine with main program



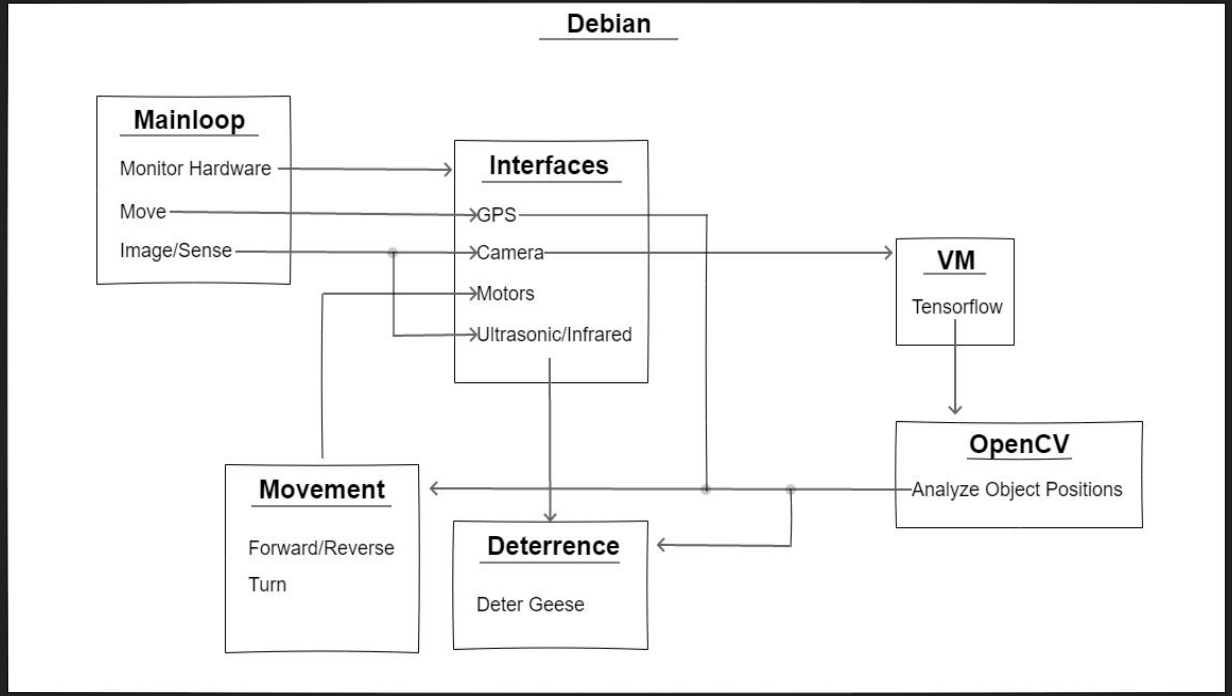




Above Right: Diagram of GPS connection to board.
***Right*:** Raw data from GPS before it's parsed for relevance.
Left: Photo of GPS Module connection.

Software

Software Relationships



Driver Implementation

Adafruit_BBIO

- Preferred over native Bonescript + Node.js
- Exposes GPIO, PWM, UART, etc. to Python

Design Patterns

- Singleton
- Object-oriented

Decoupled Configurations

- Initializes functions

Tensorflow

- Developed by Google Brain Team
- Used for creating and executing deep neural networks

Image Processing

- Easiest method is to use existing trained model
- Different architectures provide different costs and benefeits
- We used SSD_MobilenetV1 originally trained on the COCO set
- Models retrained via feeding large tagged image sets and undergoing regression training

```
Humans: 2 | Geese 0
Human : 0.7126725
Human : 0.63643134
Goose : 0.61423206
Humans: 2 | Geese 1
Goose : 0.6951252
Human : 0.5403131
Human : 0.5283611
Human : 0.5094879
Humans: 3 | Geese 1
Goose : 0.6687057
Humans: 0 | Geese 1
Goose : 0.58644223
Human : 0.50393367
Humans: 1 | Geese 1
Goose : 0.71345943
Humans: 0 | Geese 1
Goose : 0.6673095
Humans: 0 | Geese 1
Goose : 0.6975125
Goose : 0.5992429
Humans: 0 | Geese 2
Goose : 0.62237763
Human : 0.5789455
Humans: 1 | Geese 1
```

Bot’s Mainloop Logic

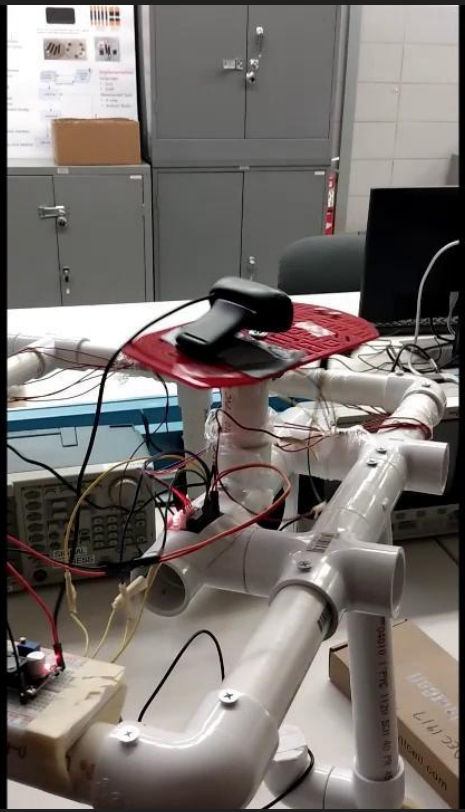
Detection

- Shrink and feed image through tensorflow
- Filter results to return detection classes of humans and geese
- Data contains confidence percentage of detections and bounding box coordinates

Roaming

1) Scan each direction via swivelling the stepper motor
2) If target found, charge towards target
3) Otherwise, continue along route

Demo



Conclusion

Project Successes

- Successful component testing with proper compatibility to Beaglebone
- Created working Tensorflow model that can classify geese and humans
- Built usable chassis from scratch
- Knowledge gained on previously unexplored topics
- Laid groundwork if project picked up by senior design group in the future

Project Issue and Challenges

- Desire to find “perfect” solution led to short-sightedness on ease of development
- Long planning period reduced overall development and testing time
- Late assembly did not allow enough time to diagnose and fix motor problem
- Single microcontroller slowed development

Question?