Goose Chaperone

PROJECT PLAN

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List of Definitions

Autonomous: Denoting or performed by a device capable of operating without direct human control.

Scare Tactics: Ways to achieve a particular result by frightening animals/people to do what you want them to.

Terrestrial: Of or on dry land.

Infrared: Wave spectrum longer than visible light, used to gauge temperatures.

Microcontroller: A board used in systems to control processes such as movement and power.

1 Introductory Material

1.1 Acknowledgement

The Goose Chaperone Project team would like to begin this plan by giving our regards to the College of Electrical and Computer Engineering for giving engineering students a great opportunity to create a project while also ensuring our readiness for our prospective careers. We would also like to take this opportunity to thank Dr. Randall Geiger for not only advising us through the design process, but also for being our client and providing the financial backing necessary to create our project.

1.2 Problem Statement

Across North America, golfers, pilots, and homeowners all face a similar pest: *Branta canadensis*. That is, the Canada goose. Whether they are nesting in front lawns, attacking golfers on the greens, or even destroying millions of dollars worth of aviation equipment on the runway, one thing is certain - the current methods of goose prevention are not sufficient.

For this reason, our group has been tasked with finding a way to effectively keep geese out of areas in which our potential clients do not want them. This project will be centered around a autonomous “robot” that will utilize scare tactics of various shapes and sizes in order to accomplish this goal.

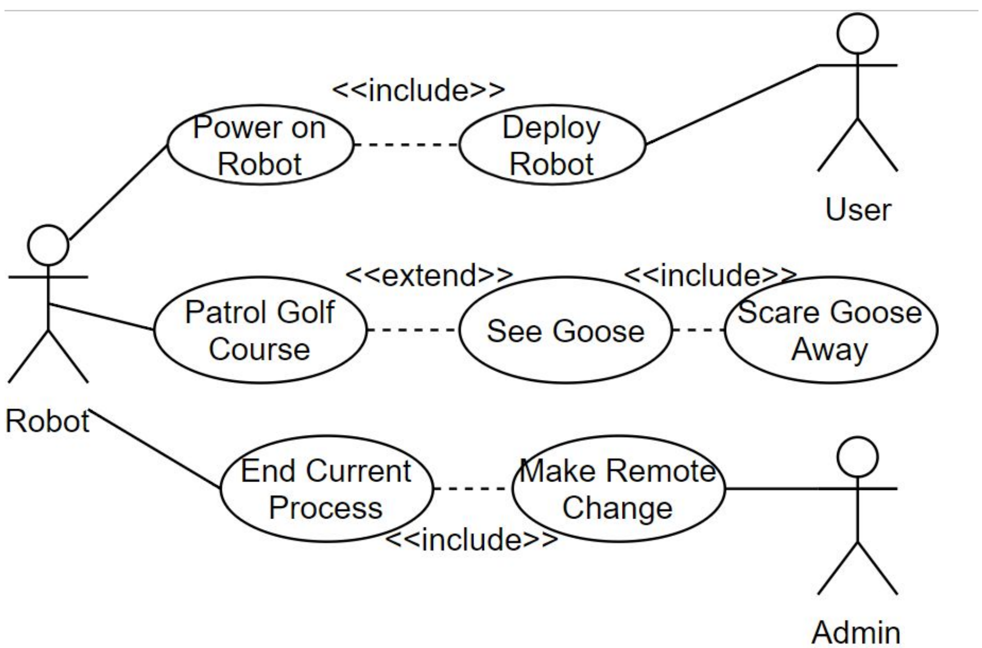

Figure I: Use Case Diagram

1.3 Operating Environment

While the project will have the ability to work in almost any terrestrial environment, we are initially limiting the scope to just a golf course in Ames. Given the often unpredictable weather in Iowa, we will need to keep in mind both hot and cold temperatures, as well as the constant threat of precipitation and take measures to ensure the safety of our robot.

1.4 Intended Users and Intended Uses

Given the project's nature with an autonomous robot, there will not be many use cases that are not centered around the robot itself. Because of this, we will have to be careful when defining users and use cases to ensure a good design.

We have identified a handful of users that are necessary for the project. They are listed below along with their use cases:

- User - Golf course owner/ employee who will need to deploy robot.
- Robot - Or created robot that will scare and chase geese, patrol, and scan areas.
- Admin - A member of our team that can make remote changes.

1.5 Assumptions and Limitations

Assumptions:

- Materials necessary for the project will be able to be ordered in a timely manner.
- A GPS module will allow for accurate movement within a couple of meters.
- The initial unit will be used only on a golf course.
- Geese will be scared by the methods chosen to frighten them.
- Geese will continuously be scared by said methods.
- The software library chosen will be sufficient to recognize geese.
- The robot will be able to move at speeds greater than 3 MPH.
- The robot's battery will last more than 30 minutes (in use).

Limitations:

- The amount of memory on the microcontroller is expected to be low (< 1 GB), so we will need to use it wisely
- Processing power will also be relatively low, so applications should not be too demanding.
- Overall costs may not exceed $400.
- No AC motors will be used, only direct current.
- No internet access will be used by the robot.
- Project must be completed by December 2019.

1.6 Expected End Product and Other Deliverables

The final delivered project will be a fully-functioning autonomous robot that is able to scare geese away using a number of on-board scare tactics.

The robot will be accompanied by a charging cable that will be used by clients to charge the unit's battery in between uses.

The unit will also be accompanied by a user manual that further describes the robot's autonomous process and how to get the robot up and running.

The estimated delivery date for the completed robot will be the end of the fall semester, in December of 2019.

2 Proposed Approach and Statement of Work

2.1 Objective of the Task

The purpose of this project is to investigate, design, and build a functioning robot and software to fulfill the primary task of controlling goose population on golf courses.

2.2 Functional Requirements

The product must meet several requirements involving both software and hardware, including their ability to integrate and function cooperatively.

Physically, the machine must be capable of movement by means of motorized wheels. They must be able to carry the robot reliably, and efficiently in terms of energy consumption. Additionally, they must be damaging to the course.

Additional motor requirements include an actuator of some form to be used in startling and/or moving geese away from certain areas.

A functioning logic board must be integrated and programmed to process data from sensors including GPS, optical sensors (camera), ultrasonic, and infrared. This data then must be used to drive the hardware components.

The sensors applied must be capable of recognizing geese from periodically captured images, and determine the distance and orientation of the robot in relation to identified targets. Sensors must also be capable of notifying the logic board of obstacles and hazards.

2.3 Constraints Considerations

There are several physical and legal constraints to be taken into consideration when developing this system.

As this is designed to be an autonomous robot, and will largely be active outdoors, considerations including is safety from hazards and weather are important. Additionally, as the machine may have to operate for long periods of time without external power, all devices must be energy efficient, and used only as needed.

A constraint worth noting is that the algorithm used to process images and make real-time decisions requires quite a large amount of both processing power and flash memory. This eliminated the possibility of using several popular boards, namely those manufactured by Texas Instruments.

There is one notable legal constraint, article 481A.38 of Iowa legislation titled "The Migratory Bird Treaty Act of 1918". As geese are protected under this act, the product must follow certain constraints. The machine may not harm the birds, nor drive them away from expanding into new territory. The machine may not target nests, and will have limited options to keep them out of particular areas without violating the code.

When writing code, the primary focus is on functionality and efficiency. All potential libraries have licensing taken into consideration to avoid legal conflicts. Data collected, notably from images taken that may include guests on the golf course, may be collected for image recognition training purposes only. There appears to be no conflict of ethics listed by either the IEEE or ACM.

The methods of moving geese may have some perceived, but legal, ethical conflicts in certain possible methods. Of these methods, some potential ethical concerns may arise from sonic or optical attacks, or from discomfort through use of sprays or chemicals.

2.3.1 Standards

There are several standards applicable to our project listed below. It will also be important to standardize code syntax for uniformity and clarity and interfaces for easy to use communication protocols between components.

- IEEE 1008-1987: Standard for Software Unit Testing
  - *Description* - This standard is about unit testing of software or firmware systems. It describes methods with which unit testing should be carried out and how. The standard helps developers to write useful, relevant unit tests to ensure the functionality is true to its intended use.
  - *Application* - The software written to fulfill project requirements will need testing to prove the functionality of software units. Writing units tests based on the standard will lend to consistency across tests and validation of testing methods.
- IEEE 1625-2004: Standard for Rechargeable Batteries for Portable Computing
  - *Description* - This standard provides a framework for the creation of lithium-ion and lithium-ion polymer batteries. This includes the standardization of interfaces between batteries and their consumers. This standard helps assure reliable power to portable computing systems.

- *Application* - Since one of our deliverables is a mobile computing system we will need ‘mobile’ power. Lithium-ion batteries fit the bill perfectly and a knowledge of their design and how to interface with them will be necessary.

2.4 Previous Work And Literature

There are a handful of similar products, including those developed by SMP Robotics ("SMP Robotics Systems Corp." 2016). Of their products, applications include partially and fully autonomous rovers, attached with cameras and application specific hardware. For instance, there are several robots in a line of products that are designed to scare away pest birds. Another offers acts as a stand in for a patrol officer, and drives around designated paths.

Similar to our design, we are also planning on adopting a rover-esque design. We intend to include a camera and some method to discourage geese for inhabiting places meant for human presence. However, some specific methods that differ from ours, depending on the model, include means of discouragement such as a human safe laser scanner, and focused propane power sonic blasts.

These robots do not appear to be fully autonomous in all models. Additionally, it seems that the tires on the devices are primarily for easier relocation of the otherwise stationary devices. Our design is to allow the robot to rome in search of targets, instead of merely securing a single area. Primarily, this is planned to be accomplished through use of GPS and programmed markers.

2.5 Proposed Design

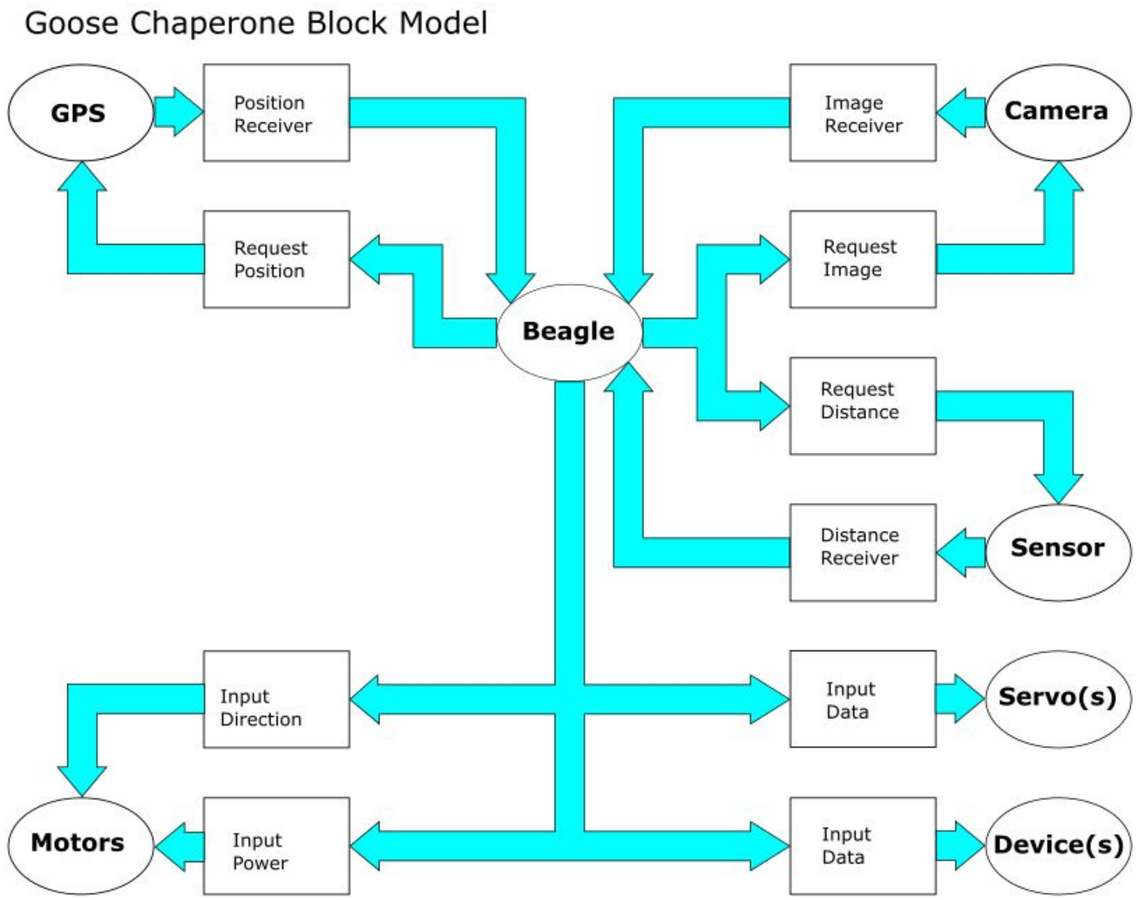

Figure II: Block diagram

The block diagram in Figure 2 shows the basic function of the product. The Beagle will request and receive image from camera, sensor, and GPS. It will send data to control the movements of servos, motors, and devices.

Currently, we propose a fairly simple design. A motor power chassis with lightweight structural materials added to increase the perceived size of the device will be integrated with a low-power microcontroller. Several sensors, including a camera, infrared and ultrasonic sensor, and a GPS unit will be connected to the controller. An additional motorized 'arm' will be affixed in order to actuate a physical deterrent.

Alternative designs discussed included changes to the wheels, chassis, and microcontroller.

Substituting the wheels for continuous track, similar to those found on tanks or large farming equipment, may aid in maneuverability, especially if stuck on an obstacle or hazard, such as a sand pit or steep hill. Additionally, to aid in friction reduction, it may be beneficial to limit the device to two wheels, and provide structural support with minimal surface area for balance.

A power controller may be beneficial in allowing more complex decision making by software, and reduce the limitation imposed by traditional prototyping controllers. Energy consumption will increase with this decision. This could be offset by a well controlled usage of resources, keeping processing use low until a target has been identified. In particular, a series of one-shot operations for movement and scanning/processing interleaving may conserve power and increase the reliability of the sensors.

2.6 Technology Considerations

The availability of powerful and efficient motors and computation alone make this a viable project. The combination of electric movement, GPS navigation, and microcontroller computation allow, in design, a full fulfillment of technological requirements necessary.

Motors are an absolute requirement for this project. Premade assemblies exist in an affordable range. However, these are consume a fair amount of energy, and will be in frequent use.

The microcontroller is similar to the aforementioned motors. However, there are more flexible alternatives in terms of capability and power consumption.

As the robot must be able to navigate around the property, current design includes a GPS unit to guide the machine. While GPS is generally reliable, there is the drawback that it introduces a critical source of failure; if for some reason the GPS unit malfunctions, the device may be forced to stop operation, as it may have to way to return to its base.

Alternatives to GPS include training the image recognition set to also include visual cues on location, and adapt the location of these cues into a pre-programmed map. This way, the robot may periodically scan its environment, and adjust its internal model of its location.

2.7 Safety Considerations

There are safety concerns list below:

- unbalance power distribution may burn the robot
- robot may fall down during movement
- threaten technique failures cause damage to people or environment.
- fail to scare geese away may cause geese fight back and damage to robot

2.8 Task Approach

To approach the task, the first thing to do is generate ideas and do design thinking. Design thinking helps us to develop the possibility of a project. Then research these ideas and choose the applicable ideas implement on prototype. Next, construct the prototype and run tests to check functions. If tests fail, then fix errors and step back to improve the prototype. If tests are successful, we continue to improve.

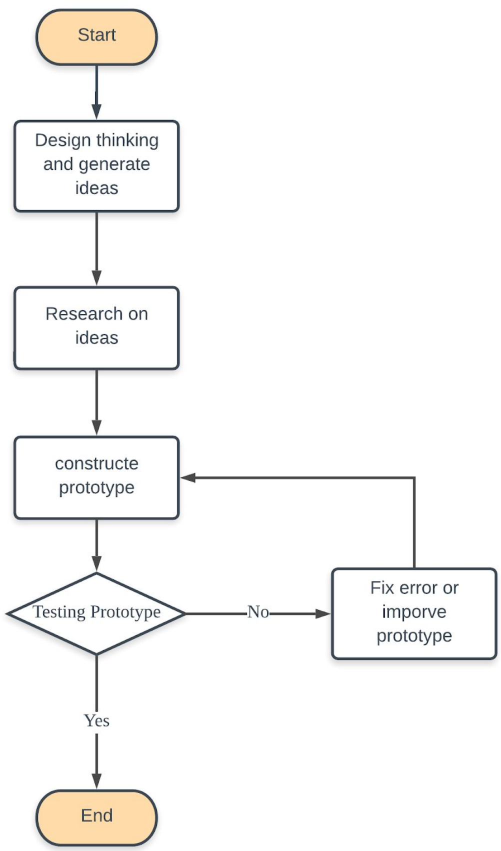

Figure III: **Task process diagram**

2.9 Possible Risks And Risk Management

For now, we are planning and doing research. The first concern that would slow us down is that cost of the robot may over the budget. This includes cost of motor, pre-built motor and chassis assembly, wireless control, GPS, sensors etc. The second concern would be that each component may not communicate very well. For example, the sensors may need more memory and the Beagle may not have that much to support the sensors.

2.10 Project Proposed Milestones and Evaluation Criteria

There are 3 milestones of our project. we built up our robot and power it on is our first milestone. it make it work we need run test to check robot status and each function of the robot. then let robot contact with geese, identify and scare geese away successfully is the second milestone. we may run many test to see what could our robot do to confirm these function works. the last milestone would be the robot comes back to charge battery. to comfire it works we could do test that pur robot awat from charge station and let robot comes back.

2.11 Project Tracking Procedures

We have a website and a list of task of the week, we usually tracking our process on that website. For weekly meetings with client, we will discuss what we have done and what problems we have in this week and set tasks to solve problem or develop project for the next week.

2.12 Expected Results and Validation

For our project, we need to build a robot that could scare geese away on the golf course. Then we may consider about how the robot could work on snow or ice. We may have many designs corresponding to different conditions. We may have multiple designs for different requirements and it is depends on how much time we left after we finished the first prototype.

2.13 Test Plan

A list of tests needed to be done are below:

- Robot motor test
- Microcontrollers test
- Analog sensors test
- Image processing test
- Data flow test
- Prototype test
- Compatibility test
- GPS test
- Navigation test
- Scare technical test
- Goose identity test
- Robot movement test
- Safety test

3 Project Timeline, Estimated Resources, and Challenges

3.1 Project Timeline

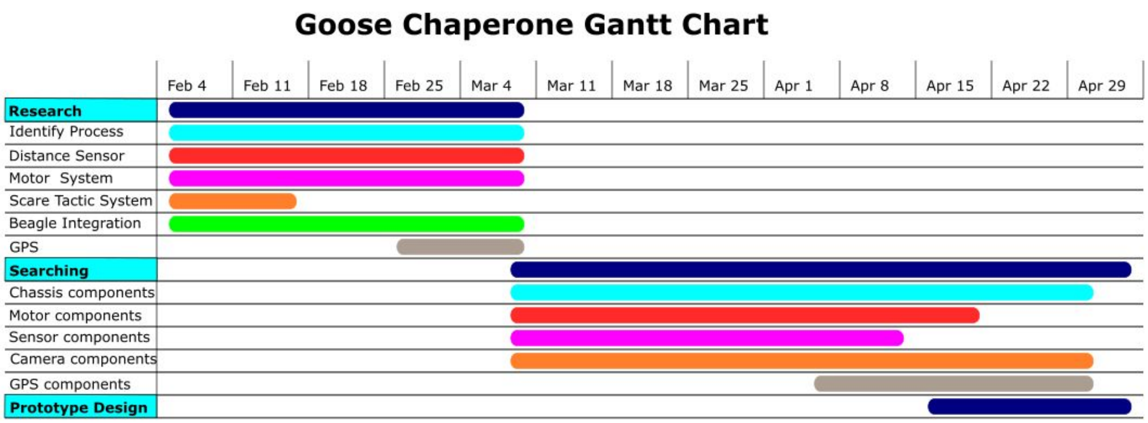

Figure IV: Gantt chart Semester 1

Within the first semester, our team did not start due to lack of contact with our client for a few weeks. As shown in figure 4, our first task was to do researching. Our second task was to look for the cheapest and best material. Due to some wrong material, our search was extended. For the final two weeks, we begin creating prototype designs for our project.

3.2 Feasibility Assessment

The project will be an in depth exploration of a new idea for animal deterrence from areas of interest. This means no final product is necessarily expected. Research on animal deterrence via robots, the advantages and disadvantages of different methods, and a semi-working prototype on what we argue the best options to be are the deliverables.

Possible challenges are legal and practical. Geese are protected animals under law and it is prohibited to impede their ability to nest within their habitat. With the robot we will be operating in somewhat of a gray area. The robot will not travel into geese's habitats but stop them from expanding into new areas. The law containing this clause is also from the 1800s so the enforceability is unknown. A practical concern is how the robot will interact, directly or indirectly, with humans in its areas of operation. If operating on a golf course noises may disturb golfers or some may attempt to move or interfere with the robot. If the robot uses a spray as deterrence it may affect humans caught within the effective radius. The robot will also potentially be used in a diverse group of environments; therefore, the deterrence method needs to be generalized well enough to work across all of them.

3.3 Personnel Effort Requirements

A comprehensive listing of tasks for this project are presented in chronological order in Table 1.

- Each major component for the robot will be researched approximately 30 hours. This gives time for several different options to be explored.
- There are few legal caveats with geese protection outside hunting and lethal intervention methods. 15 hours is most likely an overestimate of how much time will be spent dealing with the legality of this project.
- It will not take long to compile research results for presentation to the team. Team members should complete this in an hour or two. Deliberation of which options best suit our project may take longer.
- Reading component documentation helps familiarize team members with the intricacies of the components. This step is also necessary to ensure components are compatible. Each component will take approximately four hours to complete this task for a total of 20 hours.
- Ordering the parts is a trivial task. Finding a good vendor to order from may take several hours.
- Testing individual components is a check on its working status and how it functions. Components will be tested separate before combining them together in the prototyping stage. This will take 10 hours per component.
- Prototyping encompasses hooking components together, testing the behavior of the robot, and making refinements. Team members will spend 8 hours per week for 15 weeks resulting in 600 hours combined time.
- Weekly reporting takes 30 minutes per week for eight months, give or take a few weeks, resulting in approximately 20 hours.
- Documentation involves the creation and revision of documents, such as this project plan. It is estimated this will take a hundred hours of work between team members over the course of the project.
- Creating, practicing, and performing presentations is estimated to take a little under one hundred hours over the course of the project.

Table I: Projected time requirements

Projected Tasks	**Projected Time to Complete (hrs)**
Research robotics platforms	30
Research microcontrollers	30
Research sensors	30
Research image processing software	30

Research legal complications	15
Compile research results; Decide which parts in each category fit project best	15
Read part documentation	20
Order parts	2
Initial part functionality testing	40
Prototyping	600
Weekly reporting	20
Documentation compilation	100
Presentations	75

3.4 Other Resource Requirements

A robotics platform consisting of a chassis and wheels, a microcontroller, and sensors are required to construct the robot. Connectors will be needed to interface the components together. Plastic or light metal will likely be used to construct a protective hull for the robot and any other attached appendages.

3.5 Financial Requirements

Table II outlines initial cost estimates for the project.

Table II: Project cost estimates

Component	**Cost Estimate**
Robotics Platform	$100
Microcontroller	Less than $50
Sensors	Less than $100
Extra Material	Less than $100

This puts us within our tentative budget of $400.

4 Closure Materials

4.1 Conclusion

Geese are a nuisance and potential danger to golfers, pilots, and homeowners. Removing geese without harming the animal or yourself is challenging and possibly expensive. Our team is exploring the idea of using robots to deter geese from occupying areas of land. The goal is to come up with a working prototype which is cost effective and easy to use.

This document establishes the steps our team will take to achieve the goal for the project listed above. Steps are categorized into four main groups: preliminary research, construction of software, physical prototyping, and testing and refinement. Successfully following and completing each of these groups will lead our team to a functioning solution.

4.2 References

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4.3 Appendices