Garden Guardian Proposal

Aleah Gacek, Claire McGrath, Nick Hartmann

Team 7

University of Illinois Urbana-Champaign

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Introduction

1.1 Problem

A widespread problem when it comes to owning a garden is protecting your garden. People spend countless hours working hard to produce a healthy and fruitful garden. They invest in highest quality soil, pesticides, and seeds to produce the best garden that they can. But even with the most elite equipment, gardens are still prone to being attacked and destroyed by animals in nature.

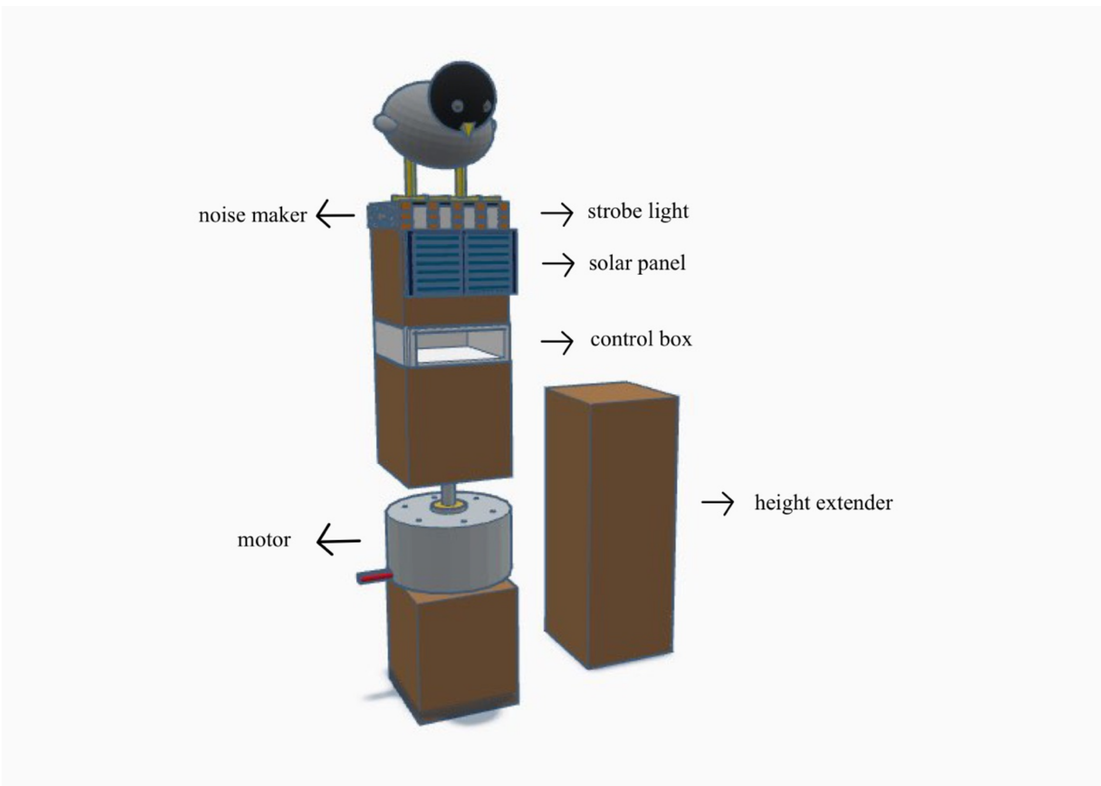
An easy solution to this problem is to surround one's garden with a fence. While effective in preventing some animals from damage, it is not effective in keeping out all animals based on varying size and abilities in terms of travel over, though, or under fences. Another solution is to use different pesticides and traps throughout one's garden. With this approach, while protecting the garden in some ways, introduction of these pesticides and traps into nature toxically harms animals and the garden itself. Also, the cost is high to continually repurchase and reapply pesticides to be an effective deterrent against animals. Our strategy is one that is low-cost, effective, and does not cause negative harm to the environment, wildlife, or one's garden.

1.2 Solution

Our solution is to create a device that will identify, locate, and deter all animals that approach a person's garden. This device will be easily mobile and can be placed anywhere in one's garden so that any approaching animal will be spotted. The device will then turn toward the detected animal and make a loud, alarming noise during the day or a strobe-like light at night to deter the animal. The reason we chose to use noise during the day and a light at night is that we did not see the light as very effective during the day due to the sun being out and we did not want noise going off at night to disrupt any neighbors.

This device is very beneficial towards garden owners, because it is very easy to move and set up anywhere in one's garden. The device will be height adjustable and have a bird on the top to be able to 'blend in' with the garden. The owners can change the device to change the render distance and height. Our goal is to create a device that everyone can place in their garden and adjust to their own preference to match their needs and keep out all animals.

1.3 Visual Aid



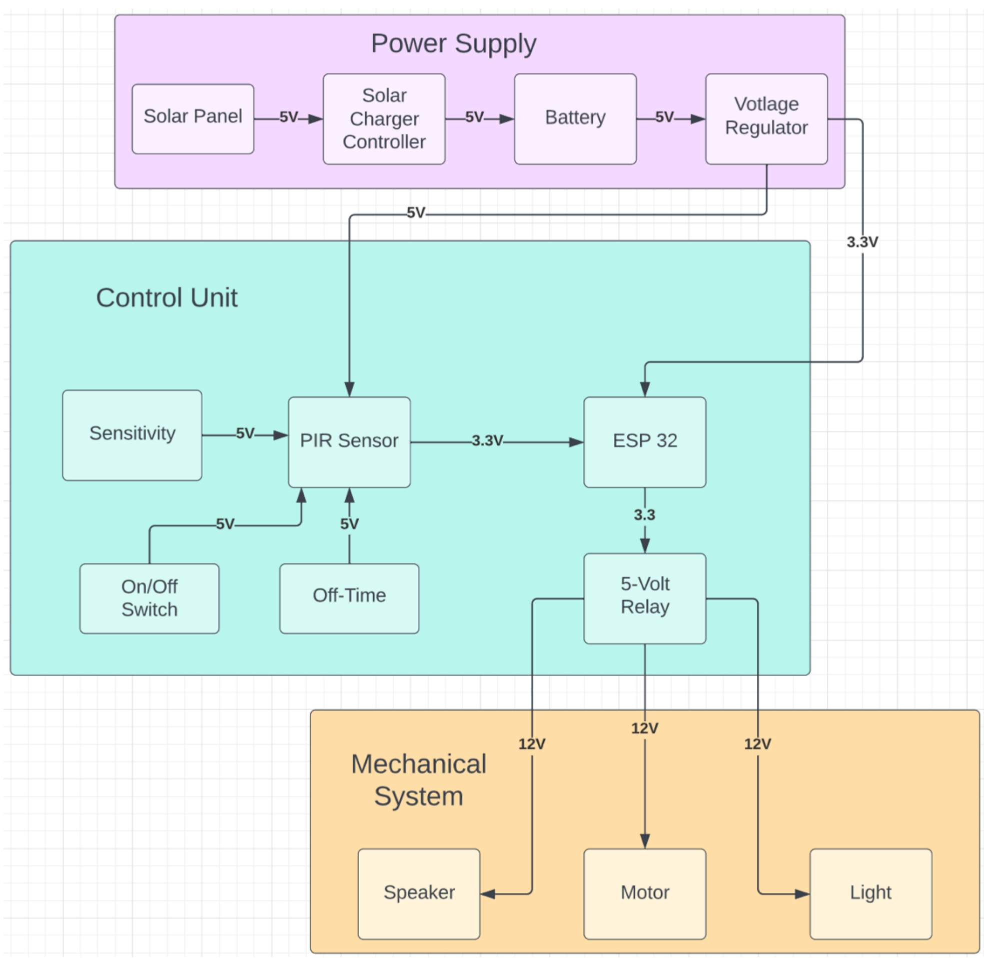
1.4 High Level Requirements

1. Device can detect motion up to seven meters away and then send a signal to turn on the noise/light deterrent.

2. Device determines where the motion is coming from and rotates the noise/light deterrent towards the movement.
3. Solar panel can power the device and all its needs without an external power source at five volts.

Design

2.1 Block Diagram



2.2 Subsystem Overview

2.2.1 Power Supply

For the power subsystem, there are 4 main components to it. The components are a solar panel, a solar charge controller, a battery, and a voltage regulator. The power system begins with the solar panel generating electricity and sending this through a solar charge controller. This will help regulate the amount of voltage and amperage that is sent to the loads. The next step is the battery that will store excess energy to use overnight when the solar panel is not able to generate electricity. The solar needs to be able to completely power all components of the device. Because of this, the solar panel will be able to generate six watts to be used for the whole device. The power sent from here is then sent to a voltage regulator that is like the solar charge controller where it regulates the amount of voltage and amperage that is sent to the rest of the components of the device that need to be powered.

2.2.2 Control Unit

The control unit has 5 main components: PIR sensor, microcontroller, sensitivity, off time, and 5-volt relay. All humans and animals emit infrared radiation. PIR sensors use pyroelectric sensors to detect heat energy in an environment. Multiple sensors will be by each other and if there is a difference in heat signal from one sensor to the other, the sensor will read high. This high signal will go to the microcontroller. The microcontroller will be programmed to determine if it is daytime or nighttime to send out light or noise. It will also be programmed to turn the device toward the detected motion. From the microcontroller, the signal will relay to a 5-volt relay. This way, the signal will be increased to a higher voltage that can power the necessary items of the mechanical system. The sensitivity sensor is a sensor that can be adjusted to change the distance of which the PIR sensor can detect motion. The bigger the garden, the higher the sensitivity needs to be. The off-time sensor is also adjustable. This sensor leaves the signal from the PIR sensor and microcontroller too high for an additional amount of time after the PIR sensor has stopped detected motion. This way the flashing lights/noise goes on for a couple extra seconds after the animal has been eluded.

2.2.3 Mechanical System

The three components of the mechanical system are the strobe-light, noise producer, and the stepper motor. The strobe-light and noise producer both receive signals from the 5-volt relay to turn on both devices when needed. The stepper motor is a programmable motor that will be able turn the top of the device a full 360 degrees toward the motion.

2.2.4 External System

Some of the components of the external system are the PCB that we create and the on/off switch. When the garden owner wants to work on the garden, the owner will flip the on/off switch on the device to turn off the PIR sensor. This way the device's owner can work in the garden without the PIR sensor going off. After finishing up working on the garden, the owner can flip the switch back on for the device to be activated again.

2.3 Tolerance Analysis

The power supply system for our project needs to be carefully designed to ensure stable voltage regulation for all its subsystems. There are a couple considerations when using a linear voltage regulator: the dropout voltage and the thermal performance. The dropout voltage ($V_{dropout}$) is the minimum voltage between the input and output required for the regulator to operate. One example from our design is that we are inputting 5 V to the voltage regulator and want to output 3.3 V to the microcontroller. We should take our maximum input to be 4.8 V to account for the maximum amount of ripple. In this case, $V_{dropout}$ must be greater than or equal to

1.5 V. The thermal concerns can be addressed by determining the power dissipation (P_D). If too much power is dissipated, then the regulator will overheat. We can calculate the power dissipated using the expression $P_D = i_{out} * (v_{in} - v_{out})$. To find i_{out}, we must perform ohms law on the thermal circuit. Using the simple thermal circuit from the wiki page, we can solve ohms law and find that the junction temperature, $T_j = i_{out} * (v_{in} - v_{out})(\theta_{jc} + \theta_{ca}) + T_a$.

Variable	**Value**	**Comment**
Maximum Operating Temperature (T_j)	125 ºC	From LM317 datasheet
Ambient Temperature (T_a)	38 ºC	Assuming warm board as they did in the example on the wiki
i_{out}	171 mA	Maximum current drawn from 3.3 V components
v_{in}	4.8 V	Assuming input voltage to be 5 V, choose 4.8 V to account for ripple
v_{out}	3.3 V	Desired output
Junction-to-Case Thermal Resistance (θ_{jc})	4.2 ºC/W	From LM317 datasheet
Case-to-Ambient Thermal Resistance (θ_{ca})	50 ºC/W	From LM317 datasheet

With these selected values, we can solve for the junction temperature, T_j = 51.9 ºC which is less than the maximum operating temperature of 125 ºC, so our linear voltage regulator should operate correctly for our design.

2.4 Ethics and Safety

Our project presents minimal safety concerns. The primary safety consideration revolves around the solar panel. Given its continuous activity, there is a potential risk of electrical shock that demands careful handling and adherence to safety protocols. Furthermore, our use of a motor introduces another safety consideration, as there is a potential risk of being pinched during its operation. Attentiveness in these areas, alongside strict adherence to safety guidelines, will ensure the overall safety of our project. While completing this project, we will strive to uphold the IEEE Code of Ethics and use it as our framework in maintaining ethical standards. Since our project aims to assist the public with a task, we will be mainly upholding the IEEE Code of Ethics [1] to ensure the safety of those using our product as well as the surrounding environment.

References

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