UNIVERSITEIT TWENTE.

SMART ENVIRONMENTS PROJECT

DOCUMENTATION REPORT

Bird Deterrent Box (BDB)

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Chapter 0: Introduction

With thousands to millions of people traveling throughout the streets, filling restaurants and filing shelves in massive skyscrapers. Cities are the quintessential hub of human activity. However even if we built them, we are not its only inhabitants. From big to small every city is expected to at least be populated by some wildlife. They could be rats training in the sewers, to birds perched on concrete trees animals of all sorts can be found walking alongside us. However, being animals they do not abide by the same rules we do. Birds in particular have been notorious litterers as their main way of gaining food is by feasting in our trash[25].

Even though it might seem comical at first, this behavior actually results in a variety of issues for us and them. Attempting to ingest trash is dangerous due to how some of it might be hazardous. While birds have an uncanny ability to regurgitate what they can't digest, sharp objects and large ones could easily pierce the body or choke them out. Trash feeding has actually been one of the leading causes to bird population decline[21]. We as the **Avian Seer Society** feel that it is important to address this issue under our topic of wildlife motivation. While birds feed on a variety of trash locations, we chose the trash bin as our object of interest. Birds feeding on trash bins are more of an issue as they cause littering in human surrounded environments. Modifying it so it can detect when a bird approaches and activating deterrents is the solution that we have agreed upon. Our research has shown that birds are negatively affected by bright lights and loud sounds which we can easily attach to trash bins. We feel that if we place these smart trash cans around areas where birds commonly feast at, we could have a sustainable deterrent solution.

Chapter 1: Literature Review

. A Technical Guide for Monitoring Wildlife Habitat [1]

This publication centers itself on providing protocols specifically tailored to monitoring wildlife, albeit in their natural habitat or a controlled environment. It serves as a technical guide for creating a scientific process in which to inventory and monitor, this is mainly taken from the monitoring done by the U.S. Department of Agriculture and the Forest Service.

This takes into consideration problems such as: monitoring human disturbances or effects of climate change. After all of the protocols the publication extends to how to use the data acquired with such protocols in mapping as well as creating their own models of data.

There's a clear distinction between flora and fauna but the publication mainly focuses on the monitoring of vegetation as well as the overall structure of the habitats in which they reside. Lastly there is an analysis regarding the landscape in which this vegetation resides and how this may affect monitoring and the retrieval of data.

II. Annual Report on Surveillance for Avian Influenza in Poultry and Wild Birds in Member States of the European Union in 2021 [2]

A publication reporting the findings of European Union members monitoring of avian influenza in poultry and wild birds. In overall, 24,290 poultry establishments were sampled, of which 27 were seropositive for influenza A(H5) and 4 for A(H7) viruses. This was done in order to monitor the spread of these kinds of disease to make sure that this is contained and not a threat to humans living near these areas.

III. Scientific Opinion on Bluetongue Monitoring and Surveillance [3]

The Panel on Animal Health and Welfare was asked to deliver a Scientific Opinion on the expected prevalence (design prevalence) under different circumstances, and an updated scientific assessment of the size of the relevant geographical

area for the purpose of monitoring and surveillance programmes for bluetongue. This was mainly done for estimating the impact of interventions on the prevalence of infected animals, as well as for establishing freedom from infection, smaller areas result in lower design prevalence for a region as a whole and take better account of local differences in infection dynamics on the bluetongue virus

IV. A plan for the North American Bat Monitoring Program (NABat) [4]

Using 4 different techniques to monitor bats in North America.

1. Winter Hibernaculum Counts
2. Maternity Colony Counts
3. Mobile Acoustic Surveys
4. Acoustic Surveys at Stationary Points.

They want to count the bats as they sleep during hibernation, Thanks to the stable climate inside caves it will make it easy to count. Done by either average amount of bats in area, or individual count.

For the bats that don't form colonies there will be an acoustic survey/ mist netting. Mist netting has many drawbacks, and would not be feasible for large scale surveillance like in NABat. Though it is useful for collecting data on whether or not bats are there at all.

For acoustic surveys, two approaches will be used; Stationary and mobile transects. Stationary points will be placed across a landscape, while mobile transects are cars with acoustic collectors on the top of the roof, driven at night.

Mobile transects have several advantages and disadvantages compared to point surveys. They're more costly, but they provide a better insight into how many bats there are as it is better at picking up individuals rather than a general noise floor. This is thanks to the fact that bats usually don't travel faster than 32 Km/h. They're also easier to implement in privately owned land, and are quick to set up. Stationery however removes the road biases of some species of bats who like to congregate near roads, and they're easier to control for factors that may affect call quality and quantity.

V. Wildlife Monitoring Across Multiple Spatial Scales Using Grid-Based Sampling [5]

Sampling noninvasively (DNA, through hair and feces) to monitor wildlife. It's inexpensive, reliable and unambiguous. Through genetic patterns you can infer various other data than just species identification. It also requires a relatively small sample to infer this data.

Linking this to vegetational data will further deepen the knowledge about the wildlife. using statistical WHR and genetic monitoring, together with plot data, spectral DEM, climate, and Censuses. This is then a multiscale monitoring system, using various different factors.

In using landscape data you need to look at what can influence species population, like movement corridors, barriers. But since these are difficult to fully monitor, you can also look at DNA to inspect how and where they breed, which will tell you about their movement pattern.

VI. Wildlife Habitats in Managed Forests (1979) [6]

The forests were one of America's last remaining natural habitats for terrestrial wildlife. Thanks to timber harvesting and roadbuilding, the wildlife habitat has been altered completely. There were several federal laws and legislation that have been set forth to manage and help wildlife.

Specifically set for the blue mountains, and Oregon forests, but can be taken in use for any coniferous forests.

The paper has three purposes:

1. develop a common understanding for resource specialists about wildlife in managed forests.
2. provide a system, for which to predict impact of forest management
3. to show that the system can be applied to specific cases in the aforementioned territories.

The biggest hindrance for advancement of a coordinated ise program was failure to imaginatively use preexisting knowledge of forest wildlife needs.

There are several guides about different terrain and timbre:

1. Plant Communities and Successional Stages
2. Riparian Zones

   the most important type of wildlife habitat in the blue mountains.
3. Edges
4. Snags / dead trees

   tagging birds being especially highlighted
5. Dead and Down Woody material
6. Cliffs, Talus, and Caves
7. Deer and Elk
8. Silvicultural Options

VII. Implementing Practical Methods to Estimate Population Density of Wild Boar and Other Wild Mammals [7]

The report proposes camera traps as means of estimating wild boar population density. They propose the use of REM (Random Encounter Model), wherein you set up camera traps and wait for random encounters, then use a predetermined function to estimate the population based on the data received through the camera traps..

The publication also goes through various variables that can affect the effectiveness of the camera trap, like detection angle, radius, and other environmental factors that should be taken into consideration when placing traps.

VIII. Monkeypox Risk Assessment [8]

This report details the risk monkeypox poses to multiple groups of countries. It focuses on how monkeypox spreads through underdeveloped nations such as those in Africa, and tries to model how an outbreak would occur in the EU regions.

It first details how monkeypox is spread through human to animal contact and then to human-to-human contact through sexual acts. Mammalian pets are of primary focus as they are at high risk of contracting monkeypox. Finally the study outlines what are the necessary responses when one has contracted monkeypox.

IX. Scientific review on Tuberculosis in wildlife in the EU [9]

This paper aims to create a scientific review regarding the current state of tuberculosis disease among animals. It has conclusions for a wide array of animals alongside a possible way to combat the spread of tuberculosis. Animals in the bovine category for example have been shown to almost eliminate tuberculosis among their population. This is most likely due to the stricter testing and quality control of cattle.

Wild boars are a type of animal highly susceptible to tuberculosis. This is due to their constant intermingling between different groups and their likelihood to spread in large areas. Researchers have undergone multiple methods to try and combat tuberculosis in animals. The most promising method is to inject our livestock with vaccines that can decrease the risk of an infection.

X. Next Generation DNA Library of Freshwater Species [10]

Across the EU there are multiple ongoing projects that all aim to increase the genomic database of freshwater species. This report is a funding call to combine all these separate sources of data into one large and cohesive DNA library of the freshwater species in EU borders. More specifically this report tries to argue for a digital E-library for all of the data.

The report outlines several interesting disciplines related to freshwater observation. They address usages of, genomics, marine biology, ecology, big data analysis and machine learning that all aim to

expand your knowledge of the species inside our freshwaters. Furthermore they reference existing databases that collect information of other marine data as evidence for its efficacy.

XI. Development of protocols to inventory or monitor wildlife, fish, or rare plants [11]

In order to maintain the safety and health of the ecosystems we monitor, certain guidelines have been put in place. This paper serves as a guidelines to base these protocols on.They provide certain criteria that needs to be upheld before monitoring nature.They include specifying the area of interest and its surrounding biome, including listing the wildlife of interest that are to be monitored. Furthermore one should include ways of how monitoring an environment could affect its natural wildlife.

XII. Analysis of wild ungulate-livestock interface in Europe: preliminary results [12]

One of the essential elements of evaluating the risk for shared diseases between wild ungulates and livestock across Europe is evaluating their spatial interface. The ENETWILD consortium (www.enetwild.com) aims to do just that by representing the richness of the species, their specific occupancy and abundance and the spatial overlapping across Europe. About 90% of the continent is home to a few groups of wild native ungulates. Consequently, the interface between wild animals and livestock is common. Most widely seen are the native wild boar and the roe and reed deer. The richness of ungulate species is highest in Central Europe.
To summarize, livestock husbandry, landscape uses and wildlife management are all huge factors in influencing the interface between wild and domestic ungulates. However, most of these factors are operating locally, so there is a need for a better look of the interface at continental scale.

XIII. Spatial spread and maintenance of foot-and-mouth disease virus infections in wildlife populations of Thrace region applying epidemiological modeling [13]

Wildlife disease epidemiology is not well enough understood. Consequently, this limits the management responses required for mitigation. EFSA (AHAW) put out a request for the spread and maintenance of foot-and-mouth disease (FMD) to be assessed using a model. The selected region was the segment of the Bulgarian-Turkish border in the Thrace region. Combining rule-based representation of ecological details on host species and epidemiological evidence on FMD virus a structured computer model was developed. A seasonal increased chance of virus fade-out was the outcome, due to FMDV being strongly dependent on temperature plus the host's particular reproduction pattern. The end result indicated that the sustainability of FMDV will be weak for a long time, however, spread may occur.

XIV. Precision Wildlife Monitoring using unmanned Aerial vehicles [14]

This article describes a study that demonstrates the use of UAVs (unmanned aerial vehicles) for wildlife monitoring in polar and tropical habitats. It also indicates that UAV-derived counts of colony breeding birds are a great deal more accurate than conventional ground counts. Many wildlife monitoring initiatives that rely on population counts will probably switch from conventional methods to UAV technology as a result of the higher count precision provided by UAVs and their capacity to survey difficult-to-reach species and areas. A method for figuring out the number of duplicated (concurrent UAV and ground counts)is suggested as sampling points required to guarantee data compatibility. Careful consideration will be required to ensure the coherence of old data sets with new UAV-derived data.

XV. Using wildlife indicators to facilitate wildlife monitoring in hunter-self monitoring schemes [15]

According to this study, it was determined if wildlife indicators may be useful for wildlife monitoring under such schemes because they could eliminate the need for hunter surveys to estimate effort and consolidate records of several species into a single relevant indicator.

A hunter self-monitoring program was also put into place in eight communities in the northern Republic of Congo. Records were gathered using shotguns, snares, and camera traps throughout hunting villages. The hunters would roughly estimate different types of data that would then be later used in estimating species abundance and mean body mass.

XVI .Development of harmonized schemes for the monitoring and reporting of Echinococcus in animals and foodstuffs in the European Union [16]

This paper monitors the reports of echinococcus in animal food stuffs around the eu. Echinococcus is a genus of worms that may infect an animal carcass infecting it in the process. Ingesting meat infected by echinococcus causes a variety of illnesses to humans. Furthermore, harmonized echinococcus is a structured spread of echinococcus cases that can be linked back to a root cause. Hence the reason for the meat inspection on a large scale.

XVII. Trans-Canada Highway Wildlife Monitoring and Research Annual Report [17]

The Trans-Canada Highway (TCH), located in the Canadian Rocky Mountains, has long been acknowledged as a deadly barrier to wildlife and a possible weakening zone for population connectedness in the Yellowstone to Yukon region. This research discusses these issues. This work's goal is to create a wildlife monitoring and research plan that will direct the monitoring of the TCH Phase 3B Project's goals and objectives, which include reducing wildlife-vehicle collisions and enhancing habitat connectivity and genetic exchange for important species.

XVIII. Critical evaluation of a long-term, locally-based wildlife monitoring program in West Africa [18]

The "locally-based" monitoring strategy has been pushed in this study as a means of enhancing biodiversity monitoring in underdeveloped nations, however the veracity of data from many of these programs has not been fully evaluated.

Through comparison with camera trapping and an analysis of sampling error, the author evaluated a long-term, patrol-based wildlife monitoring system in Mole National Park, Ghana, and discovered that patrol observations underrepresented the park's mammal community, recording only two-thirds as many species as camera traps over a similar sampling period.

XIX. Development of harmonized schemes for the monitoring and reporting of Trichinella in animals and foodstuffs in the European Union [19]

Similarly this paper aims to identify the spread of trichinella from foodstuffs we consume. Primarily in untested foods, trichinella is a parasite that disturbs the digestive tract of its victims. It is commonly more found in pork related meats possibly from a lack of hygienic regulation in slaughterhouses.. This study however cross references trichinella found in pork with other animals to find a more cohesive result.

XX. Digital Surveillance: A Novel Approach to Monitoring the Illegal Wildlife Trade [20]

The authors talk about how they introduced an automated web crawling surveillance system developed to monitor reports on illegally traded wildlife. It is a resource for enforcement officials as well as the general public, the freely available website provides a customizable visualization of worldwide reports on interceptions of illegally traded wildlife and wildlife products. This helped 858 illegal wildlife trade reports to be collected from 89 countries.

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Chapter 2:
Identification of General Problems and Challenges

Problems & challenges we encountered from the publications

1. The main problem regarding these publications is the scope in which they are created. Most of the publications had really large scopes with clear intent, such as forest areas as well as the whole population of fauna, this is something that we cannot achieve with the resources at hand.
2. Many of these publications come from government funded organizations with large amounts of resources at their disposal, this means they are able to sample large amounts of data with large teams, this is something that is out of the scope of our project.
3. Scientific terms and in depth knowledge are some of the advantages that these publications possess. Understandably, wildlife expertise is out of our reach for this project.
4. Most of these publications deal with highly dangerous variables such as viruses and pathogens. It would be unwise for us to deal with these risks without proper training first.
5. Some publications explore areas that stretch entire continents. That allows them access to a wide arrange of biomes, species and flora to study, We are limited in that regard as we are confined to the netherlands
6. Usage of public databases are used in studies such as the " **Next Generation DNA Library of Freshwater Species",** however it would be challenging for us to do as not many of us are versed in its usage.
7. We might have difficulty accessing high quality tools such as cameras and sensors.
8. As we aren't properly trained or equipped to handle wildlife. It might cause danger to us and whatever animals we are monitoring.
9. It would be very time consuming and expensive to do manual field work
10. Some species might be hard to locate, let alone monitor.

Chapter 3:
Identification of Relevant Problems

1. **Poaching (illegal hunting)**

Poaching has become a real big problem, especially for large game animals in Africa like rhinos, or big cats in India like tigers. Many animals are wanted for their thick luxurious fur, their folk remedy horns, or their brothy fins; It is very hard to cover enough area, or to outsmart/outplay the poachers to be effective at stopping this mass of people looking for a quick way to earn cash on the open and black market. Rules and regulations, as well as modern technology, have been taken into effect to try to fight off Poachers, and although it has helped, it has not done enough to fight against them. There is still a big problem with Illegal hunting, and we want to see if there are other angles we can look at to help.

Consequences of poaching are many, the biggest and most feared one is the extinction of big animals that help feed and fuel an ecosystem. Every animal does its part to control, maintain, help, and feed other animals in its ecosystem. The shark for example helps control other species that hunt on vital ocean floor cleaners, and small fish. Without the shark these species of fish will go rampant and just like the humans outgrown their habitat which could destroy it by overfeeding.

2. **Wildlife feeding on plastic waste**

Wild animals feed on plastic all the time, on a mass scale. The reason being, they mistake certain plastic products for food. For example: turtles often mistake plastic bags for jellyfish.

By consuming plastic, their stomachs get full, thus reducing their appetite. However, as opposed to actual food, plastic gives the animals no energy. Consequently, they get weaker, until eventually they die either of starvation or poisoning. It is a slow and excruciating process. Data from the Plastic Soup Foundation shows that in the United Arab Emirates, half of all camel deaths are due to plastic. Moreover, a sperm whale in Indonesia in December of 2018 was found and had 115 cups, 25 bags, four bottles and two slippers in its stomach. This problem will, without a doubt, escalate in time, if something is not done soon.

3. **Animal overexploitation (for, food, clothing, sport)**

Basically what we just wrote about in Poaching, but here there's a bigger focus on the people not directly involved in the hunting of the animal. Rather looking at our society to see what has gotten people into wanting these animals, and how can we fight it. Last year, as stated by our sketching teacher, fast fashion was a major theme people wanted to work on. If fast fashion requires animal fur like in expensive consumer jackets, or ivory in furniture. Is there a way we can smartly inform consumers about what every item does? A display that scans the tag and tells you where the products come from and how they have been harvested? How environmentally sustainable each is, or not.People don't generally have access to this information, and it's seemingly very difficult to find it for the general person not heavily invested in the cause. This leads to people still buying all these items that use materials that heavily affect the environment.

4. **Ethics in wildlife monitoring / conservation [22]**

Wildlife monitoring is a great idea in theory, but being able to monitor a lot of animals at the same time can also be very difficult and require methods that a lot of people don't agree with. There are different values people look for when monitoring, and being able to monitor all these values can lead to some disagreement. What should be monitored, why should it be monitored? Is it for protecting crops, is it to maintain a steady supply of fur? Do you focus mainly on preserving the human way of life, or do you focus on animal welfare?

Consequences of these dilemmas are that in order to implement some of them we might have to implement policies that help, but getting policies through is difficult and takes a lot of time, so it is vital that we agree on which policies to get through. How are we gonna do that when people don't agree on what to monitor, and how to monitor it.

5. **Destruction of habitats (global warming)**

If habitat loss continues at its current rate, already endangered species may go extinct quickly. Because of the increased demand for food worldwide, agricultural sectors are now expanding into formerly uninhabited environments. Deforestation, which follows, increases the amount of carbon dioxide in the atmosphere and greenhouse gas emissions, which are the primary cause of climate change. 11.6 percent of the world's total greenhouse gas emissions, which include carbon dioxide, methane, and nitrous oxide, are attributable to agriculture in the United States alone.

6. Human interference with the ecosystem

Numerous human activities such as overpopulation, pollution, the burning of fossil fuels, and deforestation have an adverse effect on the physical environment. Climate change, soil erosion, poor air quality, and undrinkable water have all been brought on by changes like these. These unfavorable effects may influence human behavior and lead to large-scale migrations or conflicts over access to clean water.

4 Problem Selection and Motivation

Wildlife feeding on plastic waste [21]

An issue affecting not only animal but human life is the abundance of plastic waste littering our oceans. Plastic takes up the majority of plastic waste in the last 60 years. Colloquially known as the “Great Pacific Garbage Patch” some of these wastes have aggregated to such an amount that they create entire land masses made of trash.

The monstrous amounts of waste has led to a variety of different issues for us, marine and avian wildlife. There are 2 primary ways plastic can damage wildlife, ingestion and entanglement. As the waste cruises along the ocean, birds and fish alike may mistake the dump for a swarm of planktons or other small fish. They may mistakenly feast upon the toxic sludge ingesting the plastic that makes it up. Plastic is notoriously hard to decompose and when ingested, it is not digested completely and leaves small microplastics that tear and contaminate the insides of the animals. Furthermore, trash and plastic are a lot more compact than planktons or small fish. Discarded nets, plastic bottles among other things make up the heap of trash and they can easily ensnare unsuspecting fish or birds. Fishes may be dismembered from particularly sharp objects and birds might be rendered flightless and drown to the depths.

When fish are tainted with microplastic it is especially dangerous to humans. Billions of people are avid seafood lovers and entire cultures revolve their diet around the sea. When we eat microplastic tainted seafood, those same microplastics enter our system and cause the same damages as it did to the fish. Poisoning, tissue damage, and in-digestion are only some of the symptoms of eating plastic.

It is not rare to see a bird with a piece of plastic lodged between its wings as it helplessly squawks for help. As a species we are solely responsible for the issue at hand and we find it necessary for a remedy . Recycling and refusal of plastic products is a good start but it is not enough. This is a topic that requires further investigation and is a pressing issue for humanity.

5 Potential Solutions

1. Noise to scare birds at garbage bins, do they hear something we don't hear?
    - Can we use ultrasound? Two sensors, one at the entrance of the bin, one further down. We can check if something is thrown in, but if something is taken out it beeps.
2. Is there something they instinctively run away from that we can equip the bins with?
    - Scarecrow for bins (jack in the box), when birds are nearby, use a jack in the box, or a small fast action to deter the birds away from the bin.
3. Sensors that sense if there is trash and then send a signal for someone to pick it up
    - Aside from using bins we could have a sensor that monitors a large space where when it detects trash
4. Birds will be birds, so instead of trying to change the behavior of birds, we could change the behavior of the people/the environment.
    - Gamify the bins that encourage actively recycling
    - Can we have a thing that senses birds and then closes itself based on it. (loudness of birds squawks, only based on the gulls sounds or other birds that feed on plastic, and not just any bird.
    - If we sense birds, can we use strobe lights? This should deter them
        - Birds have been shown to not like blinking bright lights, they usually steer clear of them.
    - Could we do something about the street? Roomba for the pavement.
        - We could design the roomba to look like a natural predator of the targeted birds, scaring them in the process.
    - BDM (Bin Dance Music)
        - Birds don't like fast beating noises, so playing something akin to electronic dance music should deter them.

6 Solution Selection

For our project we chose to focus on a deterrent device which can be connected to a city bin. This device should be able to smartly detect birds, and use deterring sounds and or lights to ward off the birds to protect them from eating the plastic filling the bins. Not only will this help the general bird population in the city, but it should also help keep the city clean. If the birds aren't feeding off of the trash they will also not throw all the trash around, this will make the streets cleaner even further helping the birds, making it so they don't see the trash, and help us so that we don't have to go pick up after them.

Birds are deterrence is a hotly debated topic, but in general it seems that people have had great luck deterring birds using kits, predatory bird calls, aromatic chemicals, and spikes. We deemed spikes and chemicals to be out of the question as they would be dangerous to work with and obstruct the usefulness of the bin. We chose therefore to implement lights, and sounds. The device you attach to the bin should come with some sort of LED that activates in a certain pattern to confuse the birds, and a speaker that can play the required noise.

Programming:

These people will program the arduino and figure out the way of detecting the birds.

Programming : Leo, Hauk

Physical Design:

These will design the physical unit that attaches to the bin, while also making it work with several bins.

Sketching : Ruthi, Hauk

Will sketch the rough idea of how the unit is supposed to look like on paper, then further hand that in to the 3D modeling team. They will also go through several iterations of the product design. And if needed redo the design to fit other criteria.

3D Modeling and prototyping: Jeremy, Dimitar

Will take the sketches and turn them into 3D models that can be printed and made physically

Circuit Design:

Will wire up all the sensor to work the way they're supposed to so that the programming team can use it for their bit

Physical: Ado,Dimitar

Digital: Leo, Jeremy

Report:

Will keep the report up to date throughout the project.

Ado, Ruthi

7 Methodology

Our device is a detector and bird deterrent system that should help deter birds from trash bins. It will take use of lights[24], sounds and moving objects. It will also be able to be manually turned off for a time to allow humans to interact with the bins without the device receiving a false positive where it thinks it detects a bird, while in reality it is caused by a human.

We wanted to use two distance sensors to detect if anything passes by them. If something passes by the first, then the other, we will have known something has been thrown in. However if they're both activated at the same time and the first is not deactivated we will have known that there's something that hasn't fallen through. We also wanted to implement a button, if the button is pressed it will deactivate the bird deterrent system. The bird deterrent system consists primarily of speakers and lights. The lights will first turn on. According to light research birds don't like strobing lights and will shy away from them. If that doesn't work and it still detects birds rummaging around it will activate the speakers. At first the volume will not be intense, but if movement continues it will get stronger and stronger.

The device will primarily take use of the movement sensor, sensing if there is a bird rummaging around in the bin. This sensor will need calibrating, both for the bin used, and to stop false positives of trash falling through. All the functions of the bin can be disabled with the press of an easily accessible button, this should allow humans to disable the device for when they need to access something in the bin.

Due to the nature of bins, being interacted with constantly and placed in rough weather. Our device would need a casing being able to withstand the climate surrounding it. It should be able to withstand harsh temperatures, and rain. Though it need not be waterproof, it should be able to withstand the moisture and possible salinity in the air for an extended amount of time. Water will make its way into the device one way or another, so we should design it in such a way that water can leak through if need be. This design choice is taken from designs in outdoor lighting where they're not waterproof, but allow for water to safely drain out of them without hitting vital components. Though the environment is semi controlled, being in a bin gives the device some shelter, it should still be designed with these requirements in mind.

Onboard the device sits an arduino (or in the future a purpose built chip), which will monitor the different sensors and send a signal to the different outputs based on what it reads. The arduino should not need to be connected to a WAN of any sorts, and should be able to host all the program and files locally. In the case of AI implementation the arduino would need WAN access, so that it can make use of more powerful hardware.

There is not a lot of data being analyzed, only the activation of a few sensors that basically function as a monodirectional motion detector. If the motion is one way then activate, if it is another way don't activate. The data needed to be analyzed the most is the data we get on if the bird has left or not. For this we shouldn't need more than to analyze if the noise level is equal to that of when the bird first was there, or if it is lower.

The validation of our project would include testing our sensors and examining if they produce the appropriate output. This of course would be done ideally in a real life environment possibly on school grounds at an appropriate bin, or in the city center is allowed. We'll be testing for accuracy and adjust the device accordingly. We'll have to ensure that the arduino doesn't interpret the signal from the sensors wrongly, as in we need to calibrate the program to allow for more or less leniency.

Our solution should be an effective immediate help for deterring birds in certain areas. However we do acknowledge that birds learn and adapt, and so our product won't be fit for every instance. In areas where there are fewer birds, this device should be more effective, but in areas where birds learn fast from each other, and where there is an abundance of birds that other birds can learn from, it will be less effective.

Week 6 **12nd-16th December**	Finish initial draft of documentation up until chapter 7.		
Week 7 **19th-23rd December**	Make adjustments on report based on feedback	Begin data processing code for arduino	Designing casing used for our product
Week 8 **9th-13rd January**	Start conceptualizing the circuit needed	Test our software and hardware with simulations	Finalize our circuit
Week 9 **16th-22nd January**	Prototyping the device, printing the casing, and realizing the design.	Incorporating our software and hardware into the casing and final testing	Stress testing the device in a controlled environment, as well as an uncontrolled environment.
Week 10 **23rd-27th January** **(27th, Demonstration Day)**	Testing of device, troubleshooting	Finish final chapters of report	Friday 27th: Demonstration day

Ambitious Vs. Basic Scenario

Our basic plan involves detecting something by use of simple sensors, the device would use a battery for power, it would have a simple lights and sounds system only and would only be able to be attached to the bins of our choosing. It would be on a very small scale, but should be able to deter a small variety of birds.

More ambitiously our device would be self powered by using solar power or equivalent self sufficient power. It would be able to consistently deter all birds regularly, and could be fitted to any bin. It would be waterproof, and designed in a way so that it easily stands the test of weather and time.

Research

From the research we have done so far on an effective way to deter birds, we have found the different ways in which these birds react to their environment. Unknown objects, neophobia and the threat of predators are only some of the ways in which these birds are able to detect danger, and flee from it. From this we can attempt to recreate these conditions in order to get these birds to follow a certain pattern of behavior [24].

However, we have also found evidence for why this may not work as intended, as after repeating events birds have been known to learn about the dangers (or lack thereof) that our system creates, thus, will eventually be able to internalize our device as a safe environment, rendering it useless.

This research allows us to quickly figure out what sensors we would need to use as well as what methods we could implement to deter the birds, it also gives us insight into the shortcomings and problems regarding these particular tactics and thus gives us a more concrete goal to improve our device.

Define the scope

In an ideal world we would like to implement such a device on smaller cities and specifically on designated areas with large concentrations of food waste, e.g. restaurants, housing complexes, etc. However, given the resources available both in terms of funding, equipment and time given to complete this task, we have decided to instead focus on creating a prototype to be used in a simulated environment, used in a smaller scale to prove the concept of our device rather than to create a finished product.

Prototype a device - Gathering data

After defining the scope we need to make a prototype that can be used to gather important data for us to further improve our device. For this we will have to figure out an efficient way of gathering data.

- Make a small bin, add food, and test different tactics.
    - record the tests.

Make the device | Everyone

After prototyping, and gathering the data, we need to use that data to actually improve the device and make a final product. In this final product we need to incorporate all the different areas of our device, like programming, physical design, circuit design etc. whereas before we could test each separately we now need to put them together cohesively.

Programming | Leo, Hauk

The arduino will have to be programmed to be able to use the sensors and automate systems based on them. Challenges that could occur are:

- The program reads the incoming data incorrectly and processes it in the wrong way.
- The data is too noisy and needs to be refined.
- The required code is out of our skill level and we're unable to perform it.

Physical design and First round of testing | Hauk, Dimitar, Jeremy

For physical design we will have to make the device be able to withstand the rigors of the outside world. We'll have to test for:

- Water resistance/ accommodation
    - As mentioned, it shouldn't be water resistance, but allow water to safely exit the device without harming vital components.
    - Is humidity a problem
- How to power the device.
    - will we use batteries
    - solar
- Feasible design
    - does it all fit inside a bin, how will it all be incorporated

Second round of testing

After having improved on the points made during the first testing round, we will be able to test the improvement (if any) on said points, and either find following issues, changes to be made or what works. Finally we will return to the prototyping stage once again in order to further improve on these flaws to refine the design further

Report | Ado, Ruthi

Throughout the process we will be recording and logging all of the data used as well as our reflections, successes and shortcomings. This data will prove exceedingly useful when it comes to reflect on the process of design and development of our device and will also allow us to show the development of it to future prospects.

8 Validation

Problem: *The problem to be addressed is the presence of birds at trash bins, which can lead to health and sanitation issues, like littered trash, or the spreading of diseases.*

Hypothesis: *The device's lights and sounds will effectively repel birds from trash bins, which will lead to less trash spread around the bin, and deter birds without the means of harming them.*

Studying the behavior of birds, we've seen that they are initially scared of novelty, neophobia. Which when used to the original fear they ignore it. However seen over and over again is the fear of raptor sounds, like that from hawks, and eagles. There are gadgets that exist marketed to deter birds, like flashing lights, or speakers that regularly mimic raptors. Our product combines these features into one device, and also seeks to automate the process of keeping the novelty for longer by just activating once a bird has been detected. A lot of our validation comes in the form of the already proven effectiveness of these products.

According to our studied behavior of birds in the field we verified our approaches to the bird problem. Birds are frightened of flashing lights, according to research, yet many gadgets that promise to deter them employ them. We have also seen that they dislike loud noises, possibly because they resemble the calls of raptors like eagles. By utilizing an LED strip to produce flashing lights and a buzzer to produce an abrupt loud sound, we have combined these two aspects to make our device. The bird's adjacent objects would be startled by this and learn to avoid the waste as a result.

There have been many inventions to stop, distract, or deter birds from bins in cities, and we present our solution to the problem. Though some more traditional means like putting chains in front of the entrance to the bin, or the use of locked electronic bins are confirmed to work and already put in place around in cities, they do not qualify as smart environments as there is no processing of data, nor form of automation.

Sensor and Element validation

Ultrasonic module (x2) :

The use of sonic sensors are able to detect objects being thrown into the bin, but are flawed in their use. They do not have a wide cone of visible range, and so would in theory not be able to detect

trash thrown into from the corners of the bin. This is a problem that has not occurred in our testing, but it could become a scalability concern for the product.

Button (1) :

Our inclusion of a button to deactivate the product in case humans should need to perform actions that would usually set off the bird deterrence should not hamper its ability to deter birds, as birds will not be able to hold the buttons while at the same time getting at the trash inside the bin. The button effectively disables the Arduino, and has not shown to be a problem in our testing.

Buzzer (1) :

Our buzzer does not reproduce the noise of raptors, but it should work as a proof of concept in this case. It does not always reproduce the high pitched sound it should, and we believe it to be a problem with the circuity, but we have not been able to find a solution to it other than disconnecting everything else in front of the Arduino and running the buzzer off of the pure 5V output.

LED Strip :

Our LEDs work as intended, and are covered in a rubber shell for waterproofing. The testing of this waterproofing has not been tested, but according to the laws of physics it should work as expected.

Bird deterrent validation

We have not had the ability to test our product due to time and bird availability restraints, but we hypothesize that it will be an effective way to deter them by use of traditional methods proven to work previously.

Sonic Sensor:

Our sonic sensors have no problem sensing birds as they only rely on the presence of an object and not its heat or sound, which can vary for each individual bird, and can lead to false positives of, for example, warm food being thrown into it. They are in essence a more rudimentary method of detection, but in our case they should lead to less problems in their simpler design when it comes to data analysis.

Buzzer:

The buzzer does not effectively mimic that of a raptor, but with limited resources we want to include it as a proof of concept that our product does its primary function of detecting a bird well.

LEDs:

Although the LEDs work as intended their usefulness is yet to be validated, apart from their use in already existing bird deterrent devices.

9 Results and Conclusion

As our findings have demonstrated it is clear that our sensors are functional, birds that come in and out of the bin are sensed and the proper responses are activated. We did not utilize actual birds because that would take unnecessary time, hence this project has served as a proof of concept more than anything else. Furthermore we have discovered how to utilize ultrasound sensors alongside their corresponding arduino code. Regarding our casing, it turned out to our liking and we are incredibly pleased with our design. However some alterations could be implemented for improvements in the future, for example both sensors should be oriented in the same angle as to ensure proper data collection. With the way it is now some errors could be produced such as when birds enter from the opposite side of the bin, not triggering the first sensor. Lastly our code consisted of mainly reading the values gauged by our distance sensors and determining which sensor is activated first by returning boolean values. Then it would trigger the buzzer with a set frequency and a delay for it to repeat. Initially the code wouldn't produce a stable enough sound but through exchanging the buzzer for a newer one it was solved.

In conclusion our initial issue pertaining to avian disturbances could possibly be solved by the integration of a smart environment. As showcased by our BDB (Bird Deterrent Box) it is possible to deter aggregating birds by emitting a loud high pitched frequency alongside blinking lights.

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