Problem statement

Cities contain loads of birds who cannot find enough food to stay alive. Therefore, many people help these birds by supplying them with food like seeds or peanut butter. This helps most of these birds to get through the cold winter months. However, if you have ever looked outside at one of these food spots, you might have noticed that strong or large birds often hog these for themselves. This scares away small birds, who need food more than large birds. For example, in the Netherlands, a big subset of these strong birds are Magpies, who are quite aggressive. They will guard these feeding spots often and prevent tiny Sparrows from getting food.
To help these smaller birds, we want to create a feed-dispenser-type device. It will be able to detect what birds are around it and will close off access to the food if large birds are trying to eat. To help you as a user in finding a good spot and making sure that the container will not get empty. It will send notifications about which bird is eating food, it will also send the current food level.

Objectives

Our objective is to create a food container that can be opened and closed according to which bird is trying to get food from it, thereby keeping the user posted about which bird is eating and what the food level is. The following features are needed to complete our objective:

- A container that can be opened and closed electronically.
- Detecting which bird species is trying to eat food.
- Detecting current food level.
- Notification service that communicates with the user.
- It has to be aesthetically pleasing

We formalize most of these objectives by giving a list of requirements according to the MoSCoW standard. This standard gives a priority rating to every requirement, based on how important that requirement is for the final product.
We have divided up this requirement list in two sections. The first section will document the requirements for the physical product, which is the food container the bird will interact with. The second section will document the requirements for the app, which will give the user insights in the data gathered by the physical product.

Physical design requirements

Requirement ID	Description	Priority
PD01	The system shall have a container for bird food	Must have
PD02	The system shall allow the user to hang the system on a hook	Could have
PD03	The system shall allow the user to hang the system using screws	Could have
PD04	The system shall have a landing area for the birds	Should have
PD05	The system shall have a door to the bird food	Must have
PE01	The system shall measure the amount of bird food left in the container	Won’t have
PE02	The system shall record the area in front of the door	Must have
PE03	The system shall detect birds approaching the feeder	Must have
PE04	The system shall close the door to the bird food if an undesired bird* has been detected	Must have
PE05	The system shall keep the door to the bird food open if no undesired bird* has been detected	Must have
PE06	The system shall open the door to the bird food if no undesired bird* has been detected and the door is closed	Must have
PE07	The system shall scares away undesired birds*	Must have
PE08	The system shall record the number of detected birds	Could have
PE09	The system shall record the species of detected birds	Could have
PE10	The system shall have an internet connection	Must have
PE11	The system shall produce audio to attract desired birds	Could have
PE12	The system shall refill the food if less than 50 grams of food is detected	Won’t have
PE13	An additional power source, like solar panels, shall power the system.	Won’t have
PC01	The system shall send the amount of bird food left in the container to the app	Won’t have
PC02	The system shall send the recorded data to the app	Could have
PC03	The system shall allow the user to connect the system to a registered account	Won’t have

*We specify which bird species are desired and which bird species are undesired later in the report.

App requirements

Requirement ID	Requirement	Priority
AD01	The app shall display the amount of food left in the container	Won't have
AD02	The app shall display the number of birds by species detected	Could have
AD03	The app shall graph the number of birds detected	Could have
AD04	The app shall graph the amount of food measured	Won't have
AU01	The app shall allow the user to register a new account	Won't have
AU02	The app shall allow the user to login to a new account	Won't have
AU03	The app shall allow the user to connect the account to multiple of our products	Won't have
AU04	The app shall display general information about bird species	Could have
AO01	The app shall send a push notification to the user if there is less than 50 grams of food left	Won't have
AO02	The app shall recommend bird food	Should have
AO03	The app shall allow the user to export data to a .csv file	Won't have

The naming scheme is as follows:
The first letter is the general subject of the requirement (P for physical design, A for App).
The second letter is the more specific subject of the requirement (C for communication, D for design, E for electronics, O for other, U for user interface).
The two digit number is a general number for the requirement in its category.

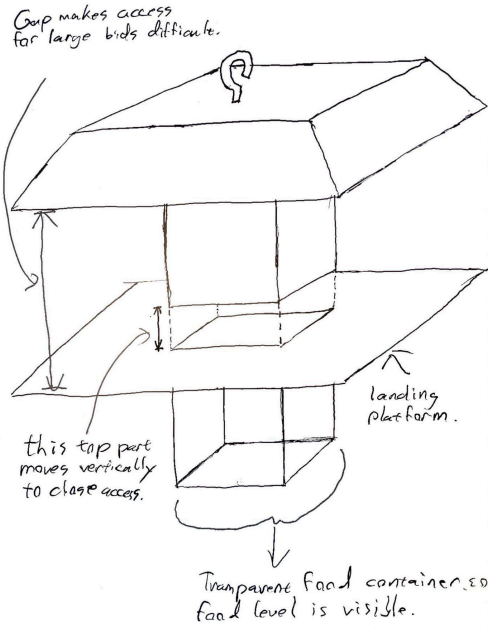
Users

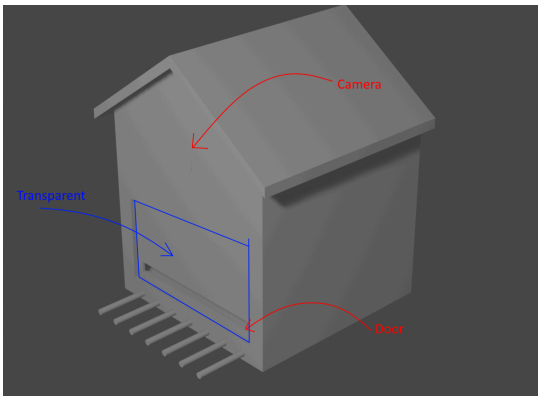
An automatic bird feeder can be made into a product suitable for multiple purposes and can be interesting for different users. Most birdfeeders are in gardens of people who simply like to watch birds from the comfort of their homes. However, they do not know

when birds are feeding and thus when they can watch them. The automatic birdfeeder is ideal for this type of situation because it can send a message to the user's phone alerting them which type of bird is in their garden. For example, an elderly man who loves to bird watch has 2 feeders in his garden at different places around his house. His vision is a bit impaired, so he cannot keep a close watch on the feeders since this costs too much energy. With the automatic birdfeeder, he does not have to keep a close watch since he now knows when and which bird is feeding, giving him a very pleasant user experience.
The automatic birdfeeder can also be used for wildlife conservation in areas where certain species have a difficult time surviving. Many habitats have exotics, species not native to an area, that were taken as pets from different countries and escaped. These exotics pose a big danger to the biodiversity of ecosystems since they do not have natural predators living there. As a result, the numbers of their population increase rapidly, leaving not enough food for native species. With the automatic bird feeder, wildlife reservists can help the native species by giving them food without the exotics benefiting from their advantage. The automatic birdfeeder can also help in helping to understand the severity of the problem by keeping count of the birds that tried to feed. This is also interesting for researchers and ornithologists to preserve ecosystems better since birds play a vital role in almost all ecosystems globally.
For the scope of this course, we decided to focus on the group of people who just like to have a feeder in their garden. To understand their needs better, we have conducted multiple interviews with different users. The research questions can be found in Appendix A. From the answers, an affinity diagram was made from different identified themes.

Sketches

We first made two rough sketches so we could have a discussion about those. These two rough sketches are presented below





Next, a discussion followed to further determine our design. We decided on the main shape and features that we could use to actually create our prototype. Following this, we made more formal drawings of our design using 3d rendering software. The results of this are displayed below. The images aren't to scale, but they give a general impression of our prototype. We will construct this prototype ourselves using electrical components and wood planks.

The dimensions of our prototype are about 14x18x20 cm. The door itself is about 6 cm. Our product contains two separate rooms. One room is used to store food, the other is used to store the raspberry pi. The door can be opened or closed using a servo connected to the raspberry pi. On the front is a camera that can record images.

We chose to use a raspberry pi, since it is easy to program, it has all the functionality we need, and it was available to use. We chose a servo since it can be easily connected to the pie, and it is cheap. We decided to put the camera at the front, since the birds need to pass there to get to the food.

We have chosen to make our product out of wood, since it is available to us, it is easy to use and it conserves the look of classical birdhouses. We decided on the specified size, as it was easily available to us and it is easy to use the birdhouse in this way.

Planning

Weeks	Task
week 1	**Brainstorming for potential ideas + State of the art research + MoSCoW theory**
week 2	**User research + Literature research and patents + design**
week 3	**Built feeder + work on user-specified features**
Carnaval break	
week 4	**Implement features into the feeder**
week 5	**Finish Prototype**
week 6	**Test prototype**
week 7	**Improve prototype**
week 8	**Finalising product + Finish Wiki**

Components

Other considerations… weight, movement, etc
Electrical hardware

- Microcontroller Raspberry Pi
- Battery Powerbank
- Raspberry Pi Compatible Camera 5MP V1.3
- SG90 Mini Servo

Materials

- Wood
- 3D printer ?

Research on existing product features.

‘Big Bird’ repellent


(From: https://www.gardenwildlifedirect.co.uk/pest-free-squirrel-proof-seed-feeder.html, and: https://www.tfmsuperstore.co.uk/products/leto-small-bird-seed-feeder-anti-big-bird/)

This feeder prevents big birds from feeding by using a closing door, based on the weight of the bird. If a small bird sits down on the metal ring to feed, nothing will happen, but when a big bird sits down on the metal ring, it exceeds the weight limit, presumably by using a spring.
The plastic barrier might also help with deterring big birds, but its main purpose is deterring squirrels with its smooth and sloped surface.

(Source: https://www.gardenwildlifedirect.co.uk/national-trust-aura-peanut-feeder.html)
This feeder prevents big birds from feeding by enclosing the entire feeder in a cage. The size of the holes in the cage is chosen such that big birds and squirrels cannot get through, while smaller birds (Like the “Koolmezen” in the image).

(From: https://www.lovegardenbirds.co.uk/meripack-pigeon-proof-window-bird-feeder.html)

This bird feeder prevents big birds from feeding by making the entrance to the food-space very small.

Bird Detection

(Source: https://www.amazon.com/GNCC-Squirrel-Notifications-Identify-B1/dp/B0CDXFPTRM)

This bird feeder has a camera that detects bird species with use of ‘AI’. It is connected to an app that notifies you if a bird is present. The app allows you to see more information about the bird on wikipedia. It allows you to store footage on-device with an optional SD card, or using their cloud subscription (The AI bird recognition also requires this subscription). The birdhouse is equipped with solar panels and an internal battery to provide its own electricity. Additionally, it is equipped with a light and a speaker that can be used to scare away squirrels, if the camera detects them.

(Source: https://mybirdbuddy.eu/product/smart-bird-feeder/)
This bird feeder has a camera for bird recognition. It has wifi connectivity to connect to an app, which can notify you if a bird is present. The app also tracks the amount of visits per species. Additionally, the app allows you to name specific birds, identify sick birds and send notifications if other animals (like pets) are near the feeder.
This feeder needs to be charged manually, unless you buy the optional solar panels.
The app also allows for you to livestream the feeder's feed (publicly). In the app can view streams from feeders all over the world.
Finally, the site claims that the photos taken by the feeder help researches track bird population and migration.

Worth noting is that neither of these feeders have a 'hard measure' for getting rid of unwanted birds/animals. They simply notify the user, flash lights or play sounds, which can be easily ignored.

Food level sensor

I was unable to find any products that advertised themselves to have an active food-monitoring sensor. This does not mean there might not be feeders out there that have this feature, but I was not able to find any.

DIY Bird detection and photography.

I stumbled across this guide while researching other parts of this section:
https://www.instructables.com/Bird-Feeder-Monitor-V20/

While it does not present some unique features (it only takes pictures if the touch sensor detects something), it does provide an extensive step-by-step guide on programming the raspberry pi. This could be a starting point for our own programming.

Design Choices

For our prototype we had to make some decisions on how we would construct it. Here we have a list of decisions we had to make, and our motivation for the decisions.

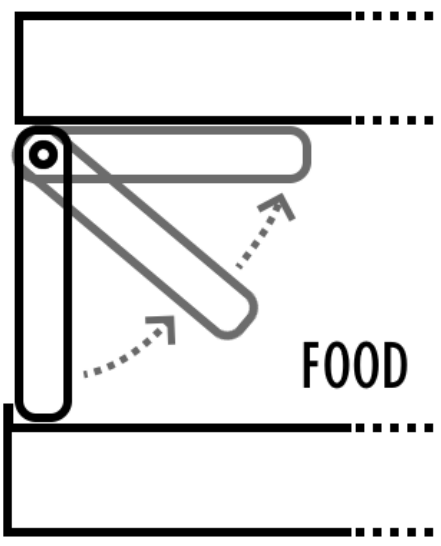
Making our own prototype from scratch

We have decided to construct our prototype from scratch, over modifying an existing bird feeder. We debated on whether or not we should buy an existing bird feeder and modify it to fulfill our needs, but we have chosen not to.
This is because building our own feeder gives us a lot more freedom to work with. It was very unlikely that we could find a birdfeeder that happened to be exactly fit for the modifications we wanted to apply (Mounting door, camera, etc.). We argued that any existing birdfeeder would require some physical modifications like cutting open or removing certain parts. This introduces the risk of accidentally breaking the feeder, having to buy another and starting again. On top of this, most existing bird feeders are designed with efficient material usage in mind. For example, for the functioning of a bird feeder, a custom molded plexiglass cylinder with 0.5cm thickness (Like the first example for ‘Big Bird Repellent’ in the section above) might be strong enough to hold the seeds while also giving a transparent look at the seed levels in the silo, this plexiglass would likely not stand well to physical modifications (drilling or cutting).
We also argued that if we were to create our own design from scratch, we could design it with all our desired features in mind, so we can make sure they are fully implemented and not like a half-baked addition.

Door mechanism

One of the two core principles is the door that closes when unwanted birds are at the feeder, so we put a lot of thought into how we wanted to design the door.
We primarily evaluated our choices on their mechanical complexity, and how dangerous they would be to birds.

The option we ended up using was a drop-down hatch. Normally, the door would rest in the horizontal position, giving access to the food inside. Then, when the system decides the door needs to be closed, it rotates 90 degrees. Closing into its vertical position, flush with the wall. If the motor turns out to not be precise enough to close flush with the wall every time, we can help with closing correctly by adding a little protrusion in front of the door, which does not allow the door to rotate further.

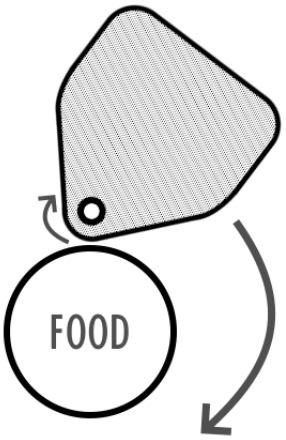


The closing of the door works exactly the same but in reverse. It rotates 90 degrees from its vertical position to its horizontal position allowing access to the food again.

Mechanically, this design is not very complicated. Depending on how you want the aesthetics of the feeder to be, you can either mount the door directly to the motor's axis, with the motor being mounted on the outside of the feeder, or you can put the motor inside the feeder and use something like gears or chains to rotate the door.
We have chosen to put the motor inside the feeder, but as we do not know the precise layout at the time of making the decisions, the actual implementation is left to design in the modeling stage.

We do also think this door is quite bird friendly. The door does not have to close fast, so if there are still birds feeding when the door has to close, they are gently pushed back without risk of getting stuck between the door.

The other option that was considered was a door that rotated in front of the circular hole the food was accessible from.
The door would normally be rotated such that it was not blocking the food, either upright or to the side, depending on where the camera would have been placed.
Then if the system decided there was an unwanted bird present, it would rotate the door such that it would block the 'food hole'. Then when the system decides the food might become accessible again, it would reverse this process, rotating the door away from the hole.



Mechanically, this idea is very simple. You can simply mount the door directly to a servo with its rotation axis orthogonal to the front side of the feeder, and then it only has to rotate a specific amount. You could even help the motor by placing stoppers on both sides of the rotation, to prevent the motor from rotating the door too far.

However, we ended up not choosing this design. Even though mechanically it is very simple, we did fear for the safety of the birds.
If the motor is very strong, we fear that birds might get their head stuck and get seriously injured, which is not what we want.
If the motor is just barely strong enough to move the door (Or you have some sort of advanced door-obstruction system), the door will not crush the bird's head. However, we might fear that the birds are smart enough to figure this out. They might be scared of a moving object closing on them the first few times, but we predict birds (especially bigger birds) will be smart enough to figure out this system is actually harmless, which then renders our entire design useless.

Overall we might have been able to make this door work, but our other idea wasn't that mechanically complex either, and we preferred how it looked/functioned over this one.\

Non-focus areas

If we were a company designing this product for the actual market, we have to think of every aspect. But as we only have a limited time for this project, we have chosen to focus on the primary aspects of our design. These are the detection of bird species (with the camera) and the closing and opening of the door. But there are some other aspects for bird feeders that might be relevant that we have placed outside of the scope for our project.

- **Power supply**
  Our design uses electronic components for the detection of birds, and the operation of the motor. This requires electricity which has to come from somewhere.
  For our current prototype we will be using whatever method is most convenient, whether this be a power bank or simply connecting it with a laptop.

  For a market ready product options like: a changeable battery, solar panels and connection to a power outlet as possible ways of getting power.

- **Mounting mechanism**
  Our prototype will simply be a feeder you can put on a table, as we have taken no special considerations for mounting the feeder.

  For a market ready product you can alternatively consider wall-mounting or pole-mounting the feeder.

- **Refilling**
  The prototype might contain a method to access the food-storage from which you can refill the food supplies, but this is not a focus.

  The most simple solution would just be to make the roof removable.

- **Raspberry PI**
  We will use a Raspberry PI in our design. This is an ideal tool for prototyping because the Pi can be programmed however you like. However, because the PI is so versatile, it has a lot of components we do not use.

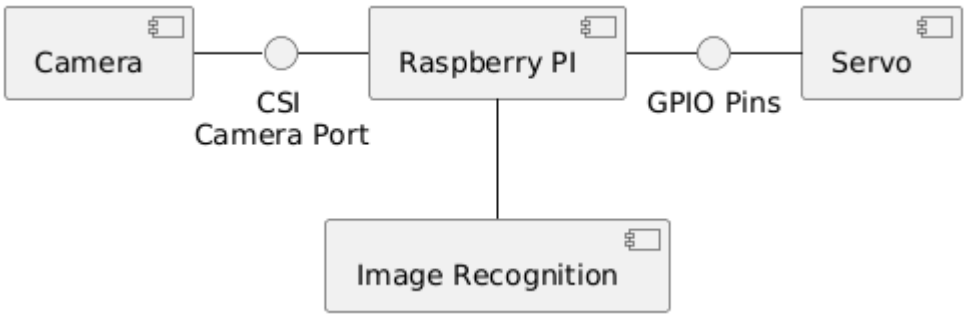
  For a market ready product it would likely be preferred to design your own electronic PCB with only the functions the feeder requires. This would make it a lot more compact and likely more power efficient.

- **Aesthetics**
  We have made some decisions for our prototype based on looks, but overall the design could be a lot more polished. However, it is also well known that prototypes are generally not concerned with aesthetics, and we will also be primarily focussed on the functional aspect of the design.

  For a market ready product, you could change the shape, creating a custom mold to fit to its exact needs.

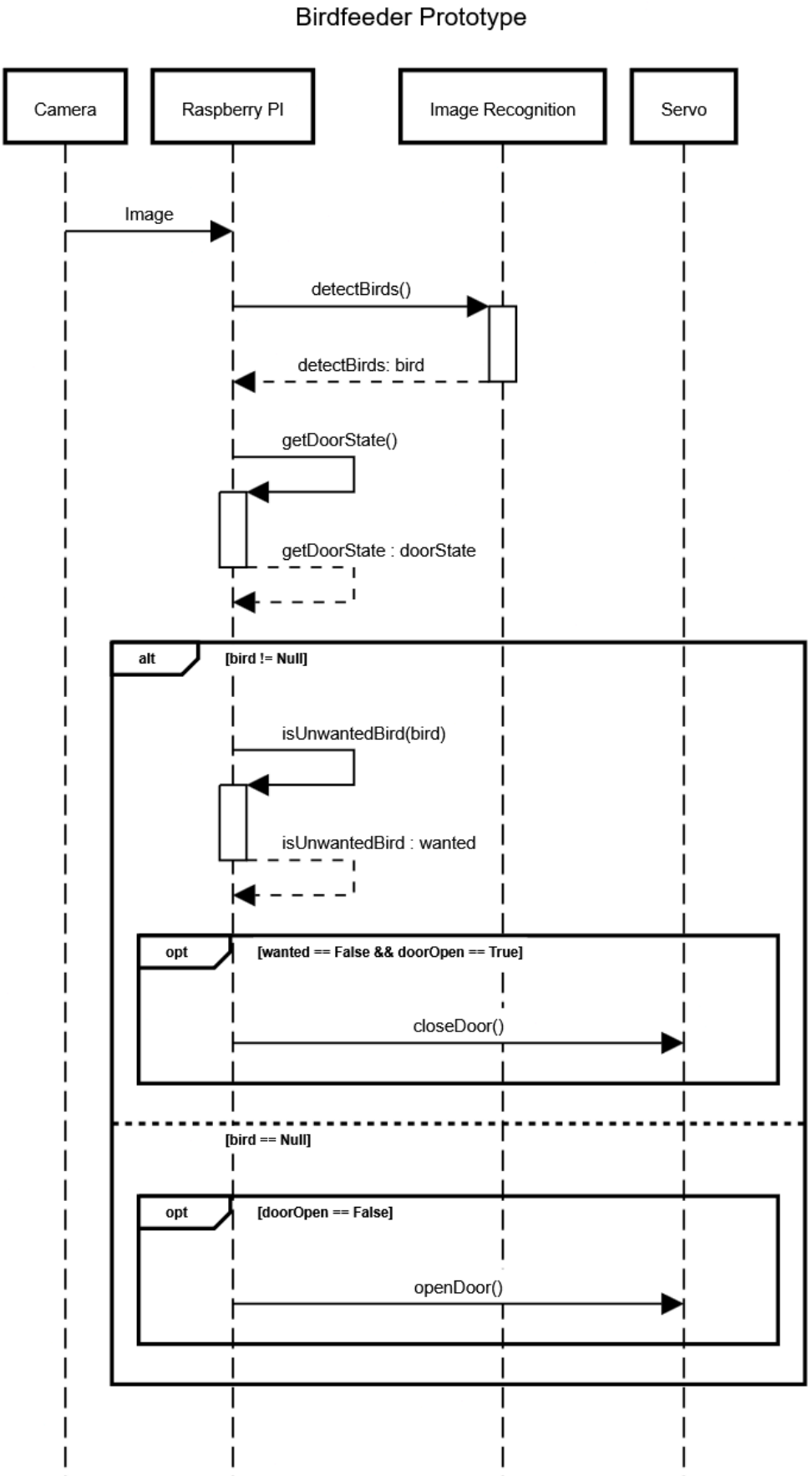
Diagrams

Component Diagram



(www.plantuml.com/plantuml/png/FO-zgiCm38LtFON8TE-GTmXak7Yw9XdT3chYkeBu1zjjwTitaI462vrplk5eA9LoVVeDp4GbtMpE7zJgYbGmCHZboLcSx19TuCenICBUWPbjVaMHvTZ0ZEHj9d4MyW0_lzXXU-EiBg7bg6EkdK25XVdJwXyrXoAkInm14cE_sNljXTh_ASctDBDxx5hmOvnEQoFC6j-XbxQ33Uj-vHS0)

Sequence Diagram



Appendix A: Literature

Interesting in general is the patent category (A01K39/0113), which is classified as *"Feeding devices, e.g. chainfeeders with means to prevent other animals or insects, e.g. squirrels or ants, from eating also"*

Mihai

- mbt bestaande producten:
  - https://mybirdbuddy.com/
    tyfuslelijke website, maar dit product is een vogelvoederapparaat met een camera er in die vogels kan classificeren – bijna precies wat wij doen. Het kan zelfs huisdieren herkennen!
  - https://www.birdfy.com/
    zelfde als hierboven, maar dit apparaat heeft een feature waarmee je *persoonlijk* tegen eekhoorns kunt schreeuwen; lmao
  - https://coral.ai/projects/bird-feeder/#how-it-works
    dit is een andere smart feeder (geen product maar een project): deze piept als het een eekhoorn ziet (om die weg te jagen)
  - In het algemeen lijken er twee oplossingen te zijn tegen ongewenste gasten: of je ontwerpt het voederbakje op zo'n manier dat eekhoorns de zaadjes niet kunnen eten, of je laat het een lelijk geluid maken wanneer het een eekhoorn ziet
  - Wanneer we een prototype tekenen raad ik aan om ook inspiratie te nemen van normale voederbakjes wanneer het komt tot ontwerp (mbt eekhoorns en muizen wegjagen)
  - Weighted birdfeeders exists to mostly prevent squirrels or rats from getting to the seeds:
    https://www.perkypet.com/perky-pet-squirrel-be-gone-wild-bird-feeder-336
    https://www.amazon.com/Squirrel-Activated-Cardinal-Chickadee-Weatherproof/dp/B0CJ98MHF7
    https://www.amazon.com/Squirrel-Outdoors-Sensitive-Capacity-Cardinal/dp/B0CF1276YS

- mbt classificatie:
  - https://thesai.org/Downloads/Volume14No3/Paper_97-Bird_Image_Classification_using_Convolutional_Neural_Network.pdf
    Op pagina 4 (857) is een zeer mooi tabel met een overzicht van andere papers over vogel classificatie (beide beeld en geluid) – nuttig om hier de citaties van te gebruiken
  - https://pure.tue.nl/ws/portalfiles/portal/320757124/Xie_Y.pdf
    onderzoek gebruikt alleen geluid en is al en al niet zo heel nuttig voor ons, maar het is geschreven door een master's student aan de tue, en dat vond ik wel interessant

    - https://www.mendeley.com/reference-manager/reader/2d59c495-ef88-32d7-95f1-88af67f70bf2/78809da6-9723-151b-17dc-8cea3ced0c3e “Bird Species Identification Using Convolutional Neural Network” by Dharaniya, Preetha wat ouder onderzoek (2022) met een vrij kleine *scope*, maar nuttig om te gebruiken als inspiratie / bron voor meer bronnen
    - https://ieeexplore.ieee.org/document/10844985
      dit is een overzicht (uit 2024) van bestaande AI modellen en technieken om vogels te classificeren, maar gaat alleen maar over vogelgeluiden
        - de paper benoemd dat dit project https://xeno-canto.org/ vaak gebruikt wordt voor classificatie op basis van geluid – dit project wordt gebruikt voor ‘wildlife sounds’ en niet alleen vogels
    - https://www.mdpi.com/2076-3417/14/10/4278
      deze gasten hebben een iets complexere AI gebruikt om hun vogels te onderscheiden
    - https://www.researchgate.net/publication/358956994_Effective_Classification_of_Birds%27_Species_Based_on_Transfer_Learning
      https://www.researchgate.net/publication/378059236_A_New_Efficient_Classifier_for_Bird_Classification_Based_on_Transfer_Learning
      niet al te interessante papers over vogelclassificatie – de meeste papers over dit onderwerp zien er precies hetzelfde uit: “we hebben een simpel dataset gedownload, er een CNN overheen gegooid, en een accuracy van 90% gekregen”
- mbt datasets:
    - Veel papers gebruiken bestaande datasets die verwerkt zijn zodat de vogel recht in het midden van het plaatje staat. Deze sets zijn vaak lokaal gefotografeerd of veel te uitgebreid. De meeste onderzoeken raden ook aan om hun AI dan zelf toe te passen aan een kleiner domein (oftewel lokale foto's).

Pijke

- https://thesai.org/Publications/ViewPaper?Volume=12&Issue=4&Code=IJACSA&SerialNo=34
  Paper that talks about using (deep) machine learning for identifying birds. They apply Principle Component Analysis to reduce computational complexity and enhance identification accuracy.

- https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/2041-210X.13075
  This paper talks about the general use of Deep Learning and CNNs (Convolutional Neural Networks), and how this used has increased over time in different fields.

- https://www.sciencedirect.com/science/article/abs/pii/S2542660522000415

This paper analyses and attempts to predict the behavior of cattle, based on data provided by microchips in the animals. In our project, we could implement something similar in an attempt to find patterns in the visits of specific birds, or to observe the bird population over a longer period of time.

- https://www.mdpi.com/2673-4591/82/1/63
  This paper describes a project very similar to ours. It discusses a smart feeder for in-house pets. It has a camera, weight sensor, ultrasonic sensor, motor and a wifi connection to accomplish its tasks. It contains an image-recognition system to distinguish between different pets, such that no pet can steal the food of other pets.

- https://patents.google.com/patent/US3126870A/en
  This is a very interesting patent. The patent was granted in 1964, which makes this an old design, but it aims to achieve the same purpose as our project. It is designed to allow small birds to feed, but prevent big birds, rodents or squirrels from feeding. In contrast to our idea, this patent solely relies on its mechanical construction to provide its functionality, whereas we aim to use some for of machine learning to more precisely distinguish between different animals.

Luca

https://www.theseus.fi/bitstream/handle/10024/808828/Seleznev_Alexandre.pdf?sequence=2 this research talks about the implementation of a solar- and battery powered bird house and the use of a camera monitoring system.

https://ieeexplore.ieee.org/abstract/document/5721481?casa_token=2-zSwSi6bdMAAAAA:d-BLOleNNwYZ6Id9-snu4sNyP-LpMizyU-QLn4yOXMt6gkCaW90cj_vjx39Gf6DT_ezH5zU
this paper discusses a smart scarecrow system while incorporating image acquisition, image processing, bird and sound recognition.

https://ieomsociety.org/proceedings/2023detroit/36.pdf
this paper discusses the design process of a solar automated scarecrow.

https://stfn.pl/blog/09-pico-solar-panels/
a blogpost which delves a little bit into solar powering a Raspberry Pi board.

Thijs

https://bioone.org/journals/ardea/volume-98/issue-3/078.098.0303/Long-Term-Population-Developments-in-Typical-Marshland-Birds-in-The/10.5253/078.098.0303.full this research talks about the bird population in the netherlands. This might be useful to determine which

birds we want to attract and which birds we want to scare away. It is fairly old, but it talks about long term population development.

https://www.tandfonline.com/doi/full/10.1080/00063657.2021.1939652#abstract This paper again discusses more trends in bird population, which will help us to determine which birds we want to attract and which birds we want to scare away.

https://www.allaboutbirds.org/news/types-of-bird-seed-a-quick-guide/ Although this is not a scientific paper, this source will help us to make a system that recommends bird food for the user to insert.

https://dergipark.org.tr/en/download/article-file/4037334 this source talks about the design of bird houses, which will help us to design a birdhouse that is both functional for birds, as well as aesthetically pleasing for the user.

Leander

https://avianres.biomedcentral.com/articles/10.1186/s40657-018-0111-z In this paper the researchers try to find if birds have certain preferences in food type.

https://feederwatch.org/community/tips-from-feederwatchers/deterring-unwanted-visitors/ They try to develop defensive methods to keep away large birds from feeders that leave the feeders easily available to small birds.

https://www.diva-portal.org/smash/get/diva2:1708245/FULLTEXT01.pdf In this paper the researchers develop a “smart bird feeder” which is similar to what we have in mind.

https://www.sciencedirect.com/science/article/abs/pii/S0149763420304395 They summarize findings of other researchers that try to find ways to differentiate different birds of the same species. Which we could use to keep track of which bird has eaten how much.

Jort

https://www.frontiersin.org/journals/ecology-and-evolution/articles/10.3389/fevo.2017.00081/full Article on types of bird species that benefit from birdfeeders and how important it is to not overfeed one kind of bird because then other species have a less high chance of survival.

https://www.publish.csiro.au/mu/MUv111n2_ED: An appetite for connection: why we need to understand the effect and value of feeding wild birds

https://www.sciencedirect.com/science/article/pii/S0006320714003553: Risks and drivers of wild bird feeding in urban areas of New Zealand

Appendix B: Interviews

Interview Questions

1. I am interviewing you because you indicated you love birds, and you have a bird feeder. What is the primary reason you have a bird feeder? What do you enjoy about feeding birds?
2. What kind of birdfeeder do you have or how do you feed the birds at the moment?
3. Which birds do you enjoy seeing the most?
4. On the other hand, are there birds that you would prefer not to feed at the feeder?
5. How would you describe the types of birds that you most often see at the feeder.
6. What challenges or frustrations have you experienced with bird feeders in the past?
7. If you could implement any features in a bird feeder, what would these features be?

<*introduce design*>

8. Have you ever encountered large birds at your birdfeeder and have you experienced problems with these larger birds?
    a. Would you like your birdfeeder to be able to deter larger birds?
9. How often are you able to see birds in your garden?
    a. Would you like to get a notification when birds are feeding?
    b. Would you like to get a notification for a specific bird type, such as rare birds?
10. Do you know what types of birds feed at your feeder? ds
    a. Would you like to get information about the species of birds when you see them at your feeder?
11. Do you get the idea that there are birds who eat too much from your feeder?
    a. Would you like your bird feeder to be able to detect if a certain bird has already gotten food from the feeder that day to prevent overfeeding?
12. Would you consider using such a smart birdfeeder?
13. Could you rank the features we have discussed from what you would like most to what you want least?

Design:
Scare away birds
Notify the user when a bird has been detected
Identify the birds, count them and show the user
Stop feeding birds if they have been encountered several times already

End

1. How did you like participating?
2. Do you have any other remarks you would like to add or elaborate on?
3. What did you expect going into this interview?

Thijs interview 1

1. Vogelhuisje want ze woont in nieuwbouwwijk dus vogels aantrekken. Ze ziet niet vaak vogels. Concern voor katten.
2. bird feeder is een cirkel met een platform en een klein gaatje voor kleinere vogels
3. ze heeft een voorkeur voor bepaalde vogels, vooral ook voor vogelgeluiden met wakker worden.
4. dr zijn vooral kleine vogels in haar tuin, dus ze heeft niet echt een voorkeur tegen bepaalde vogels. Liever geen reiger. Geen moeite tegen grote vogels maar wel moeite voor kleine vogels
5. Heel weinig vogels, maar vooral kleinere
6. Current birdfeeder is niet heel mooi. Vogels blijven niet heel lang hangen, ze komen snel eten en dan gaan ze weer weg.
7. Meer ruimte voor de vogels om te staan, meer zachte bekleding, vogels lokken met geluiden. App om vogels statistieken te zien.
8. Nog niet problemen gehad met grotere vogels. Grotere vogels afschrikken maar wel zorgen dat het niet andere vogels afschrikt.
9. Ze ziet niet vaak vogels maar kijkt ook niet vaak, dus notificaties met eventueel statistieken zijn leuk.
10. Eerder beantwoord
11. Ze ziet niet heel veel vogels dus het is nog niet voorgekomen. Overfeeding is niet echt een concern voor haar, dus of de feeder het bijhoudt of niet maakt niet uit
12. Ja
13. Statistieken en notificaties bovenaan, afschrikken/overfeeding minder

Andere ideeën: foto’s van de foto’s opslaan en aan de gebruiker aanbieden als diegene dat wil. Wel disclaimers maken over data van camera's.

Leander interview 1

1. Ze houdt van dieren en helpt graag dieren in het algemeen. Ze heeft een tuin met redelijk wat begroeiing dus er zijn veel vogels in de tuin. Dus wil ze graag deze vogels helpen.
2. Huisjes met potjes pindakaas en vetbollen.
3. De kleine vogeltjes dus mereltjes, musjes, meesjes.
4. Ja, soms hangt er een grote ekster aan een klein vetbolletje of kraai.
5. Meestal zijn het koolmeesjes.
6. Vaak wanneer een grote vogel aan zo’n vetbolletje hangt, valt de bol op de grond, waarna de meeste vogels er niet meer van eten. Of ze maken een groot gat in het netje waardoor er een groot deel uit valt.
7. Iets dat grote vogels beperkt, of iets waardoor kleine vogels meer beschut zitten en niet worden weggejaagd door grote vogels.

8. Ja wegjagen zou dus graag willen
9. Vrijwel altijd
    a. Niet per se, je kunt ook gewoon een tijdje kijken totdat je een vogel ziet.
    b. Dat zou wel leuk zijn om zelf vogels weg te jagen.
10. ja, maar meer als ze ze niet kent. Inmiddels kent ze de meeste wel.
11. Dat zou ze niet weten aangezien er veel vogels van dezelfde soort zijn.
12. Als ze grote vogels goed wegjagen ja. Maar de notificaties hoeven niet per se aangezien er geen zeldzame vogels komen.

Mihai Interview 1

[sorry, when copying my questions got renumbered, subquestions got their own numbers]

1. *I am interviewing you because you indicated you love birds, and you have a bird feeder. What is the primary reason you have a bird feeder? What do you enjoy about feeding birds?*
   Enjoys watching birds and being able to see them from their window, especially with and for their kids, also considers it educationally [educational as in 'upbringing']. Mostly feeds birds in spring and autumn, considers winter months 'too cold' to maintain feed.
2. *What kind of birdfeeder do you have or how do you feed the birds at the moment?*
   Fat balls ["vetbollen"], peanuts on a string ["pindaslingers"] -- particularly fun as an activity with kids --, empty peanutbutter jars (has a small wooden holder for it), and a birdhouse [not for feeding] which was only visited once
3. *Which birds do you enjoy seeing the most?*
   Roodborstjes, Parkieten[1], Merels, Mussen, Mezen (beide)
4. *On the other hand, are there birds that you would prefer not to feed at the feeder?*
   Kraai because they're big and seem to scare off the other birds, Meeuw because they steal trash and litter [interviewee responded in general; the common seagull of that area is "Zilvermeeuw"]
5. *How would you describe the types of birds that you most often see at the feeder.*
   Kauwen, Mussen, Meeuwen, Mezen (beide), Eendjes (who come near feeder, but don't actually feed)
6. *What challenges or frustrations have you experienced with bird feeders in the past?*
   Three frustrations: in cold months it is inconvenient to put new bird feed out; sometimes birds don't come near the feed at all; often they don't see the birds feeding, and only notice that birds have been there due to the fact the food is gone. The interviewee owns cats, which means the bird feeding spot needs to be appropriately distanced.
7. *If you could implement any features in a bird feeder, what would these features be?*
   Two features: (1) wishes they experience see the birds from closer: from far away most birds look like silhouettes. Talked about something like a live video or audio stream to see the birds. Interviewee likened it to online live streams of cat feeders.

[1] Interviewee lives in an area of the Netherlands with a wild (escaped) population of Parakeets. These can be seen roaming in cities.

(2) wishes they could know how many birds came to feed there, akin to a "vogeltelling" [ie. a counter of the number of birds in each species that came by]

8. *Have you ever encountered large birds at your birdfeeder and have you experienced problems with these larger birds?*
   Yes, specifically seagulls, which trash the place, and "big birds". Interviewee noticed that when larger birds feed on the fat balls, smaller birds are too scared to get near, and often wait nearby. Also noticed problems with cats, but not other animals [eg. squirrels].
9. *Would you like your birdfeeder to be able to deter larger birds?*
   Probably yes, but would like to retain personal freedom in selection. Would also prefer to listen to expert advice (eg. advice from national institutes) regarding which birds should be selected against instead of making the choice entirely themselves.
10. *How often are you able to see birds in your garden?*
    Many, their residence is near a park and birds often fly over or perch in yard.
11. *Would you like to get a notification when birds are feeding?*
    Yes, but the interviewee mentions that they don't want to get spammed by notifications. Proposes either the ability to silent the notifications, or [after discussion] a daily overview of which birds were spotted.
12. *Would you like to get a notification for a specific bird type, such as rare birds?*
    Yes, very much, as they consider it difficult to spot the bird specie from a distance, and would like to be aware of the presence of rare birds.
13. *Do you know what types of birds feed at your feeder?*
    see answer to question 5
14. *Would you like to get information about the species of birds when you see them at your feeder?*
    Yes, would like to receive information (such as a wiki page or encyclopedia entry) of birds. Interviewee likes this feature more than simple notifications of which birds were spotted. Interviewee doubly likes this feature with respect to unknown or rare birds [tied to the discussion of question 12]. Also considers it neat from an educational [upbringing] point of view.
15. *Do you get the idea that there are birds who eat too much from your feeder?*
    Possibly, but unsure, mentions they are not an expert at this.
16. *Would you like your bird feeder to be able to detect if a certain bird has already gotten food from the feeder that day to prevent overfeeding?*
    In terms of certain bird individuals, no. In terms of certain bird species: possibly, but wouldn't want to make that choice themselves. Would accept getting advised by national institutes regarding this issue. Believes it is not their business to decide which birds eats and which doesn't.
17. *Would you consider using such a smart birdfeeder?*
    Concerned about data privacy, but considers the notifications a nice (smart) feature.
18. *Could you rank the features we have discussed from what you would like most to what you want least?*
    Positive: photos (video) of birds, information page of birds, educational value; Neutral: large bird deterring, selective feeding; Negative: yet another app that sends notifications

19. *Further remarks*
    Considers proposed design is also fun for their kids.

Mihai Interview 2

[sorry, when copying my questions got renumbered, subquestions got their own numbers]

1. *I am interviewing you because you indicated you love birds, and you have a bird feeder. What is the primary reason you have a bird feeder? What do you enjoy about feeding birds?*
   Continues a habit started by their partner, feeds birds and watches them, enjoys seeing them incidentally.
2. *What kind of birdfeeder do you have or how do you feed the birds at the moment?*
   Mostly a handful of grains, breadcrumbs, stale bread, or other leftover grain products [eg. polenta] left on a tile or plate.
3. *Which birds do you enjoy seeing the most?*
   Duiven (spec. Turkse Tortelduiven), Zwaluwen, Ooievaars[2]
4. *On the other hand, are there birds that you would prefer not to feed at the feeder?*
   Kraai
5. *How would you describe the types of birds that you most often see at the feeder.*
   Duiven, Zwaluwen, Mussen, Kraaien, Mezen (beide), en zelden een Meeuw
6. *What challenges or frustrations have you experienced with bird feeders in the past?*
   Excrement, attracting birds makes a mess in the general area surrounding the feeding spot. Interviewee particularly has the problem that flocks of birds tend to perch on their building when much feed is available.
7. *If you could implement any features in a bird feeder, what would these features be?*
   Mostly just wishes for cleanliness, something to prevent many birds from amassing.
8. *Have you ever encountered large birds at your birdfeeder and have you experienced problems with these larger birds?*
   Yes, specifically seagulls, but no problems with other large birds. Interviewee reports sometimes spotting a bird of prey in the sky, but never had problems.
9. *Would you like your birdfeeder to be able to deter larger birds?*
   Not really, no. [interviewee does not care much about the larger birds, but considers a mechanical method of deterring 'neat']
10. *How often are you able to see birds in your garden?*
    Many, their residence is near a forest [forest is further away than the park of the previous interviewee], and birds often fly over.
11. *Would you like to get a notification when birds are feeding?*
    No, does not care much about getting live notifications.
12. *Would you like to get a notification for a specific bird type, such as rare birds?*
    In general, no, but would consider it for rare or endangered birds specifically.
13. *Do you know what types of birds feed at your feeder?*
    see answer to question 5

[2] Interviewee is fond of [Ooievaars] and informs they do not come near bird feeding.

14. *Would you like to get information about the species of birds when you see them at your feeder?*
    Yes, but would like this more if the bird feeders were placed in public domain, such as parks or forests, by 'professionals' [eg. national institutes], to get information on birds which are not common in the city. Interviewee mentioned live streams of cameras placed in stork nests.
15. *Do you get the idea that there are birds who eat too much from your feeder?*
    Unsure, but also does not care much if the pigeons get fat.
16. *Would you like your bird feeder to be able to detect if a certain bird has already gotten food from the feeder that day to prevent overfeeding?*
    No, does not consider overfeeding or under-attracting certain birds an issue.
17. *Would you consider using such a smart birdfeeder?*
    Prefers the idea [suggested] of placing a monitored bird feeder in the woods (owned by institute / association) over personally owning a smart device. Also mentioned they prefer mechanical action to electrical action.
18. *Could you rank the features we have discussed from what you would like most to what you want least?*
    Positive: information page, bird photos, originality of focussing on birds [in contrast to common house pets as cats or dogs]; Neutral: large bird deterring, selective feeding, constant information; Negative: -
19. *Further remarks*
    -

Jort Interview 1

Interview *Grandpa*

1. I am interviewing you because you indicated you love birds, and you have a bird feeder. What is the primary reason you have a bird feeder? What do you enjoy about feeding birds?

I like watching the birds in my garden. I am quite old and live alone so it is good pastime.

2. What kind of birdfeeder do you have or how do you feed the birds at the moment?

I put out the feeding balls with seeds in them and sometimes chains of peanuts. In the wintertime, I put out more food. In the summer the birds are often in my garden without having to put out food

3. Which birds do you enjoy seeing the most?

The smaller birds and the Jaybird. The Jaybird is my favourite and quite rare to see in my garden. There are also different types of sparrows where I live which are fun to see. Especially the red chest sparrow.

4. On the other hand, are there birds that you would prefer not to feed at the feeder?

I sometimes see jackdaw birds which can be a nuisance. I also often have cats in my garden from one of the neighbours. I don't like it when the cat tries to hunt the smaller birds. Luckily I have never seen the cat catch a little bird.
Interviewer: What don't you like about the bigger birds?
The bigger birds scare away the smaller birds and make a mess in my garden. Sometimes the food balls fall from the tree and I expect that that is the doing of the bigger birds, but I have never seen that.

5. How would you describe the types of birds that you most often see at the feeder.

The smaller sparrows are very common. I live close to the park and they are abundant there. As I mentioned the Jaybird is rare to see.

6. What challenges or frustrations have you experienced with bird feeders in the past?

Can be difficult for an old man like me to hang them in the tree, so you might have to help me with that in the future. I sometimes have to clean up after the food balls have fallen.

7. If you could implement any features in a bird feeder, what would these features be?

No idea, I don't know much about technology.
<introduce design>

8. Have you ever encountered large birds at your birdfeeder and have you experienced problems with these larger birds?

Already answered previously.

    a. Would you like your birdfeeder to be able to deter larger birds?

That would be nice. I don't know how, but I would prefer only small birds and jaybirds in my garden.

9. How often are you able to see birds in your garden?

When I sit at the window quite often. There are quite often birds in my garden so I don't really need to wait long, just have to focus. Spotting them gets more difficult with my bad eyes, but if I focus I can see them.

    a. Would you like to get a notification when birds are feeding?

I have an Apple phone on which I do get text notifications, so it would be possible to get the notifications, but I am not good with my phone.

    b. Would you like to get a notification for a specific bird type, such as rare birds?

That would be nice, it has been a long time since I have seen a jaybird and maybe there are other birds in my garden of which I don't know they came here.

10. Do you know what types of birds feed at your feeder?

Mostly sparrows

    a. Would you like to get information about the species of birds when you see them at your feeder?

I have lived here for very long so I think I know all the bird types by now.

11. Do you get the idea that there are birds who eat too much from your feeder?

I don't know. Never thought about that.

    a. Would you like your bird feeder to be able to detect if a certain bird has already gotten food from the feeder that day to prevent overfeeding?

Interviewer had to explain a bit more about overfeeding
That sounds indeed like a problem. I like the variety of sparrows. It is more fun to see different sorts than just them same. So if overfeeding is a real problem here than I would prefer if I didn't make the situation worse.

12. Would you consider using such a smart birdfeeder?

If I don't have to do a lot of settings or you come to help me with it then yes. The youth know a lot about technology, but I don't

13. Could you rank the features we have discussed from what you would like most to what you want least?

For which do I need to do things with my phone?
The interviewer explains for which features an app is necessary.
Scare away birds - prevent overfeeding - Notify with rare birds - Identify birds
I have no use for an app because I won't learn how to use it. I am too old for that.

End

1. How did you like participating?

Fun and nice to see what you do at school, sounds very advanced

2. Do you have any other remarks you would like to add or elaborate on?

No not really

3. What did you expect going into this interview?

I didn't know what to expect. Never thought at my old age anybody would interview me about technology.

Jort Interview 2

Interview *uncle*

1. I am interviewing you because you indicated you love birds, and you have a bird feeder. What is the primary reason you have a bird feeder? What do you enjoy about feeding birds?

I like to see them in the garden, for example when I work from home. In the wintertime, I think it is good to feed the birds.

2. What kind of birdfeeder do you have or how do you feed the birds at the moment?

On a small plateau, we have hanging from the trees. I put the food on there and watch birds feed from it.

3. Which birds do you enjoy seeing the most?

Tit birds are fun to see. They are quite small and chirp a lot.

4. On the other hand, are there birds that you would prefer not to feed at the feeder?

We have a lot of doves in the area which I don't really like. We sometimes have ravens I think.

5. How would you describe the types of birds that you most often see at the feeder.

Small birds are plentiful, I don't know all the names of the birds.

6. What challenges or frustrations have you experienced with bird feeders in the past?

Not that many to be honest. I just put seeds on the plateau and that is it.

7. If you could implement any features in a bird feeder, what would these features be?

No idea, I like the simplicity of the feeder. Doesn't have to be too complicated.

<introduce design>

8. Have you ever encountered large birds at your birdfeeder and have you experienced problems with these larger birds?

Doves as I mentioned are annoying because they shit a lot.

    a. Would you like your birdfeeder to be able to deter larger birds?

That would be something I am interested. I don't know what you are thinking about, I don't want to harm the birds ofcourse.

9. How often are you able to see birds in your garden?

Not that often. During Covid is was more, because I worked more from home then.

    a. Would you like to get a notification when birds are feeding?

Not really, I am not that fanatic

    b. Would you like to get a notification for a specific bird type, such as rare birds?

I don't know if there are any rare birds near me, but that would be cool. I rather use the feature for that then knowing when a bird is present.

10. Do you know what types of birds feed at your feeder?

No not really.

    a. Would you like to get information about the species of birds when you see them at your feeder?

I don't know how much I would use that feature. In the beginning it would be fun I guess, but eventually it would probably get repetitive.

11. Do you get the idea that there are birds who eat too much from your feeder?

I don't know to be honest.

    a. Would you like your bird feeder to be able to detect if a certain bird has already gotten food from the feeder that day to prevent overfeeding?

I mostly put out food during the winter so I don't think it is a problem then, but if it is I would like to know. Then I would put out less food or indeed your solution would also work

12. Would you consider using such a smart birdfeeder?

No, I think the idea is cool, but not everything has to be made complicated.

13. Could you rank the features we have discussed from what you would like most to what you want least?

Scare away birds - Stop overfeeding - notify user - identify birds

End

4. How did you like participating?

Was fun, but unfortunately, we had to rush the conversation a bit, because of time constraints.

5. Do you have any other remarks you would like to add or elaborate on?

Not really

6. What did you expect going into this interview?

Not that much, didn't really have the time to make expectations since you just asked me and we started it.

Luca Interview 1 + 2

Interviewed a couple

1. Primaire reden is vogels bijvoeren in de winterperiode. Het is leuk om de vogels van dichtbij te kunnen aanschouwen.
2. Silovoeder, en losse vetbollen en potten "pindakaas" en korstjes brood.
3. Pimpelmees en koolmees en roodborstjes.
4. Eksters, Vlaamse gaaien en kouwen.
5. De kleinere vogelsoorten zoals de mezen en mussen.
6. Dat de grotere vogels alles in één keer meenemen (korstjes brood) en niks voor de kleinere vogels overlaten.
7. Mogelijkheid 3: vogels identificeren en tellen. (liefst de mogelijkheid om dat in een app te kunnen nakijken.
8. Grotere vogels zijn te zwaar voor de voedersilo die wij hebben. Één voedersilo die wij hadden is door het zware gewicht van de vogels kapotgegaan.
   a. zou mooi zijn maar heeft geen prioriteit.
9. Iedere dag.
   a. + b. Zou mooi zijn maar wat ons betreft geen "must".
10. We herkennen inderdaad alle vogels die gebruik maken van de voedersilo.
    a. is leuk maar absoluut geen "must".
11. Is voor ons niet na te gaan. Vogels vliegen af en aan.
   a. Nee
12. Afhankelijk van de prijs.
13. Notify the user when a bird has been detected
    Identify the birds, count them and show the user
    Scare away (larger) birds
    Stop feeding birds if they have been encountered several times already

Appendix C: Timelog

Time Log			
Week	Who	Break down of hours	Hours
1	Leander	Lecture (2), literature research (2), meetings (2), problem statements & objectives (1)	7
	Thijs	Lecture (2), literature research (2), meetings (2), Requirements (4)	10
	Pijke	Lecture (2) Literature research (3), meetings (2)	7
	Mihaita	searching literature on classification (1), searching more literature on classification and also existing projects (3), meetings (2)	6
	Luca	Lecture (2), meetings (2), research and literature research (3)	7
	Jort	Starting lecture (2), literature research (4), user identification (2), planning (1), meetings (2)	11
2	Leander	Meetings (2), Interview (1), Sketching (2)	5
	Thijs	Meetings (2), Interview (1), Sketching (3)	6
	Pijke	Meetings (2), Researching existing features (6)	8
	Mihaita	Meetings (2), Interviews & processing (2), Collecting bird feeder pictures (1), R&D on a RPI3 (3)	8
	Luca	Meetings (2), interview (2), researched some components (3)	7
	Jort	Meetings (2), Interview questions (2), Interview (2), Conducting research into bird feeding (4), meeting (1)	11
3	Leander		
	Thijs	Meetings (2), Attracting birds research (5)	7
	Pijke	Meetings (2), Design (4), Design decisions (4)	10
	Mihaita		
	Luca	Meetings (2), electronics (5)	7
	Jort	Affinity diagram (3), Changing MoSCoW (1), working on Wiki (3), meetings (2)	9

Time Log			
4	Leander		
	Thijs		
	Pijke	Meetings (2), Design decisions (7)	9
	Mihaita		
	Luca	Meetings (2), servo + RPi (6), soldering & electronics (2)	10
	Jort		
5	Leander		
	Thijs		
	Pijke		
	Mihaita		
	Luca	Testing camera and RPi (4), implementing components (3), fixing issues (3)	10
	Jort	Testplan(2), to-do list (2), work on wiki (3), meetings (2)	9
6	Leander		
	Thijs		
	Pijke		
	Mihaita		
	Luca	Testing servo motor and RPi (5), implementing components (3), fixing issues (4)	12
	Jort		
7	Leander		
	Thijs		
	Pijke		
	Mihaita		
	Luca	Meeting, preparing presentation, work on wiki ….	
	Jort		