Automatic Pet Feeder

EEL 4914: Senior Design 1- Group 12

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1. Project Description

This project aims to fully automate the process of feeding your pet. The intention behind this is to keep them on a consistent diet, which is essential in ensuring your pet lives a happy and healthy life. The automatic pet feeder will be paired with an app that asks for your pet's breed and weight to determine the correct amount of food to give each day. The device will measure the correct amount of food out on it's own and disperse it at specific times of day set by the owner. Additionally, the app comes with the ability to send notifications to alert the owners when food or water is low and gives them the option to feed them as well. All of this creates an enjoyable experience for both the owner and the pet.

The design of the pet feeder will feature two containers where one is used for food while the other is used for water. For the container that is filled with water, it will deliver water into the bowl through the pump at a steady speed. The container filled with food will use a motor that will spin a wheel, allowing food to be dropped into the bowl. The wheel will be a set size, but if the owner decides to put more food, they can tell the app to feed more than once.

Our motivation to build a pet feeder is to solve several problems that owners encounter when taking care of a pet. Sometimes, pet owners are busy with other life events or work that they wouldn't have any time to feed their pet. As time progresses, more people are becoming busier each year. So, they would have moments where they would not be able to fully take care of their pet every day. So, sometimes they may overfill the bowl to make sure their pet doesn't starve, but what about filling the other bowl with water. It is also very important for the pet to have water but it's not like you can overfill it like a food bowl. Therefore, it would be important for there to be a set schedule for the pet feeder where the owner wouldn't have to keep filling the bowl. All they would need to do is make sure the container is filled, and the pet feeder would do the rest of the work. This way, the owner can cross that off the to-do list and take care of the business they have to attend to because the pet feeder will take care of their pet.

In addition to taking care of business, the owner also would be able to leave their home and still have the ability to feed their pet, because the pet feeder would be connected to an app where they can feed their pet from anywhere. For example, if it's just one person that lives in a house and

they work all day, while they're at work, they can use the app to feed their pet. Unfortunately, in some situations the pet needs to go on a diet. Our pet feeder will allow the owner to choose how much they want to give their pets so they could limit the amount of food the pet eats. This way, the owner wouldn't have to measure the amount of food given every time it's time to eat. Overall, the pet feeder will give pet owners an opportunity to not only set a schedule to feed their pet, but also feed them whenever they want.

This project will provide an exciting journey for our last few semesters as we will be working with developing apps and using sensors, motors, pumps, and other electronic components we don't get to work with often. Not only will it help us get familiar with these components, but it will help us learn and fully understand how and why they're used.

2. Goals and Objectives

In today's busy lifestyle, many pet parents are finding themselves having to compromise valuable time in order to ensure that their loved pets have all the basic needs they require, such as water, food and shelter. According to a report done by Science20, millennials and gen-z are considering their pets as the `new` kids and are increasingly looking for ways to provide them with the best possible care. As other responsibilities arise throughout the day, and taking into account a pandemic that has made life at home a whole lot more hectic and busy, providing pet parents with a way to streamline and automate some of the repetitive and cumbersome tasks of caring for their pet, can alleviate the complications and time required to ensure these basic needs are met.

The Automatic Pet Feeder provides the support that pet parents need in order to keep their pets always cared for. By automating the pet feeding and water bowl tasks, pet parents can focus their time on other activities, such as playing fetch, and giving belly rubs, while always having the peace of mind that their pets will always have food and water. Not only will pet parents be able to automate these tasks but also to adjust the amounts, timing and general setting of the feeder to meet their needs. The motivation for this project is to demonstrate our knowledge and understanding of engineering concepts and processes that we have acquired during our time at the University of Central Florida. Not only does this project serve as a great display of our skills

as future engineers, but it also provides us with a chance to collaborate as a team on a meaningful project and get some more hands-on experience that we can carry over to our professional careers.

This project is also composed of several goals and objectives that describe the standards that we abide by when providing an end design and the expectations that we hold for its completion. These goals and objectives include but are not limited to,

Accuracy - Different pets require different care, whether it is a dog, a cat or another household pet that requires eating dry food, the amount of food and meals can differ drastically depending on each pet and the parent's preferences, therefore ensuring that the automatic pet feeder provides accurate quantities on a consistent, accurate schedule is of utmost importance. By providing a reliable schedule, the pet parent can be sure that the dietary needs of their pet are met each and every day without fail

Convenience - As outlined throughout the entirety of this document, we aim to provide pet parents with an easy and convenient way to ensure their pets have most of their basic needs covered at all times. By providing an automatic way of serving food and water for the pet, the parent does not need to worry that the correct amount of food has been served and that the water has enough for their pet to easily access and drink whenever they desire.

Software - One of the convenient features of the automatic pet feeder, and probably one of its most important ones, is its integration with a mobile app. The mobile app will contain settings to set the amount of food that the device dispenses on each meal, how many meals happen a day and a way to halt the automatic process as required, whether this is for purposes of cleaning or because the pet isn't at home. The software that the mobile app is built on must be free of any major bugs and be reliable in order to ensure that the correct settings are being propagated to the device and that the core features that the feeder provides are all configurable and easy to modify. The software must also be active and ready to use at all times; any interruption to the service will prevent the parent to even use the feeder as they would expect and would prompt them to regress and use a different more manual alternative to feed their pet.

Hardware - Since pet's exist in a physical space, providing software without its hardware counterpart would not be much effective, and would, in our case, be borderline useless for the purpose of providing a convenient and easy way to feed pets. That is why the hardware that the device is built on must, at a minimum, be able to complete all the tasks that are listed as basic features of the feeder. The feeder must be able to plug in to a power source and stay online while it is receiving enough power. It will also include a microcontroller which will be responsible of controlling all aspects of the feeder, including the dispensing of both water and food, keeping track of when and how much food was served and allowing for notification to the mobile app as well as being able to handle the commands sent by the mobile app in a timely manner

3. Features

This section will mention the many features that the automated pet feeder will have and explain why they are important.

3.1 Basic Features

The app will be where almost everything is controlled. It can function like an alarm when there is not enough food and water in the pet feeder. It will also allow the user to pour either the water or food from their device so they would not have to physically be there to feed their pet. When pouring the meals for the pet, the user can make a decision on how much they would like to put in, and once they have made their choice, the pet feeder will then drop however much that the user decides. Another feature of the app would be different options based on the breed of the pet. There will be different options of dog and cat breeds, and the amount of food poured will vary based on the user's choice.

The flood sensor will be able to detect the current water level of the container. Once the water level reaches a certain point, the sensor will activate and this would send a notification to the app on the user's device alerting them that the amount of water in the container is not enough. When the user uses the app to send a signal to the microcontroller, the pump inside the pet feeder will activate and pour water into the bowl.

The weight sensor will be used to measure the amount of food in the other container. This sensor will operate just like the sensor for the water bowl. These sensors will make it very easy to keep track of how much food and water is in the containers and will alert you as soon as it activates. When the user chooses to add the food into the bowl, they can use the app that is connected to the pet feeder. The app will be connected to the microcontroller inside and will signal the circuit to deliver power to the motor which will then turn the wheel to provide the food into the bowl. The device would have a built-in clock that will turn the motor which will then spin the wheel by a set angle so it can pour the food in the bowl.

A motion sensor will be used when the user wants to take a look at their pet being fed. It could also be for something as simple as just wanting to see them since they wouldn't be home at the time. The sensor will sense any movement and notify the user that something has moved. This can also add a sense of security since the pet feeder would most likely be placed in something like a living room. So, if there's any event someone breaks in, their pet feeder could actually alert the user and they can take action how they see fit. However, the main focus of this motion sensor is to give the user an opportunity to see their pet whether it be for feeding time or because they just want to see them.

Although this is an automated pet feeder, it still must be washed. This is why it will include removable bowls and containers so the owner can take it out and wash it whenever they feel necessary. Some may wash more than others, but it's important for the pet owner to be able to wash the bowls and containers so their pets can eat clean food.

3.2 Advanced Features

One of the more advanced features will include a camera that shows a video of the view from the pet feeder. This will allow the user to make sure that their pet is being fed at the time that was set. They can look through the camera to also double check that the food is being poured and that it's the correct quantity of food. The user can also use the camera to look around to see if the pet is nearby which uses the motion sensors.

A microphone will allow the user to set voice messages for their pet while they're away to give a sense of familiarity to the pet. For some people, they call their pet's name when it's time to eat. Even though there may be a set time for the pet to eat, that doesn't mean the pet will come to eat. So, to fix that problem, the user will be able to set a pre-recorded voice message through the app and will play at the time the user set for the pet feeder to fill both bowls. Once it is time to eat and the voice message plays, the pet will recognize the user's voice and will be more likely to respond. Once it follows where the voice came from, the pet will see that it is time to eat and enjoy their meal.

4. Constraints and Requirements

Design constraints and requirements is an important topic to be discussed. This section will take into account things we will need to consider in our journey through Senior Design.

4.1. Constraints

4.1.1. Each component needed to complete the project should have an estimated time of arrival, taking into account the current shortages of electronics due to the pandemic and the supply and demand issues, as well as regular and temporary shipping delays.

4.1.2. Availability of each team member to contribute to the project due to other classes, individual life schedules and unexpected responsibilities that may arise

4.1.3. As it occurs in many group projects and activities, the clashing of ideas and not being on the same page could pose a threat as different priorities could arise, delaying the project's final delivery.

4.1.4. Materials and components required to complete the project might not be available during the time of the project's deadline.

4.1.5. Because we are dealing with a motor that will dispense dry pet food, which is usually several relatively small objects, there is a risk that the food will get stuck while dispensing it to the bowl.

4.2. Requirements

4.2.1 The automatic pet feeder should be of a reasonable household item size; it must not take up too much space and should be easily able to blend in with other appliances and gadgets around the pet parent's residence.

4.2.2. Sensors for detecting movement of pets in order to determine whether the food can be dispensed at the given time.

4.2.3. Sensors for measuring water levels in both, the bowl where the pet will be drinking out of and the container that will hold the remaining water used to fill the aforementioned bowl.

4.2.4. Motor that will be responsible for moving the dispensing gate and serving the correct amount of food to the bowl when the interval or preset time of feeding has been reached.

4.2.5. Water pump that will be connected to the main water container and will be responsible for dispensing to the water bowl whenever this is lower than a certain threshold.

4.2.6. A microcontroller that will be responsible for controlling the motor, reading sensor data and allowing for two-way communication between the feeder and the mobile app.

4.2.7. Ensure the noise level that is emitted by the automatic pet feeder is not disruptive to other activities happening in the household. That is, the feeder shouldn't wake up the whole family, in the event that it dispenses food in the middle of the night.

4.2.8. Both water and food containers should have funnels at the top to allow for easier refilling, assuming the food will be poured from a pet food bag.

5. Design

The current design in Figure 1 consists of two containers which serve to periodically pour food and water into the pet bowls. The two bowls contain funnels at the top in order to allow the user to fill up the containers in an easier manner. Both containers have sensors that will determine when food or water are running low to be able to notify the user for them to refill them at their earliest convenience. The water container contains a pump that is in charge of pouring the desired amount of water into the water bowl; the pump will only activate when the water inside the bowl is running low. In the same manner, the pet food container includes a measuring cup that holds about half a cup of food which is connected to a motor. This motor rotates 180 degrees in order to drop the food into the pet food bowl. If more than half a cup of food is required, the motor spins several times until pouring the desired amount the user configured in the app. Both the water and pet food bowls include weight sensors at the bottom that let the user and inner control know how much is left in each of the bowls and tell the program how to act accordingly. The pet feeder also includes a motion sensor that determines whether the pet is close to the feeder and allows for food to be dispensed.

The automatic pet feeder's design is not only composed of a hardware device that holds food and water but it also contains a mobile application which serves as a communication hub for the device. The mobile app serves as a one stop shop for managing all the settings of the pet feeder itself, it allows the user to configure different aspects of the feeder, such as the amount of food it should serve per meal, the amount of meals it should serve per day and allow for other settings such as pouring food and water on command when the user needs it instead of waiting for the predefined timer to be reached, which is a bit of a manual task, we agree. The app not only sends information to the feeder in order to change its settings but it also receives communication back from the feeder. The communications received by the feeder serve as notifications for tasks that the user should be made aware of. These notifications include letting the user know when either of the containers are low on food or water, the device is misbehaving and needs a restart, the water has not been changed in a while for the pet, or any other important information regarding the feeder.

In order to make the app functional, the feeder's main body will contain a microcontroller capable of communicating with an external mobile app. The microcontroller will contain a communications module which will be programmed to listen to incoming commands from the mobile app and react accordingly in order to adjust any settings or process and instructions the user sent. In the same manner, the microcontroller will keep track of the state of the components of the feeder in order to send the respective notifications to the user back in the mobile app.

An initial design prototype of the feeder can be observed in *Figure 1* below. It includes an outside view of all the components necessary for the actions to be properly performed in the feeder. As observed, the funnels at the top of the containers allow for easier pouring of both water and food. The feeder also contains a camera, displayed in *Figure 1* between the containers, which allows the pet parent to periodically check the camera feed in order to better interact with their pet, even when they are not physically present in the household. The food container also includes at the bottom, a predefined measuring cup which will make it easier to provide different amounts of food depending on the user's preferences.

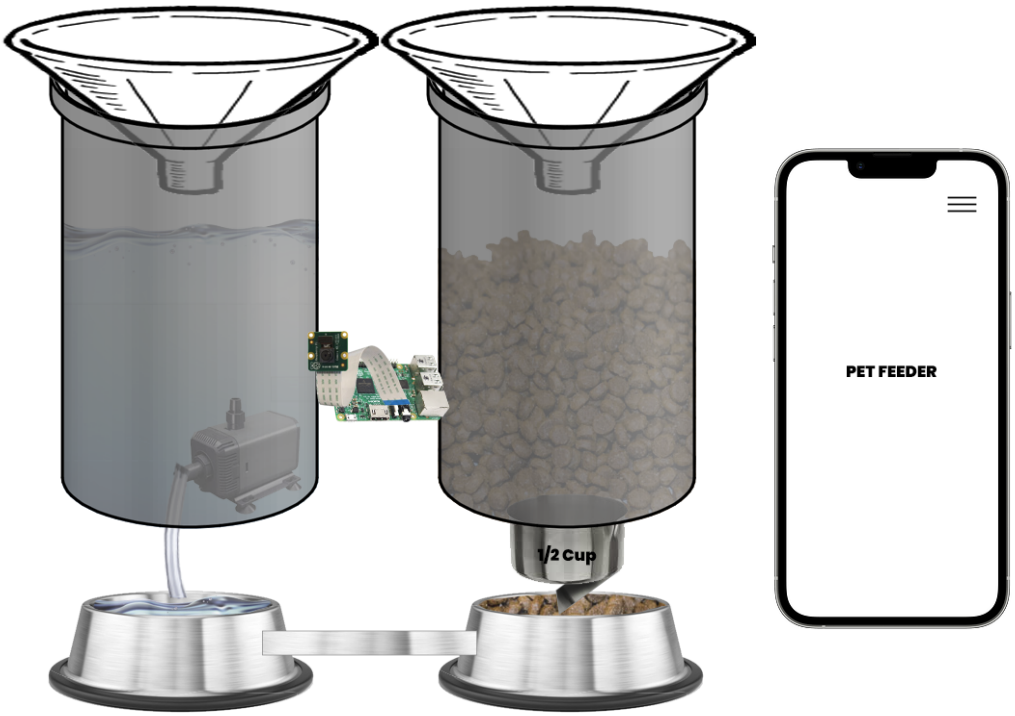

Figure 1: Initial design idea

6. Block Diagram

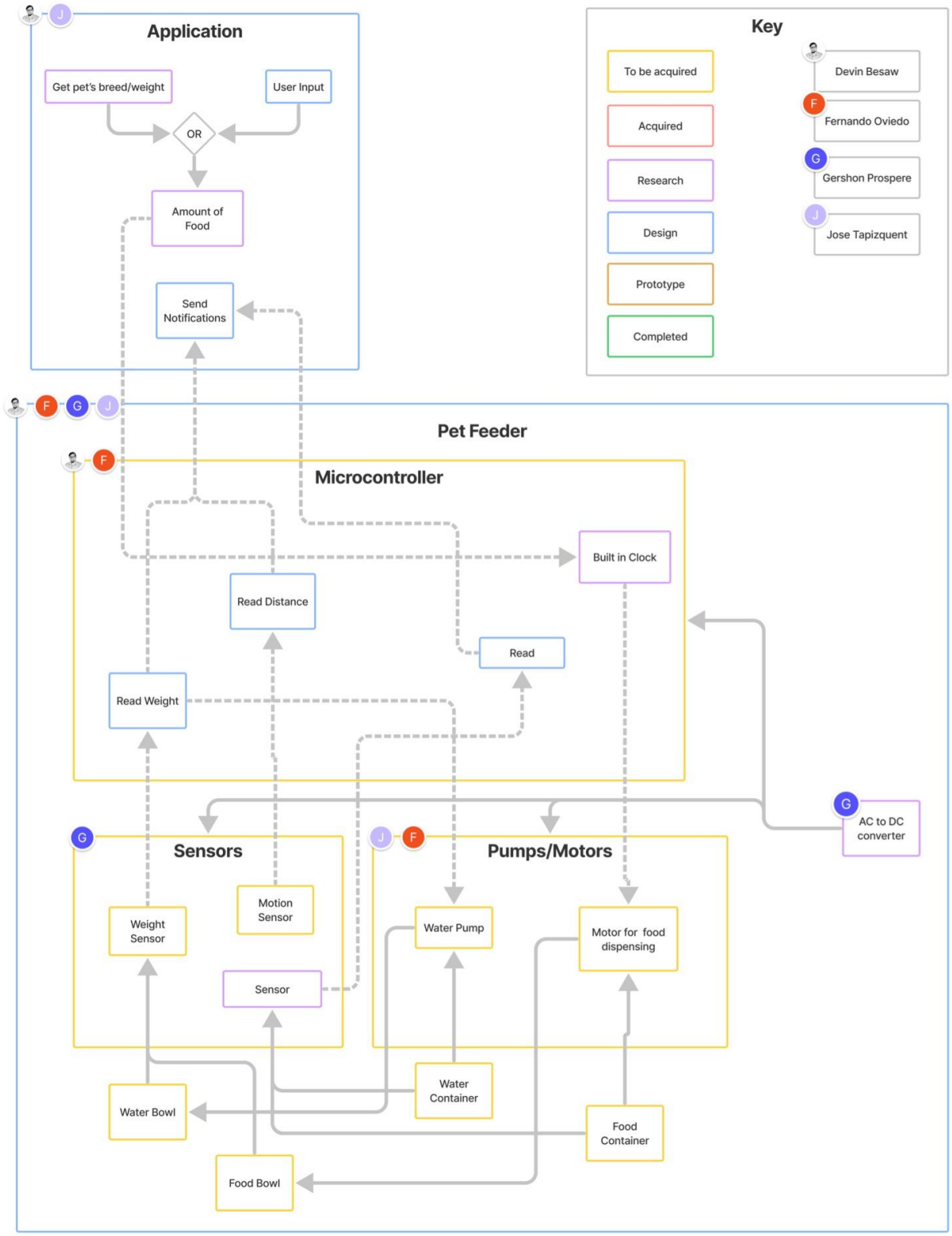

Figure 2: Block diagram of hardware and software

7. House of Quality

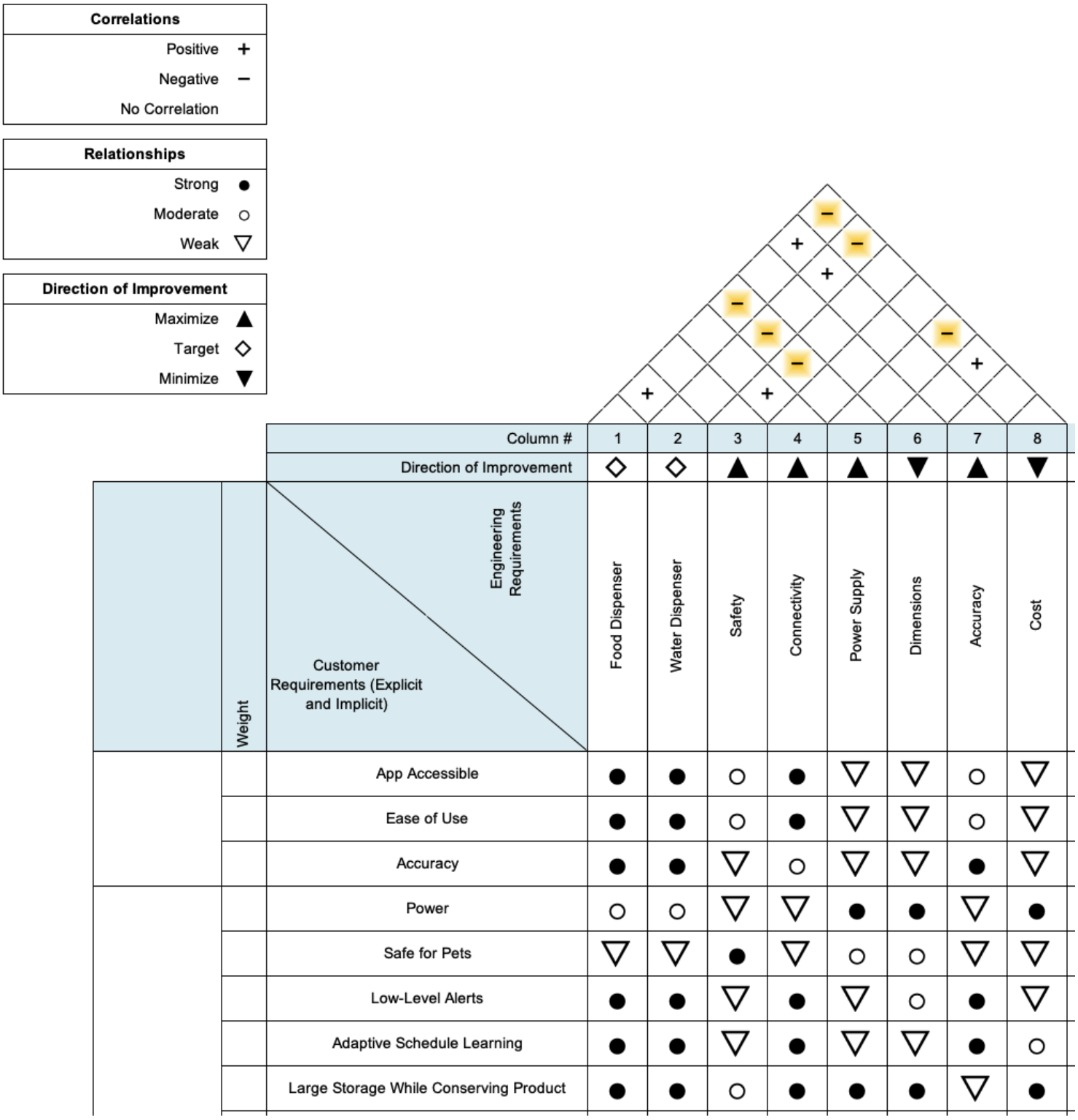

Figure 3: House of quality diagram

8. Research

In the United States alone, about 70% of households own at least 1 pet which is equivalent to about 90.5 million families (Table 1).

Pet	Number
Dog	69.0
Cat	45.3
Freshwater fish	11.8
Bird	9.9
Small animal	6.2
Reptile	5.7
Horse	3.5
Saltwater fish	2.9

Table 1: The number of households, in millions, that own pets in the United States

(Source: the American Pet Products Association's 2021-2022 National Pet Owner Survey)

It is safe to assume that most of these pet owners use some type of animal feeding system to make sure that their pet is well taken care of. A lot of pet feeders require the owner to manually pour the food in the bowl. Although it is the cheapest way to deal with feeding your pet, it also involves human error so they may end up putting too much or too little. Using a measuring cup could fix this problem, but human error is still a factor and sometimes trying to get that perfect amount is too much of a hassle for some people. So instead of having to pour the food manually every time you need to feed your pet, they can use an automated system instead which does it for them. There are pet feeders out that are automated, however, they're mostly made to dispense food. Considering that some pet feeders are automated, those tend to be more expensive.

Year	Expenditure (2)
2010	$48.4
2011	51.0
2012	53.3
2013	55.7
2014	58.0
2015	60.3
2016	66.8
2017	69.5
2018	90.5
2019	97.1
2020	103.6

Table 2: The amount of money, in billions, spent in the pet industry
(Source: the American Pet Products Association).

Table 2 shows that the amount of money spent by consumers on their pets has been increasing for years. Based on this trend, it will continue to be on the rise especially with the increase in demand for pet products. This includes automated pet feeders whose market size is rapidly increasing as well.

7.1 Existing Similar Products and Projects

Providing pets with their necessary daily intake of pet food and water is no new task for pet parents around the world, whether that is grabbing a cup and scooping some food out of the food bag every time they are going to feed their pets, or leaving food all day in food bowl, or keeping food in a container and having a rotating dispenser for a manual, pre-measured amount of food, this is a common task for every pet parent out there and thus several organizations have released products that help with this tasks coming in various designs and use cases.

Exploring the current products provided for the care and maintenance of pets, we can observe several different items that each, in its own way, tries to provide peace of mind for pet parents when it's time to feed their pet.

Figure 4: Indispensable Dry Food Dispenser

Currently, many pet parents are using dry food dispensers in order to keep a measured control on their pet's eating habits. During our research, we have noticed that using a dry food dispenser like that showcased in Figure 4 is a common alternative for pet parents to manage the amount of food they provide their pets. By allowing them to store the pet's dry food in a sealed container, pet parents can remove the dry pet food from the bag where it comes from and add it into the dry food dispenser's container, simplifying a bit the need to store this bag in a safe, dry place, as well as minimizing the need for a separate scoop or measuring cup in order to serve the food to the pet. The dry food cereal dispenser dispenses food by turning the knob shown at the front of the device, dispensing as much food as each of the inner turning compartments hold. If they require a specific amount of food, the user would have to measure how much food each turn provides and then they would have to calculate how many turns they would need in order to feed their pet

the correct amount. While this is, in theory, an upgrade to scooping food out of the bag, measuring the right amount and pouring it in the bowl every time the pet needs to eat, it still lacks the automation features and requires tons of manual work in order to properly feed a pet.

Figure 5: PetSafe Gravity Feeder

Figure 5 provides a clever and inexpensive approach attempting to automate, to some extent, the task of feeding a pet throughout the day. Per PetSafe's description of the gravity feeder, the feeder let's a pet eat their food whenever they are hungry. This is done by continuously releasing food onto the bowl once the food starts lowering. The feeder includes a container which can hold up to 4 pounds of pet food and PetSafe claims it to be very easy to clean by allowing the user to remove the feeder's stainless steel bowl and drop it in the dishwasher. While PetSafe's Gravity Feeder provides some level of automation, the thematics of the design are quite cumbersome. Allowing food to always be in the pet bowl while not having a way to measure the amount that has been poured or how much food the pet has eaten could lead to some pets overeating, as well as not having a consistent feeding schedule, causing the pet to potentially get confused about the feeding time and, in cases where the pet might be undergoing potty training, it promotes an unpredictable potty schedule. It is good to note that this feeder does not account for the water bowl, which is equally, if not more important that the food dispensing itself, requiring that the

user acquire an extra separate bowl, probably from a different brand, and have yet another thing to worry about and keep track of to ensure the pet has enough water at all times. This feeder is nonetheless an improvement from having to scoop out food from the food bag each feeding time and comes with a relatively low cost but it still does leave a lot to be desired.

Figure 6: Arspic Automatic Pet Feeder

The Arspic Automatic Pet Feeder (depicted in Figure 6), on the other hand, provides some more control over the automation of the pet feeding. By providing accurate and programmable timed feeding, the automatic pet feeder allows to schedule a healthy routine for the pet. It dispenses pet dry food up to 4 meals per day with 1-20 generic portions per meal, so that the pet can get a more precise amount of food at a more precise interval. This pet feeder provides a lot more functionality than the previously discussed pet feeders but it still falls a bit short of what could be implemented in order to make the process of pet feeding a whole lot easier. It is also good to mention that this feeder also comes with a higher price tag, making it harder to acquire for some families. While the feeder provides pet owners with a preset amount of food at specific intervals during the day, the process can still be quite manual. The feeder only allows for the setting of the

intervals of food only through the on-device screen and buttons, still requiring the pet owner to be present at the site where the feeder is in order to initially set these meal intervals as well as the amount of food that is going to be dispensed. The preset amount of food also poses some issues; it only allows for one preset amount of food for every meal the pet requires. While to some pet parents setting the same amount of food for every meal could be enough, it makes it harder on other pet parents who might need their pets to have different amounts on each meal, whether this is due to a dietary restriction, or even their own personal preference.

9. Estimated Budget and Financing

The first item on our list in Table 3 has to do with the casing that will contain everything. For this we will be going with a pre-existing design to avoid having to deal with any mechanical engineering. So, for the food dispensing portion, we'll have to find an already working dispensing mechanism that we can gut and override. For the water dispensing portion we will only need something to contain the water and a water bowl for the pet to drink out of. The water dispensing will be done with a pump and tubing that goes from the container to the water bowl. The type of pump we will be purchasing will be an aquarium pump because of low cost, low power consumption, and the fact that we don't need a high flow rate. For the microcontroller, we can go with an arduino or a raspberry pi which will come at no cost due to group members already owning them. Both of these microcontrollers come with the benefit of ease of use. Arduino has their own IDE with the primary coding language being C/C++. A Raspberry Pi's primary programming language is Python which is a higher level language. Both have their pros and cons and we'll have to decide which one better fits our needs. Next, in Table 3, is the PCBs we'll have to print. The cost of this comes down to how many PCBs we need for the project and how many work when we get them. For the power supply, we plan on going with an AC-DC wall power adapter. These are cheap and supply a constant voltage for our device. They also eliminate having to deal with high voltages. Lastly, we will be using a small DC motor to open and close a door and some sensors that should be inexpensive and power efficient.

Item	Price
Casing	$50
Aquarium Pump with Tubing	$20
Microcontroller	$0
PCBs	$10 - $50
Power Supply	$20
Motor	$5-$20
Motion Sensor	$0
Water level sensor	$0
IR sensor	$16
Pressure Sensor	$10

Table 3: Itemized list of materials

10. Initial Milestones

At the start of Senior Design I, our class was tasked to start planning for a timeline of how to accomplish this project through thorough research and detailed analysis of the components chosen. These tasks are called milestones by the Senior Design Advisors. In the Goal section, we discussed what we want to accomplish week by week. The report's time table is approximately 15 weeks, in which we will go over different resources that will help build our project. Also list several active products in the market as a form of research and comparison to further achieve the goal that we have in mind to pursue a unique Autonomous Pet Feeder by adding some small yet very effective features that will separate our product from the rest. This list (Table 4) will display the week in which we are working on, the deadline when the milestone is due, and description of our project based on the milestone we are trying to accomplish.

Week #1	Due Dates	Milestones
1	1/14/22	Form a group and brainstorm ideas
2	1/21/22	Complete ABET quiz 1 and 2 Attend Bootcamp Choose an Idea
3	1/28/22	Complete Bootcamp quiz
4	2/4/22	Complete ABET quiz 3 and 4 Finish Initial Project Document - Divide and Conquer
5	2/11/22	Complete ABET quiz 5 and 6 Work on D&C V2
6	2/18/22	Complete ABET quiz 7 and 8 Finish Updated Divide and Conquer D&C V2
7	2/25/22	Start ABET quizzes Work on 60 Page Draft
8	3/4/22	Work on 60 Page Draft
9	3/11/22	Work on 60 Page Draft
10	3/18/22	Finish ABET quizzes Work on 60 Page Draft
11	3/25/22	Finish 60 Page Report
12	4/1/22	Work on 100 Page Draft
13	4/8/22	Finish 100 Page Report
14	4/15/22	Critique 100 Page Report
15	4/22/22	Critique 100 Page Report
16	4/29/22	Complete the Final Document by Tuesday 4/26/22

Table 4: Senior Design 1