Automated Pet Food Dispenser

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***Abstract* — Feeding pets while away from home is difficult to do manually. How can you ensure that your beloved pet eats one meal during lunch instead of multiple prepared portions? The Automated Pet Food Dispenser is designed to allow pet owners to freely feed their pet from a remote location as if they were present themselves. The design allows the user to fill the feeder's container with dry pet food. The food is dispensed to the pet with a specified amount that is set by the user to allow exact portion control for their pet.**

***Index Terms* — Sensor systems, Microcontrollers, Circuits, Displays, Mobile applications, Wireless networks**

I. Introduction

The automatic pet food dispenser aims to ease the daily life of the average pet owner that is occupied with the daily woes of a busy life. The design will allow the pet owner to provide measured food portions to their pet. The food portions, or meals, will be dispensed to the pet's bowl at specific times that are pre-set by the owner. The dispenser is made to help the pet owner set a schedule to feed their pet automatically without the extra cost of a pet-sitter or the need for a friend that has to be "let in" to feed their pet. This can help those who are traveling since they don't have to worry about feeding their pet while on vacation. This device will also make life easier for most working people, they can simply set scheduled times and the portion amount they want for their pet instead of worrying about filling the bowl before leaving for work. This also eliminates the possibility of leaving too much or too little food, the owner can control the diet of the pet. This device allows the owner to set the desired amount to dispense. This easy feeding ecosystem will help people carry on with their daily lives and enjoy the peace of mind that comes with the automatic pet feeder.

An important key feature of the automatic pet food dispenser that we will implement is portion control. We know that not all pets are the same size or may have different appetites so there will be a proportion control option. The amount of food dispensed will be based on a setting the user can change through the LCD display. Whenever the user needs to release food, it will always be at the amount they specified.

The pet food dispenser is designed to be automatic, however manual integration is also implemented. The pet owner will be able to manually release food for their pet without any pre-set times or schedules. This allows the owner to control their proportions without an automatic operation.

One difference between traditional pet feeders and the Automatic Pet Food dispenser is the mobile application. The automatic pet food dispenser allows users to get notifications while they are away. The dispenser will be connected via Wi-Fi and alerts the user about the status of the pet food dispenser, such as the contents. If the food container is empty, the user will receive a notification to refill it. The user will be able to sign into their Automatic Pet Food dispenser via the mobile app to receive all the details they need.

II. Goals

Ideally, we would like to have wireless control from a remote location with the design having up to 30 feet of wireless connection to WiFi. For portability, we want the design to be compact and lightweight for the average user.

The container size fits in with this as it decides the overall loading capacity thus affecting the design of the weight and dimensions.

For food reminders, this will be tied in with the scale and will notify the user by LED, display or by the app. Most of the power consumption will be based on a per use basis. This is because the device will only need to draw power when it is being used, otherwise, it is in a low power mode that waits for use.

The setting timer and manual dispenser will be able to be set from the app or directly on the design itself.

III. Microcontroller

Microcontrollers are the brain of the project and one will be selected to suffice for the project. The microcontroller will need to handle many tasks such as weight measurements, connecting to Wi-Fi, infrared-sensor, and button presses. All of these microcontrollers can handle the tasks required but some do it easier than others. This can be because of libraries, accessibility of parts, or built in functions.

The Arduino Uno uses an ATmega328 microchip for its CPU. This 80bit RISC-based microcontroller gives 32KB ISP Flash memory that can read-while-write. It has 32 general registers, serial programmable USART (used to receive and transmit communication with a computer), a programmable timer, and 5 power saving modes. It operates between 1.8 - 5.5 volts and has 32 pins.

One thing that makes the Arduino popular is its ease of use and accessibility. The Arduino is programmed in its own IDE using sketches. The sketches are the files that are used to run programs on the Arduino.

Another thing the Arduino Uno is known for is its open source community libraries and projects. Due to Arduino's massive third party support, many of the add-ons and shields have accompanying libraries made by the manufacturers that allow for easy use. The support that Arduino has allows for easier implementations and less trial and error for code and execution. With time saved from other people's work, more can be done.

Due to the pandemic, it would come to no surprise that we would have a shortage of parts. However, similar to the Arduino's massive amounts of community projects and libraries, there are also a multitude of different parts. For example, we originally started with a servo motor for dispensing. However, due to the limited rotation of the servo motor we had to switch the motors on short notice. This was not a huge problem due to the many different kinds of motors that were not only available but also compatible with the Arduino.

IV. User Interface and Control

The Automated Pet Feeder has a visual user interface for the operator to view the menu and settings presented. They can navigate the interface on the LCD display with buttons.

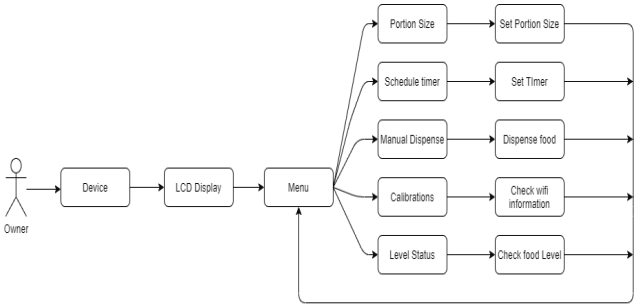

Fig. 1. The flow-chart of the interaction between the user, LCD, and menu.

Along with the mobile application pet owners will also have the ability to control the automatic pet feeder through a LCD display that is right on the physical device.

We can see the flow chart starts off with the client or we can also call the pet owner. They will then need to acquire one of our automatic pet feeders. Once that is complete they will have to plug in the pet feeder and turn on the device. The device will then turn on with a welcoming message for a little while then it will automatically proceed to a menu. The menu will have a few control options that the user will then be able to use to control the pet feeder. To scroll through the options there will be an up, down, and select button.

The first menu option will be the portion size, the user will be able to set portion sizes such as snack, small, medium, and large for their pet. The sizes will be calculated based on recommended meal sizes for pets.

The second option will be the Schedule timer option. This option is for setting a timer to dispense food for your pet at specific times throughout the day. This is especially useful for pet owners alway on the go, and/or forgetful. This feature can also be useful for owners who are occasionally late, because it happens every once in a while.

The third option is manually dispensing food, this is for manual use if users would rather keep their pet for an irregular eating time. It can also be very useful if your pet is behaving well and you would like to just give them a little snack for a treat.

We then have the Calibration options, which is like a settings option where you can view and edit information of the device. This can be used to look at your information on the device, the wifi, and much more.

Finally we have the level status which will allow you to see the status of your food level within the pet feeder. Once you have selected your option and finished your command you will be directed back to the menu screen where you can choose a different option and complete another command if needed. Otherwise, after some time the LCD will go to sleep until the next time it is in use.

The OSEPP LCD Module utilizes an Arduino Uno shield which fits its pins on the corresponding pin sockets on the Arduino board for testing. This is especially helpful for programming as there is no need to wire or solder any components to the Arduino chip itself.

This handy function for the OSEPP LCD Module is carried over to our PCB design to be fitted in similar pin sockets for interfacing with the Arduino Atmega328P, as well as any other board components that will be added to the PCB design.

In the fully integrated PCB design, this is further demonstrated to a working prototype to be produced in the final prototype physical design. It will work and look like the pictures below.

On startup, the code compiled to the Arduino Atmega328P MCU will display the startup screen then load into the menu. This will be further elaborated on in the LCD Software Implementation section below and will cover the basic code that is used to startup and run any processes that print out to the LCD screen.

The screen will have an interactive menu that the user will be able to cycle through and effectively read any sensor data along with any other information that may be

desired. Also, the user will be able to use a few commands in the menu by simply following the simple but organized menu system.

Fig. 2. Automated Pet Feeder LCD startup

The screen will have an interactive menu that the user will be able to cycle through and effectively read any sensor data along with any other information that may be desired. Also, the user will be able to use a few commands in the menu by simply following the simple but organized menu system.

V. Power

The Automated Pet Feeder has electrical components that require power; the microcontroller for the pet feeder, the Arduino Uno, and wi-fi module. The voltages needed are 5V for the arduino uno and 3.3V for the wi-fi module. Voltage regulation for this design is very simple since we only need two levels of voltage regulation, 5v and 3.3v.

A voltage regulator is basically an active feedback electronic circuit which takes in a higher voltage and provides a stable lower voltage at its output. There are two main types of voltage regulators: linear and switching. Linear voltage regulators use op amps and feedback loops to maintain a stable voltage level. These voltages will be supplied to different components of the design. Two linear regulators are the best choice for the voltage regulation needed for our pet feeder. Linear voltage regulators are more widely used due to their simplicity and low cost. For 5VDC output, the most common voltage regulator IC is LM7805. The LM78XX family of regulators comes with a heat sink. The reason for using a heat sink is that the voltage regulator dissipates extra voltage in the form of heat and therefore the IC package gets heated. Without a proper heat sink, the voltage regulator will be overheated and damaged if its temperature rises above the manufacturer's operating specifications.

Linear voltage regulators use a transistor design to convert an input voltage into a constant specific output voltage. They can be purchased as small integrated circuits which can be easily implemented on any printed circuit board. Linear regulators can provide both positive and negative output voltages. They are available in fixed voltage ratings and as adjustable voltage regulators. Linear voltage regulators provide output voltages from 1 to 40 V with current Load from 1 to 1.5A. The operating voltage requirements for Linear voltage regulators have minimum and maximum ratings and limitations. The minimum operating voltage requirement is determined by the drop off voltage as specified in the datasheet of the linear regulator. The drop off voltage is typically between 2 and 3 V and for 5 V regulators. For such a regulator, a minimum input of 7 to 8 volts would be required in order to supply 5 volts output. The maximum input voltage depends on the series of the regulator and typically reaches a 40 V maximum as an input. A linear voltage regulator would provide sufficient power to our project since the specifications required for our design are 5V and 3.3V. the micro-processor and sensor also require minimum currents which can be easily achievable with a linear voltage regulator.

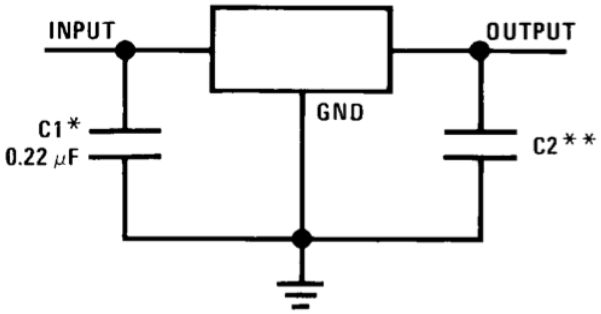

Fig. 3. Fixed output voltage regulator

The drop out voltage requirement will not be an issue for our design. Therefore, a linear voltage regulator meets the required specifications and could be used for all the voltage regulation needs for our project. The benefit of using a linear voltage regulator is its simple circuitry since a typical voltage regulator has only three pins.

When we selected linear voltage regulators, we only needed to meet a few specifications. For our design, we need a transformer to step down the wall outlet voltage to a range that would meet the regulator's input specifications. These specifications are typically between 12v and 40v as input voltage to the regulator which will in turn drop this input voltage in order to produce an output of 5v and 3.3v and 1.5A as the output current. Our final choice for the voltage regulator is to use linear regulators

that will meet these requirements. We ended up choosing the Texas instruments LM7805 fixed output voltage to supply the 5v to the main PCB. We also ended up selecting the LD1117 to supply the 3.3v required to power the wi-fi module. These linear regulators are rated at 1.5A and 1A which is sufficient to accomplish what we need to power the pet feeder.

After deciding on the right voltage regulator for the power supply, we proceeded to build a prototype that would allow our group to start testing. We used basic components to build the two voltage levels required for our project. We built the circuit on a breadboard using a combination of resistors, diodes, capacitors, and voltage regulators. Working with the breadboard was not complicated since we were familiar with building these circuits during the lab experiments. Therefore, from experience these components are first checked with a multimeter to assure they have the correct values that we requested.

The next step was to order the parts used in the prototype and start building the power supply. We started by designing a printed circuit board using one of the numerous platforms available for this purpose. Since we are already familiar with Eagle software that we used in junior design class, we used it again to build our schematic and design the PCB for the power supply. The advantage of using Eagle is that it offers a large content library of components from different manufacturers, it also offers a price quote for the PCB manufacturing as well as a bill of material. In addition to these advantages, it also provides a schematic sheck option which allows the designer to let the software check for any error in the design. If any errors were detected, Eagle pinpoints these errors to make it easy on the designer to go back and make any necessary changes to correct those errors.

When designing the power supply, we made multiple attempts at the schematic design. After completing each design, we run a quote for the price of the PCB as well the BOM and the lead time from different manufacturers or part suppliers. We found that there are long delays for certain parts, this puts more constraints on our design since we have certain deadlines to meet. The delays for the parts manufacturing delivery is mostly due to the pandemic which forced some manufacturers to shut down. In addition to that, some countries are still having forced lockdowns which makes the logistics more difficult. This is the main reason why we had to make multiple design attempts. Each time, we have to modify certain components; we have to remove the parts that have long delays or low availability and replace them with parts that are readily available and with less delays.

VI. Sensors

The Automated Pet Feeder requires a sensor to accomplish its task. The sensor required is an ultrasonic sensor: used to check the contents of the dispenser.

A. Ultrasonic Sensor

One sensor that is required for this project is an ultrasonic sensor. The purpose of this sensor is to check whether or not the container for the food is empty or full. This signal will be displayed with LED lights. The ultrasonic sensor can check the contents of the container by the distance the sound travels. If the container has low contents then the sound should travel a distance before it hits the other side of the container and goes back to the receiver.

If the distance is very short, there should be food in the way of the container and the sound will instantly bounce back to the receiver. This way we can check the capacity of the food.

For this project, the distance we have used for detection is 5cm. Any distance greater than 5cm picked up by the ultrasonic sensor means that the tank is empty. If the tank has food remaining, then the ultrasonic waves from the sensor should bounce back from hitting the food.

The ultrasonic sensor sends its data back to the MSU so it can either continue or stop dispensing and also to notify the user.

Ultrasonic sensors are generally known for their lower power and easy detection method. Since it relies on sound waves; color, light and transparency don't affect it. The ultrasonic sensor will be in a container to measure its contents, so the range doesn't need to be far and the objects are still-moving: the food and the container.

One minor problem with the ultrasonic sensor is being blocked. When testing the reading for the container being full or empty, the sensor would inaccurately return a result if it is directly blocked. It was unknown why the sensor would have this problem; however, due to the sensor getting multiple distance samplings, this problem did not occur often.

B. Weight Sensor

Originally there planned to be a weight sensor for this project. The purpose of the weight sensor would be to weigh out food proportions that were dispensed. The weight would be sent to the MSU to check if it needed to keep dispensing or have the dispensing stop once the right portion was given. However, it was discovered that the amount dispensed is relatively the same every cycle. Therefore, a weight sensor would not be needed.

VII. Motors and dispensing

The motor is one of the most essential components for this project. It is responsible for dispensing the food properly, as it also needs to be sturdy enough to prevent the food in the container from spilling out.

The first motor we chose for this project was the Adafruit Micro Servo. This motor also came with accessories such as different shaped gears. However, when we began early testing with the motor, it could not properly dispense food correctly and the gear that was meant to hold back the food was too weak. Therefore, we needed to change the motor.

Ultimately we ended up with the UXCell DC motor. This all-metal motor allowed up to use a different kind of dispensing method, a corkscrew. The corkscrew allows a reliable and consistent way to dispense the food. By allowing the dispensing to be done in rotation cycles, we were able to control how much is dispensed. For larger measurements (1 cup or 2 cups) we would only need to turn more. As stated before, this removed the need for a weight sensor.

While the UXCell DC motor was made of a strong material and had 360 degree rotation that fulfilled our needs, it did have some problems. The main problem was the torque speed. The UXCell turned the corkscrew very slowly, slower than the Micro Servo motor. Dispensing took a little longer, however it was still fast enough to reach our manual dispensing goal of “Dispenses food within 30 seconds of command”.

VIII. Wifi and Mobile Application

One of the motives of our product is that many people have pets but also have a busy schedule. Many times we may leave our homes and forget to feed our pets, or are gone for long periods of time and feel the need to rush home just to feed them. So one of the ways we want to make this product fix that situation is to give the users of our product the ability to dispense food for their pet remotely. This solution gives us many problems such as needing the ability to connect to the device remotely, and having a way to control the device.

To connect to the pet feeder device we have a few options such as bluetooth, wifi, and zigbee. Each coming with their own complications and benefits. More information of each type will be specified below in the connection comparison section. While there are more ways to connect remotely these are the most popular and easily accessible options.

One of the options we have to connect to the pet feeder device is bluetooth. Bluetooth is a very popular method of wireless connection. It is able to transmit data between devices wirelessly, is inexpensive, low energy consumption, and much more. The biggest downfall for bluetooth is its range of usability, bluetooth can be only used at a max of 100 meters.

Another option we have for connecting to the pet feeder is zigbee. Some advantageous features of zigbee are that it is low cost, it is easy to implement and install, and it has a flexible network structure, which means that it can easily be changed and altered. Some downfalls of zigbee are some of the same as bluetooth. It is not fully secure when transmitting data, it is slow transmitting data, and since zigbee doesn’t have a lot of end devices yet it also has limited range like the bluetooth technology. The range of the zigbee device is much larger than bluetooth, it is still much smaller than the wifi module and the data transfer is much slower than both other options.

Finally the last option we have considered for our pet feeder is connection over wifi. Some advantages of wifi is that it can transfer data fairly quickly compared to bluetooth or zigbee. It can also transmit a lot more data that a zigbee can in less time. Wifi also has very far reach and allows a very large range compared to the two other options. Some disadvantages of using wifi is that there can still be security issues. Installation might be another problem since wifi can be interfered with by other radio waves and signals around.

So after looking through our options a big thing for us is that we wanted to allow users to connect to our device remotely from anywhere so wifi gave us the range we needed. Even though the other two options were great, they didn't have the range we needed.

The Wifi module that we ended up selecting for the project was the ESP8266. We had some issues with having the module actually get the device connected to the internet but we then altered our course of action and created more of a wifi direct connection. This way the device gives off a wifi signal that the user can then connect to and send the signal to the physical device that way. Unfortunately for us we could not integrate the wifi module itself onto the PCB that we created due to the company not selling one of the essential chips that we would need to solder onto our board, so we had to just solder a full wifi module onto our PCB.

With the altercation of the way the wifi module is working we also had to shift the code development for both the wifi module and mobile application. We first decided to use the Arduino IDE for the wifi module development and Android Studios for the mobile application creation. We still ended up using the Arduino IDE for the wifi connection set up, but altered our medium to create the mobile application. We switched to a platform called RemoteXY because it allowed us to create

a simple and easy to use mobile application that remotely controlled the automatic pet feeder. It also helped with all of its libraries to make the code in C++, making it compatible with the Arduino IDE.

For the circuit creation of the wifi module to the Arduino uno these are the pin connections.

ESP8266	Arduino Uno
TX	RX
RX	TX
CH_Enable	3.3V
Vin	3.3V
GND	GND

Table 1. Wifi module pin connections

We can see above that the TX pin of the ESP8266 is connected to the RX pin of the Arduino uno or we can say our PCB. The rest of the pins follow the same trend where the ESP8266 to Arduino Uno are RX to TX, CH_Enable to 3.3V, Vin to 3.3V, and GND (ground) to GND respectively. We would like to state that the connection table belongs to imjeffparedes from instructables and will be referenced below.

After setting up the wifi module and having it work and sending off a signal we had to configure it and create the mobile app that went with it. This is where the RemoteXY application comes in. it allowed us to use its libraries to configure the Arduino uno for wifi module, and create a simple application on its website.

For the mobile application we had two main parts we really wanted it to have which are the controls for the user and the vitals so the user can see what is happening with the automatic pet feeder.

In the controls page we had the four main controls which were to set portion sizes, set timers to dispense food, set portion calibrations, and finally manually dispense food whenever the user wanted to. The set portion control had 5 options which were 1/4 Cup, 1/2 cup, 1 cup, 2 cups, and 3 cups to cater to how much is needed for your pet. The set timer control had 6 options that allowed the user to set the timers to dispense food every 1,2,4,8,12 hours. This feature is especially nice for busy pet owners who are always out and about. The set portion calibration control allowed users to fine tune the portion amount to make it more customizable for their pet. The portion calibrations allowed for ½ times, 1 times, 1.5 times, and 2 times the portion sizes that were already available. Finally we had the Dispense button that allowed the user to dispense food whenever they liked, depending on the pre-selected portion size and calibration that is what would be dispensed everytime they clicked the dispense button. The mobile application also shows the selection that was chosen and allows the user to change it as often as they want and does not set until each of the set buttons are pushed to set it to the MCU. Below is an image of the controls page on the mobile application. We can see that in the image that the default settings are shown on the side like we mentioned on the user selection and that can be changed as needed by the user.

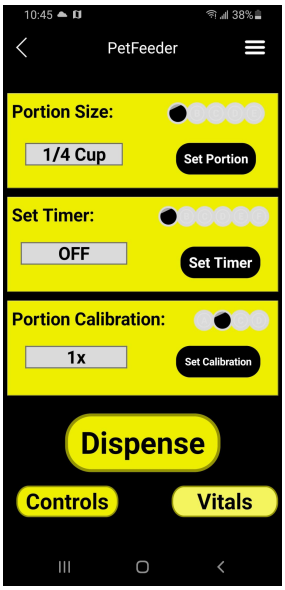

Fig. 4. Mobile App controls page

The second page of the mobile application has the Tank status, connection status, and power information. The tank status shows the level of the food in the tank. If it is full then it will say that it is good. The way it works is if the food is above the sensor it will state that it is good and the LED would show green, but once the food falls below the sensor it will say that it is low and the LED would turn red. The connection status is a nice simple little show of if the mobile application is actually connected to the automatic food dispenser if it is then it shows connected, if it shows not connected. Finally there is the power information that shows the different power levels that are used by the pet feeder which are 5V and 3.3V. Below is an actual image of our vitals page on the mobile application. You can see the statuses, LEDs, and all of the power information. There are also two buttons labeled as “controls” and “vitals” that allow you navigate back and forth between the two pages.

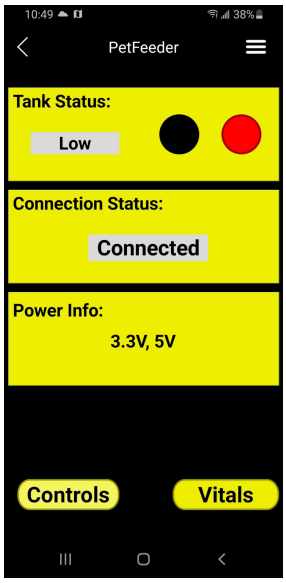

Fig. 5. Mobile App vitals page

IX. Overall Design

The project we had made has a lot of peripherals that are also included that all go into the ATmega328P. Below is an image of all the pin connections of the overall project. We can see the ATmega328P is the big yellow box that everything is connected to. Slightly to the left there are the LCD, ultrasonic sensor, and the ESP8266 wifi module. To the left of that is the timing crystal and some capacitors for stability of the PCB. All of the components on this schematic were integrated on the PCB or soldered on afterwards. all of these components are then enclosed in a housing shown in the physical design.

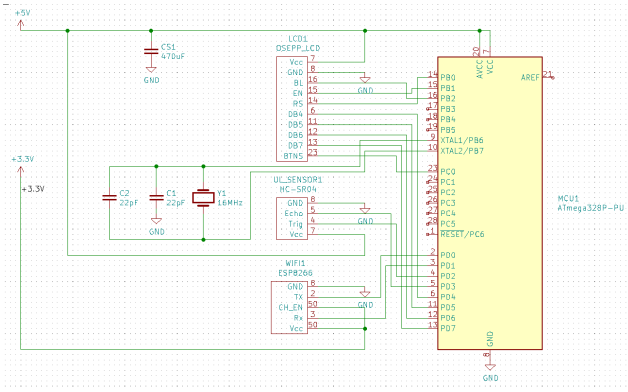

Fig. 6. Overall Schematic

We planned to keep the Automated Pet Food Dispenser as one entire unit. All the major components: power supply, MCU, motor, sensor, and dispenser were all able to be put together so none of the parts are separate. This allows anyone to simply lift up the dispenser to move it anywhere and they can plug it in to any power source.

Keeping the dispenser as one unit also allows for stability. If the dispenser falls over, parts would not fall out and disconnect. We were able to keep this goal into our final design as shown in the figure below. The pipe is on two stands to keep it stable and from rolling. Inside the pipe is the corkscrew and motor that dispenses the food. The top part of the pipe with the large opening is the food tank where the food is input by the user and stored. The big box is the enclosure where all the circuitry is stored and protected, in the final design the enclosure was moved to the side of the pet feeder and not the front view.

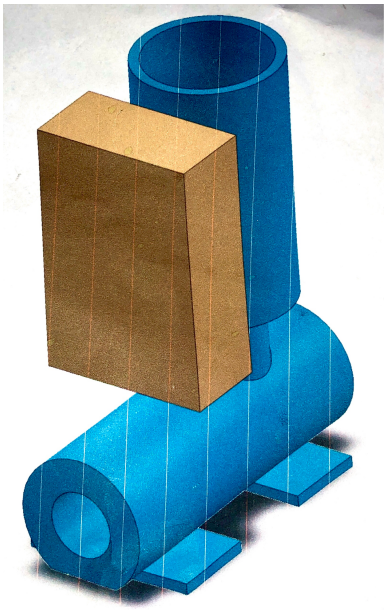

Fig. 7. Physical Design

X. Conclusion

The reason we chose this project was because many individuals have pets and need a way to feed them when they are away so we are here to address this problem. The way we fixed this problem is an automatic pet feeder that a pet owner can control from wherever they are. To do this we made an automatic pet feeder that users can set timers to allow food to dispense or manually dispense food from their mobile device from a companion application. Our device has the ability to portion meal sizes to meet the needs of their pet.

We first started off by researching each of our parts and comparing different technologies and different parts to see which one would best fit our product. After comparing and careful consideration we then selected our parts, and went into detail about how we plan on using it in our design and

the importance of it. We then ordered the parts for the breadboard testing since things may take some time to arrive due to COVID-19 and high mailing volume.

Some standards we covered were coding development and planning standards and power standards. Some constraints we have are time, finance, and the ability to get certain materials.

After discussing how we planned on designing we then went into the design phase which is where each of us designed how each of the parts should look and work individually. Once designed we then tested our design using breadboard testing to confirm our hardware and software was working. After we finished testing each component separately we then moved on to an integrated design where all of our components came together to the microcontroller. Once finished with the design we then proceeded to the PCB design to mount all of the parts.

Finally, we then covered our milestones and seeing if we made all of them, we seem to do pretty well on making sure everything was turned in, but we did have a few mistakes on what was supposed to be covered in each section, but after the first review we then fixed all of our mistakes by the next check in. We also discussed our estimated cost versus our actual cost after ordering most of the parts. This section covered any problems we had while researching and designing the product as well. Project roles and what each member was in charge of is also covered.

Our goal of this product was to create something that would solve an issue that we have in society today. The issue is finding a way to allow pet owners to feed their pets even when they are far from home. It is to make the lives of all pet owners easier and make them feel more secure about living their lives and we have demonstrated a very basic example of that principle design/solution.

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The Authors

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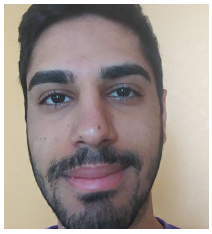
Hamid Igliou, a student of the electrical engineering department at the University of Central Florida and is graduating in the Summer of 2021. He will continue to develop his HVAC career at Walt disney world. Member of the IEEE and ASHRAE.



Mehrob Farhangmehr, a student from the University of Central Florida, currently studying Computer Engineering and graduating in the Summer of 2021. He will start work after graduating in the field of IT and computer programming. After some time from school and working in the industry, he hopes to return to the University of Central Florida to pursue a Masters degree in Systems Engineering.

Bao Nguyen, a student from the University of Central Florida, currently studying Computer Engineering and graduating in the Summer of 2021. He is currently job searching in the field of software engineering and plans on working after graduation. After working for some time he plans on pursuing a Masters degree in computer science, hopefully back here at the University of Central Florida.

Nick Nabors, a student from the University of Central Florida, currently studying Computer Engineering and graduating in the Summer of 2021. He will continue work after graduating in the field of industrial metering and engineering with a focus on Computer Engineering and contracting including a vision of future computer related engineering projects and business opportunities.