ECE445
SENIOR DESIGN PROJECT LABORATORY
DESIGN DOCUMENT

# PawFeast: Food on Demand


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**Date:** March 6, 2025

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# 1. Introduction

## 1.1. Problem

All household pet owners must remember to feed their pets—whether they are birds, guinea pigs, rabbits, dogs, or cats—at set periods during the day. But there can be times when people forget to feed their pets, double feed them, or have trouble feeding them on schedule. This can be due to poor communication between family members or even occur when pet owners come home late from work or prior commitments. During these times, pets either overeat, go hungry, or eat irregularly. As a result, timer-based pet feeders have been developed to release food at set intervals. When food sits out for extended periods of time, the risk of the food becoming stale or getting infected with bugs increases drastically [4.1].

If an insect is near your food, it is a common reaction to remove or swat it away, but that mechanism is not present for the pet's food bowl, especially when the family is not at home. Another issue is that smarter pets can nose into the food storage and overeat or eat something that their bodies will reject (like chocolate for dogs). With a set schedule to limit food dispensation throughout the day, the pet will not take advantage of either a careless overpour of food or of an unmanned food station. Furthermore, data on how much food was dispensed and eaten will help track and optimize the pet's eating habits.

## 1.2. Solution

We are seeking to solve this problem by having timers coupled with a button and RFID component to release food—thus preventing overeating. Given all of these conditions, the dispenser will release the pet food. This ensures that the pet is not only fed on time, but that the food is not polluted when the pet goes to eat; additionally, a chime will go off signaling to the pet that it is time for them to eat [4.2]. We will incorporate a notification system to alert the owner(s) whether the pet has eaten or when the food store has low levels of food.

If the pet were to not eat all the food at once and leave the food dispenser, the pressure sensor will tell the dispenser to cover the food until the pet returns ensuring freshness and preventing bugs.

## 1.3. Visual Aid

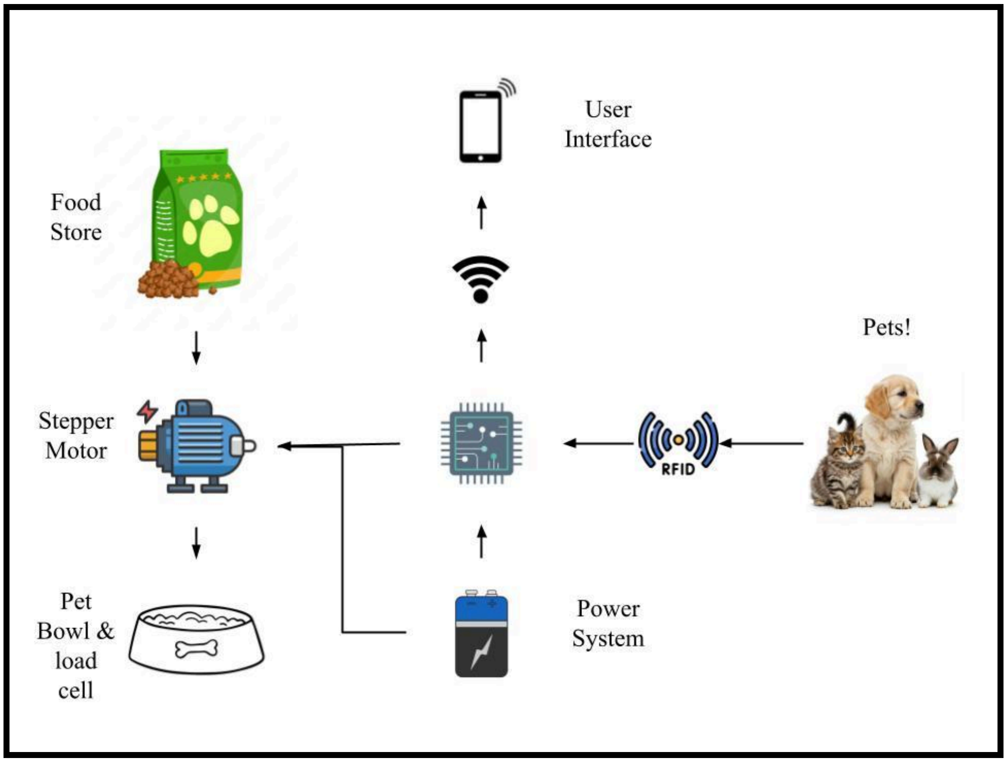


Fig. 1: High-level pictorial representation of system architecture

## 1.4. High Level Requirements List

For this project to be considered successful, our project must meet the following requirements:

1.4.1. The Pet Food Dispenser must not dispense food before user preset times, such as 10 AM and 6 PM, daily, with a 10-minute tolerance.

1.4.2. The Pet Food Dispenser must dispense food into the designated food bowl upon detecting the presence of the pet via the button and the 2+ RFID tags on the pets' collar within 2 minutes.

1.4.3. The user interface must update within 5 minutes of an event on the application we create detailing the pet's feeding status, low food store (20% & 10%), and unfinished meals.

# 2. Design

## 2.1. Block Diagram

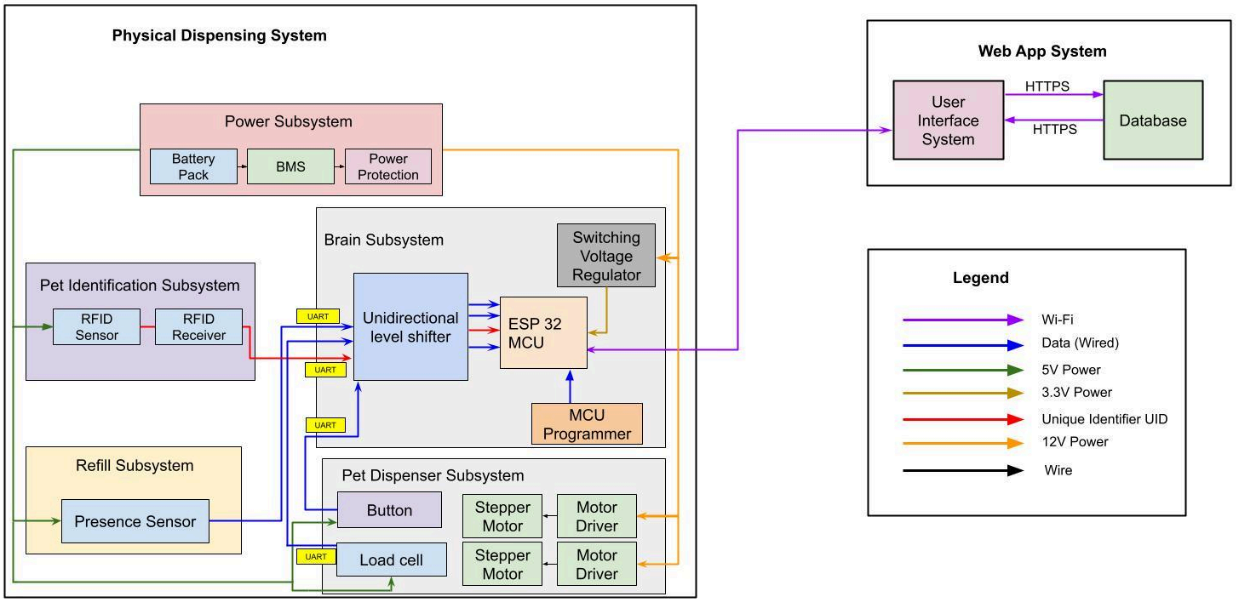


Fig. 2: Block diagram of system architecture

## 2.2. Physical Design

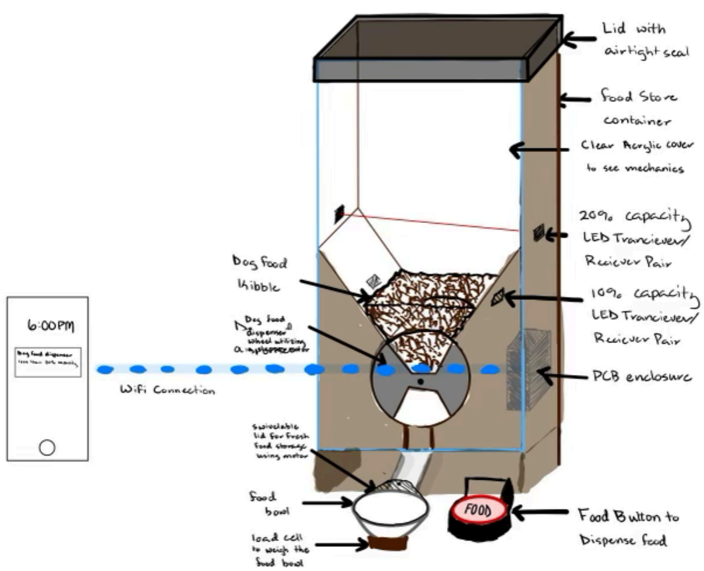


Fig. 3: Physical design representation of system architecture

## 2.3. Subsystem Overview

### 2.3.1. Subsystem 1: Refilling Food Store

The subsystem for checking if the food store is empty will include a through-beam optical sensor that is able to determine whether an object is present—this will serve to detect whether the food inside of the container is low and needs to be refilled. When the food store reaches a certain level, a signal will be sent to subsystem 6 (the brain), which will send an automated message to notify the owner to refill the food store.

### 2.3.2. Subsystem 2: Power System

The power system will supply energy to all of the various subsystems, including the microcontroller of subsystem 6 (the brain), the stepper motor driver in subsystem 3, and the various sensors in subsystems 1 (refilling food) and 3 (food dispenser). The low voltage buses will be 3.3V, 12V, and 5V, all of which will be powered by a combination of rechargeable lithium-ion batteries with voltage regulators and buck converters. This compact, custom 3s2p battery pack will allow the pet dispenser to be portable, even for family vacations or road trips—more importantly, it will provide a steady current, even when the pack voltage drops (unlike standard AA/AAA cells). The 12V to 3.3V regulator chip will be Monolithic Power Systems's MP2315SGJ-Z, which can take a 12V input and output up to 2.5A [4.7]. The 12V to 5V regulator chip will be Monolithic Power Systems's MP2338GTL-Z [4.6]. The 12V input into the motor driver IC circuit will come straight from the battery pack. There will also be a backup supply voltage of 5V from a typical barrel jack wall-outlet, integrated into the brain board. This will implement the AMS1117 LDO, which is perfect for 5V to 3.3V power conversion. Just to be clear, this 5V barrel-jack addition will just be included on the brain board as a backup power subcircuit in case of power shutdown.

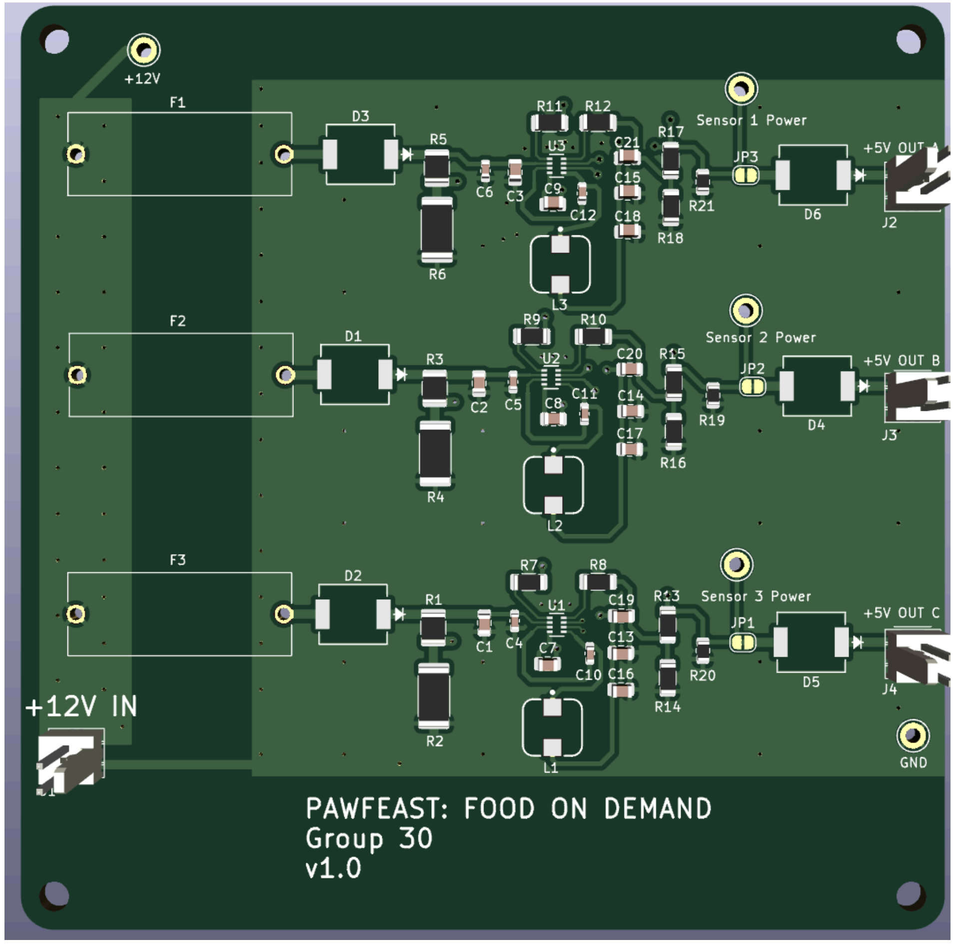


Fig. 4: 3D View of Power Board

2.3.3. Subsystem 3: Food Dispenser

This subsystem will utilize a E Series Nema 17 stepper motor that will rotate a door to the food container when needed and allow a set amount of food through before rotating again to close the door [4.8]. The motor will be controlled by a stepper motor controller IC (DRV8825) with a custom control circuit that takes in 12V and outputs 3.4V to the motor. We will define hard cut offs that will be coded for maximum amount of food to be dispensed and specify times at which food may be dispensed during the day.

The main objective of this subsystem is to make the system an on-demand food system. We will utilize a large button for the dog to step on when hungry. When pressed, the system will start the motors to release food, on the condition that enough time has elapsed since it ate last. The pet would be trained how to ask for food using this button. Only when the button is pressed and enough time has passed, will food then be dispensed.

### 2.3.4. Subsystem 4: RFID for pet identification

We will have a receiver for a minimum of 2 HF RFID tags 9662 Long Distance Passive Alien H3. We will use the RC522 RFID chip for reading and writing to the RFID chips. The RFIDs would be used to signal which pet is using the dispenser, so the owner is able to utilize the same dispenser for one or more pets.

### 2.3.5. Subsystem 5: User Interface

The subsystem for notifications will be a web application that we will build that is able to connect with the pet feed dispenser system. For the application side, we will utilize Bottle for our backend, SQLite for our database, and html pages for our frontend to create a user friendly method to check the pet's eating habits. This will notify users for when the pet has been fed, if the food tank is low and requires refiling, and if the food was covered due to an empty bowl or a partially filled one.

### 2.3.6. Subsystem 6: Brain

The brain subsystem will take in inputs from all of the other sensor subsystems and output the according signals to the user interface (for notifications) and the food dispenser motor driver. This system will also track the amount of time that has passed and sound a soft chime for when enough time has passed for the pet to be able to eat. The ESP32 WROOM-32E-4N microcontroller, known for its wifi connectivity and security measures, would have a set of I/O pins for taking in these signals. This MCU programmer circuit and other control level circuitry—firmware or equivalent—would be incorporated onto this board along with a UART circuit to detect pet RFIDs (done with the UHF RFID reader JRD-4035).

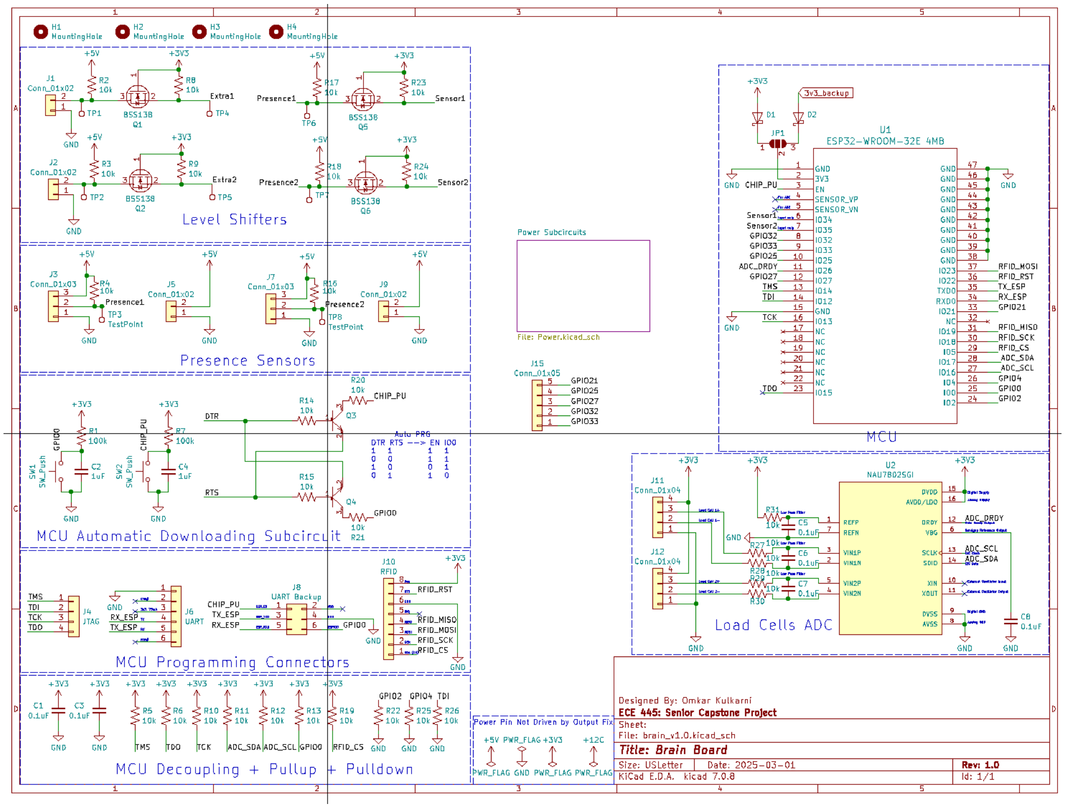


Fig. 5: Schematic Capture of Brain Board

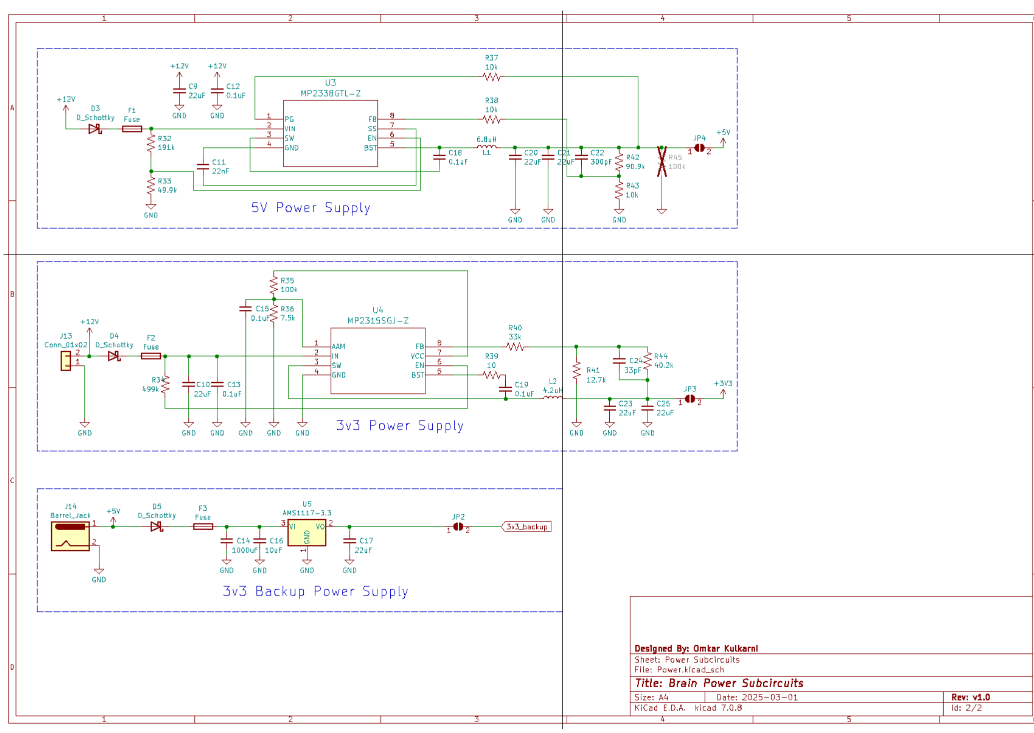


Fig. 6: Schematic Capture of Power Board

## 2.4. Subsystem Requirements

| Requirements and Verification Table by Subsystem | |
|---|---|
| | |
| **Subsystem 1: Refilling Food Store** | |
| **Requirement** | **Verification** |
| Must utilize a presence sensor to determine how full the food store is at said volumes, 20% and 10%. | Fill the food store to 20% capacity. Check if the Presence Sensor reflects the capacity. |
| Must send readings to the UART located in the Brain Subsystems. | Check if the ESP32 is able to read the value of the sensor. |

| Subsystem 2: Power System | |
|---|---|
| **Requirement** | **Verification** |
| Must be able to provide enough power to all components within a tolerance of ±0.2V for the 3.3V supply and ±0.5V for the 5V supply during the periods of operation. | We will probe test points with J-hooks to test voltage ripple and average voltage meet specifications. |
| If there are any unsafe conditions, such as the supply reaching undervolt range or short-circuiting, the current will be cut-off from the rest of the subsystems to prevent damage and fire hazards. | We added power protection components like fuses and Schottky diodes for reverse polarity and overcurrent protection. We have a commercial BMS that is designed for over- and under-voltage and over-current protection. Successful testing of this product would mean that we discharge cells to their undervoltage limit and verify if the BMS shuts off load current. |

| Subsystem 3: Food Dispenser | |
|---|---|
| **Requirement** | **Verification** |
| Implements a timer system to determine “feeding times” assigned by the user. Will not dispense food prior to these times within a small tolerance of ±10 minutes. | We will set the times in the user interface for food dispensal. We will see if the food is dispensed at these times. We will set a timer on our phones to see to what tolerance it takes before the food is dispensed. |
| Utilizes a button for the pet to step on to indicate the pet’s presence. Upon pressing, during the feeding time the stepper motor will start dispensing food to the food bowl [4.5]. | We will see if the food is dispensed when we press the button. We will see how much force is required for the food to be dispensed. We will measure our success through the dispensal of food following the pressing of the button. |

| | |
|---|---|
| Implementing a stepper motor design, a lid will cover and uncover the pet bowl upon request of signal. | We will verify if this works if the lid closes after the pet leaves. We will test using the RFID tag. We will test the ranges that the RFID tags can be within the RFID reader while the lid stays open. If the lid closes and opens upon detecting the presence of the RFID tag, we will consider the operation successful. |
| We will also have a load cell to detect the bowl weight and if there's a stoppage in dispensing when it should have done a cycle of dispensing. | We will see if the load cell can read the weight of the food bowl. The food bowl will be mounted on top of the load cell. When we connect the load cell to the ESP32 chip, we will be able to read the strain applied to the load cell. We will print these values to the terminal and see if the strain changes as we apply varying pressure to the food bowl. |

| **Subsystem 4: RFID for pet identification** | |
|---|---|
| **Requirement** | **Verification** |
| The RFID UIN will be detected by the brain microcontroller within a range of 6 inches. | We will test the ranges that the RFID is able to pick up the tag using a ruler. If the tag is able to be detected, we will see the tag UIN in the Brain Subsystem. |
| The 2+ RFID tags will be preprogrammed and recognized by the reader. | When we detect the RFID tags with the RFID reader, the tag UIN will be seen by the ESP32. We will be able to visually determine the tags have unique UINs. |

| **Subsystem 5: User Interface** | |
|---|---|
| **Requirement** | **Verification** |
| The user interface will be able to connect with the Brain subsystem to receive different notifications. | The user interface will be able to see and print readings from different sensors/motors on the screen. |
| The user interface must be able to update with the current status within 5 minutes of an event. This includes pet eating habits, food store levels, and if food has been dispensed. | We will manually verify if the user interface updates as food is dispensed, the food store level changes, or if the food has not been finished. |

| **Subsystem 6: Brain** | |
|---|---|
| **Requirement** | **Verification** |
| Sends and receives UART signals to and from the other subsystems successfully. | The Brain will be able to connect to the different sensors and motors. The values read by the sensors will be printable to the terminal when connecting to the ESP32 chip. In addition, given a command from the ESP32, the server will be able to turn on or off. |

## 2.5. Tolerance Analysis

2.5.1. The power subsystem poses the risk of being unable to deliver the intended power for all the other subsystems in the project—this total power can be estimated from component data sheets. This is done below in Part 1. Then in Part 2, the discussion moves towards losses, mainly in the stepper motor and in the switched-mode power components of the linear regulators (transistors). The diagram below is a general circuit representation of some of the main power sinks, and by no means considers all loss mechanisms.

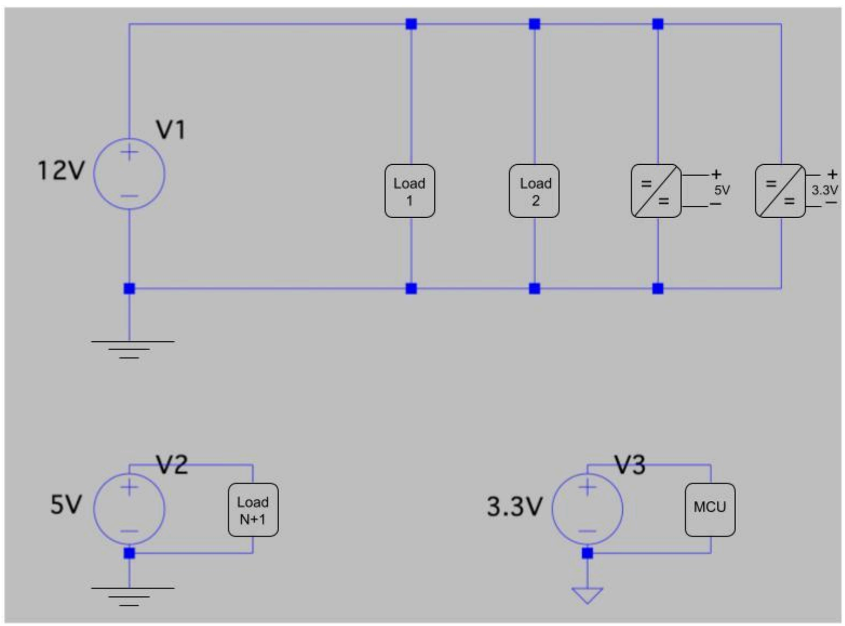


Fig. 7: Schematic capture overview of power system.

# 1 Power Dissipation vs Supply Power

The power subsystem needs to supply power to multiple sensors, drivers, and the microcontroller. The ESP32 microcontroller dissipates a maximum RF power of:

$$P_{\text{ESP32}} = 19.5 \text{ dBm} = 0.0981 \text{ W}.$$

It is supplied with 3.3 V and can support input currents of 600 mA to 750 mA, leading to a maximum supplied power of:

$$P_{\text{ESP32 supply}} = 3.3V \times 0.75A = 2.475W.$$

The reflective object sensor has a maximum power dissipation of:

$$P_{\text{reflective}} = P_{\text{phototransistor}} + P_{\text{diode}} = 150 \text{ mW} + 75 \text{ mW} = 225 \text{ mW}.$$

The Vishay Presence sensor dissipates:

$$P_{\text{Vishay}} = 5V \times 5 \text{ mA} = 10 \text{ mW}.$$

The RFID receiver operates at 3.3 V with a peak output current of 200 mA, giving:

$$P_{\text{RFID}} = 3.3V \times 0.2A = 0.66W.$$

The two motor drivers each take a supply voltage of 12 V and drive up to 1 A, resulting in:

$$P_{\text{motor}} = 12V \times 1A = 12W \text{ per motor}.$$

For two motors:

$$P_{\text{motors total}} = 2 \times 12W = 24W.$$

Two load cells each take 5 V with 10 kΩ pull-down resistors, giving the following from the combination of Ohm's Law and P=IV:

$$P_{\text{load cell}} = \frac{5V^2}{10k\Omega} = 2.5 \text{ mW per sensor}.$$

For two load cells:

$$P_{\text{load cells total}} = 2 \times 2.5mW = 5mW.$$

Summing up the total power consumption:

$$P_{\text{total}} = 2.475W + 0.225W + 0.01W + 0.66W + 24W + 0.005W = 27.375W.$$

The battery pack is a 3s2p configuration with 3.7 V nominal 3200 mAh cells, giving:

$$V_{\text{pack}} = 3 \times 3.7V = 11.1V,$$
$$Q_{\text{pack}} = 2 \times 3200mAh = 6400mAh,$$

which results in an energy capacity of:

$$E_{\text{pack}} = V_{\text{pack}} \times Q_{\text{pack}} = 11.1V \times 6.4Ah = 71.04Wh. \tag{1}$$

This means the battery can theoretically supply:

$$P_{\text{supply}} = 71.04W \text{ for one hour.}$$

Since $P_{\text{supply}} > P_{\text{total}}$, the battery should be sufficient for at least an hour of continuous operation. We expect that in reality, the power process of detecting the RFID tag and pressing the button to dispense the food should take no more than 5 minutes. This means that the battery should theoretically last for 12 meals or 6 days of operation, though this estimate doesn't consider the power that is required to keep the microcontroller running (passive losses).

## 2 General Loss Discussion

In addition to the main power dissipation, we must consider the losses in the motor and driver system. The primary loss in the stepper motor follows the ohmic power dissipation:

$$P_{\text{motor loss}} = 2I^2 R_{\text{phase}}, \tag{2}$$

where:

- $I = 1A$ (current per phase) limited by us based on loss mechanisms and motor speed requirements,
- $R_{\text{phase}} = 30m\Omega$ (resistance per phase),
- Factor of 2 accounts for two active phases.

Calculating:

$$P_{\text{motor loss}} = 2 \times (1A)^2 \times 30m\Omega = 60mW \text{ per motor.}$$

For two motors:

$$P_{\text{motor loss total}} = 2 \times 60mW = 120mW.$$

Other losses such as PCB trace resistances, wiring resistance, and connection losses are considered negligible. Additionally, eddy current, windage, and hysteresis losses in the motor are also assumed to be negligible.

Other losses such as PCB trace resistances, wiring resistance, and connection losses are considered negligible. Additionally, eddy current, windage, and hysteresis losses in the motor are also assumed to be negligible.

Somehting

We also consider power lost in the switching components of the linear regulators. There are two primary loss mechanisms:

- **Conduction losses:** These follow the standard ohmic loss equation:

$$P_{\text{cond}} = I_{rms}^2 R_{\text{ds,on}} \tag{3}$$

- **Switching losses:** These depend on switching frequency and transition times:

$$P_{\text{switch}} = \frac{1}{2} V_{ds} I_{ds} f \frac{Q_{\text{gs}} Q_{\text{gd}}}{I_{gate}} \tag{4}$$

  where $V_{ds}$ is the drain-to-source or input voltage, $I_{ds}$ is the drain-to-source current, $f$ is the switching frequency, $Q$ is the gate-to-drain and gate-to-source charge, and $I_{gate}$ is the gate current.

For the switching voltage regulators:

$$P_{12\text{-}3.3\,\text{V}} = 1.25\,W, \quad P_{12\,\text{V-}5\,\text{V}} = 2.27\,W.$$

These values are given for continuous dissipation at 25 °C, but more precise values can be computed using datasheet parameters like the switching frequency, on resistance, and load current.

For the backup linear voltage regulator:

$$P_{5\,\text{V to }3.3\,\text{V}} = (5V - 3.3V) \cdot 750\,mA \approx 1.275\,W$$

The theoretical maximum allowable power dissipation of the low dropout regulator (LDO) for backup power is based on the maximum operating junction temperature, the junction to ambient thermal resistance, and the ambient temperature. This value was calculated to be 1.25 W for 40°C and 1.42 W for 25°C. Thus, the maximum operating current of the ESP32 will cause the LDO to enter thermal shutdown if ever it occurs, but the fuse will stop any large damage from propagating. During normal operation, the load current should remain below 500 mA, though short spikes above this threshold may occur.

# 3. **Cost Analysis**

## 3.1. Labor Costs

Assuming a salary of \$42/hour based on ECE post-graduate salary averages, the labor costs for our members over 10 weeks at 20 hours per week per member and 4 weeks at 10 hours per week per member is calculated as:

$$\text{Total Cost} = 3\times((20 \text{ hours/week} \times 10 \text{ weeks}) + (10 \text{ hours/week} \times 4 \text{ weeks}))\times\$42$$

$$= 3 \times (200 + 40) \times 42$$

$$= 3 \times 240 \times 42$$

$$= 30,240$$

The supply shop has not given us a specific quote for price, so we will assume it takes 15 hours to build our food store at an hourly rate of \$25/hour or \$375 total. This rate is based on Illinois state averages.

Thus, the total estimated labor cost is \$30,615.

## 3.2. Part Costs

| ACQUIRED MISCELLANEOUS SENSORS AND PARTS | | | | | |
|---|---|---|---|---|---|
| **Power** | | | | | |
| **Part Description** | **Manufacturer** | **Part #** | **Quantity** | **Cost/Item** | **Cost** |
| BMS | N/A | N/A | 1 | 9.99 | 9.99 |
| Li-ion Batteries | N/A | N/A | 3 | 14.88 | 44.64 |
| 12V-5V Voltage Regulator | N/A | MP2338GTL | 5 | 2.54 | 12.70 |

| Sensors and Motors | | | | | |
|---|---|---|---|---|---|
| **Part Description** | **Manufacturer** | **Part #** | **Quantity** | **Cost/Item** | **Cost** |
| Presence Sensor | | | 1 | 5.95 | 5.95 |
| Load Cell | DigiKey | 1528-4541-ND | 2 | 3.56 | 7.12 |
| Nema 17 Stepper Motor | STEPPERONLINE | 17HE15-1504S | 1 | 10.88 | 10.88 |

| Parts for Breadboard Demo | | | | | |
|---|---|---|---|---|---|
| **Part Description** | **Manufacturer** | **Part #** | **Quantity** | **Cost/Item** | **Cost** |
| Motor Breakout Board | | | 1 | 15.95 | 15.95 |
| Load Cell Breakout Board | | | 1 | 5.95 | 5.95 |

| Miscellaneous | | | | | |
|---|---|---|---|---|---|
| **Part Description** | **Manufacturer** | **Part #** | **Quantity** | **Cost/Item** | **Cost** |
| Dog Food Bowl | Walmart | N/A | 1 | 1.99 | 1.99 |
| Dog Food | Walmart | N/A | 1 | 5.00 | 5.00 |

**PCB Parts**

| Part Description | Manufacturer and Part # | Quantity | Order Quantity | Cost |
|---|---|---|---|---|
| 0.1uF | KEMET – C0603C103F3GECAUTO | 13 | ESHOP | 0 |
| 1uF | Taiyo Yuden – TMK107B7105KA-T | 2 | ESHOP | 0 |
| 0.1 uF | Yageo – CC0603KRX7R7BB104 | 4 | ESHOP | 0 |
| 22uF | Samsung Electro-Mechanics – CL21A226MAYNNNE | 16 | 30 | 3.12 |
| 22nF | KEMET – C0805C223F3GECAUTO | 4 | 10 | 9.33 |
| 1000uF | Nichicon – PCG1A102MCL1GS | 1 | 1 | 2.33 |
| 10uF | KYOCERA AVX – F951E106KAAAQ2 | 1 | ESHOP | 0 |
| 300pF | KYOCERA AVX – 08053C301JAT2A | 4 | 10 | 1.46 |
| 33pF | Murata Electronics – GJM1555C1H330FB01D | 1 | 4 | 0.56 |
| D_Schottky | Vishay General Semiconductor - Diodes Division – VS-30BQ015-M3/9AT | 11 | 11 | 7.76 |
| Fuse holder | Keystone Electronics – Fuse Holder | 3 | 3 | 2.43 |
| Conn_01x02 | Molex – 1718560102 | 9 | 10 | 2.45 |
| Conn_01x03 | Molex – 0022272031 | 2 | 6 | 1.74 |
| JTAG | Harwin Inc. – M20-9990446 | 1 | 2 | 0.32 |
| UART | Harwin Inc. – M20-9990645 | 1 | 2 | 0.56 |
| UART Backup | Würth Elektronik – 61200621621 | 1 | 1 | 0.43 |
| RFID | HARTING – 14110813001000 | 1 | 1 | 2.68 |
| Conn_01x04 | Molex – 0022292041 | 2 | 4 | 2.88 |

| Part Description | Manufacturer and Part # | Quantity | Order Quantity | Cost |
|---|---|---|---|---|
| 0.1uF | KEMET – C0603C103F3GECAUTO | 13 | ESHOP | 0 |
| 1uF | Taiyo Yuden – TMK107B7105KA-T | 2 | ESHOP | 0 |
| 0.1 uF | Yageo – CC0603KRX7R7BB104 | 4 | ESHOP | 0 |
| 22uF | Samsung Electro-Mechanics – CL21A226MAYNNNE | 16 | 30 | 3.12 |
| 22nF | KEMET – C0805C223F3GECAUTO | 4 | 10 | 9.33 |
| 1000uF | Nichicon – PCG1A102MCL1GS | 1 | 1 | 2.33 |
| 10uF | KYOCERA AVX – F951E106KAAAQ2 | 1 | ESHOP | 0 |
| 300pF | KYOCERA AVX – 08053C301JAT2A | 4 | 10 | 1.46 |
| Barrel_Jack | Same Sky (Formerly CUI Devices) – PJ-102AH | 1 | 2 | 1.52 |
| Conn_01x05 | Harwin Inc. – M20-9990546 | 1 | 2 | 0.4 |
| 6.8uH | Würth Elektronik – 7447786006 | 4 | 4 | 9.44 |
| 4.2uH | Würth Elektronik – 744053004 | 1 | 1 | 1.4 |
| BSS138 | onsemi – BSS138 | 4 | 10 | 1.58 |
| SMD-TRANSISTORS-NPN-25V-500MW_SOT-23_ | NextGen Components – S8050 | 2 | ESHOP | 0 |
| 100k | Yageo – RC0805FR-07100KL | 7 | ESHOP | 0 |
| 10k | Susumu – HRG3216P-1002-B-T1 | 41 | ESHOP | 0 |
| 191k | Panasonic Electronic Components – ERJ-14NF1913U | 4 | 10 | 1.51 |
| 49.9k | Stackpole Electronics Inc. – RMCF2512FT49K9 | 4 | 10 | 1.26 |
| 499k | Vishay Dale – RCS0805499KFKEA | 1 | 3 | 0.6 |
| 7.5k | Vishay Dale – CRCW08057K50FKEAHP | 1 | 3 | 0.6 |
| 10 ohms | TE Connectivity Passive Product – CRGP2512F10R | 1 | 2 | 1 |
| 33k | Vishay Dale – RCS080533K0FKEA | 1 | 3 | 0.42 |
| 12.7k | Vishay Dale – CRCW121012K7FKEA | 1 | 3 | 0.6 |
| 90.9k | Stackpole Electronics Inc. – RNCP1206FTD90K9 | 4 | 10 | 0.19 |
| 40.2k | Vishay Dale – CRCW080540K2FKEAHP | 1 | 2 | 0.4 |

| Part Description | Manufacturer and Part # | Quantity | Order Quantity | Cost |
|---|---|---|---|---|
| 0.1uF | KEMET – C0603C103F3GECAUTO | 13 | ESHOP | 0 |
| 1uF | Taiyo Yuden – TMK107B7105KA-T | 2 | ESHOP | 0 |
| 0.1 uF | Yageo – CC0603KRX7R7BB104 | 4 | ESHOP | 0 |
| 22uF | Samsung Electro-Mechanics – CL21A226MAYNNNE | 16 | 30 | 3.12 |
| 22nF | KEMET – C0805C223F3GECAUTO | 4 | 10 | 9.33 |
| 1000uF | Nichicon – PCG1A102MCL1GS | 1 | 1 | 2.33 |
| 10uF | KYOCERA AVX – F951E106KAAAQ2 | 1 | ESHOP | 0 |
| 300pF | KYOCERA AVX – 08053C301JAT2A | 4 | 10 | 1.46 |
| SW_Push | Omron Electronics Inc-EMC Div – B3U-1000P | 2 | 2 | 2 |
| TestPoint Red | Keystone Electronics – 5011 | 13 | ESHOP | 0 |
| ESP32-WROOM -32E 4MB | Espressif Systems – ESP32-WROOM-32E-N4 | 1 | 3 | 14.52 |
| NAU7802SGI | Nuvoton Technology Corporation – NAU7802SGI | 1 | 2 | 5.28 |
| MP2338GTL-Z | Monolithic Power Systems Inc. – MP2338GTL-Z | 4 | 5 | 12.7 |
| MP2315SGJ-Z | Monolithic Power Systems Inc. – MP2315SGJ-Z | 1 | 2 | 5.84 |
| AMS1117-3.3 | UMW – AMS1117-3.3 | 1 | 3 | 2.04 |
| Test Point Black | Keystone Electronics – 5011 | 1 | ESHOP | 0 |
| Fuse @ 2.5 amps | Littelfuse Inc. – 023502.5MXP | 3 | 3 | 1.53 |
| Crystal Oscillator | Murata Electronics – XRCGB27M120F3G00R0 | 2 | 0.32 | 2.82 |
| Rfid Chip | NXP USA Inc. – MFRC52202HN1,151 | 2 | 7.91 | 15.82 |
| Motor Driver | Texas Instruments – DRV8825PWPR | 2 | 4.61 | 9.22 |

### 3.3. Total Costs

| Cost Type | Cost |
| --- | --- |
| Total Labor Costs | $30,615 |
| Total Part Cost | $250.91 |
| **Total** | **$30,865.91** |

# 4. Schedule

| Date | Goals - Team Member |
| --- | --- |
| Week 3 | 1. Finish Team Contract (due 02/14) - All<br>2. Create Weekly Goals for the semester - All<br>3. Start Project Proposal (due 02/13) - All<br>4. Start a Parts List - Arash |
| Week 4 | 1. Submit Team Contract (due 02/14) - All<br>2. Finalize a Parts List for the project - All<br>3. SUBMIT Project Proposal (Due 02/13) - All<br>4. Start working on Breadboarding - All<br>5. Start designing PCB - Omkar<br>6. Start looking at amazon for parts/make the initial order - Kathryn |
| Week 5 | 1. Review Proposal w/ Prof and TAs - All<br>2. Start finalizing design of PCB - Omkar<br>3. Get amazon parts - Arash, Kathryn |
| Week 6 | 1. Finalize and send out Power PCB - Omkar<br>2. Finalize Design Document - All<br>3. Start working on the user interface app - Kathryn |
| Week 7 | 1. Submit order for Power PCB - Omkar<br>2. Design Document (Due 03/06) - All<br>3. Teamwork evaluation (Due 03/5) - All<br>4. Keep working on the user interface app - Kathryn<br>5. Start programming ESP32 - Kathryn<br>6. Work on testing the sensors and motors - Arash, Omkar<br>7. Connect ESP32 to user interface - All<br>8. Finalize layout for Brain PCB - Omkar |
| Week 8 | 1. **Breadboard Demo** - All<br>2. Program ESP32 - Kathryn<br>3. Order second round of PCB (Due 03/13) - Arash, Omkar |

| | |
|---|---|
| Week 9 | 1. Spring Break<br>2. Start working on 3rd round PCB - Arash, Omkar |
| Week 10 | 1. Finalize 3rd round of PCB if necessary- Arash, Omkar<br>2. Start individual progress reports - All<br>3. Work on the user interface - Kathryn<br>4. Work on ESP32 Code - Kathryn<br>5. Start integrating product - All |
| Week 11 | 1. Submit 3rd round of PCB<br>2. Submit individual progress reports - All, individually<br>3. Start testing functionality with PCB - All<br>4. Test integrated product - All |
| Week 12 | 1. Team contract fulfillment - All<br>2. Finalize project - All<br>3. Make sure the project acts as built - All<br>4. Finish and refine integrated product - All<br>5. Prepare for Mockup Demo - All |
| Week 13 | **1. Mock Demo** - All |
| Week 14 | **1. Final Demo** - All |
| Week 15 | **1. Final Presentation (05/5-6)** - All<br>**2. Final Paper (Due 05/07)** - All<br>3. Lab Notebook (Due 05/08) - All |
| Week 16 | |

# 5. Ethics and Safety

5.1. As with any moving part, there is a small risk of the pet hurting themselves on the bowl lid closing mechanism, which opens/closes the pet bowl. The group plans on finding a way to mitigate this risk by slowing down the rotational speed of the motor or adding a sensor which will stop/slow down when detecting objects nearby.

5.2. The power system is relatively low voltage, but still poses a risk to users in case of unintended operation, such as short circuits or spliced wires. The group plans on mitigating this risk by adding a power protection aspect to the board (overvoltage, overcurrent, reverse polarity protection) and rating the components (wire gauge, etc.) above a safety tolerance threshold.[4.4]

5.3. We will apply the ACM Code of Ethics to ensure ethical and safe data privacy handling by implementing responsible data collection, secure storage, and deleting collected data after set periods of time. User privacy will be respected by obtaining consent and not selling or publicizing any user data. Principle 1.6 ACM Code of Ethics.[4.3]

5.4. Animal safety: This proof of concept product is not designed to remove the owner's responsibility for the pet, but rather be an assistive dispensing and data collection tool [4.1]. No animals will be hurt in the design and testing of this product and the goal is to prevent overfeeding. Additional trial testing needs to be conducted before using this product for vacation purposes.

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