"Pawsitive" Pet Feeder

Senior Design II – Group 8

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Project Motivation

- 70% of U.S. households (90.5 million homes) own a pet as of 2022.
- With families become increasingly busy with their lifestyle after the COVID-19 pandemic, often pets may get neglected

- Pet Feeders do exist in the market, however:
  - Designed for only 1 pet in mind
  - If owner does have multiple pets, each pet may have different nutritional requirements

Project Goals

Core Goals:

- Having a power supply that allows the system to function properly
- Using optics and photonics to recognize pets with the correct tag to access each individual feeding bay
- System will store approximately two days' worth of food for all 3 pets
- The food dispenser dispenses the user's desired amount per pet feeder
- Having a self-opening & self-closing lid when the pet arrives and leaves the device

Advanced Goals:

- Create LED collar tags to avoid damage while not altering the pets' lifestyle
- Create an application for the user to save the amount of food to dispense at a certain time

Project Objectives

Core Objectives

- Utilizing a wall outlet adapter
- Creating a camera system that recognizes RGB colors from LED collar tags to open an assigned feeding bay
- Utilize the use of 3D printers, and maximize components to drive cost of materials down
- Calculate the amount of food to be dispensed within one rotation and calculate to the correct serving

Advanced Objectives

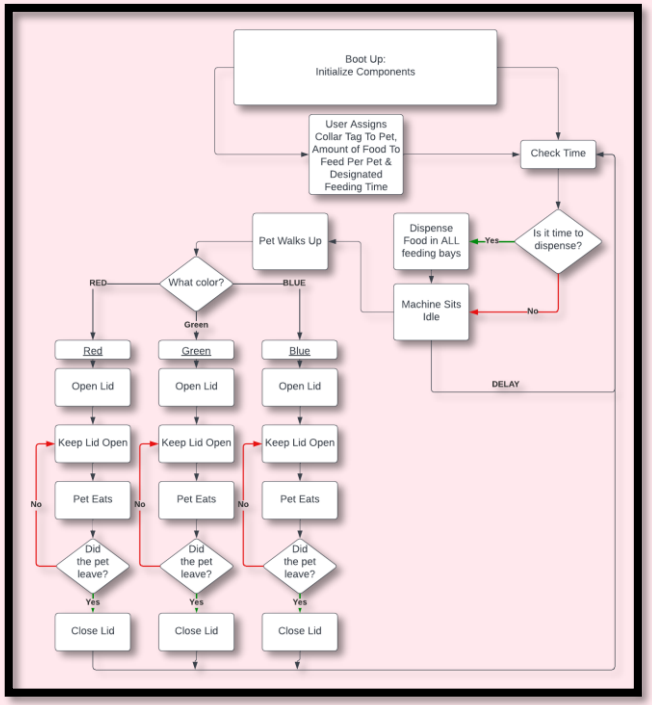
- Use IPX-4 LEDs
- Use sensors within the system as received data
- Create an Android mobile application for the user to use to set certain times when the pets' food should be dispensed and to dispense the desired amount of food

Specifications and Requirements

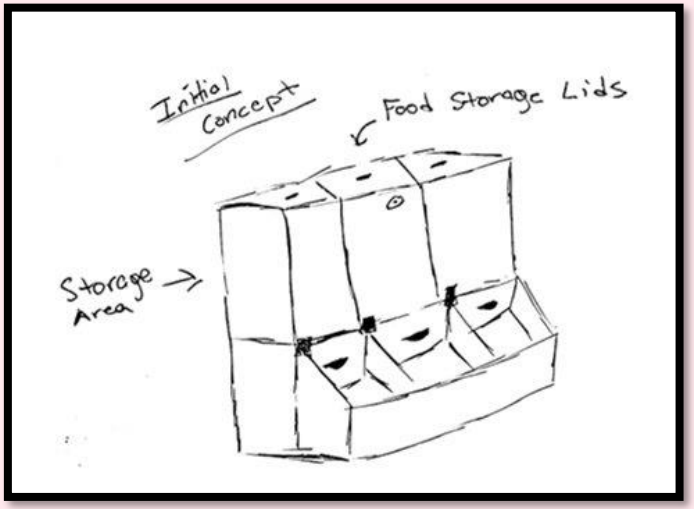
Component	Parameter	Design Specification
Collar Tag	Water Resistance	IPX - 4
Camera	Color Detection	3 (Red, Green, Blue)
Camera	Detection Range	< 2 Feet
Dispenser	Dispensing Time	< 60 Seconds
Lid	Activation Time	< 30 Seconds
Pet Food	Accuracy	± 20% of User Inputted Amount
Android Application	Mobile Use	Set Time And No. Of Cups To Dispense Food

Engineering Requirements

Component	Parameter	Design Specification
Camera	Color Detection	3
Dispenser	Dispensing Time	< 60 Seconds
Lid	Activation Time	< 30 Seconds
Android Application	Mobile Use	Set Time And No. Of Cups To Dispense Food



Housing



Size of Housing:

24 Inches W x 20 Inches L x 17 Inches H

Main Electrical Components

Microprocessor

Purpose:

- Process image data presented by the pets' collar tags and deliver commands to the microcontroller for motor control.
- Host a Node.js server for the Android Application to receive amount of food to be dispensed at a certain time and call the microcontroller to dispense food.

Raspberry Pi 4:

- Easy to integrate with camera system
- Communicates easily with microcontrollers via USB ports
- Ability to run multiple python files and node server files simultaneously

Model	Raspberry Pi 4	Odroid XU4	Asus Tinker Board
Price	$84.00	$67.00	$160.00
Cores	4	8	4
Clock Speed	1.5 Ghz	825 MHz	1.8 Ghz
GPIO	40 Pins	30 Pins	40 Pins
Memory	8 GB	2 GB	2GB
Chosen Component			

Microcontroller

Purpose:
- Read input string from Raspberry Pi
- Parse the string to either dispense a certain amount of food or open/close the lid.
- Easy to integrate photodiodes to help facilitate the lid stay open for a period of time while the pet is eating.
- One for each feeding bay

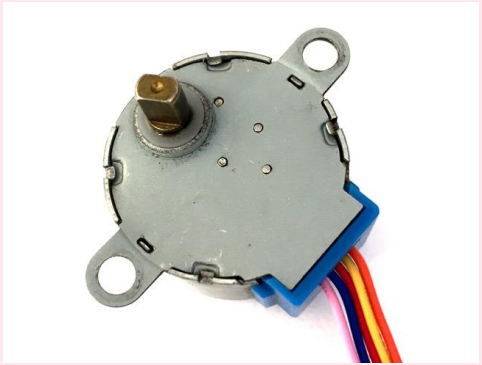
Arduino Uno Rev 3:
- Simple communication with Raspberry Pi
- No external oscillator needed

Model	Arduino Uno Rev 3	MSP430 FR6989	MSP430 G2553
Price	$28.50 (Previously Obtained)	$19.99 (Previously Obtained)	$9.99 (Previously Obtained)
Clock Speed	16 MHz	32 MHz (With External Oscillator)	24 MHz (With External Oscillator)
Memory	32 KB	128 KB	16 KB
Digital I/O	14 Pins	35 Pins	16 Pins
Analog Inputs	6 Inputs	8 Inputs	8 Inputs
Chosen Component			

Stepper Motor - Lid

28byj-48

- Rated Voltage: 5V DC
- Number of Phases: 4
- Stride Angle: 5.625° /64
- Pull in torque: 300 gf.cm
- Insulated Power: 600VAC/1mA/1s
- Coil: Unipolar 5 lead coil



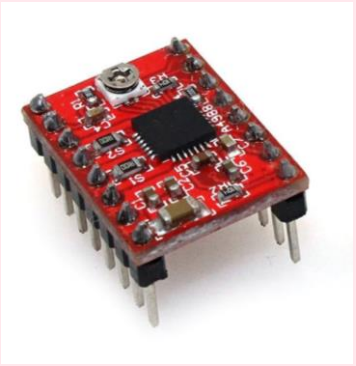
Motor Controller Used :
ULN2003 DRIVER

Stepper Motor - Dispenser

NEMA17

- Rated Voltage: 12V DC.
- Current: 1.2A at 4V.
- Step Angle: 1.8 deg.
- No. of Phases: 4.
- Motor Length: 1.54 inches.
- 4-wire, 8 inch lead.
- 200 steps per revolution, 1.8 degrees.
- Operating Temperature: -10 to 40 °C.
- Pull in torque: 3.2 kg-cm

Motor Controller Used : A4988

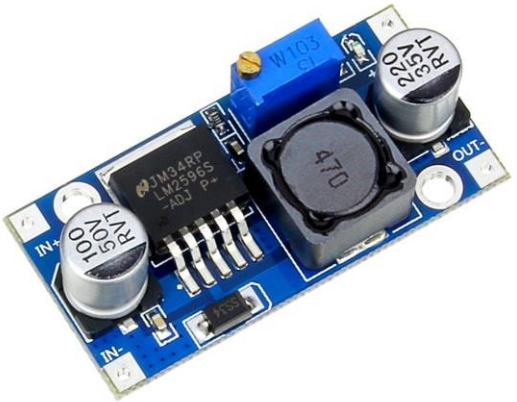


Buck Converter (12V -> 5V)

LM2596

- Input: DC 3V to 40V
- Output: DC 1.5V to 35V

Note: Input voltage must be higher than the output voltage to 1.5V above cannot boost



Color Detection Technology Comparisons

	OV5647 Mini Camera Module	OV5647 Pi Camera Module Ultra-Wide Angle Fisheye Lens
Price	$8.99 for two	$28.99
Compatibility	Raspberry Pi	Raspberry Pi
Resolution	1080 p	1080p
Size	0.98 x 0.94 x 0.35 inches	2.09 x 1.65 x 1.57 inches
Port Type	CSI	CSI

Red LED Comparison

	5 mm Round Top Red LED – Ultra Bright	RL5-8030 (Red LED)	SSL- LX5093ID-5V
Wavelength (nm)	630	635	635
Forward voltage (V)	2.1	2.2	5
Operating Current (mA)	20	20	-
Viewing angle (degrees)	30	30	60
Typical Intensity (mcd)	8000	18000	2000
Cost	$0.18	$1.47	$0.69

Green LED Comparison

	SLR-56MG3F	ALMD-CM3E-Y1002	Super Bright Green 5mm LED
Wavelength (nm)	572	525	520
Forward voltage (V)	2.1	3.2	3.8
Operating Current (mA)	10	20	20
Viewing angle (degrees)	40	30	20
Typical Intensity (mcd)	16	9300	8000
Cost	$0.59	$1.47	$8.00 for 25

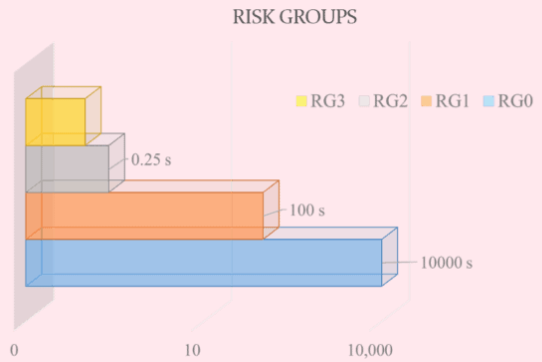
Blue LED Comparison

	APTD1608QBC/D	C503B-BCS-CV0Z0461	Super Bright Blue 5mm LED
Wavelength (nm)	470	470	465
Forward voltage (V)	3.3	3.2	3.8
Operating Current (mA)	20	20	30
Viewing angle (degrees)	40	30	20
Typical Intensity (mcd)	250	4800	7000
Cost	$0.59	$1.47	$8.00 for 25

Lens Comparison

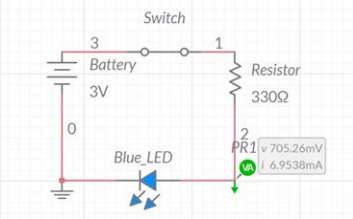
Lens	LA1951	FRP125
Focal length (mm)	1	25
Diameter (Inch)	1	25
Efficient with multiple wavelengths	Yes	No
Cost	$25.14	$23.27

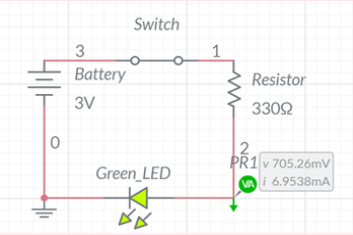
LED Safety

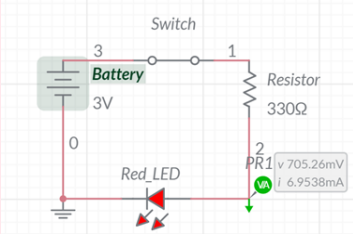


Risk Group	Philosophical Basis
Group 0 (Exempt)	No photobiological hazard
Group 1 (Low Risk)	No photobiological hazard under normal behavioral limitations
Group 2 (Moderate Risk)	Does not pose a hazard due to aversion response to bright light or thermal discomfort
Group 3 (High Risk)	Hazardous even for momentary exposure

Collars Schematic







Collar Detection Overview

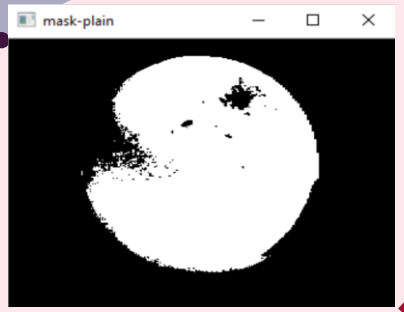
RGB Color Detection Algorithm:

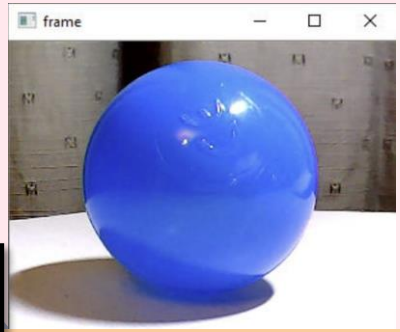
- Capture an image frame from the camera video. Convert frame->BGR->HSV image.
- Apply mask and morphological transformation to remove noise.
- Find the mask contours and calculate the area of the contour.
- If contour area >= designated minimum area, then call the corresponding Arduino to open lid.
- Use threading to call three Arduinos simultaneously in case every color is detected.

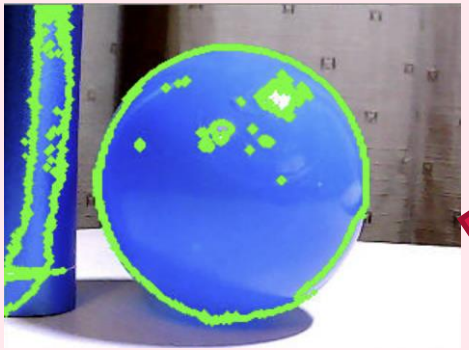
RGB Contour Detection:

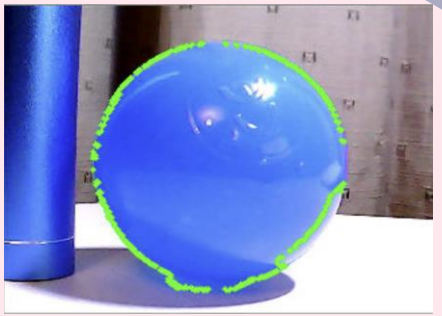
- Use OpenCV and Numpy library functions to detect colors and draw all contours based on the color (R, G, B)
- Find the contour with the largest area.
- Convert the contour to a bounding rectangle.
- Calculate area of the rectangle.

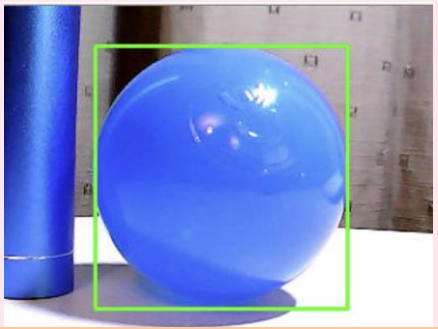
Color Detection Example











IR Detection Technology Comparisons

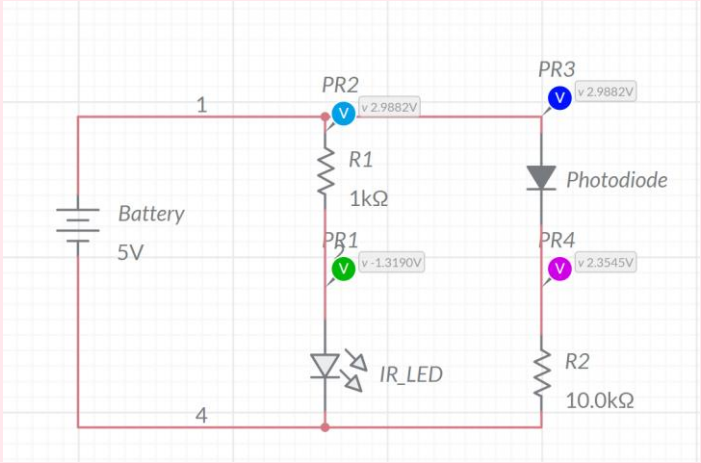
Photodiode Comparison

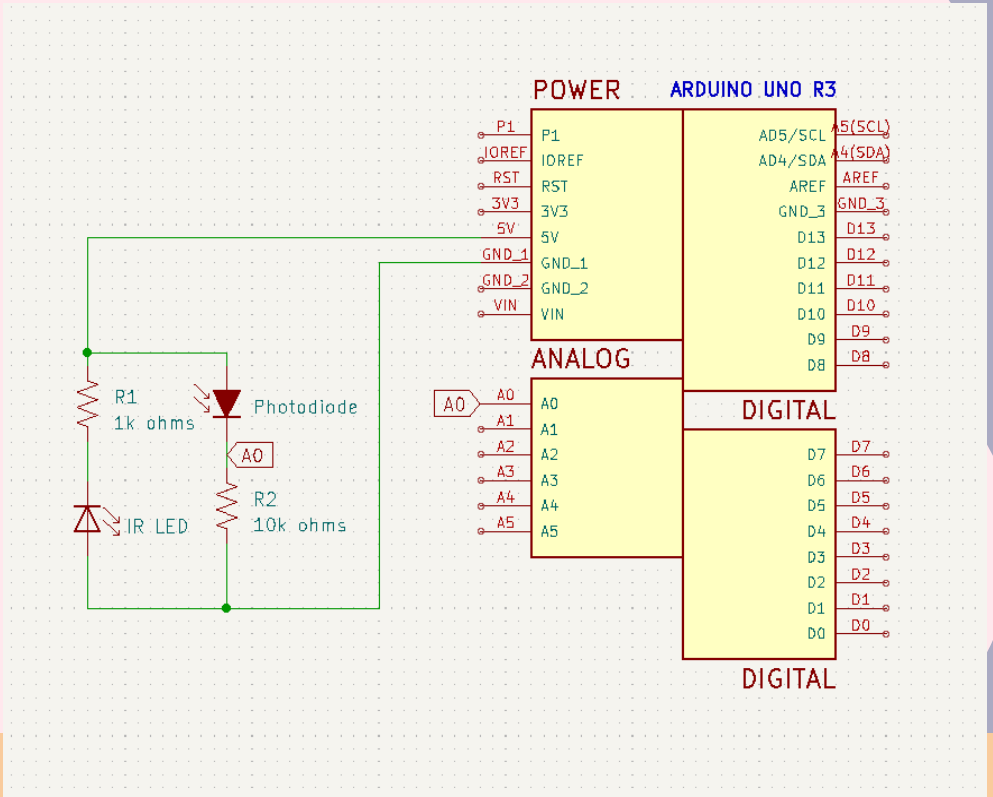
	BPV23FL	S2386-5K	BPW82
Price ($)	1.05	12.09	1.04
Spectral Range	870 - 1050 nm	960 nm	950 nm
Dark Current	2nA	5 pA.	2nA

IR LED Comparison

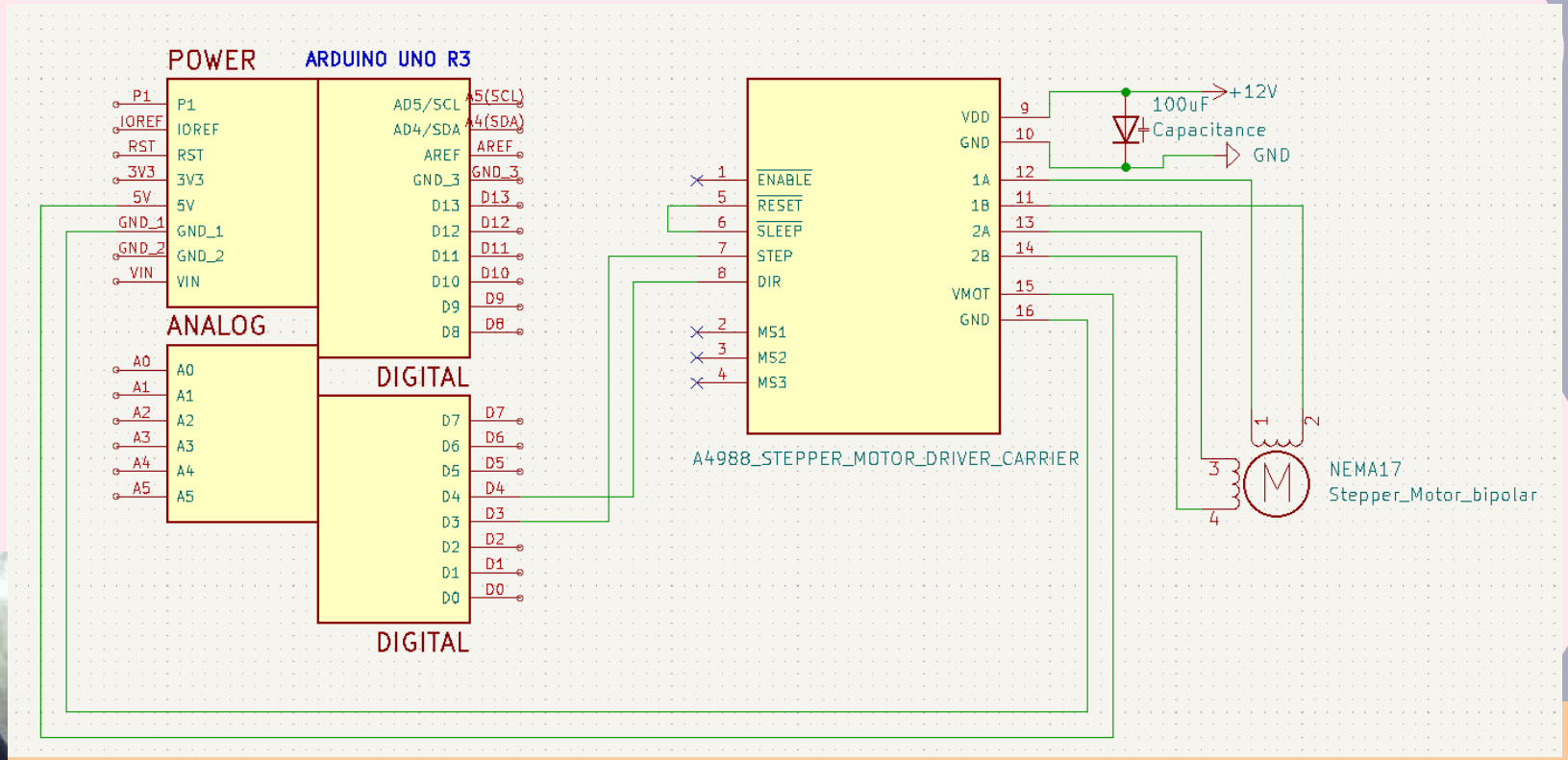
	SFH 4546-AWBW	Super-Bright 5 mm IR LED
Price ($)	0.81	0.75
Viewing angle (degrees)	40	20
Wavelength	950 nm	940 nm

IR LED Motion Detection

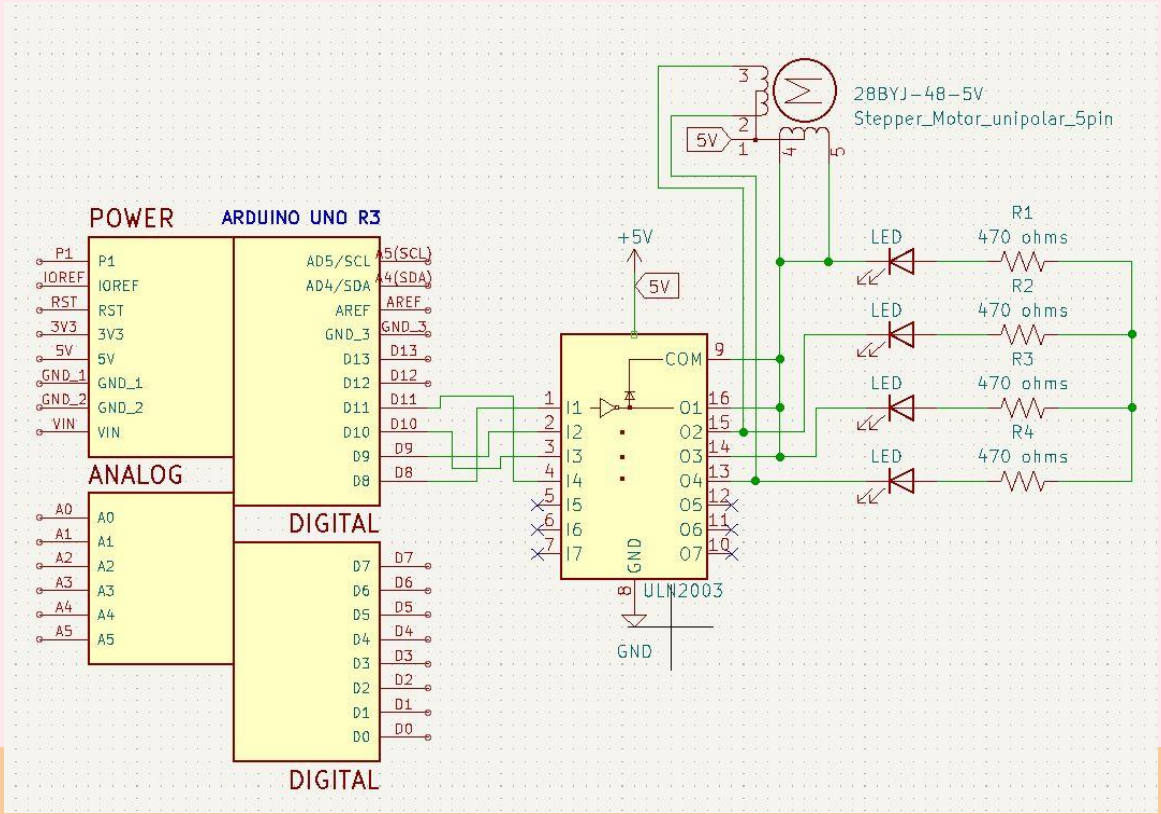




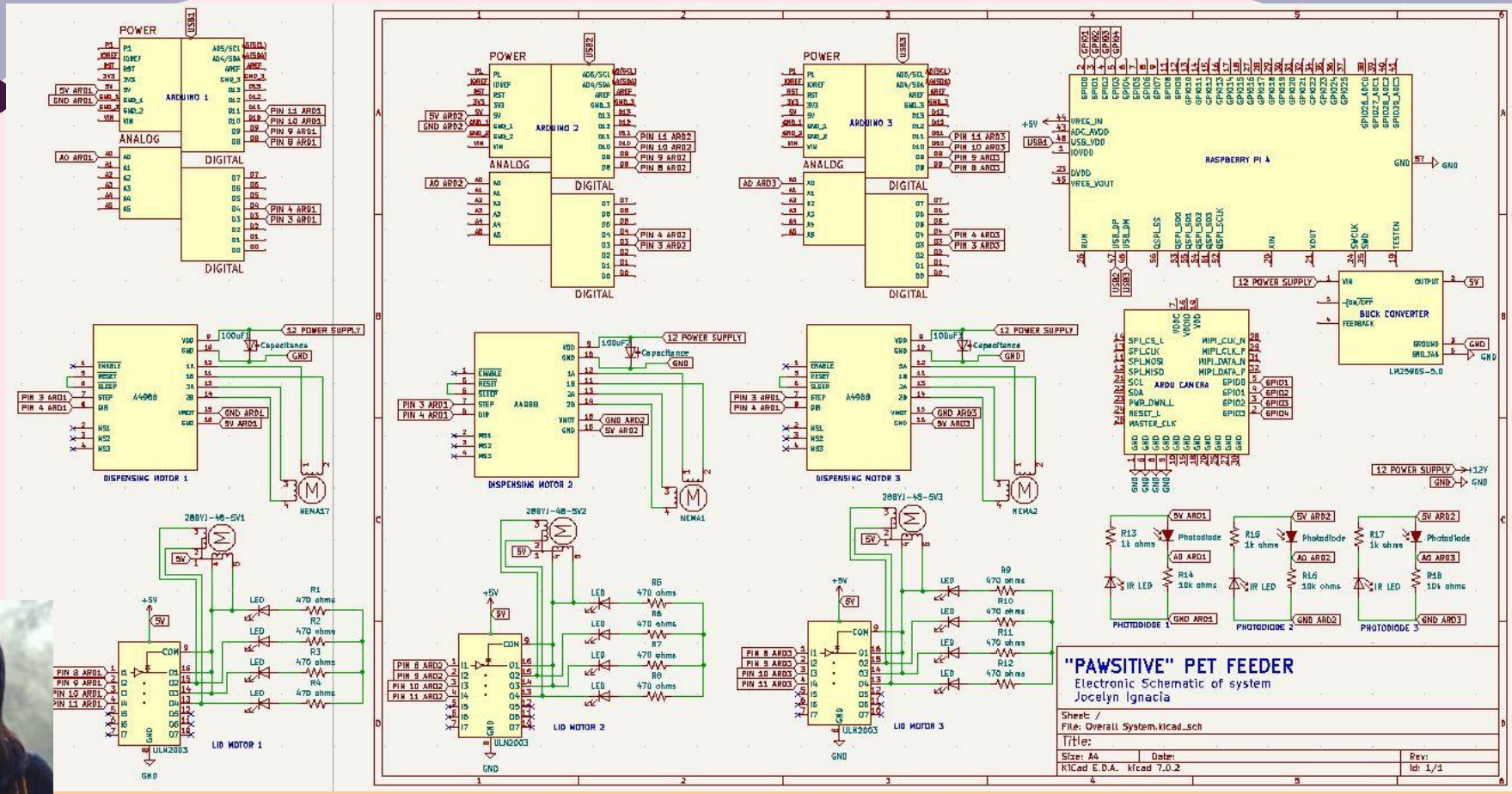
Food Dispenser



Lid System


28BYJ-48-5V
Stepper_Motor_unipolar_5pin
5V
POWER
ARDUINO UNO R3
P1
IOREF
RST
3V3
5V
GND_1
GND_2
VIN
AD5/SCL
AD4/SDA
AREF
GND_3
D13
D12
D11
D10
D9
D8
ANALOG
A0
A1
A2
A3
A4
A5
DIGITAL
D7
D6
D5
D4
D3
D2
D1
D0
+5V
COM
I1
I2
I3
I4
I5
I6
I7
GND
O1
O2
O3
O4
O5
O6
O7
ULN2003
LED
R1
470 ohms
R2
R3
R4

Overall Schematic

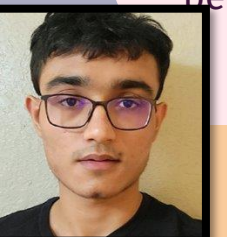


Android Application

Android Application Development Overview

User Profile

- Login and Register options. Verify account via OTP send to user email.
- Input IP address of the pet feeder to establish a connection.
- Change password and Forgot password? Facilities.
- Ability to update profile picture and username.
- Ability to create at most 3 pet profiles.



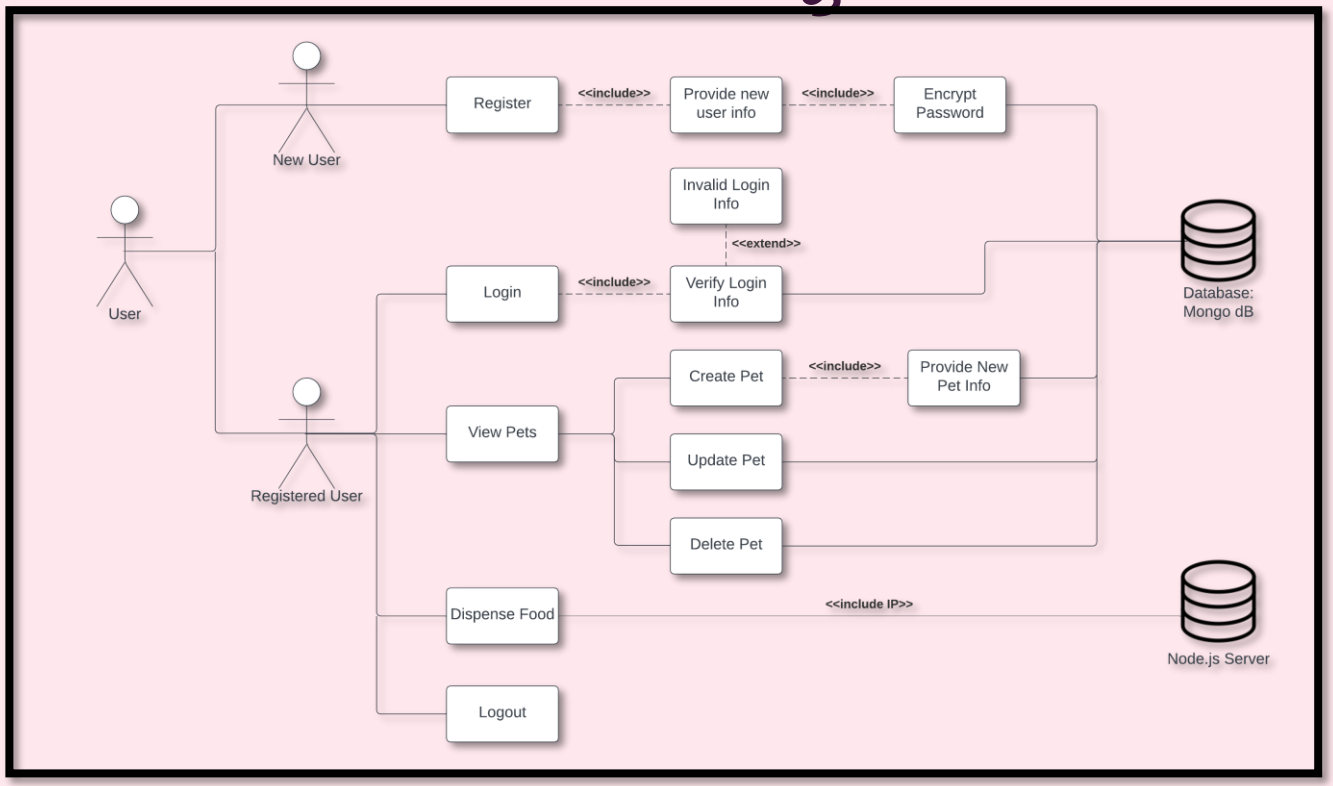
Pet Profile

- Option to enter the Pet's name.
- Save time for food dispensing using the Hour, Minute, and AM/PM format.
- Select the number of cups to be fed to the pet.

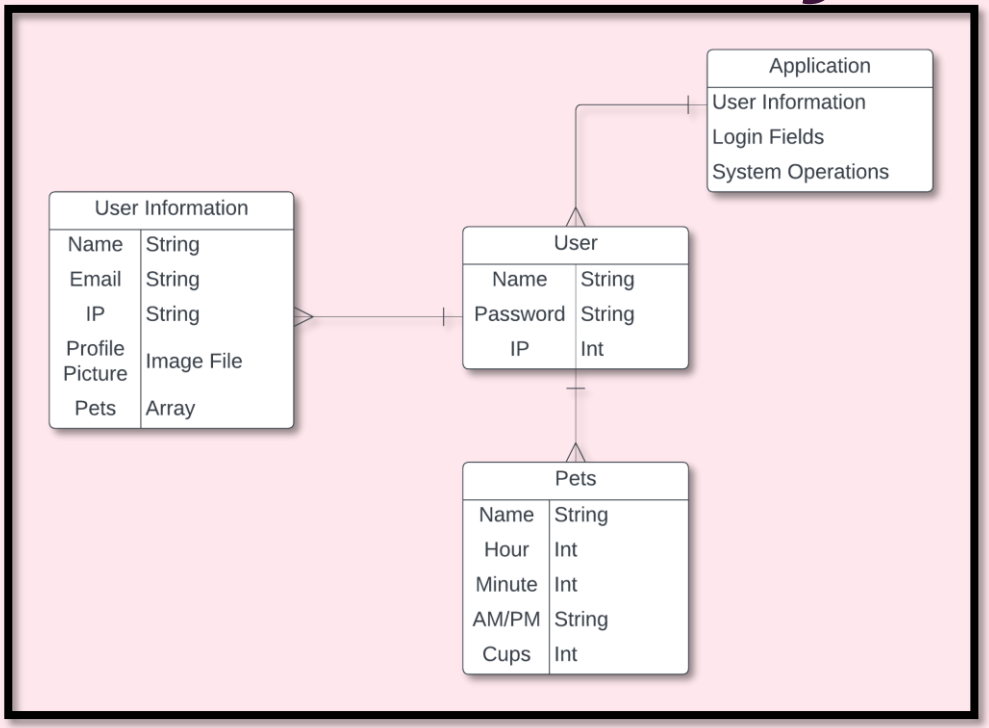
Dispense Action

- Food can only be dispensed after clicking the "Dispense" button on the home page.
- The "Dispense" button sends all three pet profiles to the Raspberry Pi.
- Host a Node.js server on the Raspberry Pi that stores all pet profiles and includes an internal running clock.
- The server checks every second if it's time to dispense food for any pet. If the time matches, the server sends the number of cups to be dispensed to the corresponding Arduino.

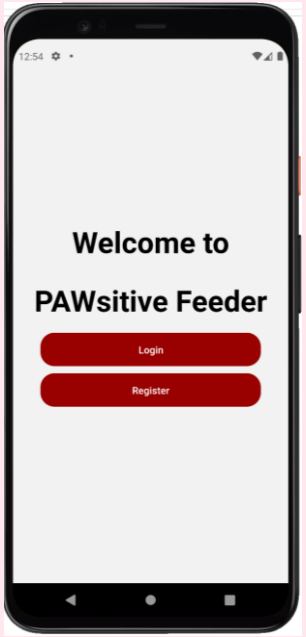
Use Case Diagram

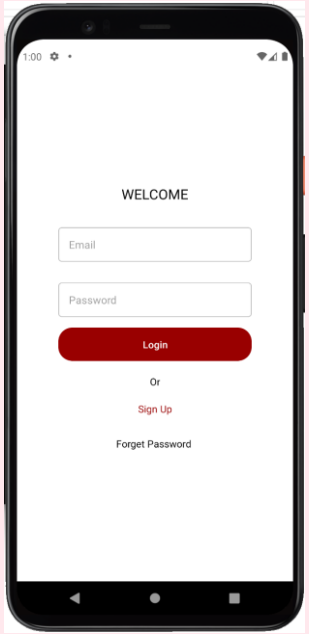


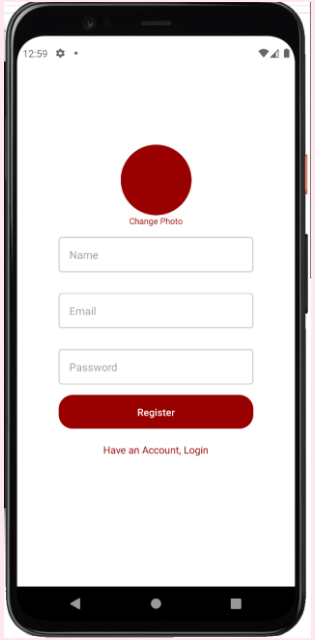
Entity Relationship Diagram



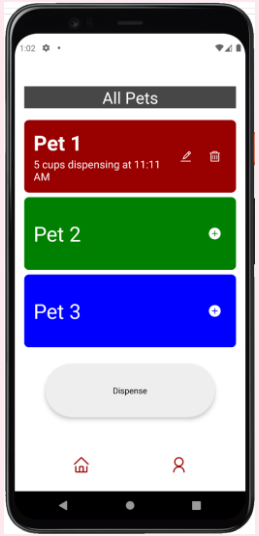
Welcome Page

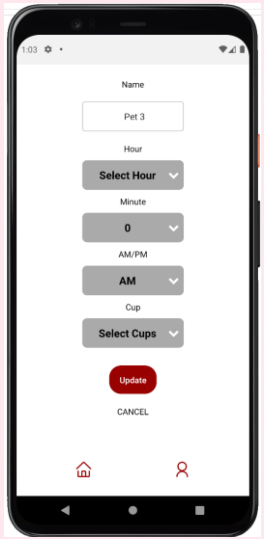


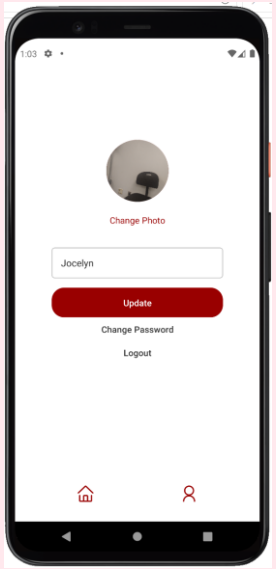


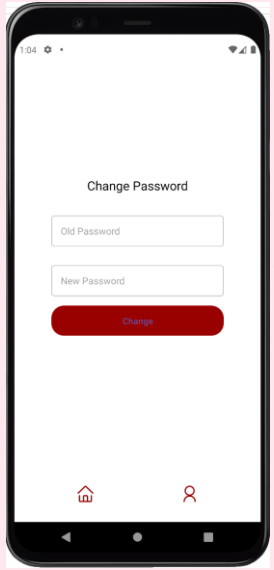


Homepage


All Pets
Pet 1
5 cups dispensing at 11:11 AM
Pet 2
Pet 3
Dispense


Name
Pet 3
Hour
Select Hour
Minute
0
AM/PM
AM
Cup
Select Cups
Update
CANCEL


Change Photo
Jocelyn
Update
Change Password
Logout


Change Password
Old Password
New Password
Change

Administrative Items

Work Distribution

Project Characteristic	Isabella Pardo	Ervin Dupuis	Jocelyn Ignacia	Ayush Pindoria
Collar Tag	Primary	--	Secondary	--
Raspberry Pi software & Camera System	--	--	--	Primary
Android Application	--	--	--	Primary
Arduino Software	--	Secondary	Primary	Secondary
Enclosure Design	Secondary	Primary	Secondary	--
Electrical System Testing / Design	Secondary	--	Primary	--
Administrative Duties	Secondary	Primary	--	--

Budget and Financing

Total Cost: $590.54
Optical Component Cost: $201.76

Cost will be split evenly among all group members

Component	Cost of Item	Quantity	Total
Camera	$9.62	1	$9.62
Red LED	$1.05	8	$8.40
Green LED	$12.81	1	$12.81
Blue LED	$7.13	1	$7.13
Frensel Lens	$32.56	3	$97.68
Photodiodes	$0.92	25	$50.63
IR LEDs		25	
Batteries		5	
Battery Holders	$8.01	1	$8.01
Switches	$7.48	1	$7.48
Stepper Motor	$14.59	1	$14.59
Stepper Motor	$14.59	1	$14.59
Belker AC/DC Adapter Power Supply	$14.90	1	$14.90
Raspberry Pi	$84.00	1	$84.00
3D Printing (First Round)	$14.50	1	$14.50
A4988 Stepper Motor Driver (5 pcs)	$14.99	1	$14.99
LM2596S Power Module (5 pcs)	$9.19	1	$9.19
Nema 17 Stepper Motor (3 pcs)	$31.02	1	$31.02
PVC Sheet	$100.00	1	$70.00
Various Housing Materials	-	-	$30.00
New Camera			$15.00
USB Extender Cable	$7.00	3	$21.00
Food Storage	$10.00	3	$30.00
Lid Supplies	-	-	$10.00

Design Constraints

Economics and Time	-	2 Semester Limit for Research, Development and Construction of Product - More expensive up-front, however does save money in the long run due to the ability to feed multiple pets
Environmental	-	Utilizes off the shelf components - Product is targeted to last the lifetime of the pet
Social	-	End User is responsible for food entering the product's system - Food storage must be refilled in a timely manner.
Political	-	Not relevant towards the project
Ethical	-	Care for animals are priority - Product must be safe and tested for use.
Health and Safety	-	Materials that contact food directly must be safe
Manufacturability	-	3D printed components must be up to standards for the longevity of the project
Sustainability	-	Using quality motors and materials will produce less waste and repairs.
Presentation	-	No pet policy on campus. Used stuffed animals to test and demonstrate engineering specifications

Related Standards

- United States Food & Drug Administration
  - Store dry pet food [] in a cool and dry place. The temperature should be less than 80° Fahrenheit. Excess heat or moisture may cause the nutrients to break down.
- Animal Welfare Act
  - 7 U.S.C. 2131: Gives the United States Department of Agriculture the authority to make regulations to implement and enforce the law by issuing regulations on the minimum standards of care and treatment for research and testing
- Soldering
  - Follow UCF Guidelines for Soldering Safety

Demonstrated Design Requirements

Component	Parameter	Design Specification	Demo Results Mean	Demo Results Variance
Camera	Color Detection	3	All 3 Detected	
Dispenser	Dispensing Time	< 60 Seconds	49.16 Seconds	0.44 Seconds
Lid	Activation Time	< 30 Seconds	6.10 Seconds	0.65 Seconds
Application	Mobile Use	Set Time And No. Of Cups To Dispense Food	Works as intended	

University Of Central Florida

College of Optics and Photonics

College of Engineering and Computer Science

"Pawsitive" Pet Feeder

Senior Design II, Group #08

Final Presentation

Professors: Dr. Samuel Richie, Dr. Lei Wei, Dr. Aravinda Kar

UCF