



**PDE3413 Systems Engineering for Robotics**

**Individual Project Draft Proposal Report**

**Automated Multi Pet Feeder (MPF)**

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## 1. Introduction

A social robot is a physical-mechanical device that interacts with its environment utilizing various robotic techniques.

They are designed with the intention of exhibiting behaviours that are inherently human-like, such as hearing, seeing, and identifying objects with the use of sensors and cameras. They may modify their movements based on the data they gather, such as hand gestures or vocal soundwaves.

One of the newest innovations of a social robot is an automatic pet feeder. The latter is designed to assist pet owners in caring for their pets while they are away from home.

The purpose of having sensors in a system like this is to automate the feed process completely with less/no human interference. (Jayaram, automatic pet feeder using internet of things, 2019, pp.1)

The human interaction shall be when refill is needed or when user wants to manually use the pet feeder.

### 1.1 Aims & Main Objectives of the Multi Pet Feeder (MPF)

#### 1.1.1 Multiple animal detection (maximum 2)

When a pet approaches the robot, the MPF will be able to identify it using computer vision and administer food accordingly. Given that some individuals own numerous pets, this will be a smart addition.

The MPF can be set up to recognize two different animals, such as a dog and a cat, and it can also be used to identify a single animal if the owner has just one.

#### 1.1.2 Pre-sets in terms of quantity

Approximately 55% of cats and dogs are overweight, which poses major health hazards such as diabetes, kidney illness, heart, and lung disease. (McDowell, n.d)

The portioned feedings your pet needs are provided by an automatic feeder, which helps to maintain the right weight. The same will guarantee that the animals are fed adequately.

#### 1.1.3 No earlier wake-up for Users

Many pet owners struggle with their pet waking them up in the early morning or late at night. When needed, MPF will feed the animal.

#### 1.1.4 Food Available even in absence of Owners

We all lead busy lives, and sometimes our schedules prevent us from keeping up a regular feeding schedule for our animals. MPF provides the reassurance that your pet will be fed while you are away or at work. It will not be difficult to fit a late meeting into your schedule if you are confident that your pet will consume the same meals as always.

## 2. Market Size

The Automatic feeder market size was valued at \$344.6 million in 2020 and is projected reach \$998.7million by 2030, registering a CAGR of 8.0% from 2021 to 2030s

From the above figures and diagram there is an existing market for Pet Feeders and same is expected to grow over the year.

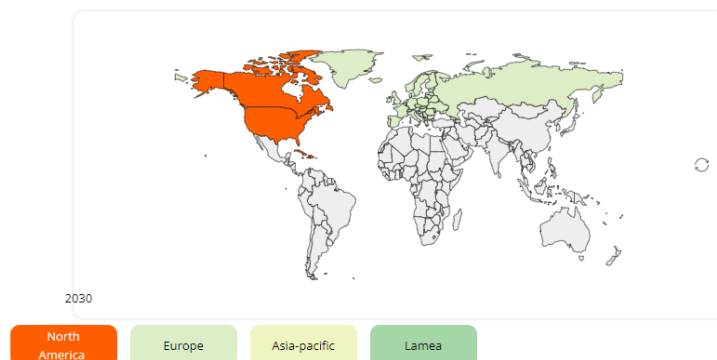


Figure 1. Market Sector (Alliedmarketresearch, Sept 2021)

### 2.1 Target Audience

The Pet Feeder is targeted for:

- Pet Owners who travel a lot
- Pet with food disorder
- Pet Owners who have a rough time keeping up with the frequent food requirements of their pets.

### 2.2 How project will fit the market?

Seeing the increase in demand and that now several residences have multiple pet a new compact solution will be suited for the homes. The main selling point of this product is that it can be used for multiple pet.

## 3. Background Research

### 3.1 Review and short analysis-Existing Projects

The Microchip Pet Feeder (McPT) was made to recognize either the Sure Petcare RFID Collar Tag (one is included - one not) or the microchip that has previously been put in your pet allowing your cat to access their food while maintaining out other creatures.

Surepetcare has created a pet feeder as Figure 2.



Figure 2. Microchip Pet Feeder (Surepetcare, n.d)

### 3.2 Features and Structural of system

#### 3.2.1 Feature Analysis

##### 3.2.1 Stock Levels

This system lacks a stock level control that would alert the user when supplies are running low, and a refill is necessary.

##### 3.2.1 Tags/Collars

Collar has a unique ID that is saved in the MPT's memory permanently.

It can tell if a pet is on the pad of the pet feeder, which has both advantages and disadvantages.

It can tell if a pet is on the pad of the pet feeder, which has both advantages and disadvantages.

But as a drawback, it raises ethical and practical concerns. For instance, many proponents of animal rights oppose the wearing of collars, even though they serve an important purpose and

that, given the nature of the animals we deal with, the collar tag is prone to loss or damage and thus increases user costs. Since it has a pricey and distinctive method of recognizing the collars, user will have to purchase one directly from the manufacturer.

### 3.2.1 Retrieving remaining food by pet for later use

Unfortunately, this pet feeder has no way to put remaining food back to the bowl which might lead to food wastage.

### 3.2.1 Identification of pet

The McPF does not include a method of identifying the animal because some households may have more than one cat or pet, for example, one household may have dogs and cats, necessitating the purchase of two separate devices, which will confuse the pet.

### 3.2.1 Food holder in metal

Because of the way the product is designed, it can hold both wet and dry food. Bowl capacity is 400 mL, which is equivalent to two pouches of wet food.

### 3.2.1 Battery powered

This product has a 6-month battery life, which is ideal if the user is away for an extended period and there is no power in the home.

## 3.2.2 Structural Analysis

### 3.2.2 Button Placement and function control

#### Pros:

1. A minimalist approach that is not tampered with by the pet.
2. Easily accessible from the side



**Figure 3. Button Placement and interaction board (Surepetcare, n.d)**

#### Cons:

1. There are not many options, and the interface is not very user-friendly.
2. The pet ID is permanently stored and must be returned to the factory for hard reset. - There is no leeway.
3. There is no variety of options available, and the same is not aimed at people who are less familiar with technology.

### 3.2.2 Lid opening

#### Pros:

1. It is a better sanitary option because food does not spill everywhere.
2. Proper food control if you have multiple pets. Only pets with tags will be responded to by the lid.



**Figure 4. Lid Mechanism (Surepetcare, n.d)**

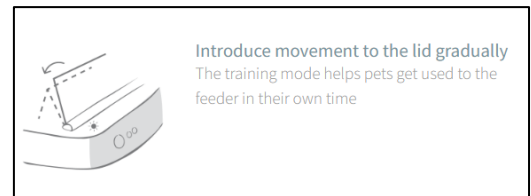
#### Cons

1. The mechanical lid should take some time to open, allowing the pet to leave.
2. The opening of the lid is determined by the tags. If two tags are too close together, a conflict will occur, and the machine will need to be restarted.

### 3.2.2 Movement of lid details

#### Pros:

1. The way the lid will use data from previous opening and closing to adapt to the pet, which is an adequate method of learning the animal to optimize optimal use.



#### Cons

1. The initial adaptation will be difficult and unpleasant for the pet.

**Figure 5. Lid Adaptation (Surepetcare, n.d)**

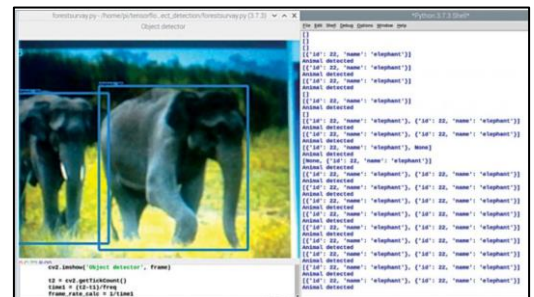
## 3.3 Review and short analysis-Existing Technologies

### 3.3.1 Contextual Info

Many animal species are still becoming extinct because of hunting, and governments can only do so much by enacting laws and conducting regular surveys. However, conducting a survey is a challenging task, especially without the assistance of technology.

This project's smart camera employs Python code with pre-trained TensorFlow models for forest monitoring and survey. The models assist us in matching and mapping the image in frame with the trained data of the model, and thus in identifying those animals.

Figure 1 shows images of elephants being detected using the author's prototype. Figure 2 depicts the author's prototype, which employs a Raspberry Pi (or RPi) with a camera module.



**Figure 6. Elephant being captured by prototype (Kumar Sinha, Sept 2021)**



**Figure 7. Pi Camera for Survey (Kumar Sinha, Sept 2021)**

### 3.3.2 Technological Analysis + Costing for Pi Camera Implementation

The Raspberry Pi uses its camera to take a video image, and the OpenCV module is used to separate the video into frames. The image of the discovered species is then processed using OpenCV and other modules, and it is mapped with a category and trained detection model. When an animal species is recognised but not included in the category list, the output is "none" and the image, data, and date are saved in the database folder for later analysis.

Bill of Materials <span>Table 1</span>			
Component name	Quantity	Description	Approx. Cost (₹)
Raspberry Pi 4/Zero W	1	Any version of RPi	4,500
RPI camera	1	Camera module	300
HDMI/RCA cable	1	For video output	200
Wires	Depends	For connection	30
<b>Total cost</b>			<b>5,030</b>

**Figure 8. Costing Table (Kumar Sinha, Sept 2021)**

The total cost for the Full prototype was INR 5030 equivalent to Roughly Mur 2515. The pros of this system is that it is cheap and need very low maintenance but a major con is that we have to feed the RaspberryPi With existing data for it to be able to get a more or less accurate result.

This technology can be used to train a pet feeder to identify different animals so as to be able to analyse and process the data for actions to be taken by the robot.

## 4. Proposal

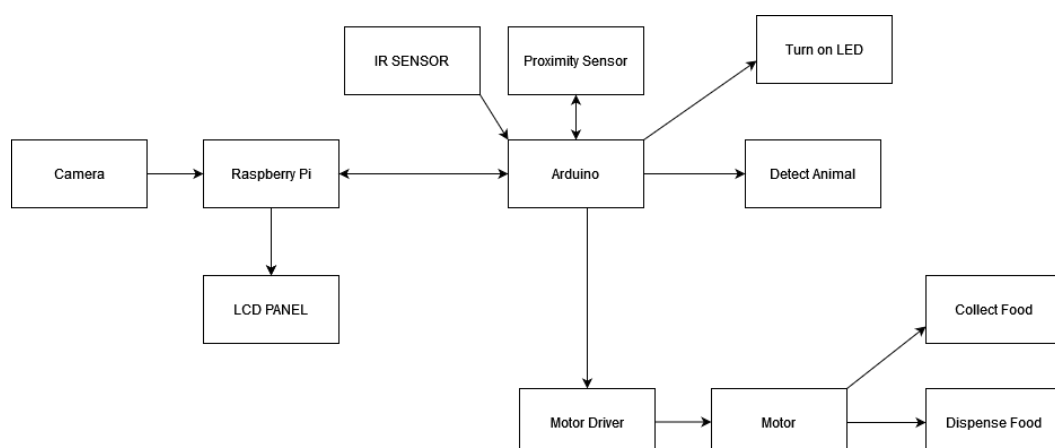
### 4.1 Description and concept behaviour.

A Multi-Pet Automated Feeder that distributes and monitors food. The same will be able to store food and identify which pet is visiting its base and will provide appropriate food. It will also have an interface for human to react directly on it. If food is left over after a while, it must be returned to the food storage. This MPF must also have a water dispenser. The concept behaviour will be in details below. (Refer Section 4.2.2 Flow of System)

### 4.2 Review and short analysis-Proposed projects

#### 4.2.1 System Architecture

The System architecture connection shall be as per diagram 9. More details is be given in a flow chart and the flow of data shall be given in full detail refer to Section 4.2.2.



**Figure 9. Block Diagram**

#### 4.2.2 Flow of the System

The sensors will interact between each other and with the Arduino & raspberry pi to generate action exactly like human using sensors to the brain. The flowchart below will give more detail about the flow of data and how sensors react between each other

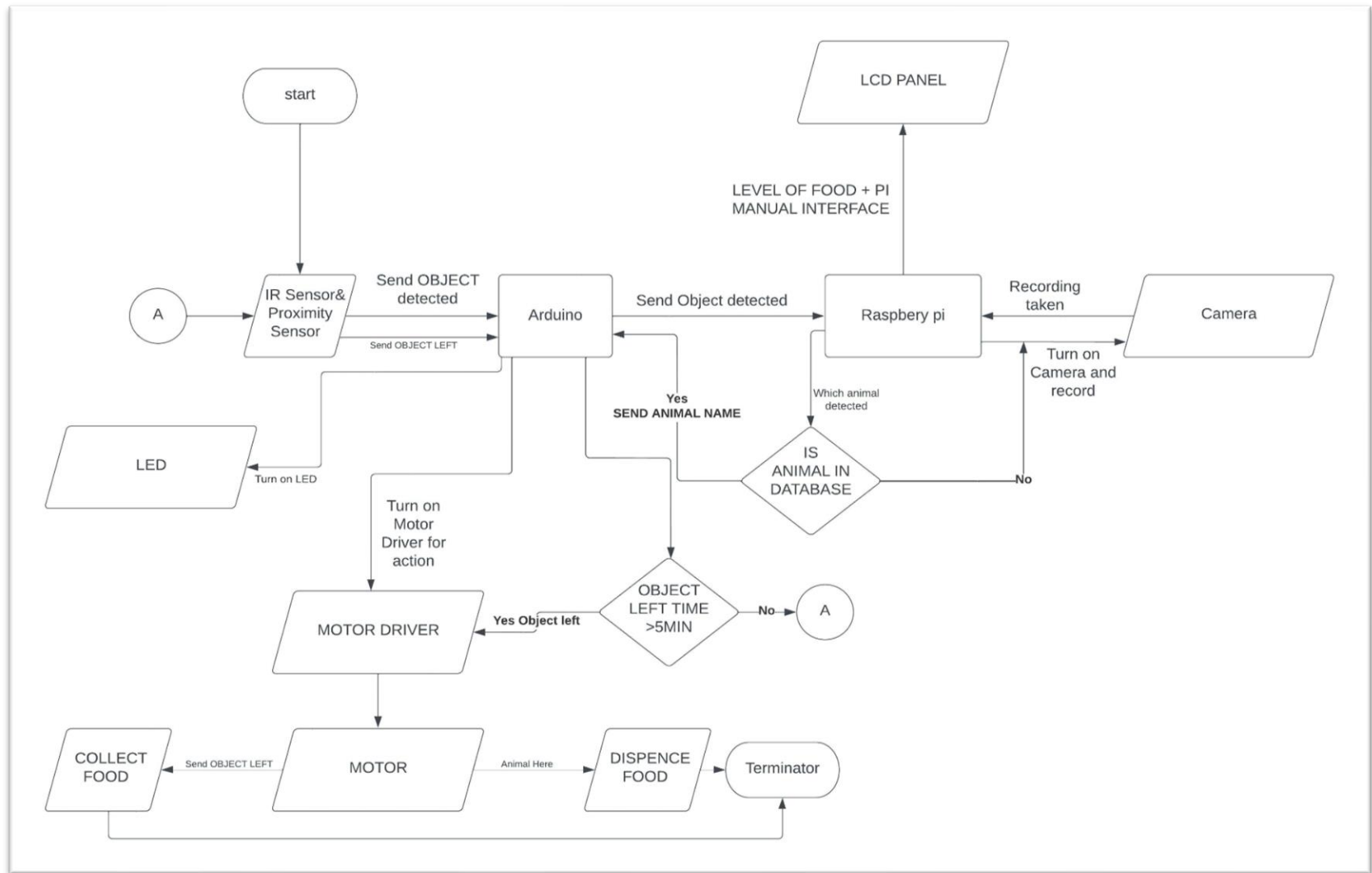


Figure 10. Flowchart



### 1.1.1 Component for data collection and action creation

All social robot-like human- have different sensors to collect data from the environment and process it to do an action.

You shall find the sensor & component list below which will be required for the proposed project.

## • Object Detection

### 1. Proximity Sensors (Sharp GP2Y0A41SK0F)

A PSD (position sensitive detector), an IR-LED (infrared emitting diode), and a signal processing circuit are merged to form the distance measurement sensor unit.

The adoption of the triangulation approach prevents the diversity of the object's reflectivity, the ambient temperature, and the operation length from having a significant impact on the distance detection.

The voltage output by this gadget is determined by the detection distance.



Figure 11. Analog Distance Sensor (Pololu, 2022)

Same will be used to detect any incoming object

**In Short, the Distance is directly proportional to the voltage output by the sensor**

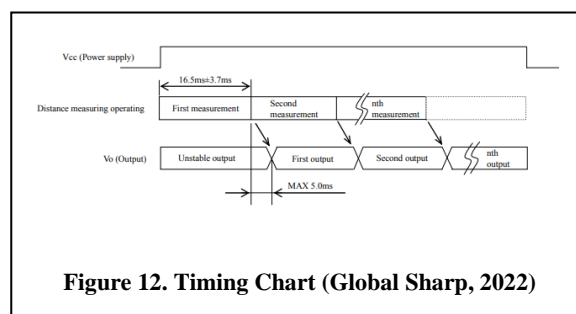


Figure 12. Timing Chart (Global Sharp, 2022)

**Operating Voltage of 4.5 to 5.5 V**

**Minimum Time on to get 1<sup>st</sup>**

**Output time: 16.5ms±3.7ms(refer to Figure 12).**

## • Machine Vision

### 2. Raspberry Pi Camera Module 2

The 8-megapixel Sony IMX219 sensor in the v2 Camera Module (compared to the 5-megapixel OmniVision OV5647 sensor of the original camera).

Both still images and high-definition video can be captured using the Camera Module 2.

Same used to capture the object detected and will be sent to the raspberry pi for further processing

**Recommended Input Voltage 5V and Input Current 2A**



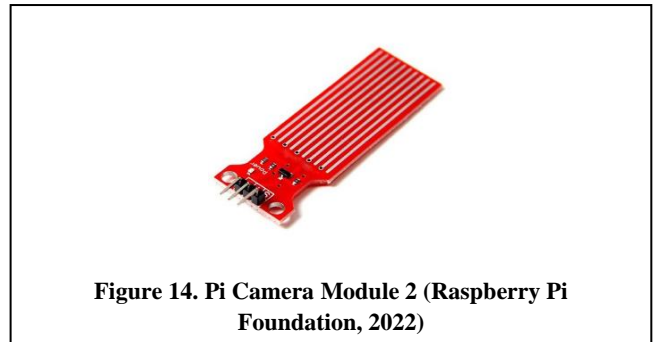
Figure 13. Pi Camera Module 2 (Raspberry Pi Foundation, 2022)

## • Water Level Control

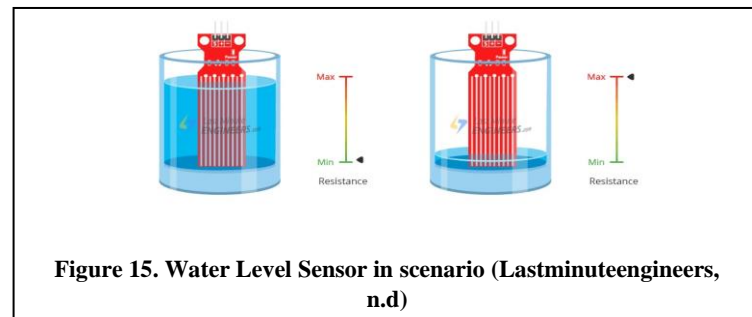
### 3. Water Level Sensor ADV00089

An inexpensive, simple-to-use water level recognition sensor, the water level sensor is made by having a number of exposed parallel wire traces that measure the volume of the water droplets.

The sensor will provide analogue values straight to the analogue input pins on your Arduino board, where they may be read and processed further. Ideal for any upcoming project using a water level alarm. 3.3V to 5V is the operating voltage and less than 20mA.



As Figure 15 shows the Water Level is Indirectly proportional to the resistance. This will be our control for us to check the level of water



#### 1.1.2 Feature Analysis

##### 1.1.2 Detection & Identification of Pet

As soon as pet come close to the sensor the Robot will detect the animal thus starting the identification process. Computer vision will be implemented to Identify which pet shall be used using camera. The Project use camera vision linked to capture the face& body of the pet and shall compared that to a database as explained above in Section 1.1.1. Base on the outcome the respected food shall be delivered

##### 1.1.2 Selection of Food

After pet has been identified a plate shall be move on the x plane to collect proper food. (More details in Structural Analysis). After selection of food, the plate shall move on the Y plane down next to the out-source to the bowl. (More details in Structural Analysis). When the plate come to the outside it shall be tiled by a motor to empty the plate into the food bowl. After that same shall be reset to initial position.

##### 1.1.2 Level of Food in Stock

Stock shall be monitored like a being in low stock same shall light a red bulb next to the slot for the corresponding food. (An on-board interface shall be implemented depending on the time frame).User will have to interact with it and refill same

##### 1.1.2 Food storage

Food will be stored internally to avoid contamination of food and risk of heal issue of the pet

##### 1.1.2 Control Panel

The MPF shall have a control panel where user will be able to interact and have full control on the system manually.

### 1.1.3 Structural Analysis

#### 4.2.2.2 Outside structure

The MPF Shall be a box like structure. Below you shall find the plan of the Robot.

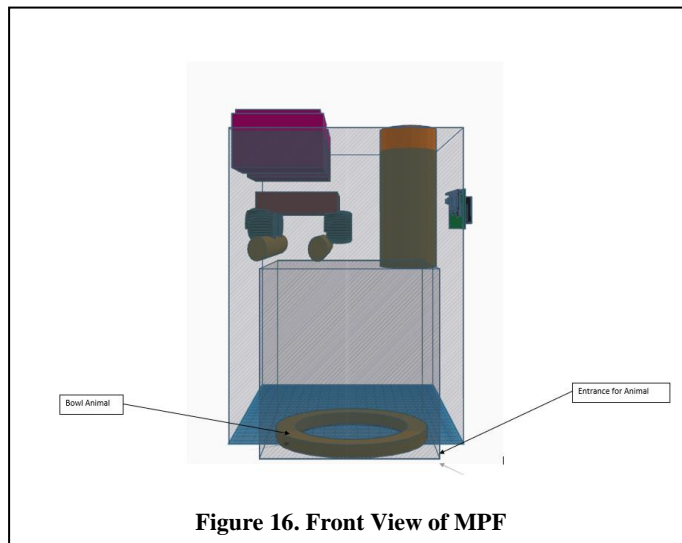


Figure 16. Front View of MPF

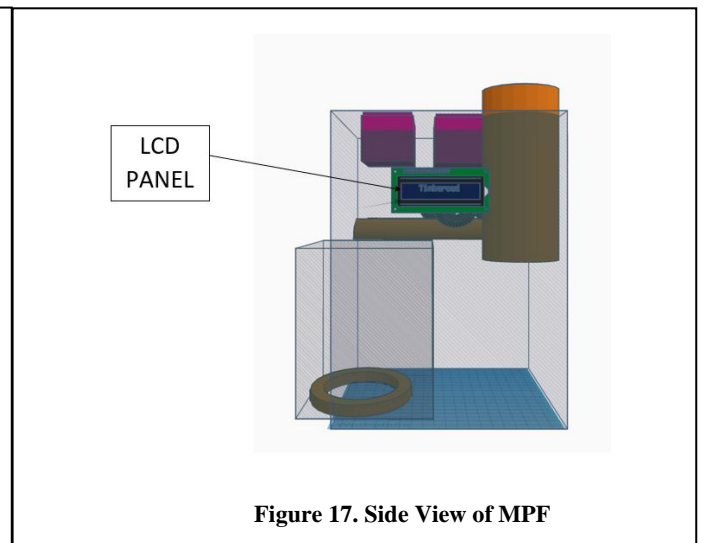


Figure 17. Side View of MPF

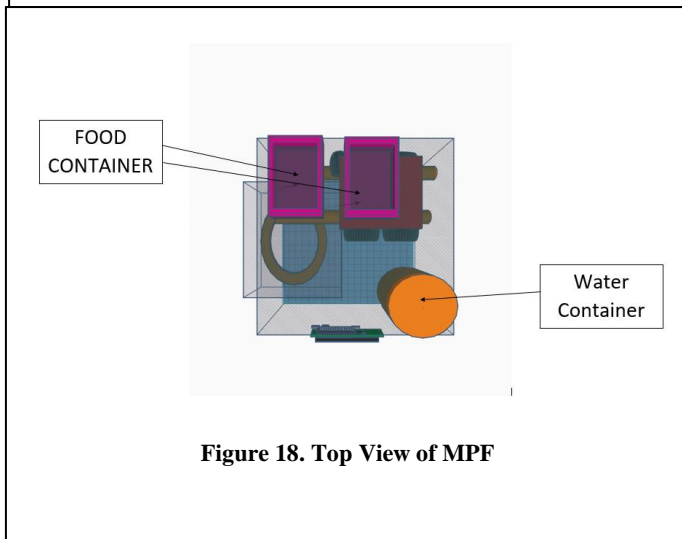


Figure 18. Top View of MPF

Proximity sensor & IR shall be placed on 4 sides of the MPF so as it can detect the animal coming from all areas. The Pi Camera will be placed only on the Front View since the bowl of food is there thus the MPF will dispense food when the animal is in front of the ball. LED will be in the small partition where the food will be given to create a cosy environment for the animal.

#### 4.2.2.2 Movement of plate for food dispense

The plate shall be place on wheels. Same structure will be put on two rods and a chain shall be attached to both end of structure.

For the movement of the plate same shall act as a pulley system to move right and left (x-axis) refer to Figure 19

For the Movement up and down system shall be same as x-axis put just on y-axis

The pulley will work with a motor. Refer to Figure 19

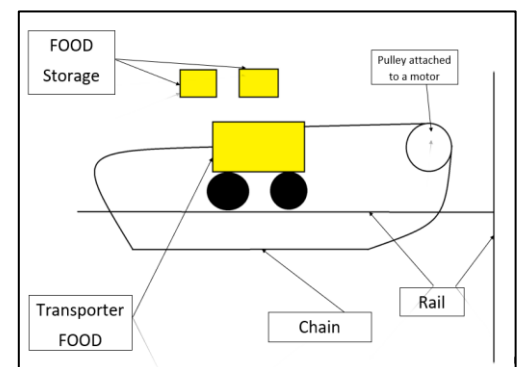


Figure 19. Side View of movement system

## 5. Testing the System

### 1. Component Testing

#### Proximity Sensors (Sharp GP2Y0A41SK0F)

For this test we shall require 1 Arduino Uno, Sharp Proximity Sensor measuring tape and three breadboard cables. The test consists of setting predefined distance from sensor to object and check if the sensor can detect the object at the pre-defined distance. The circuit will be as below.

If the object is able to detect the object at predefined distance the sensor is working properly.

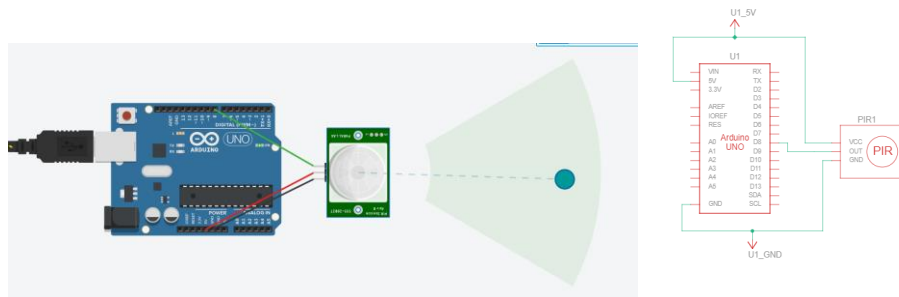


Figure 19. Connection Arduino with Sensor & Pin Out diagram

#### Raspberry Pi Camera Module 2



Figure 20. Connection Pi board with PiCam (Raspberry Pi Foundation, 2022)

For this test we will require The Raspberry Pi board, Raspberry Pi Camera Module 2 and object. We can test if it can identify object using OpenCV sample test

We will have to connect the Pi Camera to the Pi Board as shown in Figure 20. In the System configuration of the Pi board, we will have to enable the camera.

If we get an output image the camera is working with proper identification the test is successful

#### Motor Testing

For this test we will require a DC motor together with an Arduino. This will just test if the motor is working. You can also vary the amount of Power supply to it to see if it has a good speed range since calibrating on the rod/rail require precision

For the Arduino to run the motor a motor driver is Required Model L293D

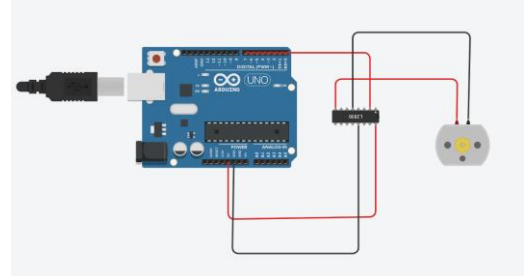


Figure 22. Motor Connection to Arduino

## 2. System Testing

- The robot must be able to use the proximity sensor to detect the pet and start turn on the machine. Same need to be calibrated
- The robot must be able to capture the photo and process it to give the correct food. The raspberry pi should give the correct answer.
- Calibration is required for the rod & the food transporter so as it moves exactly under the boxes and move exactly into the bow
- Water container should be tested for any leaks since we are dealing with electronic component.
- Software testing shall be done on all the whole system and the inference system also need to be tested and see if all required function is working correctly.
- The robot shall be able to resist small bumps and crashes since we are dealing with a pet and some pet can be aggressive.
- Do a full testing with all the component together and see if the sensors are giving the proper data.
- The output of the whole system shall be as below
  - Proper food and amount of food delivered
  - Proper Water Level display
  - Proper Alert Sign when low in stock
  - Proper timing to collect the food back in the storage section

## 6. What are the potential pitfalls of your system?

- Power Supply- The Robot should have enough power to supply to the two motors.
- The size of the entrance for the animal should be enough
- High speed movement animal cannot be detected using this model
- It can only feed 1 pet at a time
- If knocked down, internal part may move
- Since we are dealing with water, circuits may get damage.
- No cold storage in case some food needs to be refrigerated.

## 7. Future implementation?

- Same can be altered to serve animal in zoos such as ass wheel to the robot for it to move to different section in a zoo.
- A cooler can be install in the storage section can be implemented to store cold food.
- The project can be made in bigger version so as 4 animal can eat at the same time at the different side of the robot.
- Internal calibration can be more refine and it auto calibrate every time the pet feeder restarts.
- A mobile app/webapp can be developed for the user to interact with it

### 1. Reason why above features not implemented right now.

- i. Budget. This implementation require better component and more accurate one and these component are more expensive
- ii. Time constraints. Since the project is on a whole scale of 4 month the implementation of all these features will be really challenging

## 8. Conclusion

To conclude this social robot is a small prototype that has a great utility in our live. Robots are taking the spotlight in every industry. The outcomes not only demonstrate a significant advancement in the social robot technology's pet monitoring system, but also satisfy pet owners' needs.

## 9. Reference List

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