CSE461: INTRODUCTION TO ROBOTICS

Project Report: Smart Pet Feeder

Assignment 02: SUMMER 2023

Section: 03 Group: 03

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Introduction

In response to the challenges faced by pet owners juggling with busy schedules, we have to ensure that pets are fed at the right time, which can be a challenge for many pet owners. Overfeeding or underfeeding can lead to health issues for pets. Additionally, monitoring the pet's diet, identifying the remaining food quantity, and even ensuring that the pet is eating well when the owner isn't home are all significant concerns. Enter the Smart Pet Feeder - a technologically advanced solution designed to cater to these exact needs. This innovative system seamlessly merges automation, real-time monitoring, and remote interactivity to offer a comprehensive feeding solution for pets, even in the absence of their owners. The Smart Pet Feeder project aims to offer a convenient solution. This initiative involves the creation of an automated pet feeder using Raspberry Pi technology. The envisioned system will not only streamline feeding schedules but also incorporate features such as Real-time Monitoring, Adaptive Feeding (Detect when your pet approaches the feeder), Weight-based Portion Control, Manual Feed Control, Stability and Tamper Detection of the feeder. So addressing these challenges, the Smart Pet Feeder not only simplifies pet care but also elevates the quality of life for our pets, ensuring they are fed, happy, and safe, irrespective of our physical presence By integrating a variety of sensors and modules, this project seeks to alleviate the difficulties faced by pet owners in ensuring consistent and timely nourishment for their beloved companions.

Components

The Smart Pet Feeder project encompasses a range of essential components, each contributing to the overall functionality and effectiveness of the system:

1. **Raspberry Pi:** Serving as the project's core, the Raspberry Pi will act as the central control unit, orchestrating the various tasks and interactions within the pet feeder system.
2. **Servo Motor:** The servo motor assumes the critical responsibility of regulating the controlled release of pet food from the storage container, ensuring precise portions are dispensed during feeding times.
3. **Camera Module:** Integrated with the system, the camera module enables the capturing of images of pets during feeding sessions. This visual feedback not only allows remote monitoring but also provides insights into the pet's behavior.
4. **Weight Sensor:** The weight sensor plays a pivotal role in accurately measuring the amount of dispensed food. By doing so, it ensures that the pet is receiving the correct and consistent nourishment, while also sending alerts when the food supply is running low.
5. **Microphone & Speaker:** The microphone and speaker components work in tandem to facilitate a comprehensive audio interaction. The microphone captures audio messages (sound of the pets). During feeding times, audio interaction adds a personalized touch, allowing pet owners to soothe and engage with their pets even when they are not physically present.
6. **LCD Display:** The LCD display provides real-time information about feeding schedules and system status. This user-friendly interface enhances the pet owner's ability to monitor and manage the pet feeder.

7. **Power Supply:** A reliable power supply ensures the seamless operation of all components, keeping the pet feeder functional and dependable.
8. **Wi-Fi Module:** Enabling remote connectivity, the Wi-Fi module empowers pet owners to remotely access and control the pet feeder through a mobile application or web interface. This feature adds a layer of convenience and flexibility to the feeding process.
9. **Ultrasonic Sensor:** The ultrasonic sensor serves as a proximity detector, recognizing the presence of a pet near the feeder. This capability contributes to the system's ability to initiate feeding and engage with the pet when necessary.
10. **Push Button:** The push button provides a manual override, allowing pet owners to manually dispense food outside the programmed feeding schedule. This feature accommodates spontaneous or irregular feeding requirements.
11. **MPU-9250:** If feasible, the MPU-9250 adds motion sensing capabilities to the pet feeder. This component enables the analysis of pet movements and behaviors, providing insights into the pet's overall well-being and habits.
12. **DC motor:** The DC motor is a device that converts electrical energy into mechanical energy, causing rotational motion. The speed of a DC motor can be controlled using variations in voltage or, more commonly, using Pulse Width Modulation (PWM) via a microcontroller like the Raspberry Pi.
13. **Motor Driver (L298N):** A motor driver acts as an interface between the microcontroller (Raspberry Pi in this case) and the DC motor. DC motors typically require higher current and voltage than a microcontroller can provide. The motor driver safely amplifies the current and voltage and can also provide directional control.

Connectivity (Explanation and image)

Explanation: The components will be interconnected as follows:

- The Raspberry Pi 4B is the central controller. All components connect to it, either directly through the GPIO pins, USB ports, or via wireless modules.
- The servo motor will be connected to the Raspberry Pi's GPIO pins to control food dispensing.
- The servo motor's PWM pin is connected to one of the Raspberry Pi's GPIO pins for control. Additional connections for power (5V) and ground.
- The Raspberry Pi camera module can be connected directly to the dedicated camera port on the Pi using the ribbon cable. The camera module will capture images, and the microphone and speaker will be used for audio interaction.
- Typically, weight sensors (like load cells) require an amplifier, such as the HX711. So we have to connect the load cell to the HX711 and then connect the HX711 to the Raspberry Pi GPIO pins for data and clock.
- The LCD display will provide real-time information, and the weight sensor will be integrated into the food container.
- In case of Push Button, depending on which button we want to use, one end to a GPIO pin and the other end to ground (that specific row and column pin) for the manual command.
- The microphone module can be connected via USB or the 3.5mm jack, depending on the type.
- For the ultrasonic sensor, we have to connect the trigger and echo pins to two separate GPIO pins on the Raspberry Pi. In the case of the echo pin, we

will connect it by maintaining the 2:3 ratio with the resistors. Also, connect the power (5V or 3.3V depending on the sensor model) and ground.

- Raspberry Pi 4B has built-in Wi-Fi, so no additional connections are necessary. The Wi-Fi module will enable remote access and control via a mobile app or web interface.
- For the MPU-9650 we have to connect via I2C to the SDA and SCL pins of the Raspberry Pi. Additional connections for power (3.3V) and ground. The MPU-9250 will provide motion data for behavior analysis.
- DC motors require a motor driver to be controlled by the Raspberry Pi. So we have to connect the input pins of the driver to the Raspberry Pi's GPIO and the output pins to the motor. We also have to ensure the driver is supplied with appropriate power for the motor.
- For the I2C display, we have to connect it to the I2C pins (SDA and SCL) on the Raspberry Pi.
- While making all the connections, we have to ensure the voltage requirements of each component. Some components might require 5V, while others need 3.3V. Incorrect voltage can damage components.
- Also, shared ground should be maintained. We have to ensure that all components that have separate power supplies share a common ground with the Raspberry Pi to avoid potential differences in voltage levels.
- Finally, once the hardware connections are established, software libraries and scripts would be needed on the Raspberry Pi to interact and control each of these components effectively.

Images (working steps and circuit diagram)

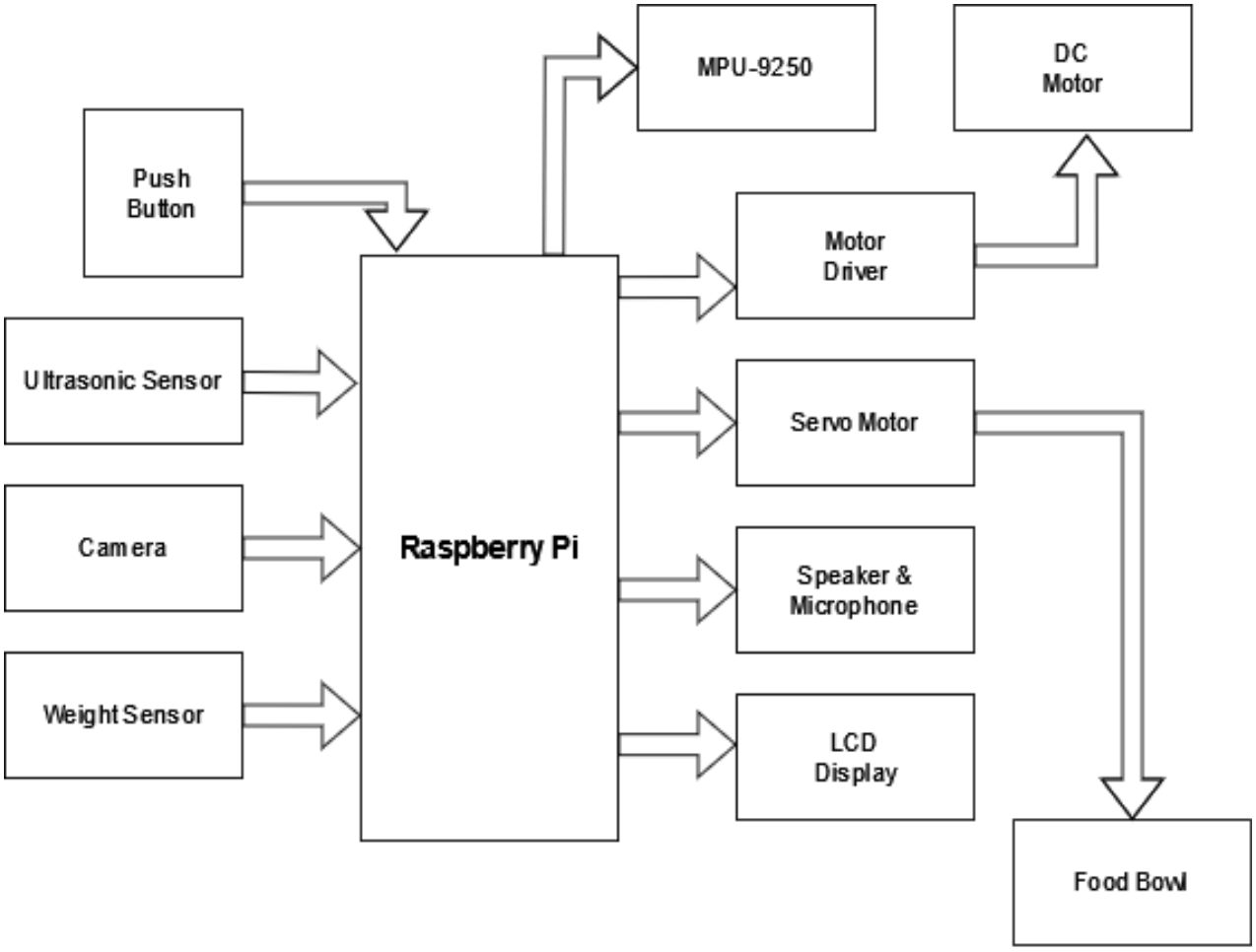

Fig : Pet Feeder Block Diagram

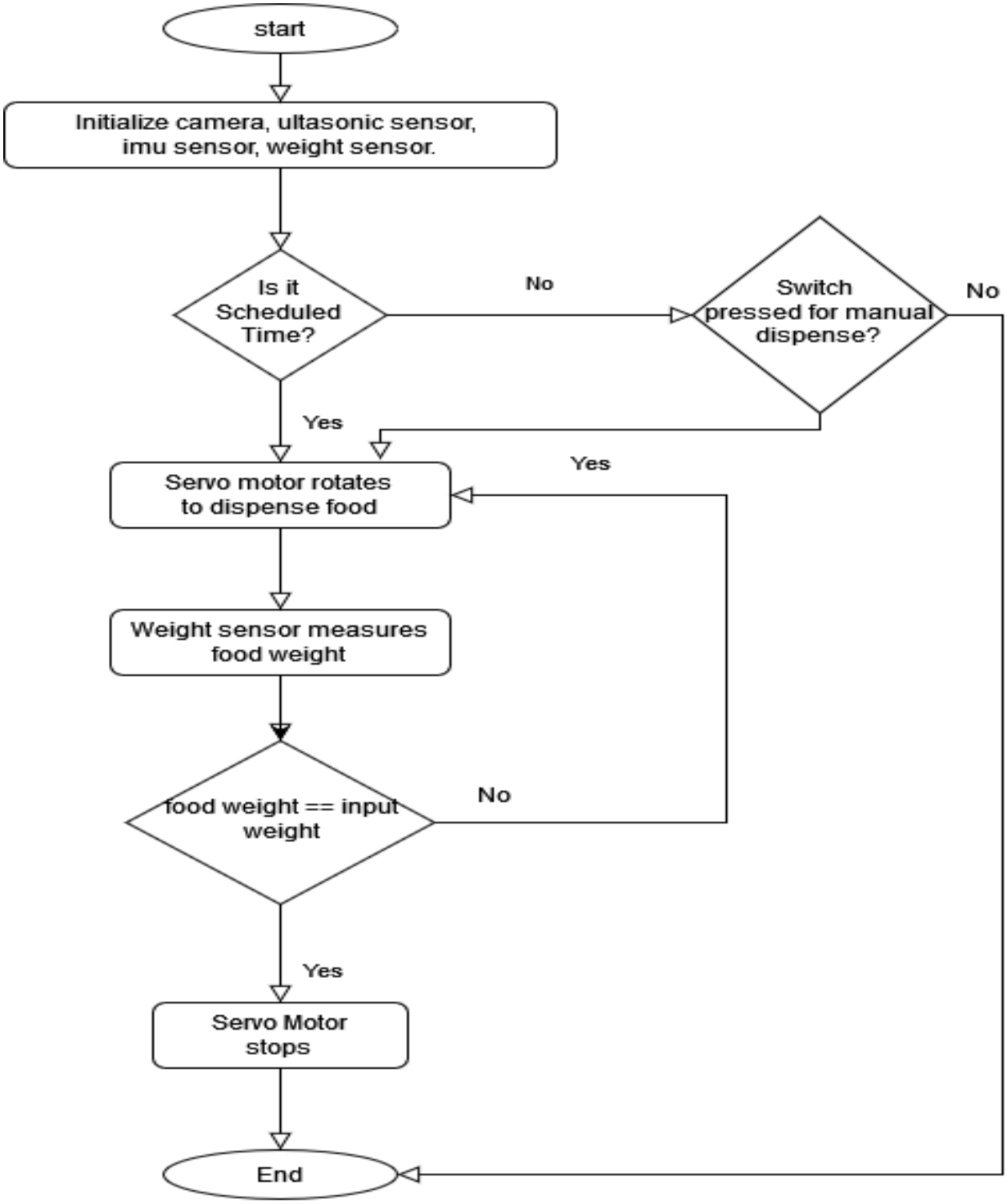

Fig: Flowchart of Pet Feeder Basic working process.

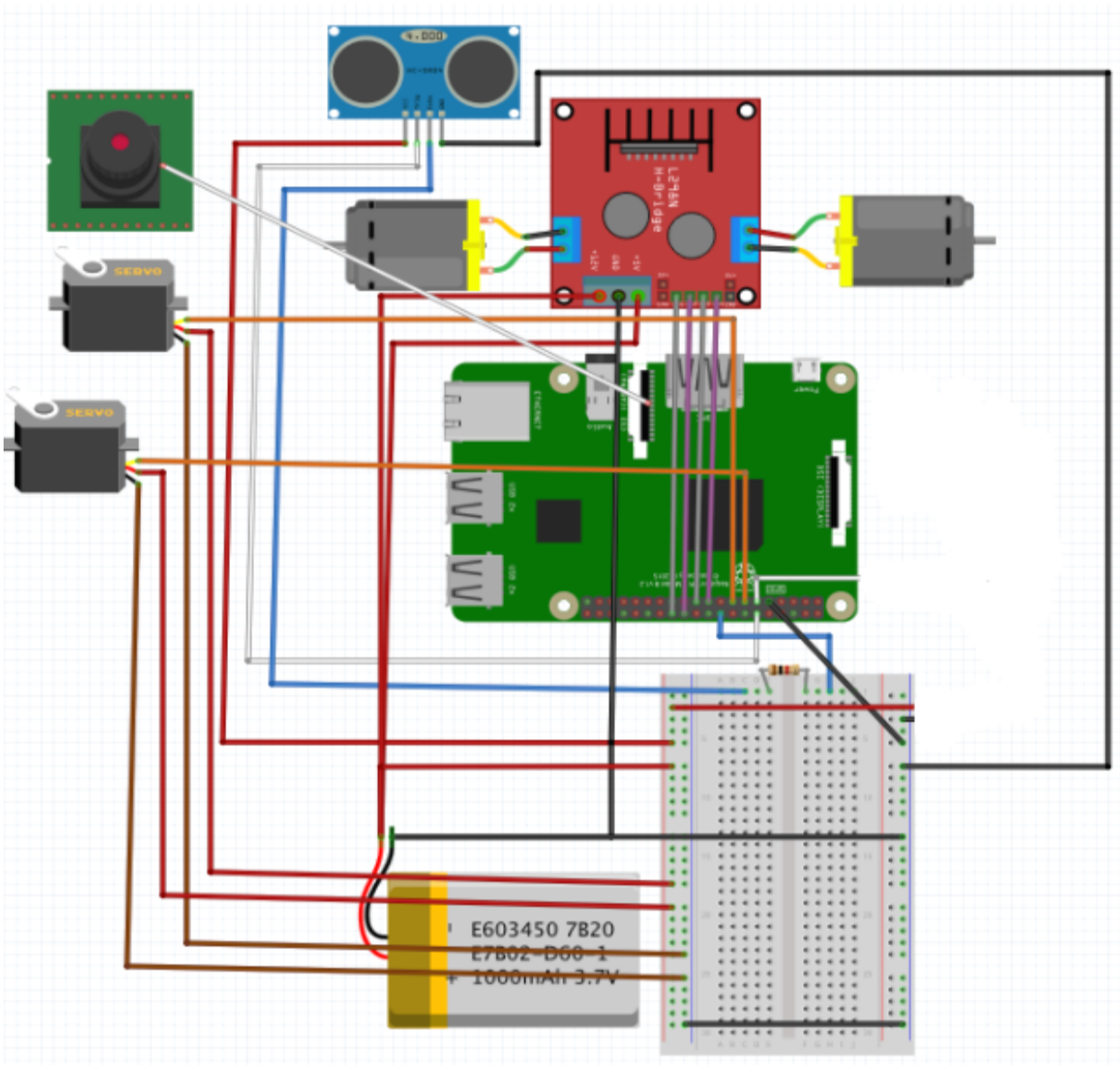

Fig: Circuit Diagram for Pet Feeder

Results

The entire process of the smart pet feeder is controlled by the Raspberry Pi. Raspberry Pi is linked to the rest of the components. The ultrasonic sensor we utilized in our project's initial step is to detect the presence of the Pet. The feeder gives food to the pet upon two conditions. First, it gives food to the pet according to the schedule that is fixed by the owner. Second, if the pet comes near the feeder, then the feeder will also dispense the food. The ultrasonic sensor transmits data input to the servo motor whenever the pet comes into touch with the feeder at a specific distance and remains beside it for a specific amount of time. But only one time in a day the pet will get food if it comes near the feeder, as multiple times the pet can go near it. In general, the servo motor acts as a lid along the center of the food storage unit. Whenever the motor gets data input, it rotates 120 degrees and the food item drops into the weight measurement plate. While the plate reaches a particular weight, it transmits data input to the servo motor, which then rotates once more by 90 degrees to prevent food from falling off. This process will also happen at the time of feeding schedule. Moreover, we used the MPU 92/65 Model as IMU in the pet feeder project to measure the feeder's right positioning as well as to track other sorts of anomalies since the IMU sensor can understand the orientation of a body in three-dimensional space. If the feeder somehow falls down by getting hit by the pet or any other thing, the IMU sensor will detect it by checking the orientation and send an alert to the user. We used DC motors and Motor Driver L298N in the wheels of the feeder in order to rotate the body of the feeder. The feeder's owner may easily rotate the feeder in forward or backward direction depending on their needs. We installed an external push button on the feeder to operate the food delivery system manually. Besides, we installed a

camera module and a microphone in the feeder to remotely monitor the activity of the pet by its owner.

Pre-set automated food dispensing timetable for pets:

Day	**Scheduled Quantity(in grams)**	**Feeding Time**		
Monday	200	8:00AM	1:00PM	9:00PM
Tuesday	200	8:15AM	1:00PM	8:30PM
Wednesday	200	8:05AM	1:00PM	8:45AM

Table-1: Weekly Average Feeding

External alert when owner not present:

Types of Anomaly	**User Alert**
Tilt	Pet knocked the feeder
Vibration	External disturbance

Table-2: Weekly Anomalies Report

Future Improvements

The following improvements might be applied to a smart pet feeder in the future to increase its usefulness :

- ☐ **Dietary Plans:** Create algorithms that can prescribe and make food programs that are specific to each pet, taking into account their age, breed, weight, and health issues.

- ☐ **Manage food freshness:** Utilize features to keep pet food fresh, such as refrigeration options for wet food, airtight containers, and vacuum sealing.

- ☐ **Accuracy of Portion Control:** To maintain accurate and consistent feeding portions, especially for animals with stringent nutritional requirements, more precise portion control techniques should be developed.

- ☐ **Veterinary Care Integration:** Veterinary services can be partnered with to offer individualized nutrition advice and link to a vet's database for certain pet health requirements.

- ☐ **Interactive Elements:** To keep pets interested and prevent boredom, include interactive features like a reward dispenser, toys, or a built-in laser pointer.
- ☐ **Health Observation:** Include sensors to monitor key aspects of a pet's health, such as weight, feeding habits, and activity levels, and to share information with owners and vets.

- ☐ **Various Pet Support:** Create pet feeders that can accommodate several animals, identifying each one and distributing food appropriately, especially in houses with multiple pets.

- ☐ **Operating with Pet Experts:** Work along with veterinarians, animal behaviorists, and nutritionists to make sure the smart pet feeder's functioning and design adhere to industry best practices for caring for animals.

- ☐ **User Information Security and Privacy:** Implement strong cybersecurity safeguards and give user data privacy and security top priority, especially if cameras and pet data are involved.

- ☐ **Automatically ordering food:** To automatically place new orders of pet food when supplies run out, integrate with an online pet food delivery service.

Conclusion

The Smart Pet Feeder Robot project, in terms of automation and pet care, marks a considerable advancement. We have been deeply committed to enhancing the lives of pets and their owners throughout our production process. We have created an advanced gadget through this project that not only caters to the changing demands of contemporary pet owners but also offers practical remote feeding alternatives. Our Smart Pet Feeder Robot is made to improve the wellbeing and enjoyment of our cherished animal companions. We're still committed to making improvements as we go. Our objective is to make sure that this product not only lives up to but

also beyond pet owners' expectations, promoting healthier and happier interactions between people and their pets. We've set out on a quest to reimagine pet care in the digital era, and we're excited to see the great effects that our Smart Pet Feeder Robot will have on many homes and their treasured dogs. We are enthusiastic about the impact our initiative will have on pets and their owners throughout the world, and have a clear vision for a more pet-friendly future.

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Contribution

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