ECSE395 Group 3 Final Report

Shoma Yukawa, Temple Shema, Camden Larson

Abstract - This paper outlines the design and development of the *Happy Pet Feeder*, a pet feeding system aimed at supporting new pet owners who are unable to maintain regular feeding schedules. The system is designed to remotely dispense two types of pet food and monitor food and water levels via a WIFI-enabled web interface. The website allows the user to dispense on command or schedule up to two days of feeding in advance. We conducted a user study with 15 participants (7 ECSE 395 students and 8 outside of the class) to evaluate usability and functionality of our prototype. The results show us that the users found the product efficient, as it received high marks in many of our qualitative feedback categories. The project highlights the importance of user-friendly design and technical feasibility in creating meaningful solutions for stakeholders.

I. Introduction and Motivation

Busy workers often face challenges when balancing pet care with their schedules. Inconsistent feeding times can lead to pet health concerns, while hiring pet-sitting services adds unwanted costs. Backed by this real-world issue faced by our stakeholder, our project hoped to develop an automatic and remote-controlled pet feeder that ensures consistent nutrition and care, especially for new or anxious pet owners to help them achieve their dream of welcoming a cat into their home. Our primary stakeholders include cat and dog owners who are new to pets with limited schedule flexibility, and their pets, who rely on regular feeding. The device is intended to reduce owner anxiety and enhance pet well-being through a user-friendly solution that can operate when owners are at work or travelling as well as at home.

II. Analysis or Existing Solution

Current commercial options such as Pet Safe Smart Feed or WOPET offer variations of functionality but are often expensive ($100–$300) and have complicated user interfaces for first-time users. These solutions also have limited food variety options. Cheaper, timer-based feeders offer minimal flexibility and no support for multiple food options or water level monitoring.

To address these issues, our system brings:

- Dual-compartment food dispensing with flexible scheduling.
- Real-time food and water level monitoring.
- A beginner-friendly and simple web interface accessible from any browser.

III. Project Objectives and Design Specifications

The system comprises both hardware and software components that work together to automate pet feeding. Mechanically, the device uses two cereal-style dispensers connected to motors that control food portions. Three ultrasonic sensor monitors are used to monitor the levels of food and water, ensuring that owners receive timely feedback when refills are needed. The entire system is powered by an ESP32 microcontroller, which also manages Wi-Fi connectivity and serves the website interface to users.

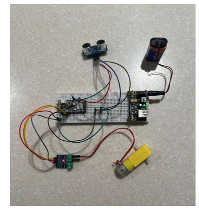

Image 1: Prototype of the ESP32 Wiring

From a software perspective, a lightweight web server hosted on the ESP32 enables users to interact with the feeder through a browser (Image 2). The interface allows for real-time scheduling of food dispensing, and live updates on food and water levels. The scheduling function is available up to 48 hours prior to the setting time, and each food dispenser is allowed to set a maximum of 3 different feeding times in advance.

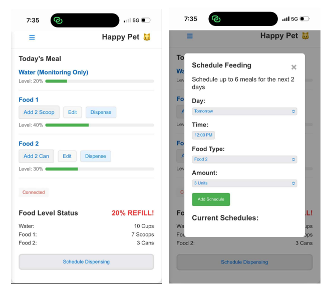

Image 2: User Interface of the web server

V. Technical Implementation

Significant effort was placed into calibrating the motor system to dispense food in 25-gram increments, which was determined to be a feasible goal based on user feedback and meetings with our stakeholder. While cereal occasionally jammed in the dispenser, adjustments to the gear-axle system by designing an improved gear system through CAD and 3D printing them improved this. The ultrasonic sensors reliably measured the remaining food and water by converting cm to a percentage that was easily interpreted by the user. Communication between the ESP32 and the web interface was stable, and most commands were executed within 10 seconds of input.

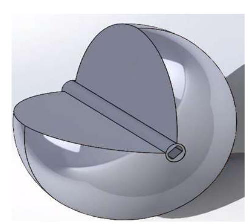

Image 3: New gear system with reduced food jamming

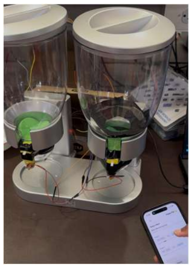

Image 4: Complete Prototype with Website

V I. User Study and Evaluation

To evaluate the effectiveness of the prototype, we conducted a user study with 15 participants over a four-day period—seven within ECSE 395 and eight external users. We gave each user a list of tasks to complete including dispensing 25 grams from food 1, dispensing 50 grams from food 2, and reading the monitored levels aloud. We did not provide any introduction or explanation other than the list of tasks and handing them a phone with the website loaded in. The primary objectives were to assess system usability, the clarity of dispensing and monitoring features, and overall user satisfaction of both hardware and software. We collected user feedback through a google form to get qualitative data and timed participants while they completed their tasks.

V II. Results

Results showed that all participants (100%) were able to identify the food and water levels without assistance, and 93% of tests ran without any issues with the prototype. The average time to complete the set of tasks was 32.13 seconds, which was well within the 1 minute to dispense food specification we set. Since this was their first time using the prototype, that would only get faster. Qualitative and quantitative feedback reflected that the website had a clean UI, and it was easy to understand the buttons and labels.

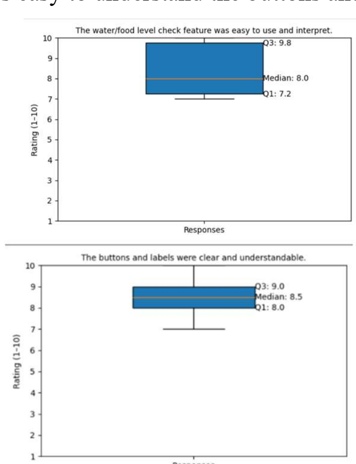

Image 5: Results of the user study

We also received some feedback that pointed to areas for improvement, particularly the minimalistic visual design of the web interface and the use of centimeter units in sensor readouts, which we altered to a percentage for our final demonstration. Despite these flaws, the prototype proved to be highly functional and met 20 of the 27 original technical specifications, achieving a 74% success rate, with some of the failed specs being irrelevant to our final design.

Unmet criteria included achieving 25g food portion control due to motor torque limitations, the use of BPA-free plastic constrained by resource availability, and the implementation of a more cat - safe exterior design, limited by CAD modeling challenges. Yet, the core goal of developing an accessible, web-controlled dual food dispenser was fully realized. User engagement and satisfaction were high, validating the design's reliability and the feasibility.

V III. Lessons

Throughout the development of the Happy Pet Feeder, we gained valuable insights into the engineering design process, particularly the importance of iterative development and user-centered thinking. One of the most significant lessons was the role of user study in shaping the final product. From our initial prototypes to the final design, input from both our stakeholder and user study participants played a crucial role in guiding decisions about interface design, feature prioritization, and hardware design. This feedback-driven process helped us identify what aspects of the design were most valuable to users and where our assumptions needed to be reconsidered. Finally, we learned that careful prioritization is necessary to manage the trade-offs between ideal design features and practical implementation. With limited time and resources, we had to identify which specifications were critical to stakeholder satisfaction and which could be deferred or simplified. Making these decisions collaboratively and thoughtfully ensured that we delivered a working product that met essential user needs.

V IV. Future Steps

While the current prototype demonstrates core functionality and usability, several improvements are planned. First, the exterior design will be refined to better protect internal wiring from external interference, particularly from curious pets such as cats. This will involve developing more enclosed and durable housing that secures electrical components without compromising easy maintenance. Additionally, the current scheduling functionality is limited to only today and the following day. An expanded scheduling system will be implemented to allow users to set feeding routines at least a week in advance. Lastly, while initial user testing was conducted with human participants, we plan to test in environments with both pets and humans. This will provide a more comprehensive understanding of how animals interact with the prototype. These improvements aim to prepare the prototype for broader deployment and long-term user satisfaction.