



Design and Development of an Integrated Smart Pet Care System

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Abstract: Urban pet care often lacks cohesive, user-friendly solutions to address feeding, behavioral tracking, and emotional bonding—particularly when pet owners are away. This project proposes an integrated smart pet care system combining a smart bed, automated feeder, and water dispenser, all controlled via a mobile app. Using ethnographic studies, user surveys, and secondary research, the study identified gaps in existing pet care products. The final prototype includes health-tracking sensors, a responsive user interface, and real-time behavior alerts. The app, “Aumora,” offers multiple profiles and smart recommendations. Initial user testing confirmed the product’s usability and emotional value. The solution enhances pet wellbeing and supports emotionally intelligent caregiving even in the owner’s absence

Index Terms – Smart pet care, Behavior tracking, Pet feeder, Emotional design, IoT Integration, User-centered design, app-controlled care, Health monitoring.

I. INTRODUCTION

As urban lifestyles become more fast-paced and demanding, pet owners find it increasingly challenging to provide regular and excellent care for their animals. The modern pet parenting experience is frequently fragmented, with equipment like automatic feeding, GPS collars, pet cameras, and activity trackers working independently. Each of these solutions usually necessitates distinct mobile applications, manual setting, and regular human engagement. This compartmentalized approach complicates caregiving and takes away from the emotional experience that is at the heart of human-animal connection.

Despite the growing emotional attachment to pets, who are increasingly viewed as family members, present technologies do little to meet the emotional demands of both pet and owner. Pets, like humans, thrive in situations that promote habit, empathy, and emotional connection. However, the lack of a unified caring environment frequently causes disturbances such as inconsistent feeding schedules, unrecognized behavioral alterations, and missed early warning indications of health problems. These oversights are especially prevalent among working professionals, senior caregivers, and members of nuclear families, all of whom have multiple duties and limited time and capacity for monitoring.

In contrast to advances in healthcare, childcare, and eldercare, where integrated, data-driven, and emotionally intelligent systems are becoming the standard, pet care technologies are still immature and narrowly focused. There is an urgent need for a solution that automates everyday pet care procedures while also providing the owner with a unified, emotionally resonant experience.

This research and design program aims to solve these important concerns by creating an integrated smart pet care system that combines key caregiving capabilities into a single, seamless platform. The proposed approach combines intelligent feeding automation, behavioral tracking, sleep monitoring, and emotional engagement via a simple mobile interface. The technology enables real-time monitoring, individualized notifications, and multi-pet administration, allowing pet owners to provide preventive and empathetic care. Finally, it intends to reduce caregiver stress, deepen the human-animal link, and improve small pet’s general well-being in today’s digitally connected environment. ^[1]

II. RELATED WORK

To learn about the existing methods of smart pet care and technological interventions in pet wellness, we reviewed research papers and articles to gain more insight. We also collected information on some of the existing products and organizations which attempt to solve this issue.

2.1 Literature Survey

Recent studies show a steady increase in the popularity of smart pet technologies, particularly those that enable health monitoring and remote engagement. However, the majority of these solutions remain functionally separated, focused on single-use aspects rather than providing a cohesive caring experience. The combination of IoT (Internet of Things) and AI has showed great promise for improving pet care by providing predictive insights into pet behavior, habits, and health condition. Advanced wearables and embedded sensors, for example, now enable the continuous monitoring of critical variables such as sleep cycles, stress levels, and activity patterns. These data points serve as the foundation for early detection of behavioral or health issues, which is especially useful for pet owners who are away from their homes for long periods of time.

From a design approach, emotionally responsive design—based on Don Norman's (2004) principles—is crucial in increasing user engagement and trust. Warmth, empathy, and feedback in products promote usability while also strengthening the emotional connection between the user and the system. The UI/UX literature emphasizes the importance of minimalism, clarity, and real-time responsiveness in creating programs that are accessible to a wide range of user profiles, including working professionals, the elderly, and individuals with limited technological skills.

A survey of existing patents, commercially available devices (such as Petcube, PetSafe, and Whistle), and academic studies indicated significant limitations in current products. While these devices offer some solutions, such as video surveillance, GPS tracking, or feeding automation, they frequently lack emotional design features, complete data integration, and straightforward centralized control. Furthermore, many systems demand users to switch between numerous apps or platforms, which adds to cognitive burden and prevents sustained engagement.

Notably, research has demonstrated the psychological and emotional benefits of remote caring. Real-time information and engagement with their pets help working professionals reduce stress and feel more connected. For older pet owners, intuitive systems provide peace of mind by automating complicated chores and alerting them to health-related irregularities. These findings underline the need for a comprehensive, emotionally intelligent solution that streamlines caregiving while improving the pet-human link.^[1]

2.2 Existing Solutions

To evaluate existing options in smart pet care, a market analysis was done on top commercial items. The analysis concentrated on product attributes, emotional engagement, and system integration. Smart feeders, cameras, and wearable collars are among the most important equipment discussed. The following table outlines these solutions:

Table 1: Market Study

Product name	Brand/developer	Key Features	Limitations	Category	App integration
Petcube Bites 2	Petcube	HD camera, two-way audio, treat dispenser, motion & sound alerts	No feeding or health/behavior tracking	Surveillance & Interaction	✓Yes
Whistle Health + GPS	Whistle	Tracks activity, scratching, licking, sleep, GPS tracking, vet reports integration	No feeding integration or smart home interaction	Health & Location Tracker	✓Yes
PETKIT Fresh Element Solo	PETKIT	App-controlled feeding, anti-blocking mechanism, portion scheduling	No behavior, health, or emotional tracking	Smart Feeding	✓Yes
FitBark 2 / FitBark GPS	FitBark	Tracks fitness, sleep, anxiety, syncs with Fitbit, health dashboard	No feeding or camera support	Health & Fitness Tracker	✓Yes
Tractive GPS Tracker	Tractive	Real-time GPS, geofencing, activity tracking, escape alerts	Requires specific collar, lacks feeding or behavior monitoring	Location Tracker	✓Yes
PetSafe Smart Feed	PetSafe	Scheduled feeding via app, remote alerts, multiple meals/day support	No health or behavior monitoring, limited to feeding only	Smart Feeder	✓Yes
LavvieBot 5	PurrSong	Self-cleaning litter box, real-time litter tracking, urine/feces alerts	Focuses only on litter, no behavior, feeding, or emotional features	Hygiene / Waste Management	✓Yes



III. PRIMARY RESEARCH AND USER INGIHTS

3.1 Questionnaire Survey Summary

To understand day-to-day caregiving challenges, a structured Google Forms survey was conducted with around 50 participants, consisting of pet parents from diverse occupational and demographic backgrounds. The survey aimed to capture feeding patterns, sleep routines, existing tool usage, and openness to smart caregiving solutions. The findings revealed that 82% of users struggled with consistent feeding schedules, largely due to professional commitments and unpredictable routines. Moreover, 76% expressed strong interest in remote pet monitoring, especially while away from home. A clear preference emerged for a unified,

app-based ecosystem over fragmented devices and applications. These responses indicated a high demand for a smart pet care solution that could blend automation, emotional connection, and ease of use.

3.2 Ethnographic Interviews and Observations

In-depth interviews were conducted with three key user groups:

- A home-based pet parent, who shared struggles with manually tracking feeding and supplement routines, and expressed a desire for automatic reminders and health insights through an app.
- A veterinarian, who highlighted recurring issues like obesity, missed medication, and late diagnosis due to lack of continuous data. They emphasized that a system combining behavioral tracking and real-time health data would greatly enhance diagnostic efficiency.
- A daycare staff member, who underscored the challenges of tracking multiple pets without digital tools. They stressed that features like automated feeding, live health data, and multi-pet dashboards would enhance care quality and reduce human error.

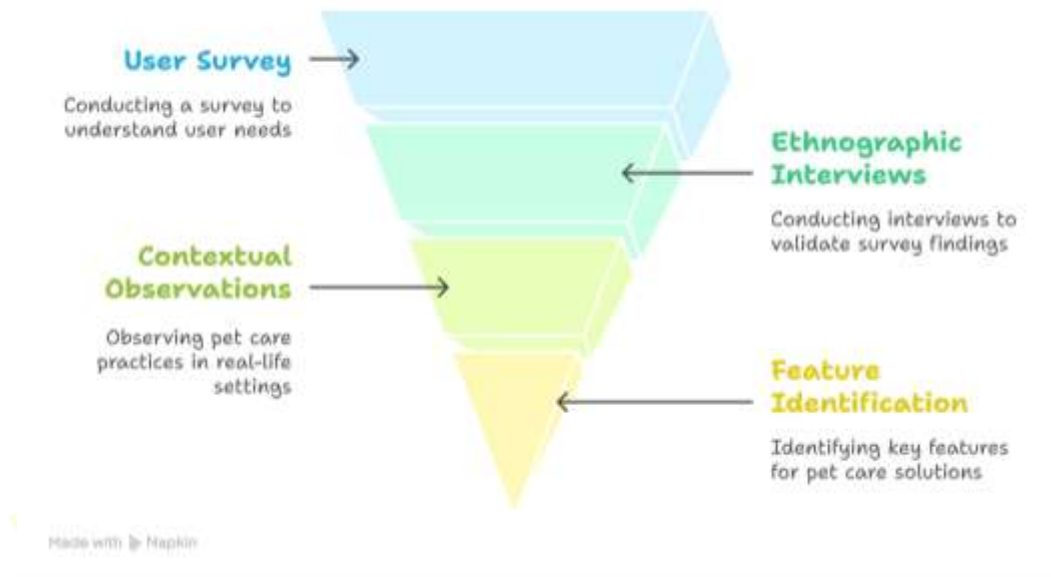


Figure 1: Secondary Research process

IV. METHODOLOGY

A structured methodology was followed to develop the integrated smart pet care system. The project started with secondary research and benchmarking of existing solutions like Petcube, PetSafe, and Whistle Health Tracker to discover functional limits and design gaps. Ethnographic research and surveys were undertaken with pet owners, veterinarians, and pet care professionals to better understand emotional needs, usage patterns, and practical expectations. Using the insights gained, numerous design concepts were created and refined using Quality Function Deployment (QFD) and weight-based ranking algorithms. A final proposal was chosen based on its feasibility, emotional appeal, and integration potential. The concept was digitally modeled in Fusion 360, and a functioning prototype was created with 3D printed PLA pieces, layered foam for cushioning, cloth for surface comfort, and embedded sensors for behavior and health monitoring. The components were enclosed in a curved form framework that promoted both visual attractiveness and user comfort. A mobile UI prototype designed in Figma supplemented the system, allowing for capabilities like remote feeding, health data tracking, and emotional notifications. User testing with selected individuals helped to validate form, comfort, interaction flow, and pet acceptability. Feedback was incorporated into design insights to help influence final modifications, ensuring that the solution was both emotionally natural and technically efficient.

Research Through Innovation

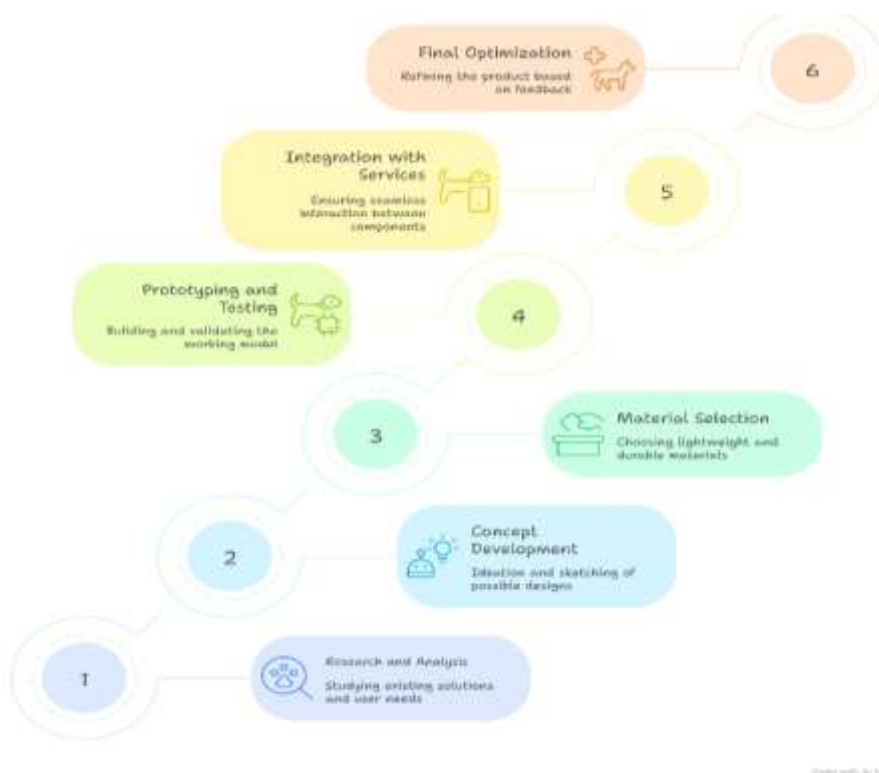


Figure 2: Development Process of Integrated Smart Pet Care System

V. PRODUCT DESIGN AND DEVELOPMENT

5.1 Quality Function Development

QFD analysis was used to convert user needs into technical specifications. Concept 5 achieved the highest cumulative score, making it the preferred choice for development. This structured decision-making helped ensure the final product aligned with real user expectations and technical feasibility.

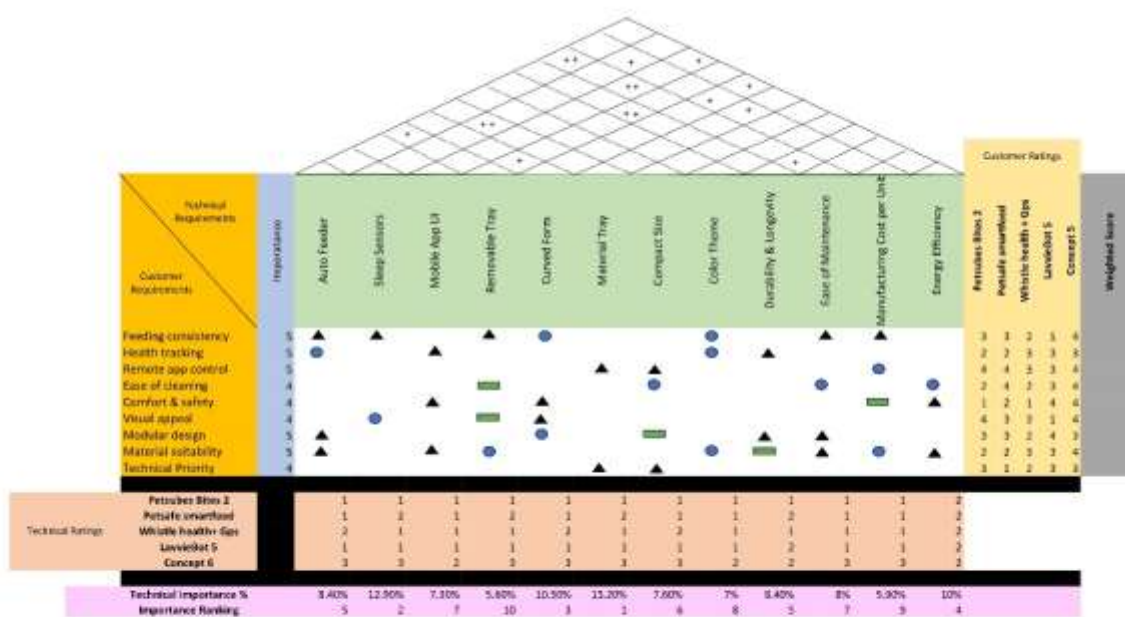


Figure 3: Quality Function Development

5.2 Product Design Specification (PDS)

A Detailed PDS was developed to guide concept development.

Table 3 Product Design Specification

Characteristic	Smart Bed	Feeder components	Mobile App
Function	Health and behavior monitoring	Scheduled feeding, weight, freshness	Live tracking, remote control, alerts
Performance	High-precision motion detection, 5-day battery life	±3g feeding precision	≤2 seconds app sync latency
Aesthetics	Organic, rounded form; soft look	Glossy interior, matte exterior	Clean, minimal UI design
Materials	PLA, PETG, ABS filaments (3D printed); memory foam	BPA-free polycarbonate + stainless steel	N/A
Safety	Enclosed wiring; chew-safe, non-toxic surfaces	Overfill and spill protection	N/A
Environmental	Recyclable materials, low-energy usage	N/A	N/A
Usability	Easy to clean and assemble; pet-accessible design	Easy refill and clean bowl	Simple navigation, accessible for all users
Durability	Scratch-resistant, impact-proof design	Durable food-grade materials	N/A
Size	1:2 ratio (scaled prototype)	1:2 ratio	N/A
Colors	Blue, Grey, Black, Red	N/A	Beige brown, grey, black and white

5.3 Mood boards and theme boards

Multiple theme boards were created to decide which would be most suitable for the device. The theme for the app would be tied to the device theme.



Figure 4: Mood board and theme board (Pinterest)

5.4 Concept generation

To tackle this issue, we designed a system that combines a smart pet care device with a mobile application. Multiple doodles and ideation were created before finalizing the product concept. Some of the main criteria included Modular integration of components, ease of cleaning, sensor embedding capability and emotional comfort for pets.

The Integrated Smart Pet Care System would have the following functionalities:

- Smart bed with sensors for health, sleep, activity monitoring and cushion
- Automated feeder with scheduled portion control and refill alerts
- Modular construction allowing easy maintenance and upgrades
- Minimal, pet-friendly design inspired by natural organic forms

The app concept named Aumora was initially explored through low-fidelity wireframes created in Figma to define the basic layout, feature flow, interaction patterns, and was later developed into high-fidelity wireframes to visualize the final user interface design.

The requirements for the app include the following:

- Multi-user profiles for pet parents, caregivers, and vets
- Live health data monitoring
- Feeding dashboard
- Smart notifications
- Pet socialization recommendations

Final concept was selected following a weight ranking method that was conducted.

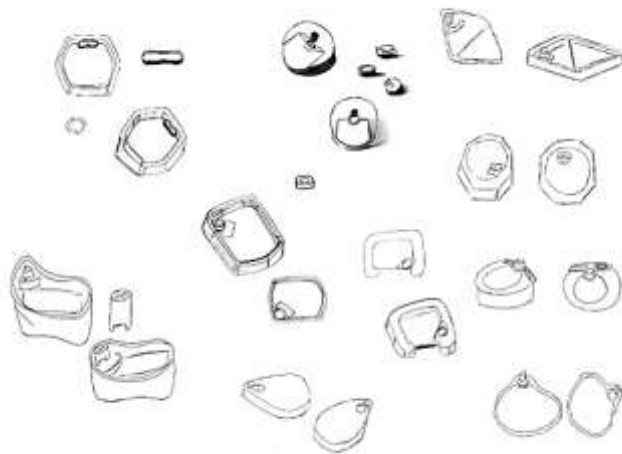


Figure 5: Concept Sketches

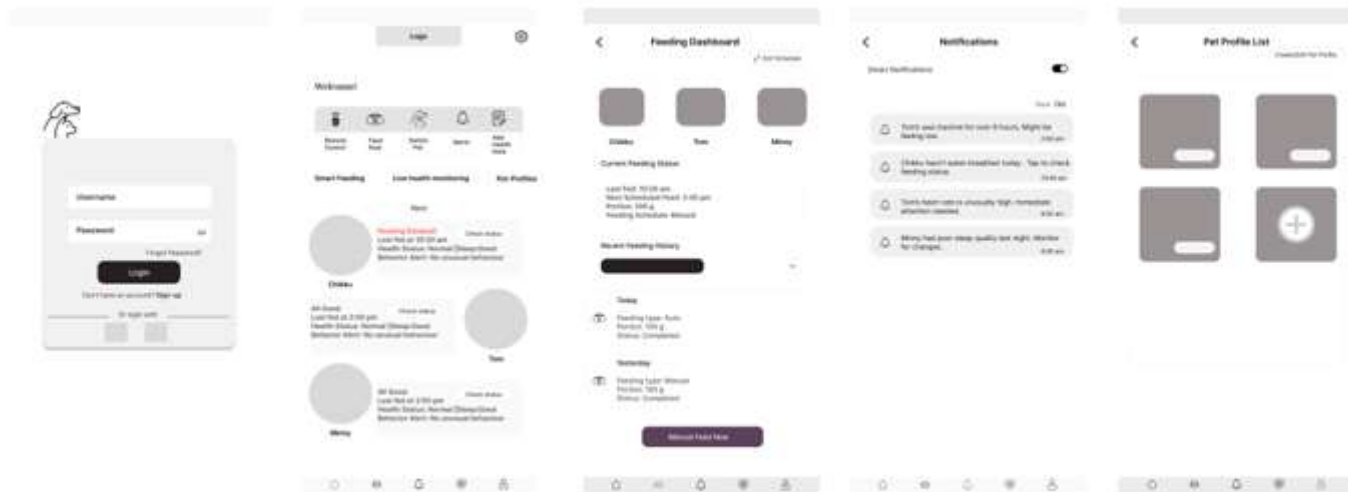


Figure 6: Low-Fidelity Wireframes

5.5 Weight Ranking Method

In parallel, a weight-ranking technique was utilized to analyze the same five concepts based on priority considerations such as ergonomics, ease of cleaning, manufacturability, and component arrangement. Weights were assigned to each criterion, and conceptions were scored quantitatively. Again, Concept 5 received the highest score, confirming its selection through numerous evaluation procedures. These systematic techniques improved the impartiality of the selection process and established the concept's suitability for future development.

Table 2: Weight Ranking Method

Criteria	Weight (%)	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5	Concept 6	Concept 7	Concept 8	Concept 9	Concept 10
Functionality Integration	30%	8 (2.4)	9 (2.7)	7 (2.1)	6 (1.8)	8 (2.4)	7(2.1)	8(2.4)	8(2.4)	7(2.1)	7(2.1)
Ease of Use	20%	7 (1.4)	6 (1.2)	8 (1.6)	9 (1.8)	7 (1.4)	6(1.2)	7(1.4)	7(1.4)	8(1.6)	8(1.6)
Aesthetic Appeal	20%	6 (1.2)	7 (1.4)	8 (1.6)	9 (1.8)	8 (1.6)	8(1.6)	7(1.4)	8.16)	7(1.4)	8(1.6)
Feasibility for Prototyping	15%	7 (1.05)	6 (0.9)	9 (1.35)	8 (1.2)	7 (1.05)	7(1.05)	6(0.9)	6(0.9)	7(1.05)	7(1.05)
Innovation Level	15%	8 (1.2)	7 (1.05)	6 (0.9)	7 (1.05)	9 (1.35)	8(1.2)	8(1.2)	7(1.05)	6(0.9)	8(1.2)
Total Score (out of 10)	100%	7.25	7.25	7.55	7.65	7.8	7.15	7.3	7.35	7.1	7.55

5.6 Concept finalization

For the chosen concepts, 3D models were developed as shown in Fig. using Fusion 360 software. The final concept (c) was selected using weight ranking method based on its overall performance in ergonomic comfort, aesthetics, and smart integration potential. Inspired by organic seed pod forms, the concept demonstrated a compact and inviting design suited for home environments while offering ample space for sensor embedding and behavioral tracking. User preferences gathered during the research phase—such as ease of cleaning, visual appeal, and comfort—were incorporated into the final geometry. The design features modular zones for the smart bed, feeder, and water unit, allowing for easy access, cleaning, and future upgrades. The Final concept 3D model was rendered in KeyShot with suitable materials. The app concept named Aumora later developed into high-fidelity wireframes to visualize the final user interface design.

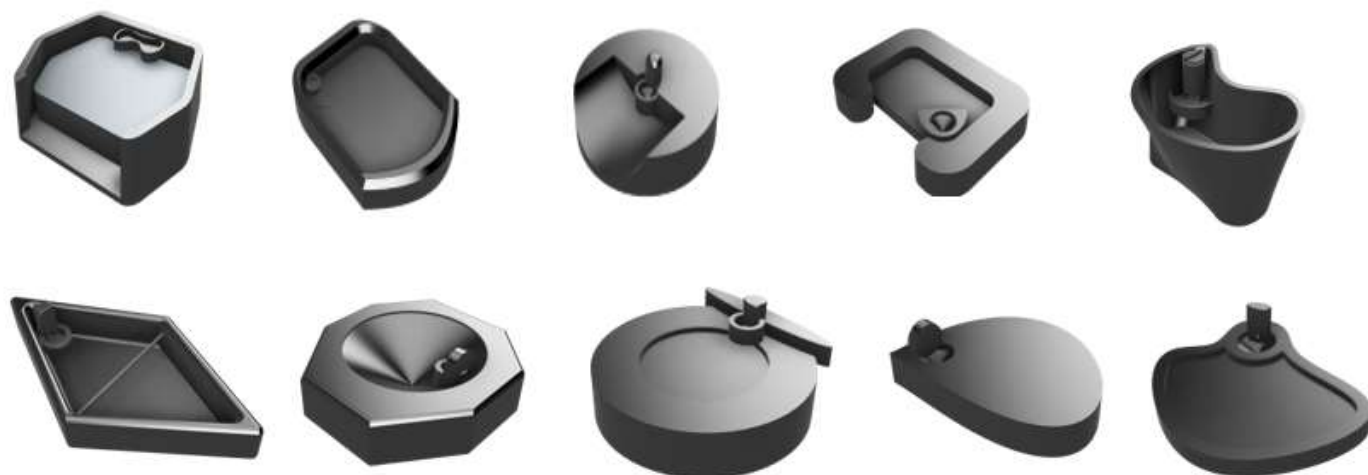


Figure 7: Clockwise from top left (a) Concept 1 – (j) Concept 10

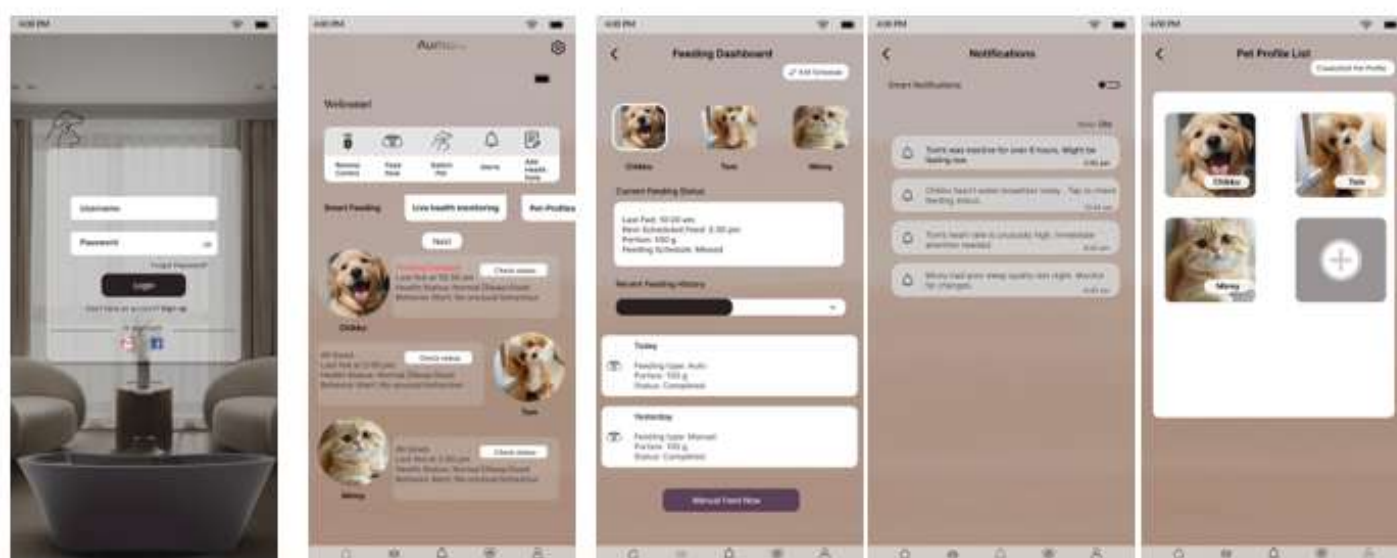


Figure 8: High-Fidelity Wireframes (UI Screens)

5.7 Prototype Development

The prototype was created according to the 3D model (Fig 9 d) built. For prototyping purposes, the model was built at a 1:2 scale to the original. The model was mainly built from PLA and ABS which were used for fabricating the 3D printed prototype, with the main body printed in two parts that were later joined together to form the final enclosure. Cushioning was created using layered foam and stitched cloth, which was securely fitted inside the bed to provide a soft and comfortable resting area for the pet. Sensors, including Pizo Electric sensor and Ultrasonic proximity sensors, were combined, programmed, and integrated beneath the bed surface within dedicated housing to enable seamless health and behavior monitoring. The integrated smart pet care system consists of four core components designed to work seamlessly together. The Smart Bed provides a cushioned resting space embedded with heartbeat and pulse sensors to monitor the pet's health and sleep patterns. The automated feeder ensures portion-controlled food dispensing and sends alerts to the owner when refilling is needed or when feeding is complete. Aumora, which offers features such as behavior logs, feeding schedules, emotional event triggers, social interaction suggestions, and support for managing multiple pet profiles—making pet care more personalized, intuitive, and emotionally responsive.



Figure 9: (from left to right) (a) Rendered Model of Final Concept, (b) Dimension drawing, (c) Prototype process (d) Finished 1:2 prototype of final concept

VI. RESULTS AND DISCUSSION

User validation for the integrated smart pet care system was conducted with six participants, including pet owners and potential users. They were given a detailed explanation of the system's overall functionality and asked to provide feedback on both the physical product and the mobile app interface. Pets involved in testing included a Shih Tzu, a Poodle, and a kitten, who interacted with the smart bed, feeder, and water dispenser. Owners appreciated the product's comfort, functional integration, and user-friendly setup, noting that the bed provided a secure resting space and that the system supported daily care routines efficiently. The mobile app prototype was also sent to three users—who evaluated its layout and proposed features. The UI was described as clean and simple, with clearly visible functions, though participants noted that a fully functional version would help in understanding real-time behavior. While the app was considered useful for pet monitoring, some users felt it would be more valuable for those who struggle with routine care. Overall, feedback across both product and app aspects was positive, highlighting emotional value, functional practicality, and areas for future improvement.



Figure 10: User Validation and Testing

VII. CONCLUSION AND FUTURE WORK

This integrated smart pet care system fills a significant gap in both emotional and functional caregiving. It simplifies everyday care by combining feeding, health monitoring, and behavioral tracking into a physical product and mobile app, while also enhancing the pet-owner link. Designed for current urban lifestyles, the system provides intuitive engagement, constant care, and peace of mind for pet owners.

The future of this concept may include AI-based behavior prediction, interaction with veterinary services, and modular modifications for different pet varieties. The system has the potential for usage in clinics, shelters, and boarding facilities, supporting scalable and holistic pet care. With its careful design and clever technology, the system lays the groundwork for emotionally intelligent pet care in the connected age.

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