Robotic Pet Care System Powered by IoT

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***Abstract*—Innovative ways to guarantee pets' well-being even when their owners are not around are required due to the rise in pet ownership and the growing demand for higher quality pet care goods. This study describes the development and application of an Internet of Things (IoT)-powered robotic pet care system. The suggested solution combines IoT based mobile application and robotics to provide pet owners with remote control and monitoring capabilities. The system includes a smartphone application powered by Sinric Pro to dispense food and water, as well as a web-based interface that allows users to control the motions of the robotic pet care system. In addition, an ESP32 camera module pan and tilt system is integrated into the system, providing flexible positioning to monitor the environment from various perspectives. With the ability to access their pets' needs and activities in real-time, no matter where they are physically located, this all-inclusive system seeks to revolutionize pet care.**

Keywords—*Web-based interface, ESP32 camera module, Food and water dispenser, Real-time monitoring, Interfaced with Sinric Pro mobile application.*

I. INTRODUCTION

Pet ownership has increased tremendously in recent years, with dogs and cats becoming cherished members of many homes across the globe. This trend is especially noticeable in the aged population, when pets provide companionship and emotional support in addition to being companions. The pet care sector has grown significantly as more people recognize the important role that owning a pet plays in society.This has led to a need for innovative technologies to meet the changing needs of pet owners. The idea that pets are members of the family has spread throughout current society, raising awareness of the significance of ethical pet care procedures. The demands of modern lifestyles, which are marked by busy schedules and little free time, can make it difficult for pet owners to provide for the requirements of their animals. This is where Internet of Things (IoT)-based solutions, such as the suggested pet care system, come into play. They provide a smooth combination of efficiency, convenience, and customized care.

The suggested solution uses the Internet of Things to automate necessary pet care tasks and give pet owners real-time insights and control over their pets' wellbeing. Users are able to remotely monitor their pets, dispense food and water, and modify settings according to their needs and preferences through user-friendly mobile application - sinric pro and developed web-based interfaces. Moreover, the use of IoT technology goes far beyond pet care, touching on a variety of industries like environmental monitoring, healthcare, and agriculture. Smarter, more efficient systems that improve productivity and quality of life are made possible by the seamless data sharing and decision-making made possible by the networked nature of IoT devices. IoT-enabled pet care solutions have the ability to completely transform conventional methods and provide a comprehensive approach to managing the health and wellness of pets. These systems collect important information on the behavior, health parameters, and food habits of pets through the integration of camera, actuators, and communication modules. This information allows for proactive intervention and preventive treatment measures. IoT platforms are further well-suited for handling a variety of needs and scenarios, from single-pet households to multi-pet environments and pet care facilities, due to their scalability and versatility. Unmatched flexibility and customization options are available with IoT-based pet care systems, whether they are tracking activity levels, monitoring food consumption, or offering remote engagement and enrichment activities.

In conclusion, the importance of IoT-based pet care solutions in the current digital era is highlighted by the convergence of pet ownership trends, technological breakthroughs, and societal needs. These technologies have the ability to revolutionize how we engage with and care for our cherished pets by utilizing the power of automation, connection, and data-driven insights. This could lead to happier and healthier relationships between people and animals.

II. LITERATURE SURVEY

In Adetokunbo A. Adenowo's paper, "Internet of Things based Pet Feeder Automation using Raspberry Pi,"[1] he presents a Raspberry Pi-powered pet feeder system. The system uses a food dispenser that is linked to a microprocessor and is fixed in place. Users are able to remotely control portion sizes and feeding schedules using a secure web application that is housed on a local server. Feeding schedules that are convenient and adaptable to the demands of the pet are made possible by this arrangement. The study demonstrates the viability and usefulness of automating pet feeding activities with a Raspberry Pi.

As stated in the paper "Pet Food Autofeeder by using Arduino,"[2] Ibrahim presents a pet feeder system that allows users to program exact feeding times and amounts. This efficiently addresses issues with forgetting and reduces costs connected with pet care services, such as pet hotels. Utilizing an Arduino microcontroller to manage the system in accordance with preset feeding schedules is the main objective of the project's design and implementation. In order

to assess the mechanism's maximal stress tolerance and guarantee its durability and consistency, Finite Element Analysis is employed. The author aims to provide a pet feeder solution that fulfills pet owners' requirements and improves the health of their pets by using this comprehensive method. It is anticipated that the consumer electronics industry's adoption of &Cube will lower obstacles for producers and developers, allowing them to more quickly and effectively build cutting-edge goods and services. &Cube promotes standardization and interoperability, which helps the IoT ecosystem become more integrated and cohesive.

B Ravi Babu's paper "Arduino Mega based PET Feeding Automation"[4] outlines the difficulties pet owners encounter in keeping their pets' feeding schedules regular and maintaining their nutrition. Concerns with overeating and obesity in pets are worsened by problems including hectic lifestyles, unpredictable schedules, and a shortage of appropriate feeding supplies. The author suggests creating an automatic pet feeder that can be operated by phone as a solution to these problems. With the help of an intuitive phone app, pet owners can now remotely control feeding schedules and give their pets the right amount of food according to their individual needs according to this smart technology.

Pim Martens explores the emotional bond between owners of companion animals and their animals in the publication of "The Emotional Lives of Companion Animals: Attachment and Subjective Claims by Owners of Cats and Dogs"[5]. Based on responses to an online survey among 1,023 Dutch-speaking owners of dogs and/or cats, primarily from the Netherlands and Belgium, the study finds that owners are willing to attribute emotions, both simple and complicated, to their animals. Owners' levels of connection to their dogs vary greatly, and gender and educational attainment are two important determinants. According to the Pet Bonding Scale, owners who give their pets human traits tend to have closer relationships with them (PBS). Furthermore, there is a relationship between the level of attachment and the owners' perceptions of the emotions in their dogs. The study highlights the close relationships that exist between pet owners and their animals and provides insight into the emotional lives of companion animals. Furthermore, there is a relationship between the level of attachment and the owners' perceptions of the emotions in their dogs. The study highlights the close relationships that exist between pet owners and their animals and provides insight into the emotional lives of companion animals.

In "The Association of Pet Ownership and Attachment with Perceived Stress among Chinese Adults,"[6] Cynthia S. T. Wu investigates the connection between Chinese people' perceptions of stress and their pet ownership. The study looks into how pet care routines and attitudes affect people's perceived stress levels. A self-administered questionnaire including demographics, pet ownership history, pet connection, and perceived stress was used to assess 288 adult Chinese pet owners in Hong Kong. To investigate the relationship between pet attachment and perceived stress. The findings suggest that, even after controlling for demographics and prior pet ownership history, owners who have higher levels of attachment to their animals' report feeling less stressed. Furthermore, reducing the stressful load of pet care is achieved by considering pets as members of the family.

The most sophisticated robotic pet on the retail market, AIBO, a dog made by Sony, is one of the robotic pets that Kahn Jr.'s paper "Robotic pets in the lives of preschool children"[7] examines through the lens of preschoolers' behavioral interactions and reasoning. Eighty children, split equally into two age groups (34–50 months and 58–74 months), took part in individual sessions using AIBO and a teddy dog as the two artifacts. The evaluation and justification findings showed that children's reasoning was identical for both artifacts. But when it came to AIBO, kids were less confident and tried reciprocity more often than they did with the plush animal. On the other hand, people were more likely to mistreat the plush animal and blame it for being animated. The conversation explores how children's social and moral development may be impacted by robotic pets, as they represent a new wave of technology. In particular, it examines how children's comprehension of social interactions and moral reasoning may be impacted, as well as how these robotic pets may erode fundamental ontological distinctions.

Harold Herzog explores the widely believed notion that pets improve the physical and mental health of their owners in his piece titled "The impact of pets on human health and psychological well-being: Fact, fiction, or hypothesis?"[8] Although pets are frequently portrayed in the media as improving the lives of their owners, research results have been conflicting. While some studies show that human-animal interaction can have positive impacts, others show that there is no discernible difference in the happiness or health of pet owners and non-owners. Herzog addresses the causes of the inconsistent findings in research on how pets affect people, emphasizing the necessity for more research. He contends that rather than being proven truth, the idea of a widespread "pet effect" on people's mental and physical health is still only a theory at this point. This study challenges preconceived notions and encourages more research on this fascinating subject by providing insightful information on the complicated relationship between dogs and human well-being.

The frequency of the tick-borne parasite Hepatozoon canis in stray dogs and cats in Bangkok, Thailand, is examined by Sathaporn Jittapalapong in his work "Detection of Hepatozoon canis in stray dogs and cats in Bangkok, Thailand"[9]. The purpose of the study is to evaluate the possible contribution of stray animals to the spread of this parasite, which has not gotten much attention in Thailand. Blood samples were taken from 308 dogs and 300 cats that were found to be wandering across 42 districts. The study discovered evidence of Hepatozoon infection in both dogs and cats using PCR tests and microscopy, with a higher incidence found in cats. As the first molecular confirmation of H. canis in Thailand, this work emphasizes how critical it is to control the parasite's prevalence in urban areas. The results of this study highlight the need for more investigation into the prevalence and management of tick-

borne illnesses in populations of stray animals. It also highlights the significance of public health initiatives to stop stray animals in urban areas from spreading zoonotic diseases to people.

Carla Maia investigates the incidence and risk factors of canine vector-borne diseases (CVBD) caused by pathogens transmitted by arthropods in her paper, "Bacterial and protozoal agents of canine vector-borne diseases in the blood of domestic and stray dogs from southern Portugal."[10] Because these illnesses have the potential to spread to other animals, the study takes a One Health stance, raising issues for both public and veterinary health. The goal of the study is to find out if vector-borne infections that have recently been evaluated in cats from southern Portugal are also present in dogs in the same region. Additionally, positivity-associated risk factors will be examined.

III. PROPOSED SYSTEM

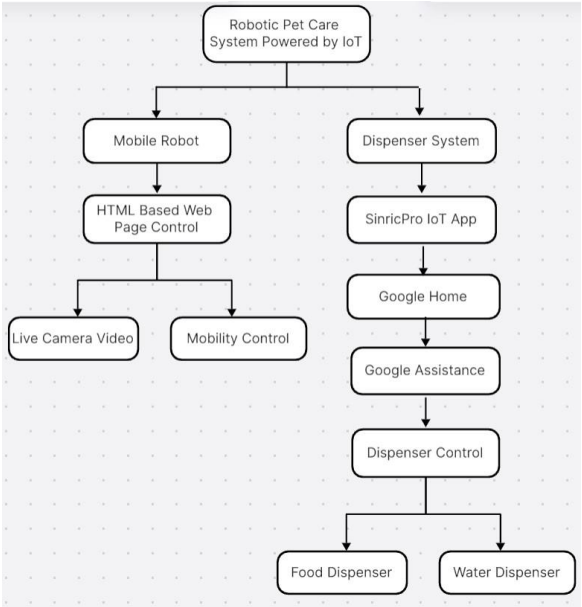

Fig.1. Block Diagram of Robotic Pet Care System powered by IOT.

Our Robotic Pet Care System, powered by IoT, is designed with two distinct components: the Mobile Robot System and the Food and Water Dispensing System as shown in figure 1. The Mobile Robot System is engineered as a mobile robot featuring four driving motors to facilitate movement. Control of the robot is managed by an ESP32 camera module microcontroller, which includes a 2MP OV series camera. To enhance user interaction, a web-based user interface has been developed. This interface provides live video streaming from the ESP32 camera and includes mobility control buttons for Forward, Backward, Left, and Right movements.

The ESP32 camera module is mounted on a pan and tilt assembly, which utilizes two servo motors for movement. This configuration allows users to achieve a comprehensive view of the environment, with control options available through the web-based interface. The interface includes Pan Left, Pan Right, Tilt Up, and Tilt Down buttons for precise control of the camera's orientation. Additionally, the ESP32 camera is equipped with a flashlight, with adjustable intensity controlled via a scroll button on the web interface. The same interface also includes a speed control feature for the mobile robot, accessible through another scroll button. The Mobile Robot System's mobility and pan-tilt functions are efficiently controlled using the ESP32 camera module, with all interactions facilitated through a user-friendly web-based interface as shown in figure 2.

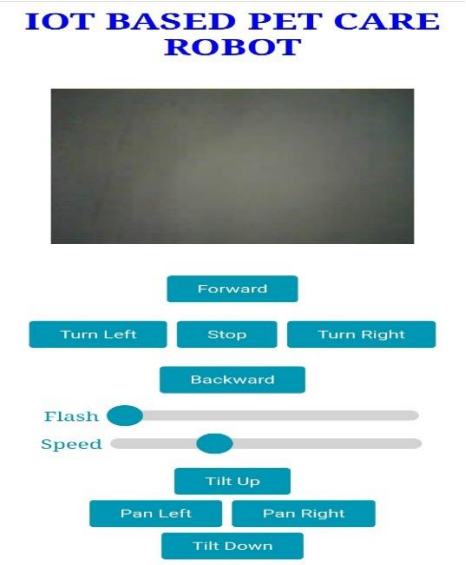

Fig.2. Web based Interface to control the mobility of the robot.

The Dispensing System comprises two units: the Food Dispenser and the Water Dispenser. It is managed by a standard ESP32 Module and operates alongside an IoT-based mobile application called Sinric Pro. This application, tailored for IoT applications, facilitates the control of the food and water dispensers integrated into the pet care robot.

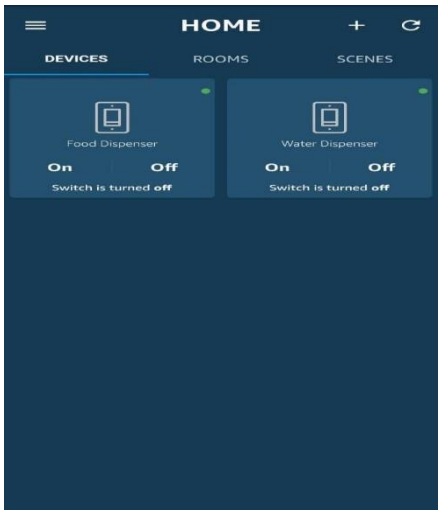

Fig.3. Sinric Pro mobile application homepage.

Through Sinric Pro, users can effortlessly switch the dispensers on or off using their mobile devices as shown in figure 3. To establish connectivity between the ESP32 module and the Sinric Pro mobile app, specific unique identifiers including app keys, app passcodes, and device IDs are required. These credentials are obtained by creating a device name on the Sinric Pro web portal. Once configured with the appropriate credentials, including app key, passcode, device ID, Wi-Fi SSID, and password, the ESP32 module automatically connects to the Wi-Fi network upon activation. Once online, the devices designated for control through the Sinric Pro app are accessible, allowing users to efficiently monitor and manage their status. In addition to manual control, the Sinric Pro application offers a scheduling feature, enabling pet owners to preset feeding times. This ensures that pets receive nourishment even when the owner is unable to operate the dispensers manually.

Furthermore, to enhance functionality, voice-controlled operation is possible through integration with Google Assistant. This integration is achieved by linking Sinric Pro with Google Assistant through the Google Home app, which acts as a central hub for IoT-based mobile applications. Once integration of Google home and Sinric pro application is done the homepage of Google home will look like the figure 4. Users can conveniently control the devices via voice commands through Google Assistant like shown in figure 5, further enhancing the system's capabilities.

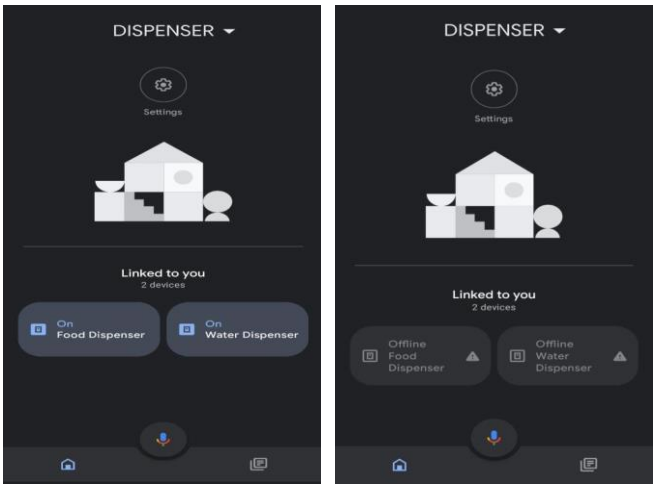

Fig.4. Homepage of Google Home Application.

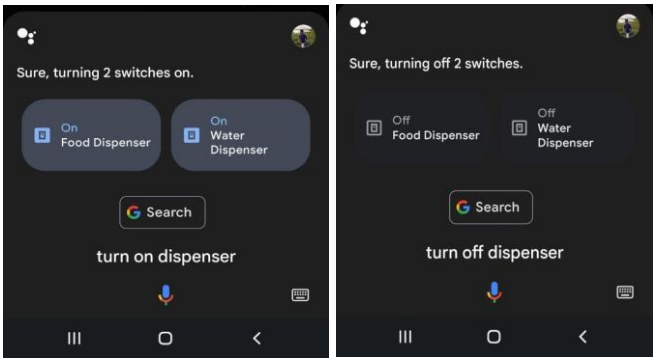

Fig.5.Voice command to control dispensers given to Google assistant.

IV. RESULT

Overall, the Robotic Pet Care System is constructed with the inclusion of circuits for the ESP32CAM, which controls mobility and the pan-tilt assembly, and the ESP32 for managing the food and water dispensers as shown in figure 6,7. Additionally, power management circuits are installed to convert the 12V battery output to 3.3V, ensuring that both microcontrollers receive the appropriate voltage to function properly.

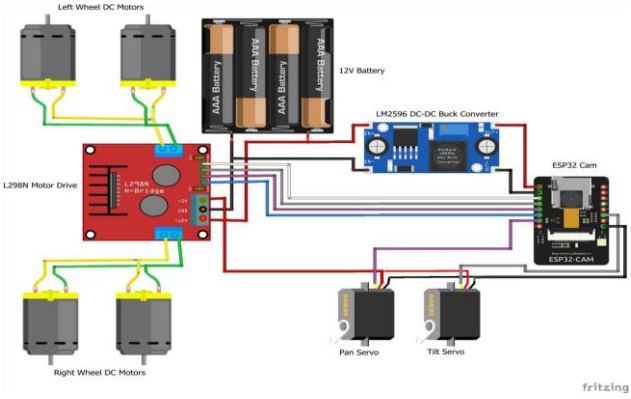

Fig.6. Circuit Diagram for ESP32CAM for mobility and pan-tilt control.

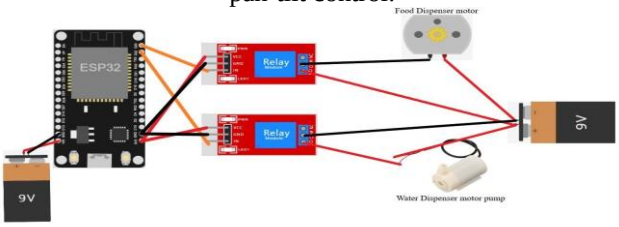

Fig.7. Circuit Diagram for ES32 for dispensers control.

The robot is fabricated using plywood for prototyping purposes, following the specifications of the designed 3D model shown in figure 8 and 9.

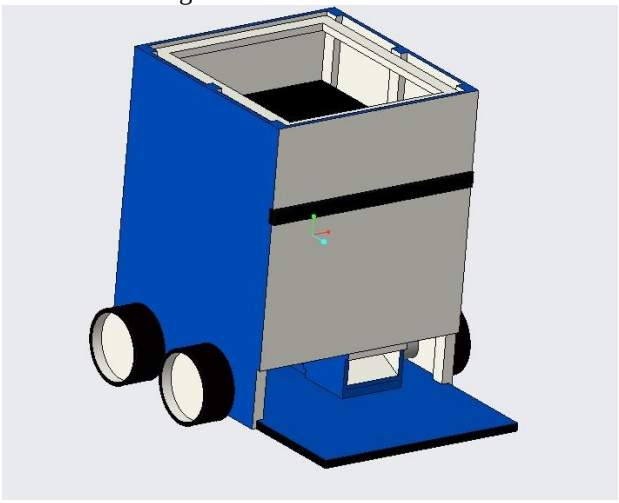

Fig.8. Design of Robot in 3D model.

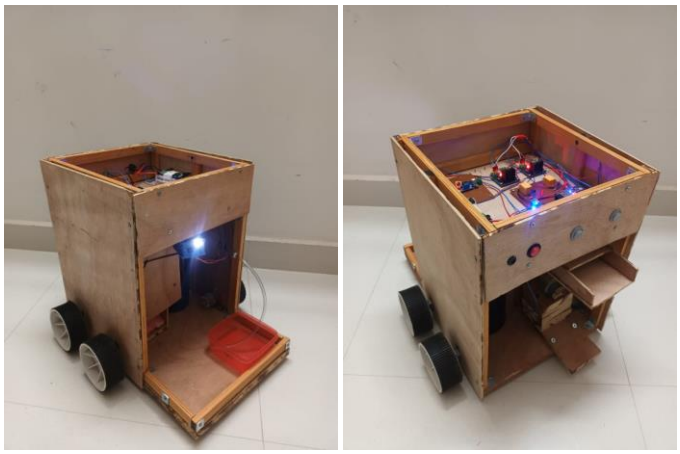

Fig.9. Fabricated Image of the Robotic Pet Care System powered by IoT.

V . CONCLUSION

The robotic pet care system ensures that food and water can be dispensed on a timely, need-based, and scheduled basis with the help of Google Assistant, ensuring consistent and appropriate nutrition for their pets. Additionally, the system allows for remote dispensing of food and water using the Sinric Pro application, providing flexibility and convenience.

This system helps prevent pet obesity by avoiding the pitfalls of traditional feeding methods, which often lead to overfeeding. The live monitoring feature allows owners to see what their pet is doing in real-time, check if they have taken their food, and monitor their well-being. In cases when the pet is not feeling well or is injured and cannot reach the food is placed, the system's mobility control feature allows the robot to move to the pet's location and dispense food there. Overall, this innovative pet care solution ensures that pets receive proper care and nutrition even when their owners are not physically present, enhancing the pet's health and the owner's peace of mind.

VI. FUTURE SCOPE

In the proposed model, only the Sinric Pro application can be operated from anywhere. However, to ensure that live monitoring and mobility control features are accessible to pet owners from anywhere and at any time, additional measures need to be implemented to enable more flexibility in control. This enhancement will make the robotic pet care system even more intelligent, reliable, and beneficial for both pets and their owners. Additionally, enhancing the system's mobility and navigation capabilities would allow it to navigate complex environments more efficiently and automatically. By adding a tag to the pet's collar, the system can track the pet's location and adjust its movements accordingly, ensuring it reaches the pet regardless of its location without dashing anywhere. This improvement will provide more seamless and hands-free operation, enhancing the overall user experience and the pet's safety.

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