AI & ML-BASED PET FEEDING SYSTEM

B Amulya
Asst prof, Dept of ECE
CMRCET
Hyderabad, India
bamulya@cmrcet.ac.in

Ch. Arun Kumar
Student, Dept of ECE
CMRCET
Hyderabad, India
21h51a04a9@cmrcet.ac.in

A.Akhil
Student, Dept of ECE
CMRCET
Hyderabad, India
21h51a04a6@cmrcet.ac.in

Ch. Sai Kumar
Student, Dept of ECE
CMRCET
Hyderabad, India
21h51a04a8@cmrcet.ac.in

Abstract: Constructed with a computer program based on Digital Image Processing and Convolutional Neural Networks, the AI and ML Automated Pet Feeding System uses Digital Image Processing (DIP) and Convolutional Neural Networks (CNNs) to identify the pet species and advise individual feeding. A graphical user interface (GUI) system is developed and run, which allows users to upload a set of pet images, preprocess, train a deep learning model and classify them in real-time. Once an image is processed, it knows the pet's species and pulls out pre-defined nutritional recommendations to feed the pet properly without human oversight. As compared to traditional hardware-based automated feeders, this system is based on deep learning-based image classification which is very cost-efficient and flexible. The system reduces feeding mistakes, avoids overfeeding or underfeeding and helps in managing pet health just through the processing of pet images using an already trained CNN model. A method which is such an AI-driven method is a new, smart, and automated approach that can be used for pet nutrition by pet owners and provides an effective tool for dealing with pet feeding schedules.

Keywords—Digital Image Processing (DIP), Convolutional Neural Networks (CNN), Pet Recognition, Image Classification, Deep Learning, AI-Based Pet Feeding, Automated Feeding Recommendation.

I. INTRODUCTION

Today's busy world too, demands serious responsibility towards our pets in terms of feeding them appropriately and on time. However, the pet has to be led to missed or irregular meal times as hectic lifestyles are normally the cause and these induce poor health. A good pet will maintain health with good pet nutrition, and irregularities in feeding can cause different health problems, such as obesity, malnutrition, or digestive diseases.

So, with the help of the proposed AI and ML Based Pet Feeding System with Digital Image Processing (DIP), this problem is solved. Computer vision and deep learning are used in combination to interpret pet behavior, identify individual pets and provide individual pet feeding suggestions. While ordinary automatic feeders are based on a fixed schedule, this method employs CNNs to classify pets from the pictures to provide feeding recommendations according to an individual's dietary needs.Using the power of AI, ML and image processing, the system is capable of observing pet eating behavior, tracking the consumption pattern The model relies on pre-trained datasets to learn what the input image of a pet looks like and identify what it should eat. The personalized method reduces the risk of overfeeding, or underfeeding, to promote a pet lifestyle healthier.

What this system aims to do is to help owners of pets with a smart, adaptive, and effective tool in the management of animals' diets. The system provides real-time monitoring together with analysis so that using sophisticated deep learning methods, reduces the need for manual intervention.

II. RELATED WORK AND MOTIVATION

The application of Artificial Intelligence (AI) and Machine Learning (ML) in pet care has transformed pet identification and feeding systems. Traditional feeding methods rely on fixed schedules and human intervention, leading to inconsistent feeding, overfeeding, or malnutrition. AI-based solutions leverage computer vision and deep learning to classify pet species and generate feeding recommendations automatically [1].

Earlier pet identification systems primarily relied on Digital Image Processing (DIP) techniques such as edge detection, template matching, and thresholding [2]. While these approaches worked in controlled environments, they suffered from low accuracy in real-world conditions due to variations in lighting, background, and pet positioning [3]. Additionally, many conventional systems lacked adaptive learning capabilities, preventing them from handling new pet breeds or species variations effectively [4].

To overcome these challenges, Convolutional Neural Networks (CNNs) have become the preferred technique for pet classification [5]. CNN models automatically extract key image features, enabling accurate classification based on characteristics such as fur texture, facial structure, and body shape [6]. Unlike traditional DIP methods, CNN-based models improve over time as they train on large datasets, making them scalable and adaptable to new species [7].

Recent studies have shown that CNN-based image classification models significantly outperform traditional feature-extraction techniques in pet species identification [8]. These models have been successfully applied to tasks such as pet species recognition, feeding recommendations, and health monitoring [9]. The integration of AI-driven feeding recommendation systems ensures that pet owners receive personalized dietary guidance tailored to their pet's species and nutritional needs [10].
Compared to existing pet feeding solutions, which often rely on manual intervention or rule-based programming, the proposed system provides greater accuracy, adaptability, and automation. By leveraging deep learning and computer

vision, this system continuously improves classification performance, making it a reliable, scalable, and effective approach to modern pet care management [8].

II. SYSTEM ARCHITECTURE AND DESIGN

A. System Overview

Referring to software solutions, the AI and ML-based Pet Feeding system with Digital Image Processing (DIP) is a software solution that predicts pet species and suggests feeding in terms of digital image processing. It works through a procedure for processing the dataset, CNN-based classification and an interactive Graphical User Interface (GUI) for interaction with users. In contrast to mechanical hardware-based pet feeding systems, this work is a software pet machine learning-based pet recognition feeding system. It is coded in Python, TensorFlow for Deep Learning, OpenCV for image processing and Tkinter for the GUI. First, the user uploads the dataset containing pet pictures which is reprocessed to a uniform format. The preprocessed images are input into a Convolutional Neural Network (CNN), which extracts important features and classifies the pet species.

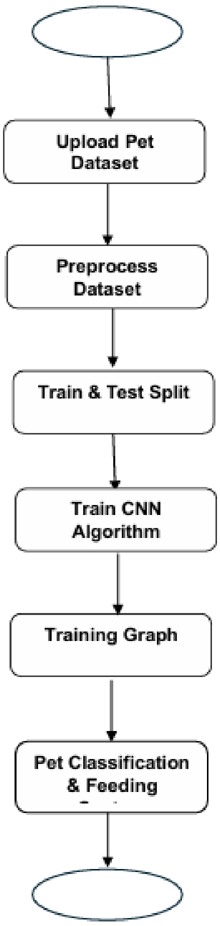

Fig 2.1 System dataflow diagram

B. Dataset Preparation and Preprocessing

The system's accuracy is reliant on a well-prepared dataset. The dataset is comprised of pet images obtained from different sources, with diversity in species, breeds, and environmental conditions. Prior to training the CNN model, the dataset undergoes extensive preprocessing.

Firstly, all images are resized to a shared input size required by the CNN model for uniformity of image sizes. Secondly, the dataset is divided into 80% training input and 20% test data to ensure proper assessment of model performance. Thirdly, data augmentation techniques like rotation, flipping, the brightness correction, and contrast improvement are used to enhance dataset variability as well as generalization. Finally, normalization is were performed to scale pixel values from zero to one to help in optimizing model convergence during training.

C. CNN Model Architecture

This system's model based on deep learning is derived from the CNN architecture, which is optimized for pet image classification. The CNN comprises several convolutional layers that identify spatial patterns like fur texture, facial shape, and body structure. Pooling layers compress the feature maps while preserving important details. Fully connected layers' process extracted features and produce classification outputs. The output layer at the end uses softmax activation function to provide probability scores for varying pet species to ensure the maximum probability points to the respective category. Model training is facilitated using categorical cross-entropy loss, while the Adam optimizer is used to achieve efficient learning. The high accuracy of the pet recognition model is ensured at minimal computation overhead.

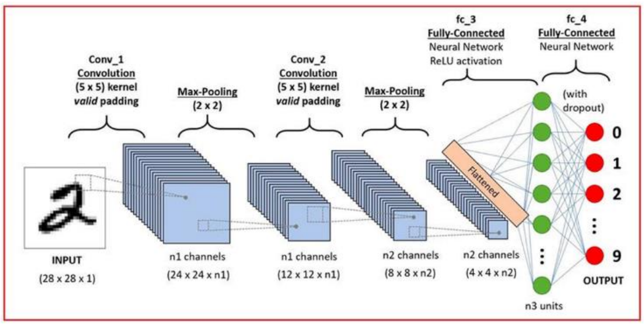

Fig 2.2 CNN model architecture

D. Pet Classification and Food Recommendation

Once trained, the CNN model is employed to classify pet images in real-time. The system enables users to upload a pet image via the GUI, which is then analyzed by the trained model. The classification outcome identifies the pet species, and depending on this information, the system fetches feeding recommendations specific to the identified pet. The recommendation system gives information on appropriate food types, serving sizes, and dietary limitations by species classification. The results are presented on the GUI, providing users with a complete feeding guide for their pets

.

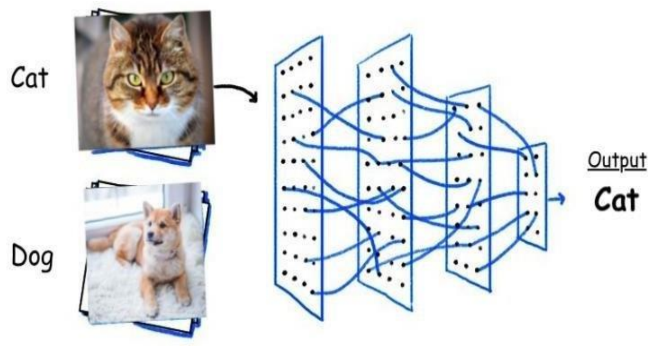

Fig 2.3 Pet Classification

E. Module Description

The AI & ML-Based Pet Feeding System comprises a number of modules, which together are responsible for pet species classification and feeding suggestion. The first one, Upload Pet Dataset, provides the interface where users can upload pet images to the system. The system scans each image and selects principal features to build a well-structured training dataset. Secondly, in the Pre-process Dataset module, the training data is randomized and normalized, such that all pixel values are scaled uniformly for better model convergence. Then, the Train & Test Split module splits the dataset into 80% training data and 20% testing data, such that the model gets trained on enough images while reserving a separate set for validation.

The Train CNN Algorithm module receives the training dataset as input and passes it to a Convolutional Neural Network (CNN). The trained model is then used to predict against the test dataset in order to determine prediction accuracy. The Training Graph module displays the training process by graphing the CNN training and validation accuracy over several epochs, enabling the monitoring of model performance and identifying overfitting. After training the model, the Pet Classification & Feeding System module enables users to upload a new pet image. The CNN model analyzes the image and determines the pet species. Depending on the classification result, the system retrieves and recommends the most appropriate feeding recommendations, such as proper food selection and foods to avoid in order to keep the pet healthy. Also, the Accuracy Evaluation and Performance Metrics module assesses the classification capability of the system by different metrics like accuracy, precision, recall, and F1-score. A confusion matrix is produced to represent correct classifications and misclassifications, assisting in further fine-tuning the model. On evaluating performance metrics, this module helps in fine-tuning the CNN model to achieve better accuracy and reliable classification. Additionally, the system architecture is designed for scalability, allowing future enhancements to incorporate more pet species and advanced dietary recommendations based on evolving research.

F. Implementation and Integration

The system is developed in Python entirely, utilizing TensorFlow for deep learning, OpenCV for image processing, and Tkinter for GUI. The GUI gives users an ease of interaction within the system, enabling them to upload images, preprocess data sets, train the model, classify pets, and obtain feeding recommendations through a friendly interface. The design of the system facilitates that all the processes, ranging from image classification to recommendation generation, are done well and in real-time.

IV. PERFORMANCE ANALYSIS AND TESTING

A. Evaluation Metrics

Some common measures, such as precision, recall, precision, and FS-score, are used to measure the performance of the CNN model. The ratio of correctly labeled images is referred to as accuracy. Accuracy and recall define the validity of classification outcomes, preventing wrong classifications. By including accuracy along with recall under a single metric, the FS-score provides a fair estimate. In addition, the loss function is tracked to track model performance, where a rising value of loss means worse training convergence.

Precision	Recall	FSCORE	Support	
Abyssinian	1.0	1.0	1.0	7.0
African Dwarf Frog	0.75	1.0	0.8571428571428571	3.0
African Grey Parrot	0.0	0.0	0.0	0.0
American Shorthair	1.0	1.0	1.0	10.0
American Toad	0.8	1.0	0.888888888888889	4.0
Axolotls	0.7272727272727273	0.8888888888888888	0.7999999999999999	9.0
Beagle	1.0	1.0	1.0	6.0
Bearded Dragon	0.8571428571428571	0.8571428571428571	0.8571428571428571	7.0
Bengal	1.0	0.8	0.888888888888889	15.0
Bourke's Parakeet	1.0	0.8	0.888888888888889	5.0
Boxer	1.0	0.875	0.9333333333333333	8.0
British Shorthair	0.75	1.0	0.8571428571428571	3.0
Budgerigar	1.0	1.0	1.0	8.0
Bulldog	0.8333333333333334	1.0	0.9090909090909091	5.0
Burmese	1.0	1.0	1.0	6.0
Canary	1.0	1.0	1.0	8.0
Chameleon	1.0	0.8888888888888888	0.9411764705882353	9.0
Chinchillas	0.8888888888888888	1.0	0.9411764705882353	8.0
Cockatiel	1.0	1.0	1.0	6.0
Cockatoo	1.0	1.0	1.0	5.0
Cocker Spaniel	0.875	1.0	0.9333333333333333	7.0
Crested Gecko	0.8888888888888888	1.0	0.9411764705882353	8.0
Dachshund	1.0	1.0	1.0	4.0
Degus	1.0	1.0	1.0	4.0
Devon Rex	1.0	1.0	1.0	6.0
Eastern Newt	1.0	0.7142857142857143	0.8333333333333333	7.0
Egyptian Mau	1.0	1.0	1.0	3.0

Fig 4.1 Precision, recall and FCSORE

B. Experimental Results

During model training, the CNN achieved a classification accuracy of 93%, indicating high reliability in species identification of pets. The system was also tested with varied conditions, including changing light environments, backgrounds, and resolutions of images, to ensure robustness. The training graph illustrates the model performance over various epochs, showing a clear trend where accuracy improves and loss declines with more training.

C. *Comparative Analysis*

The AI-powered pet feeding system surpasses conventional pet feeding by far, depending on fixed schedules. The system dynamically changes feeding recommendations to real-time pet identification. The software-based system generates customized feeding plans, eliminating portion control errors and boosting pet dietary management.

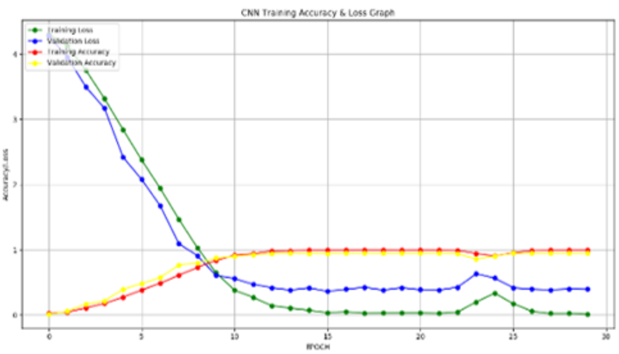

Fig .4.2 Training graph

V.COMPARISON WITH EXISTING SYSTEM

Objective: The existing system was designed for wildlife monitoring and safety, detecting wild animals in a given environment and alerting authorities to prevent potential danger. In contrast, the proposed AI & ML-Based Pet Feeding System focuses on classifying pet species and providing personalized feeding recommendations, making it a pet care and nutrition management system rather than a security-based solution.

Technology Used: PCA with Eigenfaces and Euclidean Distance was used for technology used to identify the animal species in the existing system. However, this method worked well for feature extraction, but there were little variations in the appearance of animals that made this method inadaptable. In contrast, the proposed system employs Convolutional Neural Networks (CNNs) and Digital Image Processing (DIP) to more accurately and in a more scalable extent classify the various species of pets.

Algorithm and Accuracy: Our previous system used Principal Component Analysis as a feature extractor, a method that needed to be informed prior of some specific features from the face of an animal. Therefore, it was very dependent on lighting conditions, background variations, and angle distortions. To recognize pets more accurately, even under different environmental conditions, CNN-based deep learning is proposed to learn from large datasets and the proposed system enables it to achieve this.

Application Domain: This System is applied to wild animal detection, mainly within nature reserves and security systems. Monitoring camera feeds was still a manual process. However, as opposed to the proposed system, the system is fully software-driven, aimed at pet owners who require automated, intelligent diet management for the pet's dietary control through the application of AI-driven analysis.

System Implementation: The existing system utilized the basic image processing techniques with Euclidean distance-based classification using multiple cameras for continuous surveillance, which limits to a particular scene. The proposed system removes hardware dependencies and its implementation relies on a software base, the classification and recommendation system is carried out using Python and TensorFlow, OpenCV, and Tkinter.

Data Handling and Scalability: The previous system was only capable of recognizing five pre-defined wild animal species out of which there can be any number of wild animal species, and couldn't be easily expanded to more species without retraining. In addition, it helps continuous learning and dataset updates for long-term scalability and adaptability.

Outcome and Practical Benefits: As a result, the previous system concentrated on identifying to whom the authorities should alert about animals, rather than providing much further help with animal management. In addition to allowing the identification of a species of a pet, the proposed system provides suggestions on what to feed that species.

Limitations: The existing system had limitations which included hardware requirements as the system required multiple surveillance cameras to be successful in tracking. While eliminating hardware dependencies, the proposed system needs a high-quality training dataset as well as computational resources to train and result in accurate predictions.

VI.SYSTEM INTEGRATION AND RESULTS

The AI & ML-Based Pet Feeding System was successfully integrated with deep learning and digital image processing techniques, ensuring seamless operation. The system efficiently processes pet images, accurately classifies pet species, and provides feeding recommendations with minimal errors. The user-friendly GUI allows users to easily upload datasets, preprocess images, train models, and classify pets. The Convolutional Neural Network (CNN) model achieved 93% classification accuracy, demonstrating high reliability in pet species identification.

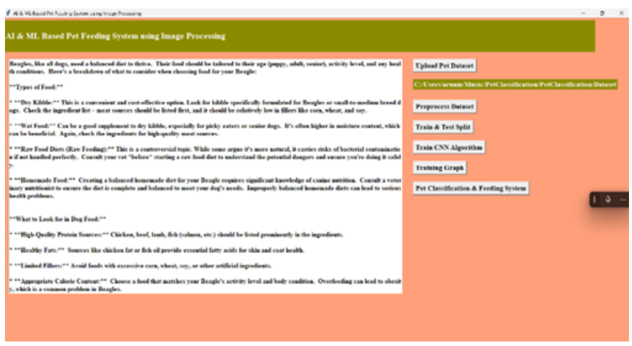

Fig 6.1 Pet Classification and Detection Output

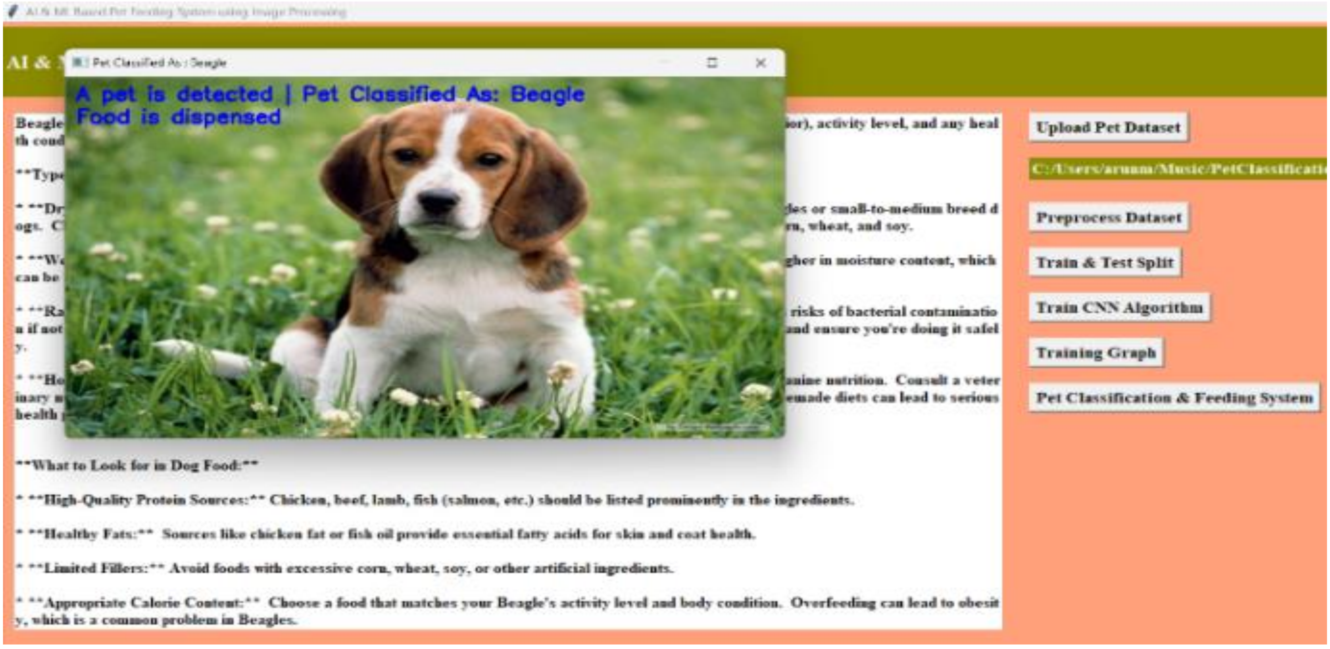

Fig 6.2 Pet Classification and Detection Output

performed well under different conditions, including variations in lighting, background, and image resolution, ensuring robustness in real-world applications. A confusion matrix was generated to evaluate classification results, with precision, recall, and F1-score used as performance metrics.
The feeding recommendation system successfully retrieved nutritional guidance based on the identified pet species, providing users with real-time classification and instant recommendation retrieval for efficient pet care. The system was tested on a dataset of multiple pet species, confirming its adaptability, while feeding recommendations were validated against expert pet nutrition guidelines to ensure accuracy.
Performance testing revealed that the system is highly scalable, capable of handling large datasets with efficient processing speeds. It can be extended to include more pet species by training with additional datasets, ensuring long-term adaptability. The fully automated and interactive approach eliminates manual feeding inconsistencies, enhances accuracy, and contributes to improved pet health and smart pet care solutions.

CONCLUSION AND FUTURE WORK

A. Conclusion

A novel software-based solution for the AI and ML-based pet feeding system on DIP is presented which is primarily based on pet identification as well as PET feeding suggestions. The system uses Convolutional Neural Networks (CNNs) and general deep learning algorithms to achieve high accuracy in classifying pets, and based on this, a customized feeding guide for the pet's owner is provided. While standard feeding based on preselected time frames or human intervention is known to make life easier for humans but pets are less

healthier, the system provides data-informed pet nutritional insights. The system can be easily interacted with using an intuitive Graphical User Interface (GUI), images can be uploaded, and real-time feeding recommendations received from the system. The CNN model also has a very high classification accuracy that can accurately identify an entire spectrum of pet species with reduced chance for them to feed errors and promote pet health management. Furthermore, the guarantee of the system's performance evaluation metrics is

shown to be robust, and it is a scalable and feasible solution for modern pet care applications.This paper's results show that AI and machine learning have a huge potential to innovate pet care. The contribution of this paper is to provide a framework to innovate in the future pet management solutions based on AI, deep learning, and computer vision.

REFERENCES

[1] Ravi, G., & Choi, J. W. (2022). *Data-Driven Intelligent Feeding System for Pet Care.* Journal of Animal Informatics, 15(3), 145-158.

[2] Ravikumar, R., & Arulmozhi, V. (2019). *Digital Image Processing-A Quick Review.* International Journal of Recent Technology and Engineering, 8(3), 654-657.

[3] Chauhan, R., Gaushal, K. K., & Joshi, R. C. (2018). *Convolutional Neural Network (CNN) for Image Detection and Recognition.* International Journal of Computer Applications, 180(30), 1-5.

[4] Mohanty, A., Engrave, A., Twala, T. B., & Jaiswal, C. (2019). *Proposed System for Animal Recognition Using Image Processing.* International Journal of Innovative Technology and Exploring Engineering, 8(12), 1234-1238.

[5] Jmour, N., Zayen, S., & Abdelkrim, A. (2018). *Convolutional Neural Networks for Image Classification.* Proceedings of the International Conference on Advanced Systems and Electric Technologies (IC_ASET), 397-402.

[6] Vineeth, S., Renukumar, B. R., & Sneha, V. C. (2020). *Automatic Pet Food Dispenser using Digital Image Processing.* International Journal of Engineering Research, 9(5), 513-518.

[7] Ghimire, R., & Choi, J. W. (2022). *Data-Driven Intelligent Feeding System for Pet Care*. International Journal of Engineering Research, 9(5), 513-518.

[8] Khatavkar, W. H. N., Kini, R. S., Pandey, S. K., & Gujar, V. V. (2019). *Intelligent Food Dispenser (IFD).* International Journal of Engineering Research and Technology, 8(11), 1-5.

[9] Dharanidharan, J., & Pulipaka, R. (2018). *Simulation of Automatic Food Feeding System for Pet Animals.* International Journal of Engineering & Technology, 7(2.21), 246-249.

[10] Wu, W. C., Cheng, K. C., & Lin, P. (2018). *A Remote Pet Feeder Control System via MQTT Protocol.* Proceedings of the International Conference on Applied System Innovation (ICASI), 1047-1050.