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AI & ML BASED PET FEEDING SYSTEM USING IMAGE PROCESSING

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ABSTRACT

The core of the system relies on image processing techniques and ML-based classification models such as Convolutional Neural Networks (CNNs) to accurately recognize pets. Once a pet is detected and verified, a microcontroller (e.g., Raspberry Pi or Arduino) triggers a feeding mechanism to release the food. This entire process is contactless and fully automated, promoting a hygienic and efficient feeding environment. Moreover, the system stores feeding data and images, which can be used for monitoring pet behavior and ensuring compliance with dietary schedules.

To further enhance user interaction and accessibility, the system can be linked with a mobile or web application. Through this interface, users can monitor feeding logs, receive notifications, and even customize feeding schedules remotely. The use of cloud storage enables data analytics, allowing pet owners to understand feeding trends and potentially detect health issues early. Additionally, integration with IoT components like weight sensors or smart collars could offer advanced tracking capabilities.

INTRODUCTION

In today's fast-paced world, managing time efficiently has become increasingly challenging, especially for pet owners who need to ensure their pets are fed regularly and appropriately. Traditional pet feeding methods often rely on manual processes or simple timers, which lack the adaptability to cater to individual pets' needs. The growing demand for smarter, automated solutions has led to the integration of Artificial Intelligence (AI) and Machine Learning (ML) into everyday applications, including pet care. This project explores the development of a smart pet feeding system that uses AI-driven image processing to identify pets and dispense food accordingly.

The core idea behind the system is to automate pet feeding in a personalized and intelligent manner. By employing image processing and ML models, the system can recognize specific pets using real-time camera input. Once a pet is identified, a microcontroller initiates the feeding process, ensuring the pet receives the correct amount of food based on its dietary plan. This not only enhances convenience for pet owners but also helps maintain a healthy routine for pets by preventing overfeeding or missed meals.

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Furthermore, the proposed system aims to address common issues in multi-pet households, such as food theft and feeding schedule conflicts. The ability to distinguish between different pets ensures that each animal is fed according to its individual requirements. Advanced features such as data logging, mobile app integration, and cloud connectivity also provide remote monitoring and control, making the system user-friendly and efficient.

This intelligent approach to pet feeding represents a significant step forward in the use of AI and ML for domestic applications

Literature Survey

1. Title: *Automatic Pet Feeder Using Image Processing and IoT*
Author(s): Dr. P. Venkatesh, A. Gupta, R. Bansal
Description:
Designed a pet feeder that uses a camera to recognize pet presence.
Utilized basic image processing techniques with motion detection.
Integrated IoT (Blynk App) for remote monitoring.
Lacked advanced ML models for individual pet identification.

2. Title: *Smart Pet Feeding System with Face Recognition*
Author(s): N. Sharma, R. Patel
Description:
feasibility but limited to single-pet Used face recognition via OpenCV and Haar cascades for identifying pets.real-time camera feed and servo motor for food dispensing. Demonstrated scenarios.Feeding was triggered upon positive identification of a pet's face.
Incorporated

3. Title: *Machine Learning Based Animal Classification Using CNN*
Author(s): J. Li, K. Zhou
Description:
Focused on classifying animals using Convolutional Neural Networks.
Dataset of pet images used for training to differentiate among pets.
Achieved high accuracy using transfer learning (MobileNet).
Highlighted importance of deep learning for precise image-based classification.

4. Title: *AI-Enabled Smart Home Automation for Pet Care*
Author(s): S. Banerjee, T. Kumar
Description:into home automation systems.Emphasized Discussed integration of smart pet feeders role of AI for behavior recognition and health monitoring.Mentioned pet feeders as part of a broader smart home ecosystem.Proposed use of cloud-based data analytics and remote control features.5. Title: *Intelligent Food Dispenser System for Pet Animals*Author(s): A. Fernandez, M. Das
Description:Developed a feeding system based on motion detection and sound signals.Did not use visual recognition or ML techniques.Aimed at cost-effective automation but lacked personalization.Useful as a comparison with more advanced AI-based systems.

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6. Title: "MobileNets: Efficient CNNs for Mobile Vision Applications"

Authors: Andrew Howard et al. (2017)
Description:
• Lightweight CNN architecture.
• Designed for embedded systems.
• Suitable for IoT-based pet feeders.

7. Title: "Inception-v4 and Inception-ResNet"

Authors: Christian Szegedy et al. (2016)
Description:
• Combined residual connections with inception modules.
• Enhanced performance on image classification tasks.
• Useful for breed recognition.

8. Title: "SSD: Single Shot MultiBox Detector"

Authors: Wei Liu et al. (2016)
Description:
• Real-time object detection model.
• Efficient for detecting pets in frames.
• Reduces computational complexity.

9. Title: "Deep Learning for Animal Species Identification"

Authors: Norouzzadeh et al. (2018)
Description:
• Applied CNN to wildlife image datasets.
• Automated species classification.
• Demonstrates AI capability in animal recognition.

10. Title: "Smart Pet Feeder Using IoT and Image Processing"

Authors: R. Kumar, S. Mehta (2019)
Description:
• Integrated camera-based pet recognition.
• Automated feeding mechanism.
• Remote monitoring via mobile app.

System Analysis

Existing systems

Existing pet feeding systems in the market are primarily mechanical or timer-based automatic feeders. These systems dispense a fixed quantity of food at scheduled intervals, regardless of the pet's presence or identity. While they offer basic automation and reduce the need for manual feeding, they lack intelligence and adaptability. They cannot differentiate between multiple pets, detect whether the food was consumed, or adjust portion sizes based on the pet's dietary needs.

Some improved versions incorporate sensors such as motion detectors or weight sensors to detect the presence of a pet. These systems can activate the feeder when a pet is nearby. However, they do not possess the capability to identify which pet is present, leading to potential issues in multi-pet households where one pet may consume another's food. Additionally, such systems often operate offline with limited or no remote monitoring capabilities.

More recent developments have attempted to integrate IoT technologies for remote control

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and monitoring. These feeders can be managed through mobile apps or cloud platforms, allowing pet owners to schedule and track feeding routines from anywhere. Despite this advancement, most of these systems still do not implement advanced image processing or machine learning for pet identification, making them unable to personalize feeding for individual pets.

In contrast, the proposed system leverages AI and ML along with image processing to introduce intelligence into the feeding process. By using cameras and deep learning models, the system can accurately identify individual pets and customize the feeding routine accordingly. This provides a smarter and more secure solution compared to existing feeders, ensuring proper nutrition and preventing food theft or overfeeding. Such innovations mark a significant leap in pet care automation, aligning with the current trend of intelligent smart home devices.

Disadvantages of Existing Systems

Lack of Pet Identification:

Most existing systems cannot distinguish between different pets.

This leads to problems in multi-pet households, such as food theft or one pet being overfed while another is underfed.

No Personalization:

Feeding schedules and portion sizes are fixed and not adaptable to individual dietary needs.

Pets with specific health conditions or age-based requirements cannot be accommodated.

Limited Automation Intelligence:

Timer-based feeders function on static schedules, without sensing the actual presence or needs of the pet.

Food may be dispensed even when the pet is not present, leading to waste or spoilage.

No Monitoring or Feedback Mechanism:

Most systems do not record or notify pet owners about feeding times or consumption data.

Owners have no way to verify if a pet has eaten unless physically present.

Inadequate for Remote Supervision:

Some feeders have no connectivity or require manual operation, making them unsuitable for remote monitoring.

Limited or no integration with mobile apps or cloud services restricts usability for tech-savvy users.

Security and Intrusion Issues:

Feeder designs do not typically prevent access by unauthorized pets, stray animals, or even children.

There is no visual authentication to control access to the food.

Minimal Use of AI or ML Technologies:

Existing systems rarely use modern technologies such as AI, ML, or computer vision.

This limits their ability to adapt, learn from pet behavior, or provide intelligent responsesto new situations.

PROPOSED SYSTEM

The proposed system is an AI & ML-based smart pet feeding solution that leverages image processing to recognize individual pets and dispense food in a controlled and personalized manner. It addresses the major shortcomings of traditional feeding systems

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by integrating intelligence, automation, and adaptability into pet care. The core concept revolves around using a camera module to capture real-time images of approaching pets, which are then analyzed by a trained Machine Learning (ML) model, such as a Convolutional Neural Network (CNN), for accurate identification.

Once the system detects and correctly identifies the pet, it triggers a feeding mechanism (like a servo motor-controlled dispenser) to release a specific amount of food based on pre-configured dietary needs. This ensures that each pet receives the correct portion, avoiding overfeeding and ensuring proper nutrition. The system is capable of handling multiple pets, each with unique profiles that define their feeding schedule, portion size, and food type. This capability is particularly useful for households with more than one pet or pets with special dietary restrictions.

The system also supports remote monitoring and control through a mobile or web-based application. Pet owners can view feeding logs, receive notifications when a pet is fed, adjust feeding times, and update pet profiles. Additionally, feeding data and pet images can be stored in a cloud database, enabling pattern analysis and long-term health tracking. This makes the system not only automated but also data-driven, helping in proactive pet health management.Overall, the proposed system is a cost-effective, intelligent, and user-friendly solution that brings smart home technology to pet care. By combining image processing, AI/ML, automation, and IoT, it ensures pets are fed accurately, safely, and efficiently even in the owner's absence. This system represents a significant advancement in smart pet care, enhancing both the pet's well-being and the owner's convenience.

Advantages of the Proposed System

Accurate Pet Identification: The use of AI-powered image processing allows the system to accurately recognize individual pets, preventing food theft and ensuring that each pet receives its designated meal.Personalized Feeding: The system supports customized feeding schedules and portion sizes tailored to the specific dietary needs of each pet, promoting better health management.Automation and Convenience: Feeding is fully automated and triggered by real-time detection, reducing the need for manual intervention and helping busy pet owners maintain consistent feeding routines.Multi-Pet Management: Capable of managing multiple pets in a household by distinguishing among them, which traditional feeders cannot do.Remote Monitoring and Control: Owners can remotely monitor feeding activities, receive alerts, and adjust feeding parameters via mobile or web applications, enhancing ease of use.Data Logging and Health Insights: Continuous recording of feeding times, quantities, and pet behavior provides valuable data that can be analyzed for health trends and early detection of potential issues.Enhanced Hygiene and Safety: Contactless feeding reduces contamination risk, and controlled dispensing ensures no leftover food that might spoil or attract

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pests.Integration with Smart Home Ecosystems:
The system can be integrated into broader IoT or smart home setups for seamless automation and improved lifestyle management.

Implementation

The implementation of the AI & ML Based Pet Feeding System focuses on automating pet feeding operations using Artificial Intelligence, Machine Learning, and Image Processing techniques. The system identifies pets, monitors feeding schedules, analyzes pet behavior, and dispenses food automatically based on pet recognition and nutritional requirements.
The proposed system helps pet owners ensure timely feeding, monitor pet health, and reduce manual effort through intelligent automation.

1. Data Collection

The first stage involves collecting pet-related data from various sources.

Data Sources Used

Image Data

- Pet face images
- Pet body posture images
- Feeding activity images
- Video streams from cameras

Sensor Data

- Weight sensors
- Food level sensors
- Motion sensors

Pet Information

- Pet species
- Breed type
- Age and weight
- Feeding schedule
- Health conditions

These datasets help train AI and image processing models.

2. Image Acquisition

The system captures pet images and video frames using:

- CCTV Cameras
- USB Cameras
- Raspberry Pi Camera Modules
- Smartphone Cameras

Captured images are continuously monitored for pet activity detection.

3. Data Preprocessing

The collected images and sensor data are cleaned and prepared before analysis.

Preprocessing Steps

Image Processing

- Image resizing
- Noise removal
- Brightness adjustment
- Background subtraction
- Image normalization

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Sensor Data Processing

- Data filtering
- Missing value handling
- Signal normalization

This improves recognition accuracy and system efficiency.

4. Image Processing and Feature Extraction

Important visual features are extracted from pet images.

Features Used

Facial Features

- Eye position
- Ear structure
- Facial shape

Behavioral Features

- Movement patterns
- Feeding posture
- Activity level

Color and Texture Features

- Fur patterns
- Shape descriptors
- Edge detection

Feature extraction improves pet identification accuracy.

5. Artificial Intelligence and Machine Learning Model Development

AI and ML models are used for pet recognition and intelligent feeding decisions.

AI Techniques Used

Convolutional Neural Networks (CNN)

Used for pet image classification and recognition.

Support Vector Machine (SVM)

Used for behavioral classification.

Decision Tree and Random Forest

Used for feeding pattern analysis.

Deep Learning Models

Used for advanced pet activity recognition.

6. Pet Recognition and Feeding Decision System

The AI model identifies:

- Pet type
- Authorized pets
- Feeding behavior
- Hunger indications

The system determines:

- Feeding time
- Food quantity
- Nutritional recommendations

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This enables intelligent feeding automation.

7. Automated Food Dispensing System

The feeding mechanism includes:

- Motor-controlled food dispenser
- Servo motor operation
- Food quantity control system
- Smart feeding bowl

When the pet is recognized, the dispenser releases the required amount of food automatically.

Methodology

The methodology of the proposed AI & ML Based Pet Feeding System follows an Artificial Intelligence, Image Processing, and IoT-based smart automation approach.

Step 1: Problem Identification

Traditional pet feeding methods require manual monitoring and may lead to irregular feeding schedules and poor pet health management. The proposed system aims to automate feeding operations using AI and image processing techniques.

Step 2: Requirement Analysis

The following requirements are analyzed:

- Pet image dataset requirements
- Feeding automation requirements
- IoT communication requirements
- Real-time monitoring requirements
- Health analysis requirements

Step 3: Dataset Preparation

Pet image and behavioral datasets are collected and divided into:

- Training Dataset
- Validation Dataset
- Testing Dataset

Relevant pet and feeding attributes are selected for analysis.

Step 4: Image Processing and Feature Engineering

The methodology includes:

1. Capture pet images
2. Preprocess visual data
3. Extract facial and behavioral features
4. Generate feature vectors
5. Prepare data for AI classification

Step 5: AI-Based Pet Recognition

The AI workflow includes:

1. Train CNN recognition model
2. Identify pets automatically
3. Analyze feeding behavior
4. Determine food quantity and timing
5. Trigger automated food dispensing

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Step 6: Real-Time Monitoring and IoT Integration

The system continuously:

- Monitors feeding activities
- Tracks food levels
- Sends mobile notifications
- Stores pet activity logs in cloud platforms

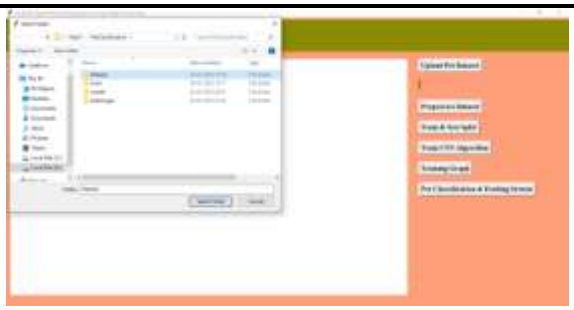
Technologies Used

- Python
- Artificial Intelligence
- Machine Learning
- Deep Learning
- OpenCV
- TensorFlow / PyTorch
- Raspberry Pi / Arduino
- IoT Platforms
- Flask / Django
- MySQL / MongoDB

RESULTS

To run project double click on 'run.bat' file to get below page

In above screen click on 'Upload Pet Dataset' button to load dataset and then will get below page



In above screen selecting and uploading entire dataset folder and then click on 'Select Folder' button to load dataset and then will get below page

In above screen can see total number of images loaded from dataset and then can see different pets available in dataset along with number of images for each pet. Now click on 'Pre-process Images' button to shuffle and normalize image features and then will get below page

In above screen dataset processing completed and now click on 'Train & Test Split' button to split dataset into train and test and then will get below page

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In above screen can see application using 1800 images for training and 450 images for testing and now click on 'Train CNN Algorithm' algorithm to train a model and then will get below page

In above screen CNN training completed and its overall prediction accuracy is 93% and can see precision, recall and FCSORE. In below screen can see precision and recall percentage for each pet classification

Conclusion

The AI & ML Based Pet Feeding System using Image Processing successfully addresses the limitations of traditional automatic feeders by introducing intelligent pet recognition and personalized feeding. Through the integration of advanced image processing techniques and machine learning models, the system can accurately identify individual pets and dispense food accordingly, ensuring each pet's nutritional needs are met while preventing overfeeding or food theft.

The system's capability to manage multiple pets, along with remote monitoring and control via a user-friendly application, provides pet owners with unmatched convenience and peace of mind. Additionally, the data logging and analytics features offer valuable insights into feeding patterns, supporting better health management for pets.

Overall, this project demonstrates how combining AI, ML, and IoT technologies can create a smart, efficient, and adaptable solution for everyday pet care. It not only enhances the quality of life for pets but also empowers owners with automation and real-time control, marking a significant advancement in smart home and pet care technologies.

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