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Breed Identification and Emotion Detection of Dogs using Deep Learning

Abhay Unnikrishnan, Dhanwanth Kishan S, Nayana M, Vaishnav O S

Department of Computer Science and Engineering, Universal Engineering College, Vallivattom, Kerala, India

ABSTRACT: In this work, deep learning approaches are employed to recognize the breed and classify the behavioral state of a dog from video input. By using Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), we aim to develop an efficient algorithm for real-time dog breed identification and emotion detection. Instead of attempting to detect specific emotions, our study focuses on categorizing dogs into passive, neutral, or aggressive states. The effectiveness of the models is evaluated based on accuracy, computational efficiency, and reliability. These insights offer valuable contributions to understanding canine behavior, aiding in applications such as animal welfare, training, and safety monitoring. The findings highlight the potential of deep learning in behavioral recognition and indicate areas for further refinement in animal behavior analysis.

KEYWORDS: Deep Learning, Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN).

I. INTRODUCTION

The project itself is designed to implement effective real time dog breed identification and emotion recognition through using CNNs and RNNs. It can recognize breeds hence facilitating their tagging, monitor temporal changes, and minimize stress leading to bizarre behaviours among animals. It can be used in issues related to dog obedience training, animal health, and animal welfare, including the relationship between owners and their companions, adoption success rates, and overall quality of life of animals. The real-time functions can support training and health care environments, and future its results can be applied in animal learning, veterinary medicine, and security service.

II. RELATED WORK

In [1] a method using adaptive learning which for simplicity involves the connection of neural networks based on EfficientNet to identify breeding sheep from low-resolution images the dimensions of the images used were measured and the performance of several different EfficientNet parameters was tested problems another limitation of this method is that it depends on the diversity and quality of the dataset which limits the ability to identify new patterns or combinations some of these technologies are deep learning EfficientNet architecture and transfer learning. In [2], identifies the breed of dog from photographs based on the features such as paws, noses and ears with the help of characteristics in the MobileNetV2 within the Convolutional Neural Network (CNN). The proposed model includes resize and augment (flip and rotate) to feed more than ten thousand images of 120 breeds. Due to its simplicity, it is both feasible with Flask on Google App Engine (GAE) and highly scalable and accessible via mobile app. The advantages of MobileNetV2 are its fast running time, augmentation methods in order to avoid overfitting as well as large-scale cloud compatibility. They are such as the ones that the size of the dataset is still small, the overfitting of the model, and how this model could perform poorly in front of images that are dark or blurry. The website uses TensorFlow, Flask and Google App Engine technologies; a mobile style is developed with Flutter for user's comfort. In [3], Therefore, the study used deep learning in the analysis of the emotions on the face of the dog, the work of Roxin et al., 2019 used Dog Clips dataset where they show five special types of emotions. The authors carry forward learn on convolutional neural networks; for situations where there are image transformations due to certain environmental interferences, the authors use the bounding boxes and segment the images with blurred backgrounds. This approach made the possibility of provocation and consequent dangers in interacting with the dogs reduced, hence improving accurate classification of the emotion displayed thus 96%. However, the study has some limitations; background context may have an influence on the study; problems with segmentation appears when non-salient background is used. In [4], which entail designing of a CNN model to classify the dog faces by applying the convolution, pooling and activation layers with an aim of training of the model through the knowledge of the various

breeds of dogs. People working in their research use principal component analysis on data and this is useful when it comes to data reduction concerning the features. As a result, the transfer learning in the technology has several pre-trained models that are also layers in CNN architecture, TensorFlow. Its benefit, which are realized high percentage of correct classification equal to 95.5%, prove the efficiency of CNN for identification of dogs breeds. However, mentioned as a drawback in this work, the improvement of the accuracy of the model depends on the quantity and quality of training material, that is, the better result is possible if in the data base there are more sample for training. In [5], utilizes a CNN-based technique leveraging on the MobileNet model to classify images into different breeds of dogs. Before feeding images into the system, images are pre-processed to look at images in terms of pixel; the CNN then models for the patterns learnt during the training and classifies the breeds of the dogs. This model specifically employs a set of tools such as TensorFlow together with others like AngularJS, Node.js and MongoDB for a smoother deployment. The benefits of using this approach are precise breed identification and flexibility derived from transfer learning that improves the model upon existing networks. However, one disadvantage is that training these CNNs is time-consuming and intensive, particularly when working with large datasets.

III. METHODOLOGY

In this project, we focus on utilizing deep learning technology techniques to detect dog breeds and analyze their emotions, aiming for precise and reliable classification. The methodology involves implementing Convolutional Neural Networks (CNNs) for static image processing and recurrent neural networks (RNNs) for handling sequential or time dependent data. Initially, the dataset is prepared by collecting and preprocessing labeled dog images annotated with breed and emotion categories. Preprocessing includes resizing images, normalization, and data augmentation to improve the model's generalization and robustness. The CNN model is trained to identify spatial features in the images to classify dog breeds and emotions. In parallel, the RNN model, designed for temporal data, is trained to identify patterns in sequences, such as video frames, for motion detection. Both models are evaluated using metrics such as accuracy, precision, recall, and F1-score. Finally, a comparative analysis is performed by visualizing these metrics through graphs, enabling us to determine the strengths and limitations of each model in solving the problem effectively.

CONVOLUTIONAL NEURAL NETWORK(CNN)

CNNs are at the core of the image-based classification tasks in this project, particularly for detecting dog breeds and identifying their emotions from static images. CNNs work by employing convolutional layers to extract spatial features such as edges, textures, and patterns, followed by pooling layers to reduce dimensionality while preserving essential information. Fully connected layers at the end of the network aggregate the extracted features for final classification. Data augmentation techniques like horizontal flipping, random rotation, and scaling are applied to create a more diverse dataset, improving the model's ability to generalize across unseen data. A pre trained CNN architecture, such as ResNet or VGG, may be used for transfer learning, enabling faster training and higher accuracy with limited data. Hyperparameter tuning, including optimizing learning rates, batch sizes, and dropout rates, is conducted to enhance the model's performance. The CNN model is evaluated based on its ability to classify breeds and emotions accurately, providing insights into its effectiveness in handling static visual data.

RECURRENT NEURAL NETWORK(RNN)

RNNs, particularly variants like Long Short-Term Memory (LSTM) networks, are employed in this project to capture temporal dependencies in sequential data. This makes them highly suitable for analyzing video frames or any time-series data related to the emotional states of dogs. Unlike CNNs, which are limited to processing spatial information, RNNs can retain information from previous steps, enabling them to understand the context and flow of data over time. The input data for the RNN is prepared by segmenting videos into frames and encoding them sequentially. The LSTM units help mitigate the vanishing gradient problem, ensuring better learning over longer sequences. The RNN is trained using techniques such as backpropagation through time (BPTT) and evaluated using metrics similar to those of CNNs. The focus is on accurately detecting emotions by leveraging the temporal relationships in the data, demonstrating the model's capability to process and classify dynamic behaviors effectively.

MODEL COMPARISON

To ensure a comprehensive evaluation of the models, the project includes a detailed comparison of the CNN and RNN architectures. The CNN model’s strength lies in its ability to analyze spatial data from static images, making it highly effective for dog breed classification. However, when it comes to detecting emotions, particularly in scenarios involving movement or temporal patterns, RNNs offer a significant advantage due to their sequential processing capabilities. Metrics such as accuracy, precision, recall, and F1-score are calculated for both models and presented in graphical form for easy visualization. Additionally, the models are compared in terms of training time, computational efficiency, and their ability to generalize to new data. By analyzing these results, the project identifies the scenarios in which each model excels and determines the overall best-suited architecture for the dual tasks of breed and emotion detection. This comparative study not only highlights the unique strengths of CNNs and RNNs but also provides valuable insights into their practical applications in real-world problems.

IV. EXPERIMENTAL RESULTS

The result focuses on evaluating the performance of Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) for the dual tasks of dog breed detection and emotion detection. The accuracy and effectiveness of both models are measured using key evaluation metrics such as accuracy, precision, recall, and F1-score. To ensure a comprehensive understanding, the performance of the models is visualized through comparison graphs, showcasing their strengths and limitations in different contexts. The analysis highlights the suitability of CNNs for static image classification tasks and the advantages of RNNs in processing sequential data, providing insights into the scenarios where each model excels. This section delves into the comparative results to determine the most effective approach for achieving the project’s objectives.

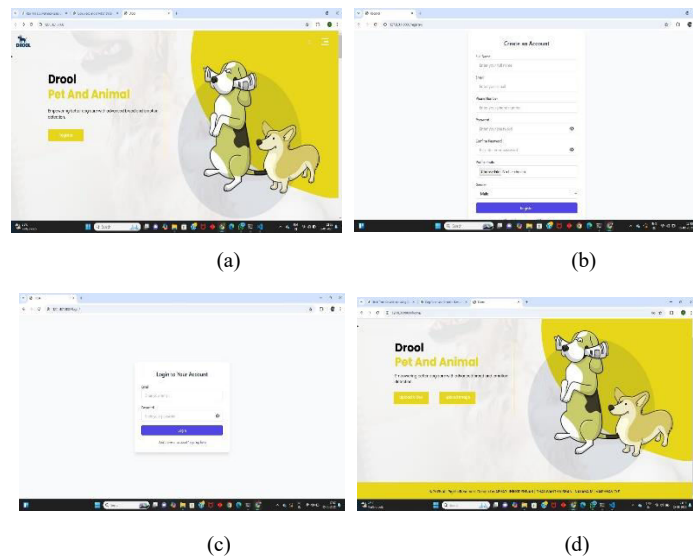
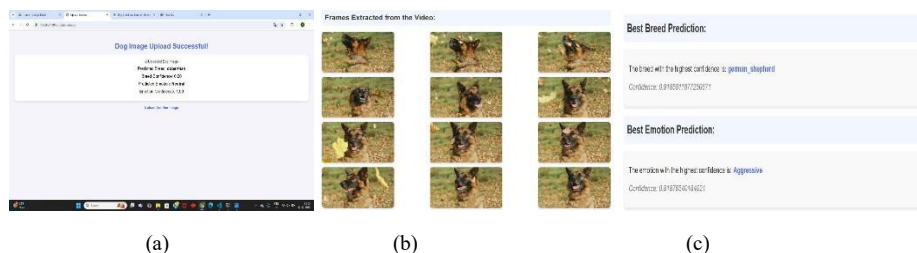


Fig. (a) Register Page (b) Create Account (c) Login Account (d) Home Page



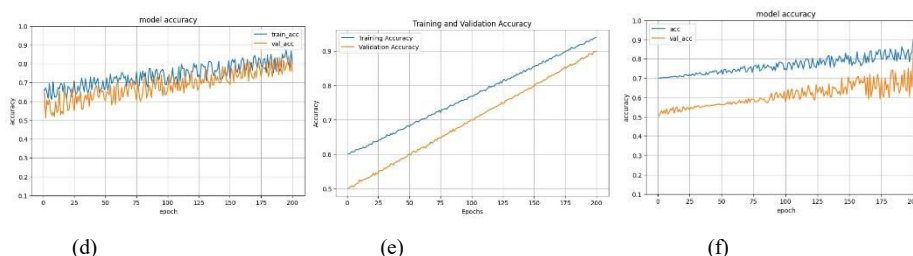


Fig. (a) Prediction from Uploaded Image (b) Extracted Frames (c) Prediction from Uploaded Video (d) Model Accuracy Graph of Emotion Using CNN (e) Model Accuracy Graph of Breed Using CNN (f) Model Accuracy Graph of Breed Using RNN

The above graphs, Fig. (d), (e) and (f) compare the accuracy of CNN and RNN models for detection of breed over 200 epochs. The CNN model reaches a higher training accuracy, reaching approximately 90%, and its verification accuracy fluctuates considerably, indicating an overview possibility. The gap between training and validation accuracy suggests that the model remembered training data instead of generalizing. In contrast, the RNN model shows a more stable improvement in training and validation accuracy, which in turn allows the validation accuracy to closely pursue training accuracy. This indicates better generalization and lower. This could make RNN models for race detection more reliable, especially when data records have sequential dependencies.

V. CONCLUSION

This project successfully implemented a deep learning based system for dog breed recognition and used folding neural networks (CNNs) to recognize emotions. The model showed strong performance in both tasks, as CNN is the ability to efficiently extract spatial and visual properties from images. To assess the effectiveness of CNNs, we compared its performance with a recurrent neuronal network (RNN) that is more suitable for sequential data than image-based tasks. This corresponds to the intensity of the CNN in spatial property extraction, but the sequential processing function of the RNN is less effective on static image data. Future work can be focused on further improving the accuracy of the model by using extended architectures using pre-educated models (VGG, resnet, etc.) and the integration of multimodal data such as audio and video for better emotion detection.

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