AI-Based Dog Skin Disease Detection Using Deep Learning and Explainable AI

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***Abstract*—The system is designed for common types of skin allergies, fungal infections, and mange in dogs, which are identified based on images of the skin. To improve the clarity of the predictions, an explainable method is used to present which region in the image produces the final result. Finally, a simple web-based application is implemented to support users by uploading the images and receiving the predictions in the shortest time possible along with a visual explanation. The evaluation indicates that the performance of the model is dependent on the quality and balance of the dataset. As a result, this approach can be effective in early disease detection and assist pet owners in making timely decisions.**

***Index Terms*—Dog skin disease, Deep learning, MobileNetV2, Grad-CAM, Image classification**

I. INTRODUCTION

Dogs get a lot of skin problems. These problems can be things like allergies or fungal infections or mange. They cause dogs to itch and get red and feel bad. If you do not find out what is wrong with your dog when the problem first starts it can get a lot worse. Sometimes you need to go to a veterinarian to figure out what is wrong with your dog. It is not always easy to get to a veterinarian especially if you live in a place that is far away from cities.

Nowadays computers are getting better at looking at pictures. Figuring out what is going on. This is helpful for doctors. It can even help with dogs. A special kind of computer program called a deep learning model can look at pictures of dogs. Figure out if they have a skin problem.

We made a computer system that can look at pictures of dogs and tell you what is wrong with their skin. This system is easy to use. You can upload a picture of your dog and the system will tell you what it thinks is wrong. The system will also show you which parts of the picture it used to make its decision. This way you can trust the system. Understand how it works. The system is simple and accurate and easy to use. Dogs skin problems are what the system is designed to help with. The system can help with things, like allergies and fungal infections and mange.

II. LITERATURE REVIEW

Recent developments in learning have made image-based disease detection much better for humans and animals. Many studies have looked into using neural networks (CNN) and transfer learning for classifying skin diseases.

Selvaraju and others proposed Grad-CAM, a technique that shows which parts of an image are important for a model's prediction. This approach is widely used in imaging to make AI systems more understandable and reliable [1]. Howard and others created MobileNetV2, a CNN architecture for efficient image classification on devices with limited resources. Its design, which includes depthwise convolutions and inverted residual blocks makes it suitable for real-time applications [2]. A study by Esteva et al and others showed that deep neural networks can classify skin cancer as accurately as a dermatologist using large datasets. Their work proved that AI can be efficient in diagnosis [3].

Rajpurkar and others applied learning to medical imaging tasks and improved disease detection by focusing on data quality and model architecture [4].

Too. Et al and others explored transfer learning model's like VGG16, ResNet and MobileNet for image classification. They found that pre-trained model's improve performance with limited datasets [5]. Kumar proposed a classification system based on

CNN that detects skin diseases in animals with symptoms like lesions, redness and hair loss [6].

Singh and others also worked on a project dermatological condition using image processing and ML [7]. Zhang. Emphasized the importance of data augmentation techniques in improving model accuracy with datasets [8]. Patel. Used learning in a veterinary diagnostic research study. They found that making AI systems user-friendly can make them more accessible to -expert users [9]. Goodfellow provided knowledge on deep learning methodologies, including CNN, optimization techniques and generalization. These form the basis of AI-based image classification systems [10].

From the literature deep learning models with transfer learning are the best for image-based disease detection. However, challenges like dataset imbalance, limited data and interpretability remain significant. The proposed work aims to solve these issues by using MobileNetV2 with Grad-CAM for explainable predictions, for dog skin disease detection.

III. PROBLEM STATEMENT

Dogs can get skin diseases like allergies, fungal infections and mange. These skin diseases in dogs can cause health problems if we do not see the signs early. To figure out what is wrong with the dog we need a veterinarian who's an expert. Veterinarians who are experts in skin diseases in dogs are not always available especially in places that are far away. The problem is that skin diseases in dogs like allergies, fungal infections and mange can look similar. They can all cause redness, hair loss and irritation in dogs with skin diseases. So, it is hard to know what is wrong with the dog by looking at the symptoms of skin diseases in dogs. The ways we have now to figure out what is wrong with the dog are not very good. They take a time and depend on what the veterinarian thinks. There is no way for people who own pets to use a computer to figure out if their dog has skin diseases like allergies, fungal infections and mange. We also do not have good pictures of skin diseases in dogs to help computers get better at figuring out what is wrong.

So, we need to make a system that can look at pictures of skin diseases in dogs and figure out what is wrong. This system should be easy to use and give us answers that make sense. The system for skin diseases in dogs should also be able to explain what it thinks is wrong. That way people can trust the system for skin diseases in dogs. That is why we are trying to make a computer system that uses learning to help figure out what is wrong with the dog. This system for skin diseases, in dogs will be able to look at pictures and give us answers that we can understand.

IV. PROPOSED METHODOLOGY

The proposed system is designed to detect and classify dog skin diseases using a type of computer learning called deep learning. This system uses a kind of artificial intelligence (AI) that can explain how it makes its predictions.

The system has four parts:

- getting the images
- preparing the images
- using a model to make predictions and
- showing the results.

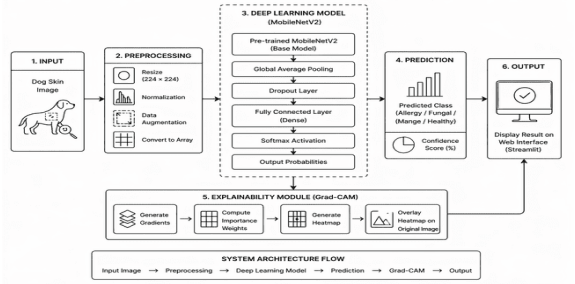

Fig. 1. Design Goal Diagram of ESRGAN System.

A. System Overview

The system takes a picture of a dog's skin. Uses a trained deep learning model to classify it into one of four categories:

- Allergy
- Fungal
- Mange
- Heathy

The system also provides an explanation of its prediction using a technique called Grad-CAM, which highlights the affected areas of the image. This helps users understand why the system made a prediction.

B. Data Collection and Preprocessing

The dataset used for this system includes images of dog skin diseases, which were collected under conditions. Since these images come in sizes and qualities, they need to be prepared to ensure they can be used by the system. The images are scaled to a size

of 224×224 pixels. Then normalized using a technique called MobileNetV2 preprocessing. This helps ensure that all images are in a format. The system also uses techniques like rotation, flipping and adjusting brightness to balance the dataset and improve the model's performance.

C. Model Architecture

The system uses a type of computer learning called transfer learning, based on a convolutional neural network called MobileNetV2. This model was pre-trained on a dataset of images and then fine-tuned to classify dog skin diseases. To improve the model's performance the system adds layers like average pooling, dropout and fully connected layers.

D. Prediction and Classification

After preparing the image the system passes it through the trained model, which produces probability scores for each class. The class with the highest probability score is selected as the predicted condition. The system also calculates a confidence score, which shows how confident it is in its prediction.

E. Explainable AI using Grad-CAM

To help users understand how the system makes its predictions it uses a technique called Grad-CAM (Gradient-weighted Class Activation Mapping). This produces a heatmap that shows the areas of the image that were most important, for the prediction. The heatmap is then superimposed on the image providing a clear visual explanation of the prediction.

F. User Interface

The system has a web-based interface built using Streamlit, which allows users to upload image's view predictions and see the analysis of the results.

The interface shows the predicted disease, confidence score and a visual explanation of the prediction making it easy to use for both owners and veterinary professionals.

G. Workflow Summary

The overall workflow of the system is:

- Image Input
- Preprocessing
- Model Prediction
- Classification
- Grad-CAM Visualization
- Output Display.

This system provides an interpretable and user-friendly way to detect dog skin diseases using artificial intelligence. The dog skin diseases are classified using learning and explainable AI techniques. The system uses dog skin disease images to make predictions. The dog skin disease detection system is designed to be easy to use.

V. SYSTEM ARCHITECTURE

The proposed system aims to detect dog skin diseases from start to finish. It uses learning and explainable AI to make this happen. The system has parts that work together. These parts help process pictures of dog skin make predictions about the disease and provide explanations. The system is designed to handle data on its own one step at a time. It also checks how well it is doing. Shows the results in a clear way. The overall plan of the system is shown in Figure 3. It involves dog skin diseases detection, deep learning and explainable AI techniques. The system has dog skin diseases detection, as goal. the dog skin diseases detection uses learning. the deep learning uses AI techniques.

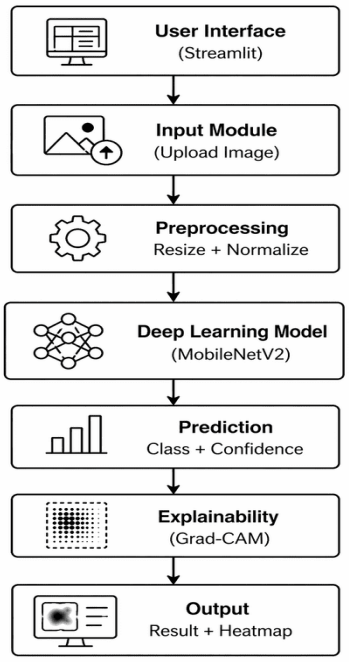

Fig. 2. ESRGAN Model Architecture.

The system is designed to support both individual and sequential data processing, along with performance evaluation and visualization. The overall architecture is illustrated in Fig. 3.

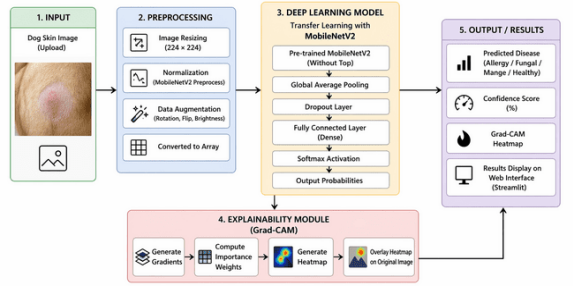

Fig. 3. System architecture of proposed system.

A. User Interface Layer

The system has a web-based user interface that was made using Streamlit. This part of the system lets users upload pictures of dog skin diseases and see the results of the predictions. It gives users a way to look at the classification of the disease how confident the system is in its prediction and explanations that they can understand.

B. Input Module

This part of the system gets the picture of the dog's skin that the user uploaded. The system can handle the common types of image files, which are JPEG and PNG. The picture is then prepared and sent to the step, which is to get it ready for the system to use.

C. Preprocessing Module

In this step the picture is prepared so that the system can use it to make a prediction. The picture is resized to 224×224 pixels, which's the size that the system needs. The picture is also normalized using the MobileNetV2 preprocessing method so that everything's consistent. Some other things are done to the picture like converting it into a format that the system can use to make sure it is ready for the deep learning model.

D. Deep Learning Model

The main part of the system is a kind of computer program called a convolutional neural network. It is based on something called MobileNetV2. The system uses something called transfer learning, which means it uses knowledge it already has to help it learn things. There are also some layers that help the system make a prediction like global average pooling, dropout and fully connected layers. In the end the system says whether the picture shows a dog with Allergy, Fungal, Mange or if the dog is Healthy.

E. Prediction Module

This part of the system takes the possibilities that the model comes up with and picks the one that's most likely. It also figures out how confident it is in its prediction.

F. Explainability Module

The system wants to be transparent so it uses something called Grad-CAM. This is a way to explain how the system made its prediction. It makes a picture that shows which parts of the original picture were most important for making the prediction. This picture is then put on top of the picture so that users can see why the system made its prediction.

G. Output Module

All of the results including the predicted disease, how confident the system's the Grad-CAM picture are shown on the user interface. So, users can see what disease the system thinks the dog has, how sure it is and why it made that prediction all in one place.

The way the system is designed makes it easy to understand how it works from start, to finish. This makes it a quick and reliable way to detect dog skin diseases.

VI. RESULTS AND DISCUSSION

For this purpose, the proposed system was built using a learning model of MobileNetV2 and made available through a Streamlit web interface. The system was tested on sample images of dog skin to see how well it works and if it is easy to use.

A. System Interface Output

The application we developed has an interface where a user can upload images and get results right away. The result the user gets is given to them along with a confidence rate. Figure 1 shows what the user interface of the system looks like.

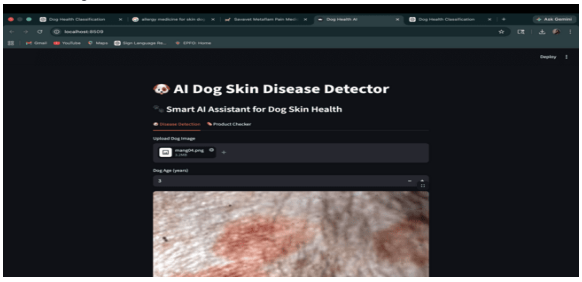

Fig. 4. User Interface of the Dog Skin Disease Detection System

B. Prediction Results

The image the system looks at can be put into categories like Allergy, Mange, Fungal and Healthy. For example, when we tested the system, it was very sure that the condition was an Allergy with a confidence score of 97.38%. The system looked at the dog skin image. Said it was an Allergy.

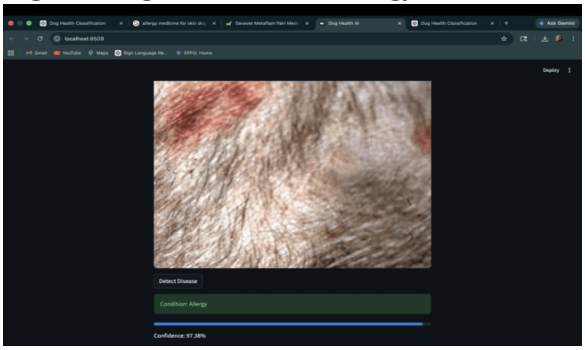

Fig.5. Sample Prediction Output

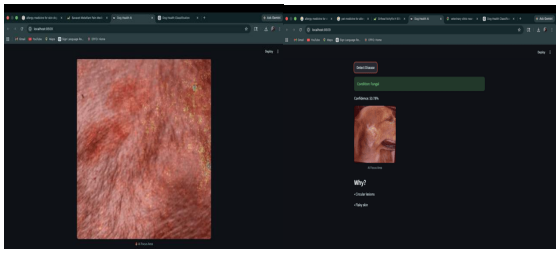

Fig. 6. Allergy Detection with Confidence Score

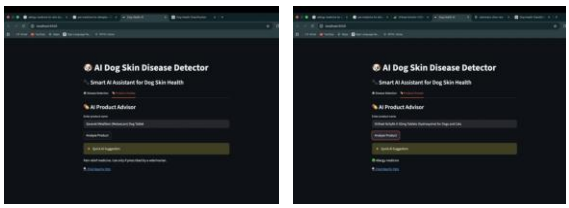

Fig. 4. AI Product Advisor Output for Dog Medication Analysis

C. Grad-CAM Visualization

To make the system easier to understand we used Grad-CAM to make heatmaps of the parts of the image that're important for the system to make a decision. So, the heatmap the system makes shows the areas of the skin that are affected. This helps the user see how the system made its decision. This helps build trust in the system and makes it more transparent.

D. Training Performance

We can see how well the model did during training by looking at the accuracy curves. The curve that shows how accurate the training was goes up consistently during training. The curve that shows how accurate the validation was has some ups and downs because the dataset is not perfect. This means the model is learning things but it is also affected by the fact that the dataset is small and not balanced.

E. Discussion

The results show that the system can find symptoms like redness, lesions and hair loss. The system did not work well as it could because the dataset was not balanced and there were not enough healthy and fungal category samples. If we get data and make it better the system will work even better.

The dog skin disease detection system we made is a start and it works well and is easy to use. There are still some things we can do to make it even better. The MobileNetV2 model and Streamlit web interface are a combination, for this kind of system. Dog skin disease detection is a topic and our system can help with it.

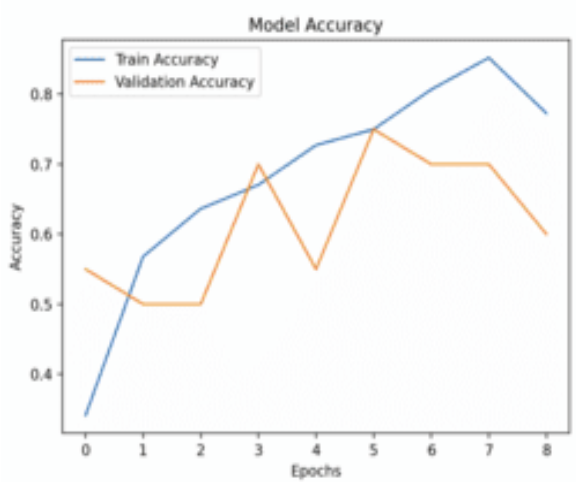

Fig. 9. Training and Validation Accuracy of the Model

VII. CONCLUSION

This paper is about a system that uses intelligence to detect dog skin diseases. The system uses a kind of computer program to look at pictures of dog skin and figure out if the dog has a disease or not. This program is called a neural network and it is based on something called MobileNetV2. The system can tell if a dog has allergies, an infection, mange or if its skin is healthy. The system has a website where people can upload pictures of their dog's skin and get an answer away. This makes the system very easy to use. One of the cool things about this system is that it can explain why

it thinks a dog has a certain disease. It does this by highlighting the parts of the picture that made it come to that conclusion. This is very important when it comes to health problems because people want to know why the system thinks something is wrong with their dog.

When we tested the system, we found out that it is very good at finding problems like redness, lesions, hair loss and skin irritation. The system gets better at finding these problems the it is used. However, the system is not perfect. Sometimes it makes mistakes. This is because the system was trained on a number of pictures and some of those pictures were not very good quality. The system has a time with pictures that are not very clear or that have a lot of distractions in the background.

With these problems the system is still very useful for helping figure out if a dog has a skin disease. It can be especially helpful when a veterinarian is not available. The system is like a tool that can help people and veterinarians work together to make sure dogs are healthy. In the future we want to make the system even better by using better pictures to train it. We also want to add diseases to the list of things the system can detect, like bacterial infections and parasites. We think the system could be more helpful if it was an app on a phone and if it could talk to veterinarians in real time. So, this system shows that artificial intelligence can be used to make a difference in the health of dogs. It is an example of how computers can be used to help people and animals and how they can make healthcare more accessible and easier to understand. The system uses dog skin diseases. It is, about dog skin diseases and it helps with dog skin diseases.

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