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AI-Powered Dermatology: Predicting Skin Disorders Using Convolutional Neural Networks

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ABSTRACT

Skin conditions are a major worldwide health issue, and successful treatment depends on early detection. This study uses Microsoft's machine learning framework, ML.NET, to present a machine learning-based skin disease prediction system. In order to predict possible skin disorders, the system lets users input skin photos, which are then examined by an image classification algorithm driven by deep learning. Data pre-processing, feature extraction, model training, assessment, and deployment within an intuitive web application are all included in the methodology. The technology provides real-time categorization and analysis, producing accurate predictions instantly. Data privacy and customized access are guaranteed by secure authentication features like user registration, login, and password recovery. Effective user administration is made possible via an admin panel. This technology, which is built for speed, scalability, and dependability, helps people and medical professionals identify skin diseases in their early stages. Early diagnosis is made more accessible and effective by utilizing ML.NET's deep learning capabilities to give high-precision classification with little processing overhead. Skin disorders are a major worldwide health issue, and successful treatment depends on early detection. This paper presents a skin disease prediction system that uses Microsoft's ML.NET framework and machine learning. Users can upload photographs of their skin, which are then examined by an image classification algorithm driven by deep learning to make precise predictions about possible skin conditions. Data pre-processing, feature extraction, model training, assessment, and deployment within an intuitive web application are all included in the methodology.

KEYWORDS: *Computer Vision, Medical Image Processing, ResNet50, Image Classification, Machine Learning, ML.NET, and Skin Disease Prediction.*

I. INTRODUCTION

Millions of people worldwide suffer from skin conditions, which impact people of all ages. Although effective therapy depends on an early and precise diagnosis, traditional treatments frequently rely on skilled dermatologists, whose availability may be restricted. Rapid developments in deep learning and machine learning (ML) have made automated methods for detecting skin diseases useful for aiding in early diagnosis and treatment. This project presents ML.NET, Microsoft's machine learning technology, which powers an intelligent skin disease classification system. It analyses skin lesion photos and categorizes them into different disease groups using ResNet50, a convolutional neural network (CNN) with a deep learning foundation. ResNet50 is a good choice for challenging picture recognition applications because of its residual learning architecture, which improves classification accuracy.

Data collection, pre-processing, feature extraction, model training, evaluation, and deployment are all steps in the system's organized pipeline. For real-time disease prediction, users can upload skin photos from their device or webcam using this user-friendly web application. While an admin panel enables effective user management, secure authentication methods, such as user registration, login, and password recovery, guarantee data protection. Millions of people worldwide suffer from skin disorders that affect people of all ages. Effective therapy depends on an early and precise diagnosis, but conventional approaches frequently depend on skilled dermatologists, whose availability may be restricted. This makes automated technologies that can help with the rapid and precise detection of skin diseases necessary. Intelligent systems that improve early diagnosis and facilitate prompt medical intervention have been made possible by recent developments in deep learning and machine learning (ML). In order to create an intelligent system for classifying skin diseases, this project makes use of Microsoft's robust machine learning framework, ML.NET. The system makes use of ResNet50, a convolutional neural network (CNN) renowned for its high classification accuracy and deep learning capabilities[3]. Because of its residual learning architecture, ResNet50 excels in difficult image identification tasks, accurately classifying photos of skin lesions into different illness classes. The system lessens reliance on specialized medical experts and improves diagnostic accuracy by integrating this cutting-edge technology.

Data gathering, pre-processing, feature extraction, model training, evaluation, and deployment are all steps in the methodology's organized pipeline. A user-friendly web application enables real-time disease prediction by allowing users to submit skin photos from their devices or take them with a webcam. In order to help users, detect any skin issues early on, the system quickly and accurately classifies the photos after processing and analysing them. The application has strong authentication features including user registration, login, and password recovery to guarantee security and effective user administration. An admin panel also makes system monitoring and user administration more efficient. This project provides a scalable, high-performance solution that enhances accessibility to early skin disease diagnosis by combining deep learning with ML.NET, thereby helping both patients and medical professionals.

II. RELATED WORK

Machine Learning in Medical picture Analysis: In recent years, there has been a lot of interest in the application of

machine learning to medical picture classification. The use of Convolutional Neural Networks (CNNs) for skin disease identification has been investigated in a number of research, which have shown how well they automate diagnosis. Deep learning models like ResNet, VGG, and MobileNet have been used by researchers to evaluate dermatological photos and accurately categorize skin diseases. By utilizing pre-trained networks on huge datasets like ImageNet, transfer learning techniques have also been extensively employed to improve model performance.

Microsoft's open-source machine learning framework, ML.NET, has become a potent tool for creating AI-driven applications in.NET environments. This helps with image classification. Research has demonstrated that the Image Classification API of ML.NET, which is based on TensorFlow, is capable of efficiently training deep learning models with pre-trained architectures such as ResNet50. The system is appropriate for real-time medical picture classification since it offers an effective workflow for pre-processing, feature extraction, model training, and deployment. The seamless integration of ML.NET with ASP.NET Core has been emphasized by researchers as a means of guaranteeing scalability and quick inference in web-based applications.

Security and Authentication in Healthcare Applications: Machine learning applications pertaining to healthcare must guarantee data privacy and safe authentication procedures. The use of JWT-based authentication for online apps has been investigated in a number of researches, offering safe user access and safeguarding private medical information. Medical diagnostic systems have also made extensive use of role-based access control (RBAC) to distinguish between administrator and user privileges. According to research, putting secure authentication and access management into practice greatly improves user confidence and adherence to healthcare data protection regulations[4].

Future Prospects and Challenges: Real-time performance, model generalization, and dataset availability continue to be issues despite ML.NET for medical imaging developments. Researchers are focusing on enhancing computational efficiency, reducing bias in training datasets, and improving model interpretability. To improve the security and precision of skin disease prediction models, federated learning techniques and cloud-based AI services are being investigated. In order to increase the accessibility and dependability of AI-driven medical diagnostics, future research attempts to improve deep learning methodologies.

III. DATA AND SOURCES OF DATA

Type of Data :

Medical Image Data: Dermatological pictures of a range of skin problems, such as melanoma, psoriasis, eczema, and others.

Patient Metadata: To improve prediction accuracy, pertinent patient data such as age, gender, and medical history are incorporated.

Image Processing Data: pre-processed photos for model training that have had their brightness, contrast, and pixel values balanced.

Machine Learning Model Data: features that have been extracted from deep learning models' convolutional layers and utilized for classification, like ResNet50.

Sources of Data:

Medical Image Databases: High-quality labelled skin disease images are available from publicly accessible datasets like HAM10000, Dermnet, and ISIC (International Skin Imaging Collaboration).

Healthcare Institutions and Research Labs: Hospitals, AI research facilities, and clinical dermatological departments all contribute to the collecting of datasets.

Machine Learning Repositories: open-source resources for classifying skin diseases, including as Google Dataset Search, Kaggle, and scholarly research articles.

Real-Time User Uploads: Users can input images for diagnosis using the program, which helps to expand the dataset and improve the model over time.

IV. RESEARCH METHODOLOGY

A systematic approach is used by the Image Classification-Based Skin Disease Prediction System to guarantee effective image processing, precise classification, and an intuitive user experience. The following are the main steps in the suggested methodology.

- Data Collection & Pre-processing: Labelled photos of different skin conditions make up the training dataset, which was obtained from Kaggle. To improve model performance, normalizing techniques are used and the photos are resized to 224×224 pixels for uniformity. To increase image clarity and classification accuracy, noise reduction is applied.
- Model Selection & Training: To categorize skin conditions, the system makes use of ML.NET's Image Classification Model, which is built on a deep learning architecture (ResNet50). Transfer learning is used to train the model, using previously learned features to identify patterns in skin lesions. To guarantee the best classification performance, features are extracted and the model is assessed using common accuracy metrics.
- System Development & Implementation: HTML, CSS, and JavaScript are used to create the frontend, which offers an interactive user interface. The ASP.NET Core-implemented backend manages authentication, image processing, and communication with the ML model. To ensure safe data storage, SQL Server is used to store user passwords, prediction history, and system logs.
- Workflow of the System: Users can use a webcam to take a picture or upload one from their device. The image is pre-processed by the system before being sent to the ML.NET Image Classification Model, which classifies the disease by extracting pertinent features. Users are presented with an understandable result that includes the projected disease category and confidence score. The system might advise submitting a crisper image if the prediction is unclear.
- Expected Outcomes: To help people and medical professionals detect skin diseases early, the suggested system seeks to classify diseases with high accuracy, make real-time forecasts, and provide a scalable and secure web-based application. It also offers thorough disease explanations and recommended treatments, assisting users in comprehending their situation and taking the necessary steps.

V. System Architecture

The multi-layered design of the Image Classification-Based Skin Disease Prediction System guarantees effectiveness, precision, and security. Every layer is made to maximize user experience, classification, and picture processing while ensuring safe data handling.

User Interface Layer: This layer offers a web-based user interface created with JavaScript, HTML, and CSS. It shows the projected disease classification with confidence scores and lets users submit skin photos from their device or webcam. The interface is made to be accessible and simple to use.

Application Processing Layer: Developed with ASP.NET Core, this layer controls communication between the frontend and the machine learning model as well as user authentication (registration, login, and password recovery). It guarantees safe system logic execution and request processing.

Machine Learning Layer: This layer takes input skin photos and categorizes them into illness groups using ML.NET's Image Classification Model. The deep learning model, which is based on the ResNet50, pulls important information from photos and produces very accurate predictions in real time.

Database Layer: System logs, prediction history, and user credentials are stored in MS-SQL Server. It permits future reference to earlier outcomes and guarantees safe data storage. The database is set up for quick retrieval and effective queries.

Prediction Result Layer: The prediction result layer is in charge of presenting the final illness categorization outcome together with a confidence level. The technology helps users effectively grasp the forecast by providing a clear and understandable output after processing the image through the machine learning model. For improved results, the algorithm can advise uploading a clearer image if the current one is unclear or does not fit into any trained category.

Workflow of Skin Disease Prediction using ML.NET

Fig. Simple workflow

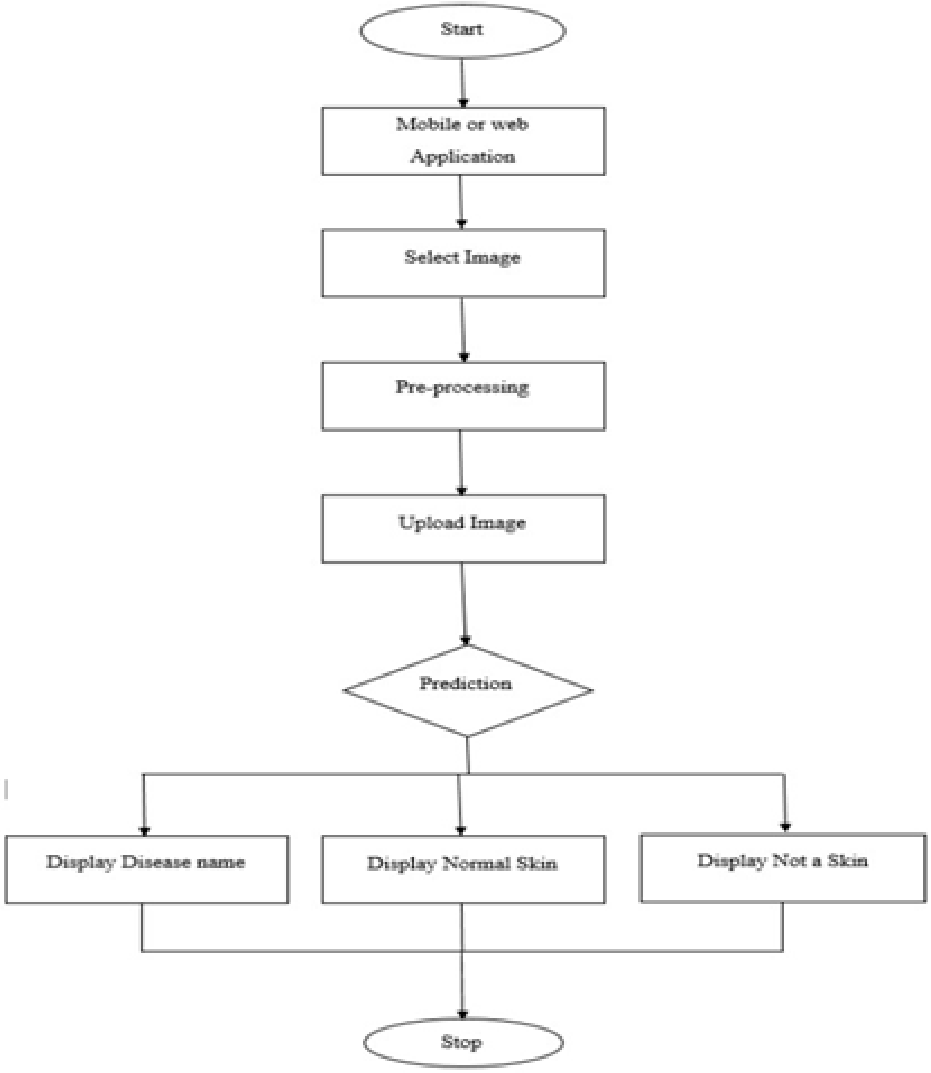

Fig. Flow Diagram

Formula:
This function is used in the final layer of CNN to classify different skin diseases.

$$P(y_i) = \frac{e^{z_i}}{\sum_{j=1}^{N} e^{z_j}}$$

Where:
- P(yi)P(y_i)P(yi) = Probability of the skin disease being class iii
- ziz_izi = Output from the last fully connected layer of the CNN
- NNN = Total number of disease classes (e.g., eczema, melanoma, psoriasis)
- ezie^{z_i}ezi = Exponential of the output value to ensure non-negative probabilities
- The denominator normalizes probabilities across all classes.

This formula ensures that the model assigns a probability to each skin disease, helping in multi-class classification.

VI. RESULTS AND DISCUSSION

Utilizing ML.NET's deep learning capabilities, the Skin Disease Prediction System offers a quick, effective, and intuitive method of identifying skin problems. Through the application of image classification techniques, the system enables users to submit photographs for immediate analysis and prediction. This makes initial diagnoses more accessible and lessens the need for specialized medical facilities, especially in rural areas.

In addition to classification, the system offers thorough explanations and recommended treatments, empowering users to understand their condition and take preventative action. By combining database administration and secure authentication, user data is safeguarded, improving dependability and privacy. The technology increases diagnostic accuracy by integrating cutting-edge image processing and machine learning models, enabling AI-driven solutions to make healthcare more accessible. The model is more effective at accurately identifying a variety of skin conditions when ResNetV250 is used for transfer learning.

This initiative opens the door for AI-powered medical applications while highlighting the important role that machine learning plays in contemporary healthcare. This approach improves patient outcomes by bridging the gap between technology and healthcare, enabling early detection, prompt action, and improved accessibility.

Fig. Portfolio Data Upload Interface for Investment Analysis

Fig. Portfolio Performance vs. Custom Benchmark Over Three Years

VII. CONCLUSION:

The promise of deep learning and machine learning in dermatology is effectively demonstrated by the Image Classification-Based Skin Disease Prediction System. The system offers an effective, real-time solution for early skin disease diagnosis by utilizing ML.NET's deep learning capabilities.

The system uses ResNet50, a potent convolutional neural network model, to scan photographs that users upload from their smartphone or take with their webcam in order to accurately classify diseases.

While a well-structured database facilitates effective user administration, the use of secure authentication guarantees data privacy. The technology also helps users understand their problems and make educated healthcare decisions by offering thorough descriptions and recommended treatments. Adding an admin panel improves system and user administration even more.

The importance of machine learning in medical diagnostics is demonstrated by this effort, especially in terms of expanding access to early detection tools. The technique improves diagnosis efficiency while lowering reliance on specialist medical experts by providing a high-precision, low-processing overhead classification system.

In order to improve security and precision, future developments might involve growing the dataset, improving model accuracy, and using federated learning strategies.

Ultimately, by offering scalable, dependable, and easily available skin disease prediction technologies, this research supports the importance of artificial intelligence in transforming healthcare.

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