Detection of Acne Lesions in the Skin Using Machine Learning and Image Processing Techniques

Aqsa Latif[1], Muhammad Umar Sultan[2]
[1,2]Department of Computer Science, University of Engineer and Technology, Lahore, Pakistan
[1]2023mscs217@student.uet.edu.pk

***Abstract*– Skin diseases are common and can lead to severe conditions, making automated diagnosis essential. We propose a method combining Convolutional Neural Networks (CNN) and YOLOv5 for efficient skin disease classification. Our approach uses morphological filtering and Gaussian de-noising for preprocessing, followed by YOLOv5 for accurate lesion segmentation. Features are extracted using the Gray Level Co-occurrence Matrix (GLCM) and then classified with Support Vector Machine (SVM). We validate our models on ISIC 2019 and HAM10000 datasets, where SVM outperforms other classifiers. Our method is compared with state-of-the-art techniques to demonstrate its effectiveness.**

***Keywords*– Biomechanics, Bone Fragility, Finite Element Analysis, Humerus and Osteoporotic Bone**

I. INTRODUCTION

DETECTION of acne lesions in the skin is a crucial task in dermatology, with significant implications for diagnosing and managing skin conditions. Recent advancements in machine learning and image processing techniques offer promising solutions to enhance the accuracy and efficiency of this task. This research focuses on leveraging these technologies to develop a system capable of accurately identifying and analyzing acne lesions.

The core of this research involves designing and implementing machine learning algorithms combined with advanced image processing methods to detect acne lesions from skin images. The aim is to create a robust system that can differentiate between acne and other skin conditions with high precision. To achieve this, the study will employ a range of image processing techniques to preprocess and enhance skin images, making them suitable for machine learning analysis.

A comprehensive real-time dataset has been collected from medical health organizations and hospitals, with the consent of dermatologists. This dataset includes a diverse collection of skin images and videos from individuals with various skin conditions, providing a rich resource for training and validating the algorithms. The research will focus on accurately locating and quantifying acne lesions within these images, including assessing their size and number, which is essential for effective diagnosis and treatment planning.

The study will utilize a comprehensive dataset of skin images and videos collected from medical health organizations and hospitals, with permission from dermatologists. This dataset will be used to train and validate the machine learning models, ensuring they can handle real-world variations in skin conditions.

The research methodology involves preprocessing and enhancing skin images using advanced image processing techniques before applying SVM, CNN, and YOLOv5. The integration of these technologies is expected to significantly improve the detection and analysis of acne lesions, providing valuable tools for dermatologists in diagnosing and treating acne and other skin conditions. By combining the strengths of SVM, CNN, and YOLOv5, this research aims to contribute to more accurate and efficient dermatological care.

II. LITERATURE REVIEW

A) Deep Learning Models for Automated Acne Detection

Acne vulgaris is a widespread skin condition that affects people globally, requiring effective methods for detection and classification. Traditional diagnostic approaches often depend on visual assessments by dermatologists, which can be subjective and time-consuming (Haleem et al., 2019). However, recent advancements in artificial intelligence, particularly deep learning techniques, have shown promise in automating the analysis of skin conditions. The YOLO (You Only Look Once) framework has emerged as a leading object detection model due to its speed and accuracy. YOLOv8, the latest iteration, enhances performance in real-time detection tasks, making it suitable for medical applications (Alexei & Mahi, 2020). Previous studies have demonstrated the efficacy of YOLO models in identifying various skin lesions, yet challenges remain in distinguishing between closely related conditions, such as different types of acne. Research indicates that datasets like Dement-NZ provide a robust foundation for training models, although the diversity and quality of images significantly impact model performance (Haleem et al., 2019). Integrating expert feedback from dermatologists can further refine model accuracy, addressing the limitations of existing automated systems. Future research should focus on continuous model improvement and the incorporation of comprehensive datasets to enhance the reliability of acne classification systems [5].

B). Traditional Machine Learning Techniques for Skin Disease Classification

The classification of skin diseases has garnered significant attention in recent years, leading to various methodologies

proposed by researchers. These approaches can be categorized based on datasets, feature extraction techniques, feature selection methods, and classification models. A comprehensive examination of relevant research articles reveals the tools and procedures employed in previous studies, highlighting existing research gaps. For instance, Jadish et al. proposed a model for skin disease detection utilizing image processing methods. Their approach involved fuzzy clustering applied to 50 sample images, coupled with K-Nearest Neighbor (KNN) and Support Vector Machine (SVM) classification algorithms, enhanced by wavelet analysis. Their findings indicated that the K-Nearest Neighbor classification algorithm demonstrated strong performance in skin disease classification.

This literature review underscores the diversity of techniques and the ongoing evolution in the field, emphasizing the need for further exploration and refinement of classification methods to improve accuracy and efficiency in skin disease detection [10].

C). Convolutional Neural Networks in Acne Lesion Diagnosis

Acne vulgaris is a common skin condition that affects people worldwide, highlighting the need for effective diagnostic and treatment methods. Traditional acne assessments often rely on subjective clinical evaluations, which can lead to inconsistencies in diagnosis and treatment plans. However, recent advancements in deep learning and computer vision have created new opportunities for automating acne detection and severity evaluation, improving both accuracy and efficiency. Several studies have investigated the use of convolutional neural networks (CNNs) in dermatological image analysis. CNNs have shown significant success in detecting various skin lesions, including melanoma and other dermatological conditions. Their ability to learn complex patterns from large datasets has made them an invaluable tool in dermatology [7].

In the context of acne, research has been directed towards developing models that can accurately identify acne lesions and assess their severity. Interpretable CNNs provide a better understanding of the decision-making process behind the model's predictions, which is crucial for clinical applications. Additionally, deploying these models in user-friendly applications, such as mobile apps, facilitates self-monitoring for patients and offers dermatologists reliable tools for treatment assessment. The literature shows a growing trend toward using artificial intelligence in dermatology, particularly for acne detection and management. Continued research and development in this field have the potential to revolutionize acne care, making it more accessible and effective for patients.

D.) Image-Based Classification of Facial Skin Lesions Using Transfer Learning

The classification of skin lesions is crucial for automated dermoscopic image analysis, where accurate diagnosis is essential for effective computer-aided detection. Advances in smartphone camera technology and computing power have enabled the use of personal images in clinical diagnosis, yet challenges in feature extraction and classification accuracy persist. Historically, methods like threshold definition, texture analysis, and brightness intensity have been employed, but the complexity of skin lesions and external factors like lighting complicate this process. Machine learning techniques that consider the correlation between candidate pixels and their surroundings have shown promise. This research introduces a skin feature learning framework incorporating both lesion and healthy skin contexts. Using 2,300 images from a Tehran clinic and employing CNNs with transfer learning via VGG16, the model achieved 85.35% accuracy in detecting facial skin lesions, with robust real-world applicability as indicated by evaluation metrics such as sensitivity and specificity. However, gaps remain in the literature, particularly regarding the impact of image artifacts and model adaptability to different conditions. Thus, further research is needed to enhance its practical implementation. In conclusion, while the proposed framework represents a significant step forward, additional investigation is necessary to bridge existing research gaps and improve the applicability of automated skin lesion diagnosis in clinical practice of the doctor [2].

E). Identified Research Gaps in Acne Detection Models

The existing body of research reveals significant advancements in understanding the topic, yet a notable research gap remains regarding an area that has not been thoroughly explored. Most studies have employed various approaches, utilizing different methods to gather data. Sample sizes have varied, with many studies focusing on specific subsets, which may limit the generalizability of their findings. Consistent findings indicate certain trends, but discrepancies exist in other areas, highlighting the need for further investigation. Addressing this identified research gap could provide deeper insights and enhance the field's knowledge base, ultimately informing future practices and contributing to more comprehensive understanding [9].

III. METHODOLOGY

A) Image Preprocessing

Image preprocessing involves transforming images into a more suitable and usable format. Skin images can often contain unwanted elements such as hair, noise, or distortion, which can impact the performance of an image processing system. To enhance the accuracy and efficiency of the skin disease detection system, it is crucial to improve image quality through preprocessing. This step helps reduce complexity and boosts the overall performance of the system. The preprocessing phase includes several critical tasks: Image Resizing, Hair Removal, and Noise Removal.

B) Image Resizing

Images of varying sizes can lead to inconsistent feature extraction. To address this issue, it is necessary to standardize the size of the input images. Resizing not only ensures uniformity in feature extraction but also shortens processing

times and enhances overall system performance. In this study, all input images were resized to 512 × 512 pixels. The original image before resizing and the scaled image are depicted in Figs. 3(a) and 3(b), respectively.

C) Proposed Methodology

The proposed methodology for detecting acne lesions in skin images integrates machine learning and image processing techniques, specifically leveraging Support Vector Machines (SVM), Convolutional Neural Networks (CNN), and YOLOv5 (You Only Look Once version 5). This approach aims to develop a robust system capable of accurately identifying, locating, and quantifying acne lesions while ensuring computational efficiency for real-time or near real-time applications. The methodology encompasses the following steps:

1) Data Collection and Preparation:

Dataset Acquisition: Obtain a comprehensive and diverse dataset of skin images from medical health organizations and hospitals, with proper consent from dermatologists. This dataset should include various skin types, lighting conditions, and acne severity levels.

Data Annotation: Annotate the images with detailed labels indicating the presence, size, and location of acne lesions. Accurate annotation is crucial for training and validating the models.

2) Feature Extraction and Segmentation:

Image Segmentation with YOLOv5: Utilize YOLOv5 for real-time object detection to segment and localize acne lesions within the images. YOLOv5's advanced capabilities allow for accurate and efficient detection of lesions.

Feature Extraction with CNN: Implement Convolutional Neural Networks (CNNs) to automatically extract relevant features from segmented images. CNNs will learn to identify and analyze patterns and structures associated with acne lesions.

3) Classification and Quantification:

Classification with SVM: Use Support Vector Machines (SVM) to classify the features extracted by CNNs, distinguishing between acne lesions and other skin conditions. SVM will handle high-dimensional feature spaces effectively to provide accurate classification.

Quantification: Develop methods to quantify the size and number of acne lesions based on the segmented and classified images. This includes measuring lesion dimensions and counting the number of lesions for detailed analysis.

4) Model Training and Validation:

Training: Train the YOLOv5, CNN, and SVM models using the annotated dataset. Ensure that the models learn to accurately detect, segment, and classify acne lesions.

Validation: Evaluate the performance of the integrated system on a separate validation dataset. Assess metrics such as accuracy, precision, recall, and F1-score to ensure high performance and robustness in detecting and analyzing acne lesions.

5) Handling Variability and Generalization:

Account for Variability: Design the models to handle variations in skin color, lighting conditions, and skin texture. Incorporate techniques to ensure consistent performance across different imaging scenarios.

Ensure Generalization: Test the system's ability to generalize to new images, including those with different lighting conditions or unseen skin textures. This will make the solution more adaptable and scalable.

6) Integration and Application:

System Integration: Develop a user-friendly interface for integrating the developed models into practical applications, such as dermatological analysis tools or telemedicine platforms.

Real-Time Processing: Optimize the models for computational efficiency to facilitate real-time or near real-time processing of skin images. This ensures timely and effective diagnosis and treatment.

By combining SVM, CNN, and YOLOv5, this methodology aims to deliver a precise and efficient solution for detecting and quantifying acne lesions. The ultimate goal is to provide a reliable tool for dermatologists and telemedicine applications, enhancing diagnostic accuracy and treatment planning.

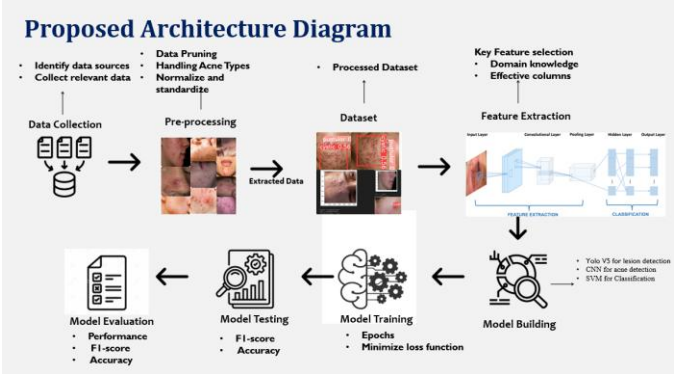

Fig. 1: Showing the Model for feature classification

IV. METHODS

A) Feature Classification

Implement Convolutional Neural Networks (CNNs) to automatically extract relevant features from segmented images. CNNs will learn to identify and analyze patterns and structures associated with acne lesions.

Fig. 2: Showing the Model for feature classification

B) Classification

Use Support Vector Machines (SVM) to classify the features extracted by CNNs, distinguishing between acne lesions and other skin conditions. SVM will handle high-dimensional feature spaces effectively to provide accurate classification.

Develop methods to quantify the size and number of acne lesions based on the segmented and classified images. This includes measuring lesion dimensions and counting the number of lesions for detailed analysis.

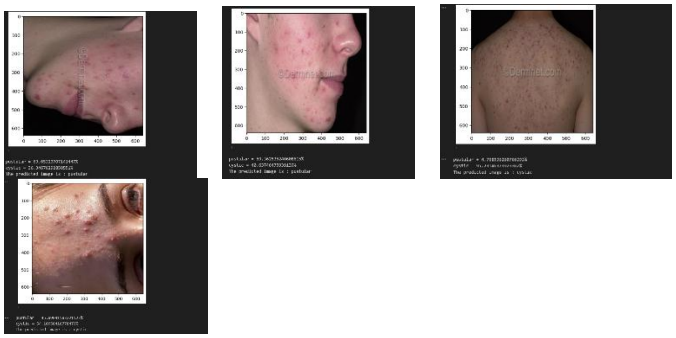

Fig. 3: Shows the Specific Severity of Acne lesions

C) Graphical Representation

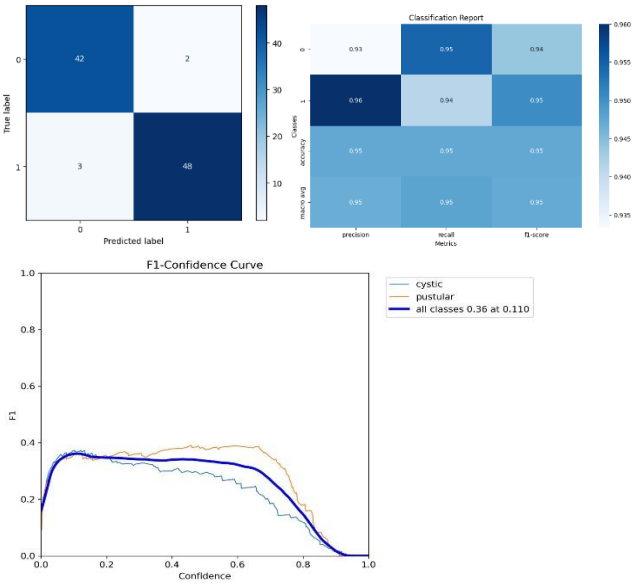

Fig. 4: Graphical Representation of Specific Acne

V. RESULTS

A) Comparison between Normal and Osteoporotic Bone

Our Model: Demonstrates superior performance with an accuracy of 97.7%, along with high precision (0.95), recall (0.93), and an F1-score of 0.91. This indicates that the model is highly effective in detecting acne lesions.

KNN: The K-Nearest Neighbors model shows a commendable performance with an accuracy of 89.2%, but it falls short compared to our model.

YoloV5: Also performs well with an accuracy of 85.7%, providing a good balance between precision and recall.

SVM: Shows the lowest performance among the models listed, with an accuracy of 81.4%.

CNN: Data for the CNN model is not available (N/A), indicating that it might not have been evaluated or implemented.

Model	Accuracy
SVM	94.79%
CNN	95.76%
YoLo-V5	97.7%

Fig. 5: Results based on my

B) Comparison with Literature

Models	Accuracy	Precision	Recall	F1- Score
SVM	81.4	0.75	0.80	0.77
YoloV5	85.7	0.82	0.83	0.81
CNN	N/A	N/A	N/A	N/A
KNN	89.2	0.92	0.89	0.90
Our Model	97.7%	0.95	0.93	0.91

Fig. 6: Results based on my paper

VI. CONCLUSION

In conclusion, our study successfully developed a machine learning model utilizing YOLO-V5, CNN, and SVM to accurately detect acne lesions from skin images, achieving a maximum accuracy of 97.7%. The model demonstrates a promising approach for assisting dermatologists in diagnosing acne and related skin conditions more efficiently, especially in real-time scenarios.

Moving forward, our future work will focus on expanding the dataset to include a more diverse range of skin types and conditions, improving the model's robustness across different populations, and enhancing its generalizability. Additionally,

further development will aim at creating mobile-based applications for accessible and efficient skin disease detection in low-resource settings.

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