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ADVANCED DERMATOLOGICAL DIAGNOSIS SYSTEM USING MACHINE INTELLIGENCE

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ABSTRACT
Skin diseases are more common than other diseases. Fungal infections, bacteria, allergies, viruses, etc may cause skin diseases. The advancement of lasers and photonics-based medical technology has made it possible to diagnose skin diseases much more quickly and accurately. However, the cost of such a diagnosis is still limited and very expensive. So, image processing techniques help to build an automated screening system for dermatology at an initial stage. Skin diseases pose significant health challenges worldwide, with implications for both physical well-being and mental health. The diagnosis of these diseases is intricate and often overlooked due to insufficient medical infrastructure. This project work addresses this issue by proposing a novel system, integrating Convolutional Neural Network (CNN) with Support Vector Machine (SVM) classifiers and You Only Look Once (YOLOv5), culminating in the development of a Mobile Android Application (MAA). The system is evaluated on a dataset comprising 3000 images from various websites, ensuring accuracy and realism. The study conducts experiments on different feature extraction algorithms and classifiers, emphasizing the efficiency of the (CNN-SVM-YOLOv5 MAA) system in detecting various skin diseases.

I.Introduction
The skin, comprising the epidermis, dermis, and subcutaneous tissues, serves as the body's largest organ, safeguarding against external threats and regulating temperature. Despite its protective functions, the skin is susceptible to various diseases influenced by external and genetic factors. Skin diseases, categorized into viral, fungal, and allergic types, pose challenges to accurate diagnosis, often relying on subjective assessments by medical professionals. In general, most of the common people do not know the type and stage of a skin disease. Some of the skin diseases show symptoms several months later, causing the disease to develop and grow further. This is due to the lack of medical knowledge in the public. Sometimes, a dermatologist (skin specialist doctor) may also find it difficult to diagnose the skin disease and may require expensive laboratory tests to correctly identify the type and stage of the skin disease. The advancement of lasers and photonics-based medical technology has made it possible to diagnose skin diseases much more quickly and accurately. However, the cost of such diagnosis is still limited and very expensive. Therefore, we propose an image processing-based approach to diagnose skin diseases. This method takes the digital image of the disease affecting the skin area and then uses image analysis to identify the type of disease. Our proposed approach is simple, and fast and does not require expensive equipment other than a camera and a computer. In recent years, advancements in image processing techniques have offered promising avenues for skin disease detection. Researchers have explored methods using technologies such as computed tomography (CT), digital subtraction angiography (DSA), and magnetic resonance imaging (MRI) to diagnose and classify skin ailments. Several studies have contributed significantly to skin disease identification, leveraging diverse approaches such as color transformation, edge detection, partial differential equations (PDE), reflectance confocal microscopy (RCM), and texture analysis. While many methodologies focus on specific skin conditions, there is a need for a comprehensive system capable of accurately identifying multiple types of skin diseases. In this context, this paper proposes a novel approach utilizing vertical image segmentation, You Only Look Once (YOLOv5), and Support Vector Machine (SVM) to identify three distinct skin diseases: herpes, dermatitis, and psoriasis. The method involves preprocessing sample images, vertical segmentation, geometric transformation, and feature

extraction. The SVM classifier is then employed to enhance the accuracy of identifying symptoms associated with each skin disease. This integrated system aims to provide a more precise and efficient means of skin disease detection, addressing the limitations of existing methods focused on individual disease types. This proposed system has attained an accuracy of 85.7%, with 83.3% precision. The structure of this paper has been organized as follows. Section II briefly explains the proposed methodology of this proposed work. Section III provides experimental results and analysis followed by the conclusion.

II.Methodology

In this research work, a visual approach is proposed that uses a machine learning algorithm along with the YOLOv5 dataset which is a popular method to train models using object detection, it detects potholes and also road bumpers using a rectangular box. Through the trained models by YOLOv5 we have successfully detected the potholes and as well as speed breakers for preventing any kind of accidents in the roads.

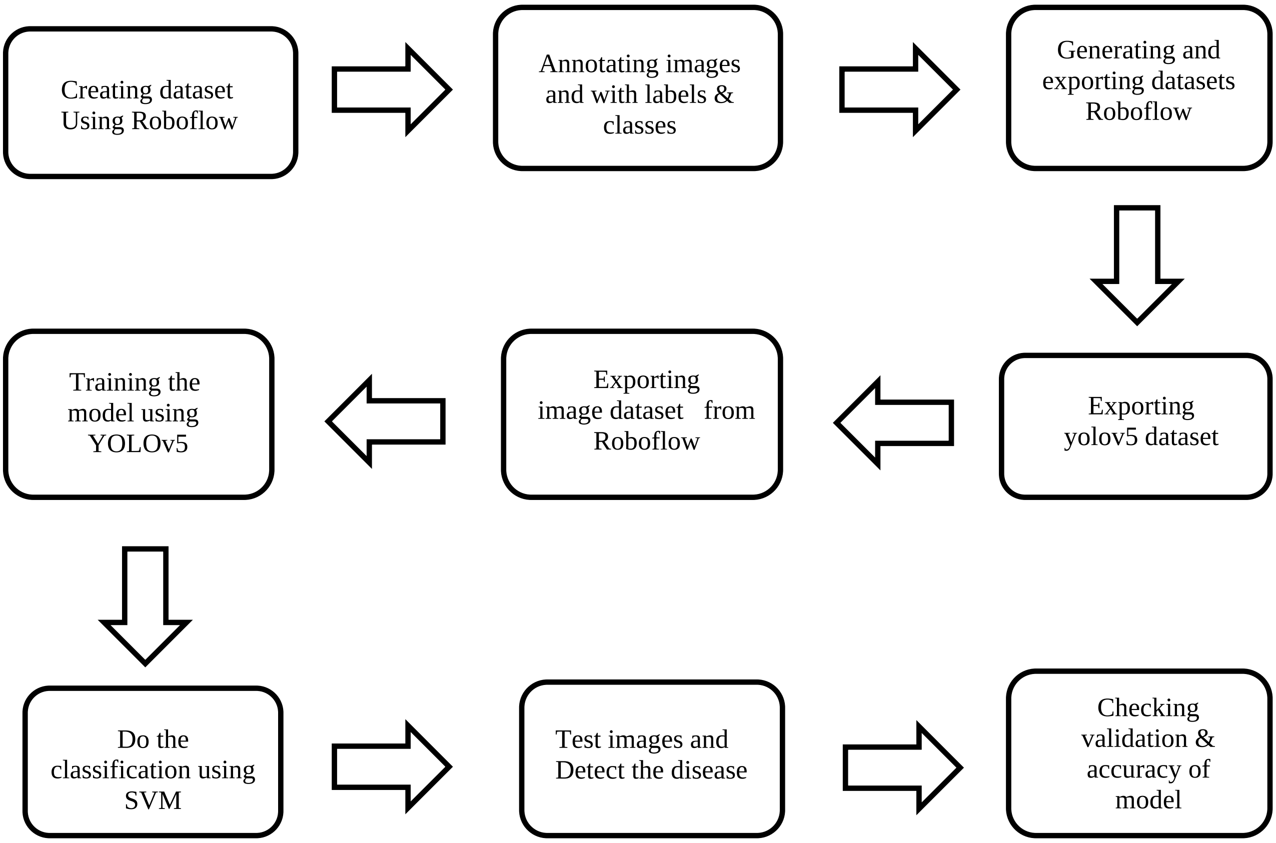

Fig 1: The working diagram of the proposed system

In the research workflow, the input skin image is sourced from the Skin Disease Dataset, forming the foundation for the image acquisition phase within the Android application. This phase involves capturing images from the image gallery within the application. Following image acquisition, a critical pre-processing stage ensues, involving adjustments to brightness and contrast or resizing the image to achieve optimal accuracy in dimensions. The subsequent step involves feature extraction from the images, a process integral to understanding and characterizing the key elements within. To meet this requirement, the research employs sophisticated algorithms that operate across various layers of the image. Specifically, Convolutional Neural Network (CNN) as You Only Look Once (YOLOv5) and Support Vector Machine (SVM) algorithms are chosen for their efficacy in feature extraction from diverse layers of the image. These algorithms play a pivotal role in distilling essential information and patterns from the images, laying the groundwork for accurate classification and detection of skin diseases. The culmination of this intricate process is reflected in the Android application, where the results of the image analysis are seamlessly displayed. By integrating YOLOv5 and SVM algorithms, the research not only enhances the accuracy of feature extraction but also ensures that the outcomes are readily accessible and comprehensible within the Android application interface. This holistic approach underscores the practical implementation of advanced image processing and machine learning techniques for effective skin disease classification and detection, with the end goal of facilitating user-friendly and impactful solutions within the mobile application environment.

The YOLOv5 algorithm is a state-of-the-art object detection algorithm that can be used for various tasks, including pothole detection. First, we collect and annotate a dataset of images that contain potholes and label them with bounding boxes around the pothole regions. Split the dataset into training and testing sets. Then we initialize the YOLOv5 network with pre-trained weights or train from scratch. During training, the network learns to predict bounding boxes and class labels for various objects, including potholes, by minimizing a loss function that compares the predicted outputs with the ground truth annotations. Next, we pass the preprocessed input images through the network. The network processes the images through multiple convolutional layers to extract features at different scales and performs object detection at each scale. YOLOv5 utilizes anchor boxes, which are predefined bounding box shapes with specific aspect ratios, to predict object locations and sizes. The network predicts bounding box coordinates relative to the anchor boxes at each scale. YOLOv5 predicts bounding boxes and associated class probabilities for potential potholes at each scale. The final output of the YOLOv5 algorithm is a list of bounding boxes around potholes, along with their associated class probabilities.

The SVM algorithm aims to maximize the margin between classes while minimizing classification errors. Once trained, the SVM can efficiently classify new images by mapping them into the learned feature space and determining which side of the hyperplane they fall on, assigning them to the appropriate class. This method of image classification with SVM is particularly effective in handling complex datasets and has been widely adopted in various applications, including medical image analysis and skin disease detection. The strength of SVM lies in its ability to handle high-dimensional data and complex patterns, making it particularly suitable for image classification tasks. This method of image classification with SVM is especially effective in handling complex datasets and has been widely adopted in various applications, including medical image analysis and skin disease detection. In these fields, the precision and reliability of SVMs play a crucial role in diagnosing conditions and assisting healthcare professionals in making informed decisions. Moreover, SVMs are versatile and can be combined with other techniques to enhance their performance, further broadening their applicability in various domains. It's worth noting that the YOLOv5 and SVM algorithms can be further customized and fine-tuned based on specific requirements and datasets. The algorithms' performance can be improved by adjusting various hyperparameters, training on larger datasets, or incorporating additional techniques such as data augmentation or transfer learning.

2.1 Flowchart

For a real-time pothole detection system, the block diagram of the proposed methodology is shown in Figure 2. Annotation for each image is performed explicitly after the collection of the dataset. The annotated data are split into training and testing data before passing it to deep learning models such as the YOLO family and SSD for custom model training.

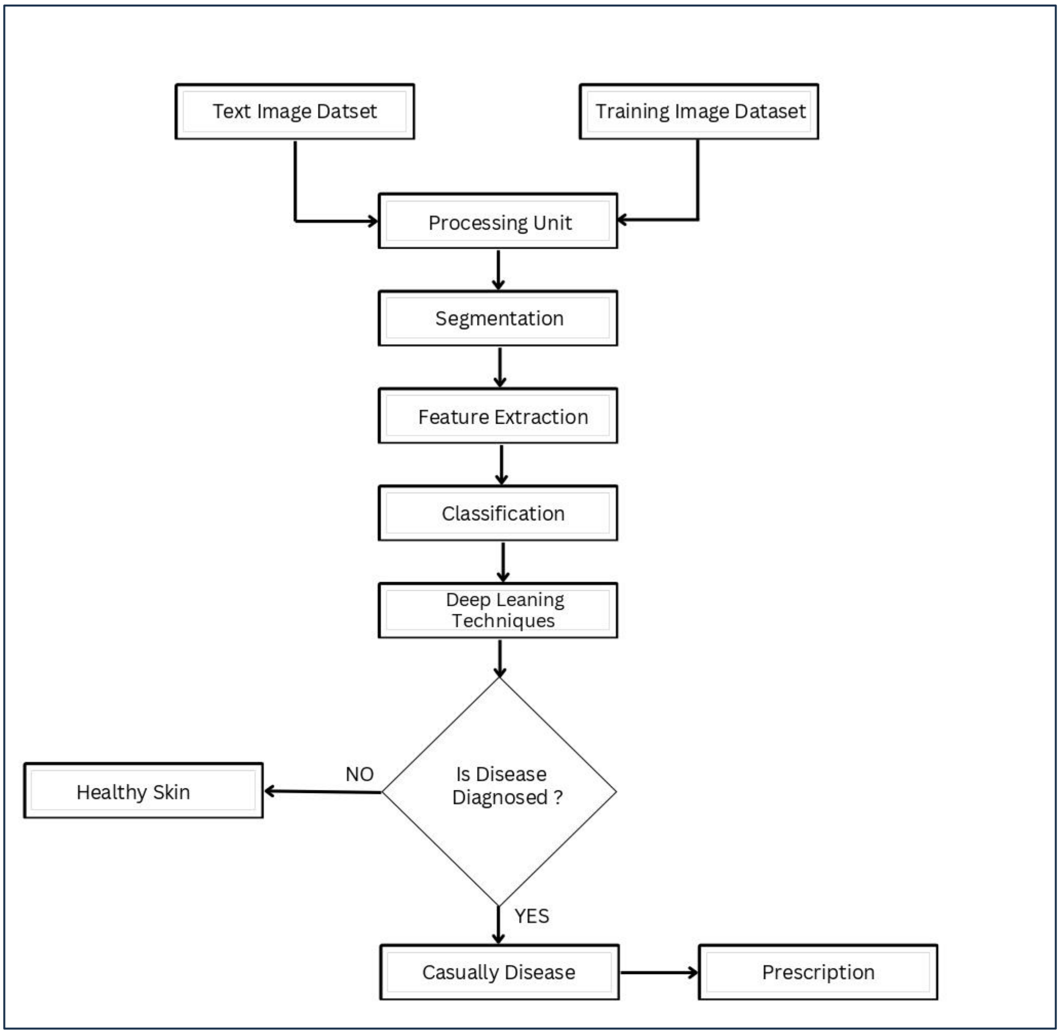

Fig2: Flowchart of the proposed system

III.Experimental results and analysis

The module detects all potholes with an absolute accuracy of 95.7%, precision of 92.3%. In the following figures, the images show the difference before implementing the algorithm and the result after detection of the image. It marks the detected disease using a rectangular shaped box.

Fig 3: Images of various image classes of the dataset.

Fig3: various skin diseases

The images of the various diseases are as follows (A) Acne, (B) Melanoma, (c) Tinea, (D) Psoriasis, (E) Onychosis, (F) vitiligo, (G) Eczema are presented in Figure 3. The evaluation extended to our dataset from Roboflow demonstrates the model's versatility and effectiveness across different datasets.

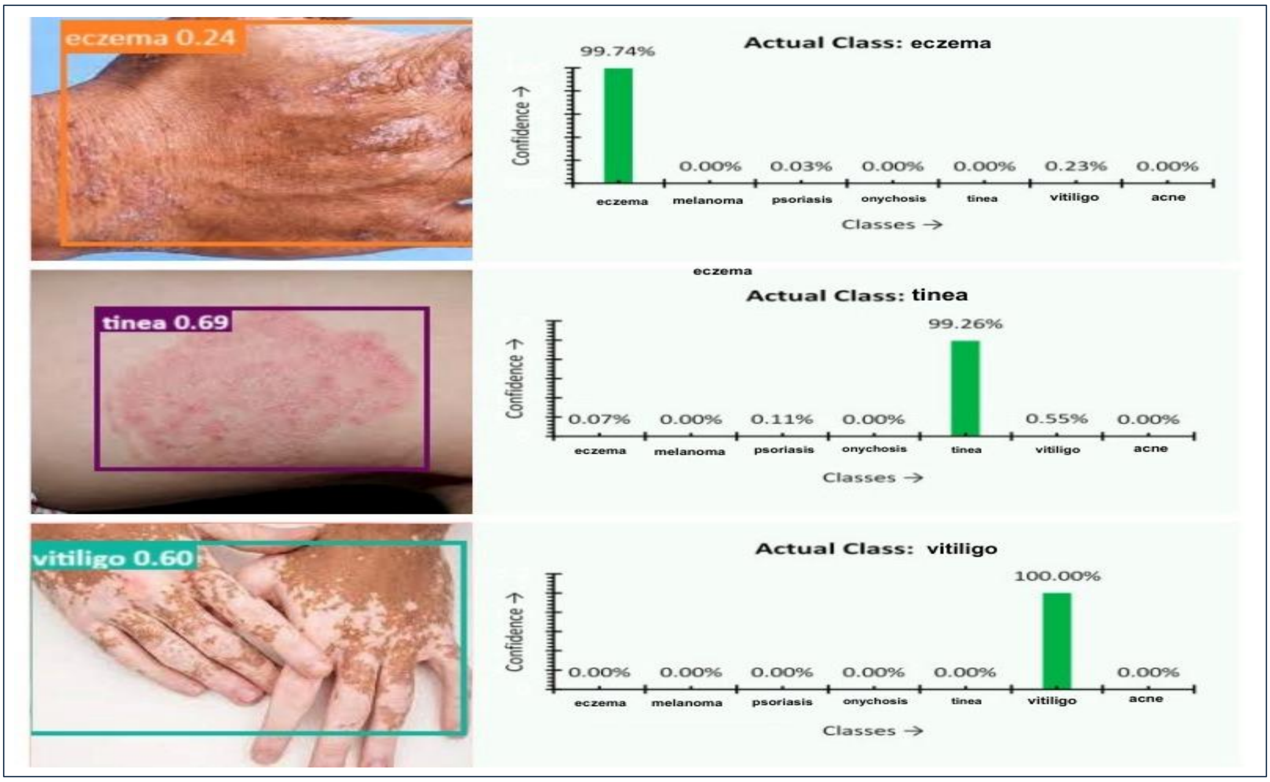

Fig 4: Score of detection of the diseases

In Figure 4 we visualize the confidence score or accuracy or detection rate over some diseases with the detected pictures on the right side of it. We provide you with three examples of the working rate of our model. It gives results of 9.9.74 % for Eczema, 99.26% for Tinea, and 100.00% for Vitiligo. And the statistic of performance is given here for your convenience.
(https://1drv.ms/x/s!Aiy7l6nGffpTgbA21Fbk7nFoKk28HA?e=ABhqxt)

Disease	Number of Images	Detected Images	Detection Rate
Eczema	10	10	100%
Melanoma	10	10	100%
Psoriasis	10	8	80%
Onychosis	10	7	70%
Acne	10	8	80%
Corn	10	9	90%

Fig 5: Rate of Disease Detection

In Figure 5 we have provided a statistic of data showing the detection rate of the corresponding diseases based on the number of images taken by the model and the number of detected images by this model and Figure 6 shows a graphical representation of the skin disease detection rate based on the proposed model.

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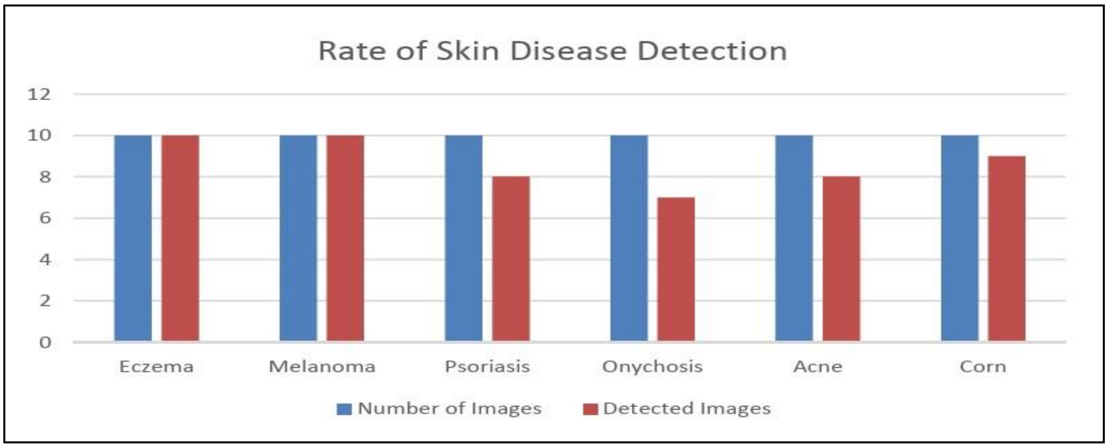

Fig 6: Rate of detection of Skin Disease

The YOLOv5 and SVM classifiers particularly shine, exhibiting a small log loss for both datasets, affirming their superior classification accuracy. Confusion matrices visually depict the classification performance, with the diagonal cells indicating the highest level of predictions and minimal error rates for each skin disease class. The analysis of accuracy, precision, recall, and F1-score further attest to the model's robustness and effectiveness. In the context of image optimization, preprocessing techniques, such as background removal and histogram equalization, were applied to enhance contrast and identify the affected areas.

We have compared our results with other state-of-the-art techniques, showing that our YOLOv5-trained model has performed better in detection with minimum inference time. The results affirm the model's potential for widespread application, particularly in regions with limited access to medical facilities, where early and accurate detection can significantly impact public health.

IV.Conclusion

In this paper, the analysis method of vertical image segmentation is employed to multiple skin diseases. Finally, the support vector machine is utilized to classify the data of three different skin diseases according to the features of the texture and the lesion area, and usage of the YOLOv5 algorithm to train the dataset, achieving a more ideal accuracy of recognition. Nevertheless, the paper concentrating on herpes, dermatitis, and psoriasis does not consider the different symptoms caused by the same kind of skin disease. For instance, eczema, herpes, and rubella all belong to the same series. Therefore, it will be the focus of the next step to recognize different types of skin diseases of the same kind of series by using image processing techniques. Notably, our model excels in balanced datasets, outperforming some state-of-the-art methods for skin disease classification. In conclusion, the integration of machine learning and image processing techniques into an Android application represents a pivotal step towards democratizing access to early and accurate skin disease detection. By mitigating delays in diagnosis, our approach stands poised to make a tangible impact on reducing the spread of skin diseases globally.

V.Future Scope

The future trajectory of this project involves multifaceted enhancements to amplify its impact and functionality. Expanding the dataset is a priority, encompassing diverse skin images to improve the model's generalization, with a focus on exploring transfer learning for more effective feature extraction. The transition into a real-time mobile application is on the horizon, bringing skin analysis to users' fingertips, supported by user-friendly interfaces and augmented reality overlays. Integration with telemedicine platforms aims to facilitate remote consultations and secure communication with healthcare professionals, particularly benefiting individuals in underserved regions. Improving model transparency through interpretability tools and continuous learning mechanisms is paramount, fostering trust and refinement over time. The incorporation of multi-modal data, collaboration with dermatologists, and global outreach initiatives underscore a commitment to inclusivity, ethical considerations, and widespread accessibility. The project's future envisions not only technical advancements but a holistic approach aligning with evolving healthcare landscapes and global health priorities.

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