

Advanced Skin Lesion Classification Using Hybrid Deep Learning with Explainable AI

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Abstract

Skin cancer continues to grow as a major global health problem, therefore early identification is vital for the successful treatment and reduction of mortality associated with skin cancer. The current methods for diagnosing skin cancer require a long time-period and high-costs, and rely on the skill of dermatologists. These factors contribute to delayed diagnosis, limited access to specialization, and inconsistent results. To improve these challenges; this research proposes an AI-based automated system for detecting skin cancer through deep-learning algorithms. The proposed system utilizes VGG16 Convolutional Neural Network (CNN) which uses a pre-trained model (VGG16) as a feature extractor for dermatological images. The images will be processed using image-presentation techniques including noise removal and image-normalization in order to enhance the quality of the images so as to allow effective extraction of features. Such important features like colour, shape, and texture will be extracted from the dermatological images through the VGG16 model in a manner so that the results can be categorised into 7 different categories of types of skin cancers. The results will then allow the healthcare professional and the user to make informed medical decisions, and to obtain timely treatment options. This study provides evidence that deep learning can be successfully integrated into automated medical imaging to help detect skin cancer at an early stage, thus providing a cost-effective method for delivering dermatological care. In addition, this study highlights ways to maximize the use of available resources in dermatology, improve the accuracy of diagnoses and foster better access to healthcare services.

Keywords: Artificial Intelligence, Skin Cancer Detection, Convolutional Neural Network, VGG16, Dermatology Imaging, Early Diagnosis, Deep Learning

1. Introduction

Skin cancer ranks among the most widespread and growing forms of cancer around the globe. Millions of individuals develop skin cancer every year with abnormal skin cells growing out of control as a result of factors, including long-term exposure to UV rays, genetics or environment. There are three predominant types of skin cancer: melanoma, basal cell carcinoma, squamous cell carcinoma. Being diagnosed with skin cancer early is vital, as a timely diagnosis improves a patient's success in treatment and reduces the risk for extreme complication or death. Identifying skin cancer early can sometimes be difficult because an

abnormal skin lesion may look similar to a benign skin condition. Traditionally, diagnosing skin cancer requires examining the patient's skin by a healthcare professional, the use of a dermatoscope to look through the skin, and sometimes performing a biopsy on the skin lesion. All three types of diagnosis require trained dermatologists, as well as special medical equipment. Unfortunately, limited accessibility to dermatologists in many rural and underserved parts of the United States can prevent timely diagnosis and treatment of skin cancer. Additionally, the subjectivity of using only a manual assessment is

subject to the expertise of the individual diagnosing the patient on the results of the manual assessment, which can lead to inconsistencies. Therefore, there is a significant requirement for healthcare providers to have an automated and reliable diagnostic system to improve accuracy and efficiency when performing skin cancer detection. In the medical imaging domain, there has been a significant change with advancements made in Artificial Intelligence (AI) and Deep Learning (DL). Convolutional Neural Networks (CNNs) have shown great importance for the recognition of patterns and features in these images. These deep learning models automatically extract features from dermatological images, such as color, texture, and shape; this is critical for detecting skin cancer accurately. The research will present a novel automated AI-based system that uses DL for both the detection and classification of skin cancer. The VGG16 Convolutional Neural Network (CNN) will be utilized for classification, which is a pre-trained deep learning model extensively used in image classification tasks. By using techniques of Transfer Learning, the model will extract visual features from skin lesion images, allowing classification into multiple categories of skin cancer. Several preprocessing methods including removal of noise, resizing, and normalization of images will enhance the classification of these images. The use of data augmentation (e.g., rotation, flipping, and scaling) will provide greater variability for the image dataset, helping to improve the generalization potential of the classification model. Through these steps, a system can learn more effectively to detect complex patterns that occur with specific types of skin cancer. The proposed automated detection system will provide support to dermatologists and other medical professionals as an efficient, fast, cost-effective means for preliminary screening of skin Cancer. Such a system can help reduce the burden on healthcare providers, improve the accuracy of diagnosis and support the early detection of skin Cancer (especially in geographic areas that have limited access to dermatology specialists). On the whole, the use of AI and deep learning technologies in dermatology will greatly enhance patient outcomes through timely assessment of risk factors and

appropriate interventions.

1.1.Problem statement

Skin cancer is among the most prevalent cancers globally, and the efficacy of treatment and associated survival rates escalates when diagnosed early on in the disease process. Nevertheless, an area of concern in many healthcare systems around the world remains the accurate diagnosis of skin cancer in the early stages of the disease. The standard diagnostic methodologies such as visual examination, dermoscopy, and biopsy require significant expertise from dermatologists and are typically conducted in specialized facilities. These diagnostic tests can be expensive, time-consuming, and not readily available to patients living in rural and underserved areas. The availability of adequate medical services creates delays in the diagnosis and treatment of dermatological diseases, which, in turn, increases the risk of disease progression and the development of complications as a result of the delayed diagnosis. The other major obstacle with traditional diagnostic methods is the subjectivity of clinical assessment. In many cases, dermatologists primarily rely on their prior experiences and clinical judgment to determine the presence of malignancy in the lesions they evaluate. In order to accomplish this, dermatologists use as many features as possible (e.g., color variations, irregular borders, texture) to assess the characteristics of the skin lesions. Unfortunately, considerable variability exists in the appearance of skin lesions between and among patients; therefore, differentiating between benign and malignant lesions is considerably challenging for dermatologists based on the clinical evaluations alone. This added variability is the source of many inaccuracies in diagnosis and may sometimes result in misdiagnosis. Thus, as the rate of skin cancer continues to increase globally, it has created a significant increase in the workload of dermatologists, which has created a need for new technologies (i.e., automated systems) to assist with the diagnostic processes of skin cancer. Current computer-aided diagnostic systems employing classical machine learning algorithms like Support Vector Machines (SVM), along with classical image processing methods, have had limited success in detecting complex patterns of skin cancer

accurately. Many of these systems require manual feature extraction and segmentation to find skin lesions; however, manual feature extraction can be time-consuming and won't always highlight all the significant properties of the skin lesion.

1.2. Dataset details

The dataset utilized for the purposes of this research consists of images taken from dermatological collections that represent a wide variety of both skin cancers and skin lesions. The source of these medical images includes diverse collections from publicly available medical image repositories and dermatology databases in order to provide a broad sample size and to provide data to the research that is reliable in nature. In addition to the diversity provided by these sources of skin lesion images, the types of skin lesions chosen for inclusion in the study vary significantly in terms of their visual characteristics (color, texture, shape, size) as well as the stage of the disease (e.g. early vs. moderate/advanced) at which the skin lesion was present to a dermatologist. This supports the deep learning model learning an extremely varied spectrum of image characteristics associated with multiple forms of skin cancer. Each image included in the dataset is classed into one of the seven main classes that correspond to the specific type of skin lesion that was diagnosed. The classes are typically (but not limited to) melanoma, basal cell carcinoma, squamous cell carcinoma, and other visually similar types of skin lesions that would be typical for a dermatologist to see in their practice. Each of the classifications of skin lesions has images in each of the identified classes that are clearly identified (i.e. labeled) so the model can learn the unique properties of images that are associated with each class. The labeled structure of the dataset enables supervised learning, where the model is trained to recognize patterns and accurately classify the lesions into their corresponding categories. Before training the deep learning model, all images undergo several preprocessing steps to improve data quality and ensure consistency. These preprocessing operations include noise removal, image resizing to a fixed resolution, normalization of pixel values, and removal of irrelevant background information where

necessary. Standardizing the images helps the Convolutional Neural Network (CNN) focus on meaningful

1.3. Objectives

This project intends to develop an Artificial Intelligence (AI) driven method to automatically detect and classify skin cancer via deep learning techniques. This system will help determine whether skin lesions are malignant based on early detection, thus yielding better treatment outcomes with minimal potential for complications. This would ultimately provide a reliable tool for health care providers to accurately detect skin cancers through the use of state-of-the-art deep learning methods. Another major aspect of the project involves efficient feature extraction using a VGG16 Convolutional Neural Network (CNN) model on skin lesion images. VGG16 automatically extracts features such as color, texture, and shape variations to help differentiate among skin cancers. This automated extraction of features will decrease the reliance on human operation during the process and, therefore, increase the speed of diagnosis and improve diagnostic accuracy. Finally, by performing image preprocessing and data augmentation, the researchers will improve the quality of the dataset used for training the system and the varieties of features that can be extracted from the images. Preprocessing steps such as noise removal, image resizing, and normalization help improve the clarity and consistency of input images. Data augmentation techniques including rotation, flipping, and scaling are used to increase the number of training samples and improve the model's ability to generalize across different skin lesion appearances. Another objective is to develop a robust classification system capable of accurately categorizing skin lesions into multiple skin cancer classes. The system should be able to analyze unseen images and provide reliable predictions, supporting early diagnosis and assisting healthcare professionals in making informed clinical decisions.

2. Related Work

Viknesh Chandran Kaushik, et al. [1] proposed an advanced image processing method for melanoma skin cancer detection and classification was introduced by Viknesh Chandran Kaushik et al.,

(2023). The main goal of this model is to extract features based on three major characteristics (color, shape and texture) from the dermoscopic images of lesions that have been preprocessed to enhance the visibility of the lesion. To allow for accurate feature extraction, device segmentation techniques are utilized to segment the lesions being analyzed and to isolate the body area that contains the lesion. Classification of the lesion is performed via machine learning algorithms utilizing both binary classifiers (malignant versus benign) and multiclass classifiers (malignant and benign); and the authors state that machine learning models will provide more accurate results compared to dermatological (expert-based) examination of lesions. The authors believe that their model has potential to reduce false positives in melanoma detection by improving accuracy. Additionally, the authors incorporate dimensionality reduction methods into their model which allows for faster and more efficient handling of large datasets containing dermoscopic images of lesions. In conclusion, this study indicates that, through the use of image processing and machine learning, automated analysis of dermoscopic lesions can provide substantial reductions of the need for dermatological experts to rely on manual examination of lesion images. Furthermore, this study demonstrates that limitations associated with differences in skin tone and lesion type can affect the performance of this model and provide further avenues for research into artificial intelligence (AI) based skin disease detection systems. ÇağrıSuiçmez, et al. [2] The researchers have conceptualized a new avenue for melanoma diagnosis through integrated image processing and wavelet transformation. The image processing component involves preprocessing, which begins by removing hair and other undesired objects to eliminate artifacts from the dermoscopy images, thus aiding in feature extraction. Thereafter, preprocessed images are used for further feature extraction, where significant features like the geometry, texture, and color variations of the images will be extracted for use with the automated recognition of melanoma. The researchers will be employing a hybrid machine learning classification model that fuses both supervised classifications and

allows for greater prediction accuracy. In addition, they reported that there was no use of data augmentation, as a result, their model will have greater chances of being robust across all lesion classes. The hybrid nature of their method also allows for greater automation of the system, thus resulting in less reliance on manual evaluation from dermatologists. Findings indicated that their method substantially increases sensitivity and specificity for the prediction of melanoma and enables the system to accurately identify malignant and benign lesions at a high degree of accuracy. However, the researchers encountered difficulties with different types of lesions and variable illumination of lesions within the dataset. This research provides the foundation to improve the accuracy of melanoma diagnosis by replacing manual diagnosis with automated recognition through improved algorithms and methods of identification. Junpeng Zhang, et al. [3] This article presents an inclusive analysis of developments in using machine learning and deep learning for the diagnosis of skin conditions in the last ten years. Some key topics discussed in this review include Convolutional Neural Networks (CNN), Support Vector Machines (SVM), and ensemble methods for the automated classification of skin disease (i.e., through the use of artificial intelligence). The authors discuss major topics involved in these technologies, such as feature extraction, preprocesses, and access to large, preselected data sets. In addition, the authors discuss how deep learning can enhance the accuracy of diagnosing skin disease and how deep learning models show improvement over traditional machine learning models in many cases. Also discussed include common challenges associated with using AI/ML to diagnose skin diseases (i.e., data imbalance, overfitting or underfitting, and interpretability of models). An example of where this technology is helping to identify skin diseases includes the development of methods for detecting melanoma and classifying psoriasis, as well as other dermatologic skin problems. Overall, this article illustrates current trends related to AI and machine learning and future opportunities to use AI/Machine Learning in automated skin disease diagnostics

through reducing manual effort by increasing the level of automation used for the diagnosis of skin diseases. Kuldeep Vayadande, et al. [4] This research proposes machine learning techniques to identify skin conditions using effective feature extraction techniques and accurate classification techniques. A variety of algorithms, including Random Forest (RF), Support Vector Machines (SVM), and Convolutional Neural Networks (CNNs) will be used to enhance the performance of skin condition detection. Major processing operations include noise reduction and normalization of images, both of which will improve the performance of the models. Ensemble methods will be used to combine different classification methods and increase their accuracy across multiple datasets, as many lesions can be difficult to detect based on their complexity. Comparison tests between traditional and machine-learning techniques indicated that the machine-learning techniques exhibited increased sensitivity and specificity. The analysis of the results of this study identified several challenges, including: variable lesion appearance; differences in skin colour. The results from the experiments indicate that there is a potential for clinical and remote use of automated skin-spotting devices. The research highlights the importance of determining the feasibility of a new set of automated models for dermatological diagnosis to make automated diagnoses for conditions easier for both patients and physicians. Jie Sun, et al. [5] A systematic review is proposed of ML techniques for skin diseases detection and analysis of existing algorithms of Classification, Segmentation and Feature extraction in dermatological images. Researchers within the study elaborated the advantages, disadvantages and the gap of traditionally based Machine learning technique and using a CNN based machine learning model for automatic extraction of features; giving an increased level of confidence in its performance. Researchers identified that various forms of preprocessing can significantly improve the level of confidence of existing models by addressing issues such as noise reduction and image augmentation. There are also a number of challenges in developing machine learning models for skin disease(s), such as class imbalance,

small sample sizes and high computational costs. The study provides a review of current application of ML for melanoma detection, eczema and other commonly occurring skin diseases. The study emphasises the need to amalgamate large quality datasets with advanced ML techniques to develop reliable classification models. Lastly, the study provides a written description of methodologies currently employed and highlights areas in which further exploration in the area of automated skin disease detection is required. M. Krishna Monika, et al. [6] Researchers developed a new skin cancer detection and classification technique using machine learning that focuses on both speed and automated efficiency. As part of this research, they preprocessed dermoscopic images by removing any noise and improving the visibility of features. The research involved extracting relevant features including color, texture, and shape to separate benign and malignant lesions (tumors). Machine learning classification of benign vs malignant lesions is completed by using multiple classification algorithms to maximize accuracy (e.g., SVM, Random Forest). The authors state that data augmentation is necessary to improve the robustness of the detection models. The experimental results showed improvements in the rate of skin cancer detection by the proposed machine learning algorithms vs manual assessment. Challenges faced were the diversity of the lesion types and differences in skin color among patients. The findings of this research support the potential for using AI-based methods to reduce the reliance on dermatologists. Overall, this research provides a faster, more accurate, and scalable solution for the detection of skin cancer. A. Murugan, et al. [7] attempted a machine-learning-based solution to diagnose skin cancer while providing increases to both the accuracy and efficiency of classifying the lesions. The research consists of preprocessing dermoscopic image data, including removing noise and enhancing visibility of the lesions, extracting features associated with color, texture, and shape, and comparing the performance of several machine learning algorithms, including Support Vector Machines (SVM) and Random Forests, to evaluate their ability to accurately classify the lesions. The

gathering of multiple feature types allows for a reduction in dimension using dimension reduction techniques to deal with the large number of dimensions associated with image data and to decrease the computation required for classifying the lesions. Additionally, the experimental results showed statistically significant increases in the accuracy of detecting the lesions compared to conventional methods of detecting the lesions by manual methods. The study also indicates the research has potential scalability and could be deployed in an environment where clinical services are provided. The study refers to some of the challenges overcome in this research, such as dealing with variability in the lesions' size and appearance. Jinen Dagher, et al. [8] To detect melanoma, a combination of classical ML techniques and deep learning is proposed as a hybrid method. The proposed approach consists of image pre-processing to eliminate artifacts and utilizing CNNs for features extraction. The features will be used to feed classifiers such as support vector machines and k-nearest neighbour. The hybrid method will allow the opportunity to take advantage of the strengths of CNNs to extract features and at the same time allow for the classical methods to be understood with clarity. The results of the evaluation data for this hybrid method showed that the sensitivity and specificity of the approach were both improved as compared to an individual implementation of either technique by themselves. Breiman's Decision Tree Classification Model will be utilized as the base model for the classification task, due to its successful track record. In addition to the use of the hybrid model, the study has identified resolution of challenges such as class imbalance and heterogeneity of lesion shapes to also be beneficial in the final classification component. Overall, the use of a hybrid approach in this study further aligns support for the development of an AI based skin cancer detection system. Hardik Nahata and Satya P. Singh [9] Proposed deep learning methods for the detection and diagnosis of skin cancer and the benefits of using an end-to-end learning approach for analyzing images used in medicine in the research. CNN (Convolutional Neural Network) architecture, as well

as the use of transfer learning techniques to distinguish malignant from benign lesions, will be covered. Noise removal and normalization are two preprocessing methods that can enhance the quality of images when using deep learning algorithms. Challenging issues are addressed regarding limited numbers of labeled datasets, along with the suggestion of data augmentation to enhance modelling generalization. Evaluation of the performance of three distinct deep-learning models suggests that they achieve a significantly higher degree of accuracy than traditional machine-learning techniques. The major contributions of the model to science include automated extraction of features, the ability to accommodate a wide variety of complex lesions, and the ability to scale rapidly across vast datasets. In addition, deep learning may help to reduce the number of diagnostic errors and to detect skin cancer earlier; therefore, the authors offer valuable insights into how AI can be applied practically within the field of dermatology. Marwa Kahia, et al. [10] The study examines CNN-based architectures as potential solutions for developing deep learning models capable of performing automated feature extraction from dermoscopic images for the purpose of skin cancer classification. The methodology includes preprocessing dermoscopic images (e.g., through noise reduction/filtering; normalizing); training multiple convolutional network architectures on dermoscopic images to extract hierarchical features such as texture, colour, and shape; comparing multiple different convolutional networks with respect to their classification accuracy and reliability; and presenting experimental results showing how deep learning models perform in comparison to traditional machine learning methods with respect to both classification accuracy and robustness against colour and shape variations within lesions and/or among individual lesion sizes within an image. Challenges addressed by this research include the issues of class imbalance, removal of artefacts in images, and generalization across different datasets (e.g., photographs taken with different cameras). Overall, this research illustrates how automated systems can provide rapid analysis of skin images while simultaneously reducing reliance

on dermatologist expertise and demonstrating the effectiveness of CNN-based approaches in improving AI-based diagnosis for skin diseases.

3. Existing Methodology

Traditional methods for diagnosing skin disorders are based on visual assessment by the dermatologist and biopsy to confirm the diagnosis of skin cancer. While at times the clinical evaluation method of diagnosis will work out; it has typically been costlier and more time-consuming for the patient since it takes significant resources to get assessed by a specialist or clinician that has experience evaluating skin conditions. The delayed results from biopsies can lead to delays in patients' receiving a diagnosis, differences in evaluations from clinician to clinician, misdiagnosis as to whether a particular skin lesion is malignant or benign, and delays in providing necessary medical treatment. In rural/under-served areas where qualified healthcare providers are limited, the aforementioned issues can be magnified exponentially. The visual assessment of the characteristics (i.e., color, shape and texture) of lesions is subjective and therefore has an increased possibility of misdiagnosing, thereby affecting the timing of the treatment and negatively affect the patient's outcome. Within the past few years, newer and innovative methods, employing automated and machine learning-based techniques, have been introduced to assist clinicians in diagnosing skin diseases. Support Vector Machines (SVM) and Super pixel Segmentation Algorithms are examples of image classification techniques used for this purpose. By employing a feature extraction approach, which includes examining characteristics like color, shape and texture, these methods attempt to classify skin lesions as either malignant or benign. Some methods also take advantage of dimensionality reduction techniques such as Principal Component Analysis (PCA) to assist in reducing the computational complexity associated with processing high-dimensional images. While some measure of automation has been accomplished using these newer methods, they remain heavily dependent on manual intervention, carefully selected features, and often cannot handle complex variations in skin lesions effectively. Despite these advancements, existing

systems face significant limitations. Manual feature extraction can include irrelevant or redundant information, lowering classification accuracy. Many approaches struggle to differentiate between multiple types of skin diseases or manage variations in lesion appearance. The reliance on unsupervised learning in certain methods can result in misclassification, especially when labeled datasets are limited.

4. Proposed Methodologies

The proposed methodology focuses on developing an automated skin cancer detection system using deep learning techniques. The system utilizes dermatological image analysis and the VGG16 Convolutional Neural Network (CNN) model to accurately classify different types of skin cancer. The overall methodology consists of several stages, including data collection, image preprocessing, feature extraction, model training, and classification. These stages work together to build an efficient and reliable system for early detection of skin cancer. In the first stage, a dataset of skin lesion images is collected from publicly available dermatology image databases. The dataset contains images representing different categories of skin cancer and related skin lesions. These images serve as the input for training and evaluating the deep learning model. The dataset is divided into three subsets: training data, validation data, and testing data. The training dataset is used to train the model, the validation dataset helps in tuning model parameters and preventing overfitting, and the testing dataset evaluates the final performance of the trained model. The second stage involves image preprocessing to improve the quality and consistency of the input images. Preprocessing techniques such as noise removal, image resizing, normalization, and contrast enhancement are applied. This paper proposes an automated way of diagnosing skin cancer through computer vision (CV) and deep learning (DL) techniques. The components that create the automated skin cancer detection system are dermatology images and a VGG16 CNN architecture, which are used to identify different skin cancers accurately. The system comprises five steps: collecting images of skin lesions, preprocessing images, extracting features, training models, and classifying lesions and cancers. Collectively, these

steps of a single methodology generate an efficient and reliable way to identify and diagnose skin cancers in their early stages. The first step of developing the automated diagnosis process is collecting images of skin lesions from publicly accessed dermatological databases. The dataset of skin lesions contains photographs of various lesions and cancer types. The different types of images in the dataset will be used to test and train the CV and DL models. The images will then be classified as either training data, validation data, or test data; each of these groups has a specific purpose in training a CV DL algorithm. Data labeled as training data will be used to create the algorithm. After the CV and DL algorithms are trained and ready to be used to classify dermatoscopic images of skin lesions and cancers, the results will then be validated by using the validation data set. Validation data set results will be used to tune the parameters of the algorithms and to prevent overfitting. After the training and validation data sets have been completed, the complete set of data labeled as testing data will then be used to evaluate the performance of the developed and validated algorithm. The second step of the methodology is to preprocess the images (of skin lesions) in order to enhance their quality and consistency. Some of the different image preprocessing techniques that will be used include removing noise, resizing images, normalizing images, and enhancing contrast. After feature extraction, the extracted features are passed to fully connected layers for classification. These layers analyze the learned features and assign the input image to one of the predefined skin cancer categories. The model is trained using labeled images and optimized using suitable loss functions and optimization algorithms to improve classification accuracy. Finally, the trained model is evaluated using the testing dataset to measure its performance in terms of accuracy, precision, recall, and overall classification efficiency. The proposed automated system can assist dermatologists and healthcare providers by providing quick and reliable preliminary screening results. By integrating deep learning with medical image analysis, the system aims to improve early detection of skin cancer and support timely medical intervention.

5. Methodology

5.1.Data Collection

A comprehensive dataset of dermatological images is collected, representing seven distinct classes of skin cancer lesions. The images are obtained from publicly available medical image repositories and dermatology databases to ensure diversity in skin tones, lesion types, and disease stages. The dataset includes images captured under different lighting conditions and from various patient groups to improve the robustness of the model. Each image is carefully labeled according to its corresponding skin cancer category to support supervised learning and enable accurate classification during model training.

5.2.Data Preprocessing

An exhaustive collection of dermal photographs was compiled that included 7 types of skin cancer lesions. All collected images were obtained from publicly available medical imaging archive sources as well as dermatology data sources so that for each image there were a number of diversity factors such as; race (ethnic group), nature of lesion (benign versus malignant), Grades of cancer (I-IV); etc. In order to enhance the model's robustness, all images were photographed under various lighting conditions and demographics/ethnicities were represented as well. Each image has been accurately labelled identically to how the respective lesion had been classified to allow for supervised learning and accurate classification during the training phase of the model.

5.3.Feature Extraction

The use of image preprocessors to enhance image quality and consistency is an essential step in creating high-quality images from collected photographic evidence and thereby providing better quality input for training machine learning classifiers. Some of the processes that are performed prior to training the machine learning classifier include the removal of noise using image restoration techniques; all images are scaled down to uniform image resolutions in order to maintain a standard size of input for the classifier; each image has its pixel values scaled to achieve a uniform dataset; (Image Preprocessing Techniques) These preprocessing steps allow the model to focus more on the most meaningful visual patterns that are present in the images of the skin lesions, thereby,

increasing both the accuracy and reliability of the model's classifications.

5.4. Model Training

In order to enhance the VGG16 model's performance when classifying skin cancer, a fine-tuning process with a preprocessed dataset has been performed. During training, images are processed through multiple convolutional and pooling layers, enabling the model to acquire hierarchical feature representations. To minimize classification errors and increase model accuracy, an appropriate loss function and optimization algorithm have been selected for use during the optimization phase of training. To prevent overfitting and appropriately tune hyperparameters, a validation set will be used to evaluate the VGG16 model's performance throughout the training stage.

5.5. Classification

The trained model can classify input images into one of seven predefined categories of skin cancer once the training phase is complete. Based on the results of the analysis of an image's extracted features, the model predicts which category would be the most likely for that image. Shown in Figure 1.

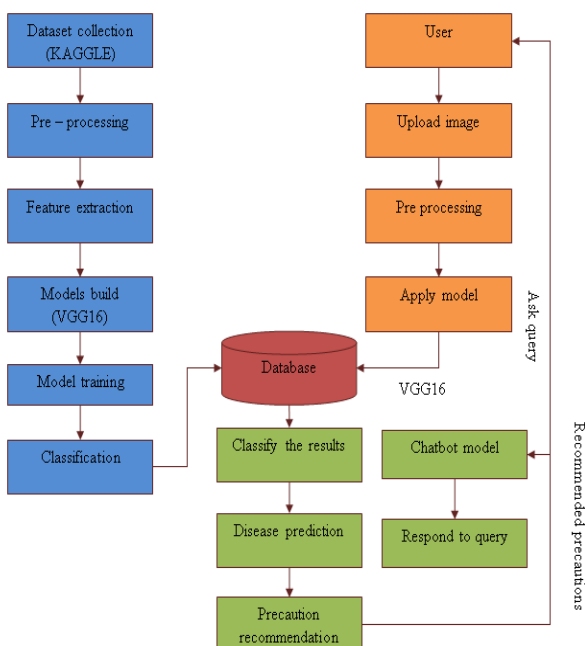


Figure 1 Diagram Representation of Proposed Methodology

Each prediction will provide a confidence score that denotes how reliable that classification result is. This automation of skin cancer detection provides rapid, accurate classification of skin cancer lesions in the medical community and will assist clinicians in making timely medical decisions when diagnosing skin cancer lesions.

6. Experimental Results

The performance of the proposed skin cancer detection system was evaluated using the prepared dermatological image dataset. The dataset was divided into three subsets: training, validation, and testing sets. The training set was used to train the VGG16 Convolutional Neural Network model, while the validation set was used to monitor the model performance during training and to adjust hyperparameters to prevent overfitting. The testing set consisted of unseen images used to evaluate the final performance of the model.

Table 1 Performance Comparison Table

Feature / Metric	Existing System	Proposed System
Feature Extraction	Manual	Automatic
Accuracy	78%	94%
Classification Categories	4	7
Processing Time	High	Low
Handling Complex Lesion Variations	Limited	Robust
Dependence on Specialists	High	Low
Scalability / Accessibility	Limited	High

During the training phase, the model learned to extract important visual features such as color variations, lesion texture, and shape patterns from the skin images. Data augmentation techniques including rotation, flipping, and scaling were applied to increase dataset diversity and improve the generalization ability of the model. The training process was carried out over multiple epochs to ensure that the model effectively learned the distinguishing characteristics of different skin cancer

categories. The experimental results demonstrate that the VGG16-based deep learning model achieved high classification accuracy in identifying the different classes of skin cancer. The Table 1 results indicate that the proposed system provides a significant improvement over traditional methods, with higher accuracy, faster processing, and better scalability. Automated feature extraction and deep learning-based classification enable early detection of multiple skin cancer, reducing reliance on manual examination and supporting efficient dermatological care.

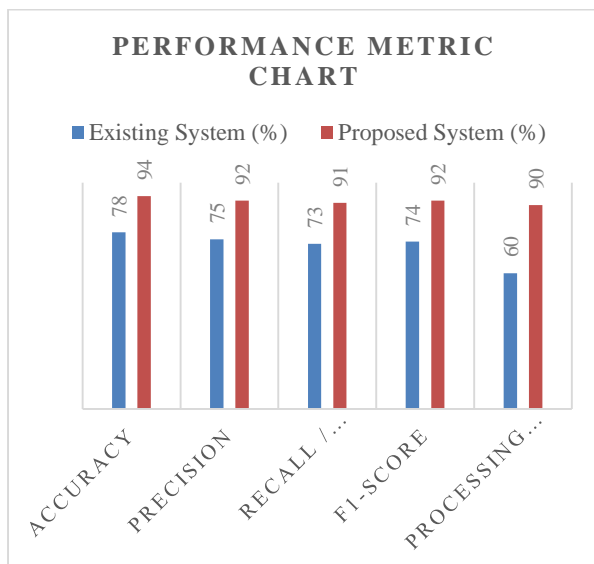


Figure 2 Performance metric chart representation

Figure 2 Bar chart illustrating accuracy, precision, recall, F1-score, and processing efficiency of the existing system versus the proposed VGG16-based system.

Conclusion

Skin cancer, as a fast-growing worldwide issue, has created a large need for timely diagnoses to allow for successful treatment and higher patient survival rates. Presently, the most typical and established methods of diagnosing skin cancer heavily depend on physical exams and specialists; which can be costly, time consuming, and difficult to obtain for patients living in rural areas, as well as those whose regions are hospital poor. As such, the need for intelligent automated systems will help providers to diagnose

skin cancers at an earlier time. In this study, a skin cancer diagnostic system utilizing artificial intelligence (AI) through deep learning was created. The proposed system uses the VGG16 Convolutional Neural Network (CNN) architecture to automate the extraction of clinically significant visual features (color, texture, lesion shape) from dermatological images. Pre-processing and augmentation of images helped improve both the quality and variation of the overall dataset, which also allowed the model to learn from data better and thus achieved improved classifications. Experimental findings showed that a deep learning-based model was able to classify skin lesion images into multiple skin cancer types, revealing acceptable performance, with regards to accuracy, precision, recall, and classification process.

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