Chapter 8
Deep Learning for Facial Skin Issues Detection: A Study for Global Care With Healthcare 5.0

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ABSTRACT

Facial skin problems can have a profound impact on an individual's self-esteem and mental well-being, sometimes leading to depression. Early detection and treatment of these conditions are crucial for effective intervention. This system uses advanced techniques such as CNN, deep CNN with random forest, and random forest algorithms. The proposed system offers a potential pre-diagnostic tool, enabling individuals to assess their facial conditions before consulting a dermatologist. By providing an early checkup, the system aims to improve the overall quality of dermatological care and outcomes for patients. Through this project, the authors aspire to empower individuals to take control of their skin health and well-being. This research represents a significant step towards revolutionizing the field of dermatology, bridging the gap between technology and patient care. By leveraging the insights gained from facial skin problem detection, the authors strive to create a future where no individual suffers in silence, but instead embraces a life free from the constraints of skin troubles.

DOI: 10.4018/979-8-3693-1082-3.ch008

1. INTRODUCTION

Motivation

In the phase of facial skin conditions, a silent battle ensues, leaving individuals grappling with not only the physical impact but also the emotional toll it takes. Feelings of depression and anxiety loom large, further amplified by the overwhelming uncertainty of when to seek professional guidance. Many individuals battling with facial skin conditions often find themselves trapped in a cycle of shyness and confusion when it comes to seeking medical help. The visible impact of their conditions leaves them feeling self-conscious and unsure about reaching out to a doctor for assistance. So, here the author team provides a more convenient way to check their condition.

This data science project focuses on the development of a facial skin problem detection system using advanced techniques such as Convolutional Neural Networks (CNN), deep Convolutional Neural Networks (CNN) with Random Forest, and random forest algorithms. Utilizing a comprehensive dataset of facial skin disease images, the project involves training and testing the classification models. The dataset is divided into training and testing sets in an approximate ratio of 80:20.

By providing an early checkup, the system aims to improve the overall quality of dermatological care and outcomes for patients. Through this project, we aspire to empower individuals to take control of their skin health and well-being. By harnessing the power of machine learning algorithms, we seek to alleviate the emotional burdens associated with facial skin problems, enhancing self-confidence and promoting timely intervention. This research represents a significant step towards revolutionizing the field of dermatology, bridging the gap between technology and patient care. By leveraging the insights gained from facial skin problem detection, we strive to create a future where no individual suffers in silence, but instead embraces a life free from the constraints of skin troubles.

Research Objectives

- Offering a seamless solution to check skin diseases on the face
- Empowering individuals with effortless convenience, we revolutionize facial health monitoring, putting control at their fingertips.
- Helps in regular monitoring of skin health
- Severe skin conditions can be diagnosed in early stages.

Scope of the Works

In today's modern world skin disease has emerged as a daily life problem. So, this research work can help in finding skin diseases at an early stage. One can also use it for making a correlation with human internal organs. It can also help the dermatologist to make the diagnosis more accurate.

Few skin diseases are recurring, this project can help in future to eradicate the problem from its root, through continuous, regular and accurate monitoring.

Figure 1. Patient visiting for regular dermatologist meeting
(https://dims.healthgrades.com/dims3/MMH/c262dad/2147483647/strip/true/crop/3949x2207+0+211/resize/800x447!/format/webp/quality/75/?url=https%3A%2F%2Fucmscdn.healthgrades.com%2F52%2Fe1%2F9ae4655e47b29bed17d8a3aeae2b%2Fimage-gettyimages-691648536.jpg)

Background and Importance of Dermatology

Dermatology is a field of medical science that focuses on skin related problems. Dermatology is important for maintaining skin health and treatment of skin diseases.It is critical to overall healthcare, fostering well-being and improving the quality of life for people of all ages.They also educate patients to keep their skin health better,and suggest ways to help them in achieving better skin health. They are trained to diagnose people's skin condition accurately and give me prescriptions to cure their skin illness (Jørgensen, P., et al., 2014).

In Figure 1, the image depicts that a person can have a healthy skin life if the person goes to a dermatologist for regular checkup. Regular meeting with a dermatologist can actually improve the skin conditions and prevent any big harms which can occur in future. The skin doctor can give useful feedback also.

Worldwide Need of Skin related Diseases Checkups

Skin related diseases checkup is really important. To ensure skin health we have to visit a dermatologist regularly. Otherwise a disease can affect the skin condition for long term. And after a long period of time it becomes very difficult to treat with correct procedures. To maintain skin health we have to attend regular meetings with dermatologists and have to follow the plan suggested by the dermatologist (Sallam, A., et al., 2019).

Figure 2. Acne face skin
(https://post.healthline.com/wp-content/uploads/2022/04/acne-vulgaris-body1.jpg).

Figure 2depicts that there is a need to visit skin related diseases doctor for a checkup to treat the acne. In order to treat acne it is highly recommended to visit a skin doctor for consultation. They can provide a personalized plan, care and medications to treat it easily and in a short period of time. The expertise and knowledge of a dermatologist are crucial in providing accurate diagnoses and recommending suitable treatment strategies for acne-related concerns (Gulati, S., et al., 2019).

Use of AI and ML to Analyze Skin Related Problems for Sustainable Health

Use of AI and ML can actually help the dermatologist for improving their accuracy and precision in diagnosis. It actually helps in early detection of disease and helps in diagnosis. The AI and ML algorithms can be trained on large datasets to give high accuracy results. It also helps in primary assistance to cure skin problems easily. It is also possible that it can help on a personal level by feeding personal characteristics as a dataset to the algorithm. AI and ML can use skin images to detect specific problems and diseases. So, eventually if the disease is discovered at an early stage it is much likely to be treatable in a short period of time (Huang, C., et al., 2021).

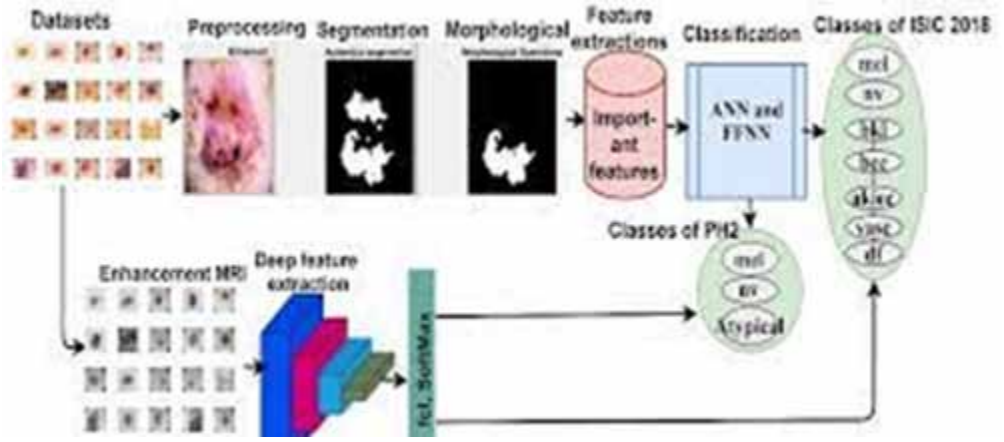
Figure 3 depicts the possible process of skin disease classification. By using AI and ML it is easy to detect the root cause of disease which helps in curing the disease from root level. Using different classification techniques, it is relatively easy for consultants and doctors to do their work with better accuracy.

Skin Related Issues in 21st Century Society and Modern Life Style

Various skin-related difficulties have evolved in 21st-century culture and modern lifestyle that are relevant to facial skin problem diagnosis utilizing deep learning. These are some examples:

- Environmental Factors: Rising pollution levels, UV radiation exposure, and pollutants in the environment all lead to skin disorders like premature aging and skin discoloration.

Figure 3. AI and ML used for skin disease classification
(https://www.mdpi.com/electronics/electronics-10-03158/article_deploy/html/images/electronics-10-03158-g001.png)



- Stress and Lifestyle: Modern lifestyles marked by high levels of stress, insufficient sleep, bad diets, and sedentary habits can result in skin problems such as acne, inflammation, and a dull complexion.

Figure 4. 21st century conditions are prone to facial skin diseases
(https://thenorthlines.com/wp-content/uploads/2022/11/download-77.jpeg)

- Prolonged exposure to digital devices, such as smartphones, computers, and tablets, has become the norm. This can contribute to skin concerns like digital aging, sometimes known as "tech neck," and can aggravate pre-existing skin conditions including dryness and redness.
- Misinformation about skincare: The plethora of skincare information available online, frequently from untrustworthy sources, can lead to confusion and misinformation. Individuals may utilize improper products or procedures, which might aggravate or trigger new skin problems.
- Global Ageing Population: As the world's population ages, concerns about wrinkles, sagging skin, and age spots have become more common. Addressing these problems through facial skin problem identification can lead to improved skincare and quality of life (Reddy, V. J., et al., 2019).

Figure 4depicts that 21 century conditions are prone to have skin diseases. 21 century environmental conditions have more air pollution, unpredictable temperature and extreme weather can cause skin problems. Global Warming is increasing day by day which causes more heat on earth results in more skin problems.

Cyber Security System and Skin Problems Impact on Global Human Health

Cyber Security System

- A cyber security system helps to keep the network, data and systems of a computer safe to get access by an unauthorized person. Most of the time data is getting leaked because the people are not aware about these threats. So, the images are well preserved and protected from these attacks.

Skin Problems' Impact on Global Human Health

- Facial Skin diseases have a great role in global human health. It affects physically as well as mentally. Diseases like acne, actinic keratosis, basal cell carcinoma, eczema, and rosacea generally occur on facial skin. Which can cause sufferers to live in a state of disharmony.

In Figure 5, the image depicts the need of Cyber Security System in the skin health care field. It is really important to securely preserve patient data. It is used to deal with data theft and data dislocation and to keep it securely. It helps in preventing data losses.

2. LITERATURE REVIEW

Nawal, S. et al.(2019) and his team highlighted the prevalence of skin disease. They mentioned that skin diseases are caused generally by fungal infection, allergies and bacteria. They first take an input image and then they resize it. After that they extract features using a pre-trained CNN. Then these features are classified using Multiclass SVM.They used 100 skin images. Their proposed method had achieved 100% accuracy.They classified into Eczema, Melanoma, Psoriasis, and Healthy Skin. Their future work is to

Figure 5. Cyber security system in skin health care
(https://www.forbesindia.com/media/images/2021/Apr/img_157875_healthcareandcybersecurity.jpg)

develop a mobile application which helps to classify all skin diseases.Their proposed method helps in classification of skin disease (Nawal, S. et al. 2019).

Shuchi, B. et al.(2019) and their team highlighted the problems faced in recognizing the medical skin condition by medical industry.They added the causes for the bad skin such as pollution, bad eating habits etc.In their study; they used five machine learning algorithms, namely Random Forest, Naive Bayes, Logistic Regression, Kernel SVM, and CNN on their skin images dataset to classify the image according to the disease. Then they found out that CNN is giving the best accuracy among all five algorithms. By using CNN their training accuracy is 99.05% and their testing accuracy is 96%. Which is highest among other used algorithms. Their future scope is to help people to make adjustments to their skin.They classified images into Acne,Lichen Planus, SJS/TEN (Shuchi, B. et al., 2019).

Pugazhenthi, V. et al.(2019) and authors emphasize that skin diseases are spreading more frequently nowadays easily; so there is a need to detect them at early stages, so it can be curable with less effort. The initial step in their system involves preprocessing the input image.Following preprocessing, the authors proceed with segmentation, which involves partitioning the image into meaningful regions. The Global Thresholding technique is utilized to separate the affected region from the rest of the image. Once the image has been segmented, the authors extract relevant features from the segmented regions. The extracted features are then utilized for disease classification. The authors employ the Decision Tree technique, which allows for the categorization of the input image into different classes: healthy skin, Melanoma, Eczema, or Leprosy. This classification step enables dermatologists to identify and diagnose specific skin conditions accurately. Their future scope is to build a GUI (Pugazhenthi, V. et al., 2019).

Table 1. Summary of reviewed papers

Paper Title & Author	Introduction	Methodology	Future Scope	Result	Conclusion
A Method Of Skin Disease Detection Using Image Processing And Machine Learning(Nawal, S. et al., 2019)	The authors of the paper built skin disease classification using CNN and SVM	First, extract image features using pre-trained CNN and then classify image using Multiclass SVM	Their future work is to develop a mobile application which help to classify all skin diseases	Accuracy 100% for classification of skin disease.	Helps in detection of skin disease
Machine Learning Algorithms based Skin Disease Detection(Shuchi, B. et al., 2019)	The authors of the paper mentioned the problem faced by medical doctors to detect the skin disease	They used five algorithms, Random Forest,CNN, Naive Bayes, Logistic Regression, Kernel SVM to classify the skin image	Their future scope is to help people to make adjustments to their skin.	Test accuracy of the following algorithms:- CNN - 96%, Logistic Regression- 68%, Random Forest-67%, Kernel SVM-50%, Naive Bayes-47%	Skin disease can be cured if it detected at an early stage
Skin Disease Detection And Classification (Pugazhenthi, V. et al., 2019)	The authors of this paper mentioned that skin disease is occurring commonly nowadays and it spread easily	The input image is first gone for preprocessing, then segmentation, then, feature extraction. After that it is classified into the disease using the Decision Tree.	Their future scope is to build a GUI for their model.	First they take an input image then they classify into healthy skin, Melanoma, Eczema and Leprosy	Their system can be used by dermatologist for detecting Melanoma, Eczema or Leprosy skin conditions
Machine Learning Approaches to Multi-Class Human Skin Disease Detection (Ms. Seema K.et al., 2018)	The authors here found out that for many skin diseases, they require an expert skin doctor consultancy to treat but the medical facilities are not available for everyone easily.	They used ANN,KNN, Decision Tree, SVM and Random Forest to classify the image into 10 different diseases	Their future work is to build a GUI for their model.	Their accuracy is 90% of classification of disease.	They collected 10 different common skin problem samples and used that dataset for training purposes and achieved accuracy of 90%. Their system can be used by practitioners if they get a doubt.
Machine learning approaches to multi-class human skin disease detection (Suchi, B. et al., 2019)	The author team found that physical diagnosis for skin disease is very time consuming.	The research focuses on CNN and an ensemble model using VGG16, DenseNet, and Inception for skin disease detection.	Development of better model training. For more accurate results.	Overall, the paper provides a comprehensive methodology for skin disease Identification.	Image processing techniques and highlights its potential to enhance diagnostic accuracy
Skin disease recognition method based on image color and texture Features (Wei, L.S. et al., 2018).	The author of a paper discussing the importance of identifying skin diseases using modern science and Technology.	Texture and color features are then extracted using the Gray-Level Co-occurrence Matrix (GLCM) method	Development of ensemble model training for better accuracy.	the paper provides a comprehensive methodology for skin disease identification	image processing techniques and highlights its potential to enhance Diagnostic accuracy.

Ms. Seema K.et al.(2018)and authors here found out that for many skin diseases, they require an expert skin doctor consultancy to treat but the medical facilities are not available for everyone easily, they need to wait for a long time. In that time period there is a chance of skin disease spreading. To evade this condition they require early detection of skin disease. They used ANN,KNN, Decision Tree, SVM and Random Forest to classify the image into 10 different diseases. Their accuracy is 90%. Their future work is to build a GUI. They collected 10 different common skin problem samples and used that dataset for training purposes and achieved accuracy of 90%. Their system can be used by practitioners if they get a doubt (Ms. Seema K.et al., 2018).

Dr. T. Kameswara Rao et al.(2012) and his team did the research is an expert representation of Skin Disease Detection Using Machine Learning" published in the International Journal of Food and Nutritional Sciences. The paper discusses the use of machine learning, specifically Convolutional Neural Networks (CNN), for the detection of skin diseases.The author team found that the traditional method of diagnosis is trivial, very time consuming and requires profound knowledge .The author's team suggested ideation that utilizes CNN and an ensemble model using VGG16, DenseNet, and Inception for skin disease detection.The outline of methodology in research process are Data gathering, Data transformation, Data augmentation, Data splitting. Model building,Ensemble model creation, Model evaluation, Performance comparison.In the end the author team focuses on using ML, specifically CNN and ensemble models, to determine different skin diseases. The author team is focused on methodology and evaluation of performance on the model based accuracy (Rao, T.K., et al., 2021).

Weiet al.(2018) along with team discussed the importance of identifying skin diseases using modern science and technology. It emphasizes the limitations of current diagnostic methods and the need for accurate identification through objective techniques. The paper proposes a method involving image preprocessing, feature extraction, and classification using support vector machines (SVM) for identifying three types of skin diseases: herpes, paederus dermatitis, and psoriasis. The preprocessing step removes noise through denoising and filtering, followed by rotation and segmentation of images for improved accuracy. Texture and color features are then extracted using the Gray-Level Co-occurrence Matrix (GLCM) method. SVM is used for classifying skin diseases based on the extracted features. The paper also mentions other research studies exploring different approaches such as confocal microscopy, CT imaging, texture analysis, neural networks, and pattern recognition. The proposed method aims to overcome the limitation of focusing on a single type of skin disease by accurately identifying multiple types through vertical image segmentation, GLCM-based feature extraction, and SVM classification. Overall, the paper provides a comprehensive methodology for skin disease identification using image processing techniques and highlights its potential to enhance diagnostic accuracy (Wei, L.S. et al., 2018).

3. METHODOLOGY

The Team have used Convolutional Neural Networks (CNN), deep Convolutional Neural Networks (CNN) with Random Forest, and Random Forest algorithm separately. After using CNN we are getting 56.21% test accuracy and by using Deep CNN with Random Forest we are getting 56.21% test accuracy and by using Random Forest we are getting 51.13% test accuracy. Author team have used 624 images for our model. In which 439 images belong to training and 185 images for testing the model. The images belong to 5 classes: acne, actinic keratosis, basal cell carcinoma, eczema, and rosacea. CNN was used first.

Data generators were created for training and testing: In preprocessing, batches were generated of augmented image data during training. It rescales the pixel values to the range [0, 1]. CNN model was created to code and then defined a sequential model and added layers to it. The model consists of convolutional layers with ReLU activation, max-pooling layers, and dense layers. The final dense layer uses softmax activation for multiclass classification. Then we trained the model and got an accuracy of 56.21%. After that Deep CNN was used with Random Forest, test accuracy was found of 56.21% and then Random Forest was used to get test accuracy 51.13%.

Use Case Diagram

The Figure 6, describes the use case diagram of the model. The arrow shows the access and oval shows the functionality. This figure shows the total working as well as the access and the functionality of the model. As shown in the figure 6, the admin has access to the dataset and algorithms and the developer can use the train model for image classification.

Figure 6. Use case diagram

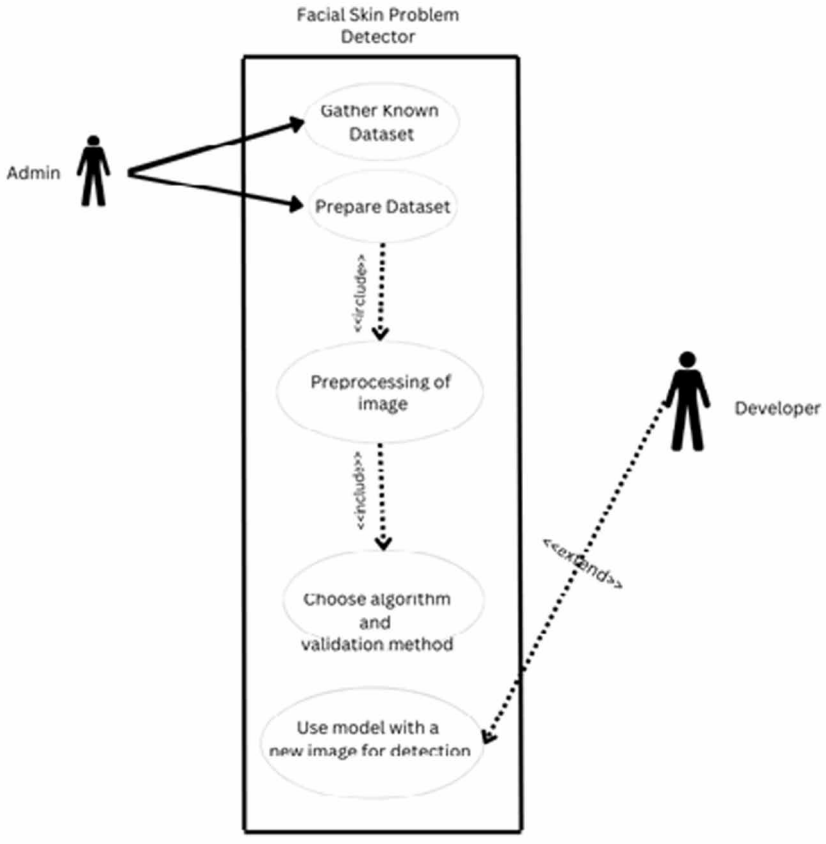
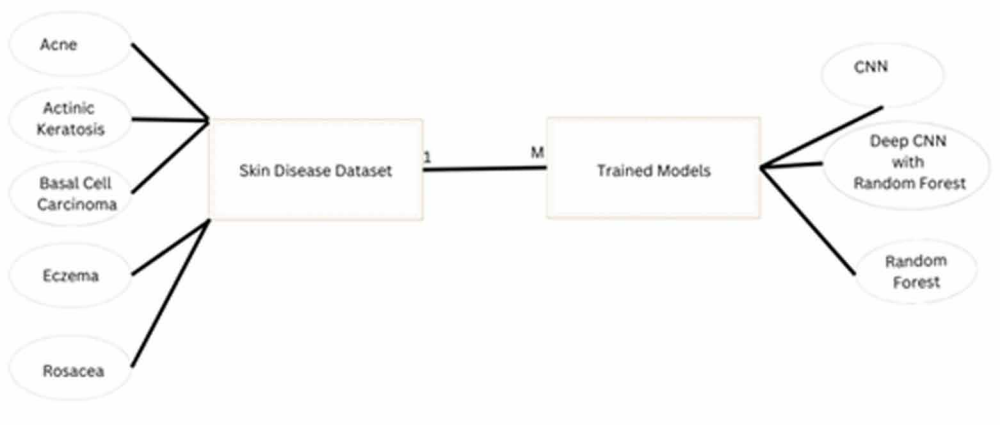


Figure 7. E.R. diagram



E.R. Diagram

In Figure 7, the image depicts the Entity Relationship. Skin Disease image dataset is in one to many relationship with trained models. Skin disease dataset consists of five diseases and this dataset is used for training of all models used in this study. The skin diseases dataset consists of images of skin diseases.

Data Flow Diagram

Figure 8 depicts the level 0 data flow diagram. In which first the data set is collected of various disease images and then used to train the models and then trained models are used to detect a facial disease. This is a very high level abstraction of the study in which only main functions are represented as the whole system.

Figure 8. Level zero data flow diagram

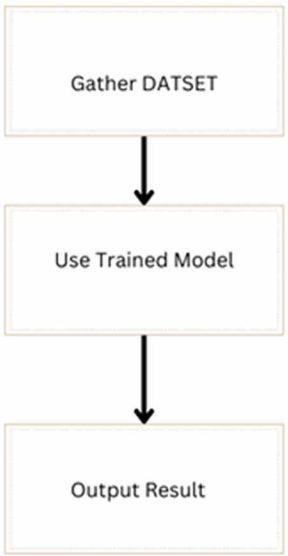


Figure 9. Level one data flow diagram

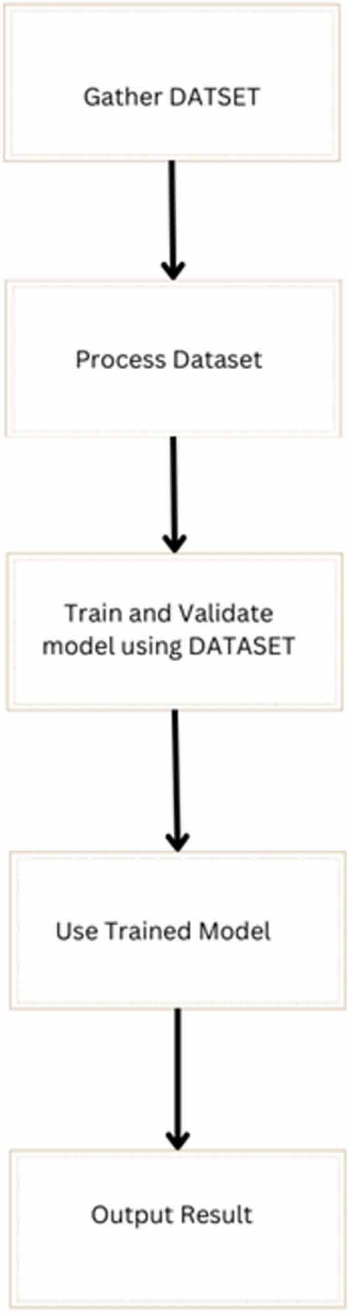


Figure 9 depicts the level 1 data flow diagram. In which first the data set is collected of various disease images. Then the image dataset is preprocessed. Then it is used to train and validate the models used in this study and then trained models are used to detect a facial disease. This is a more detailed data flow explanation than the level 0 data flow diagram of the study in which only main functions are represented as the whole system. In this the data flow is represented in relatively more detailed functionality.

Figure 10. Level two data flow diagram

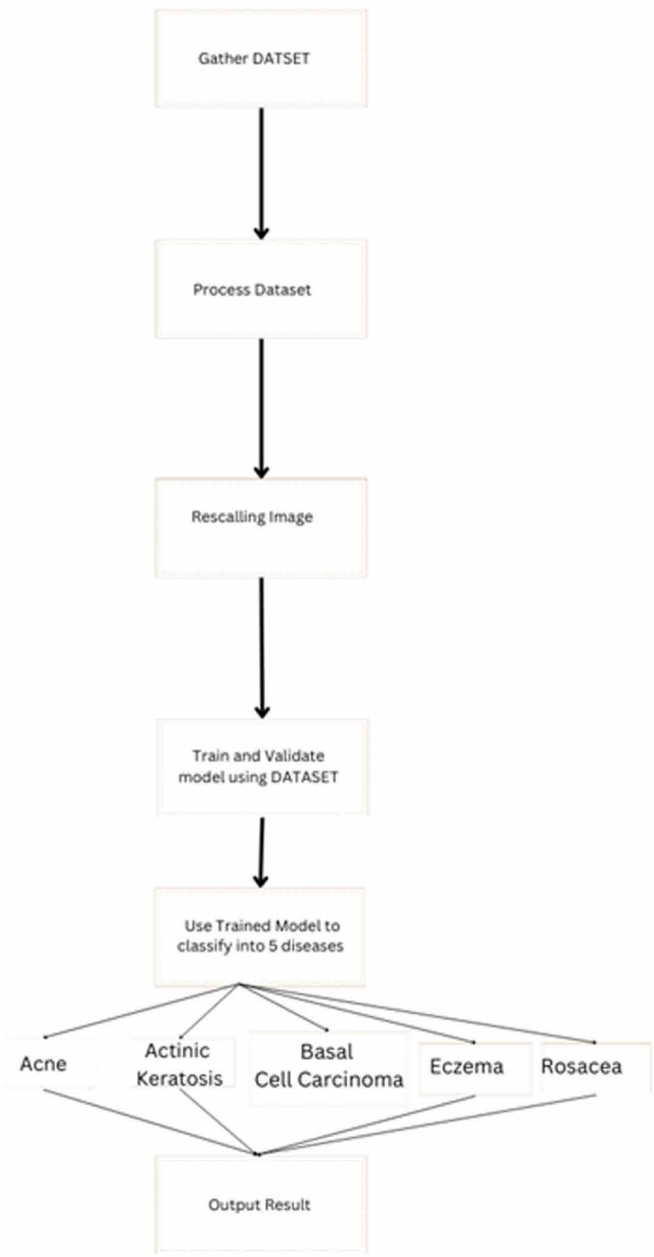
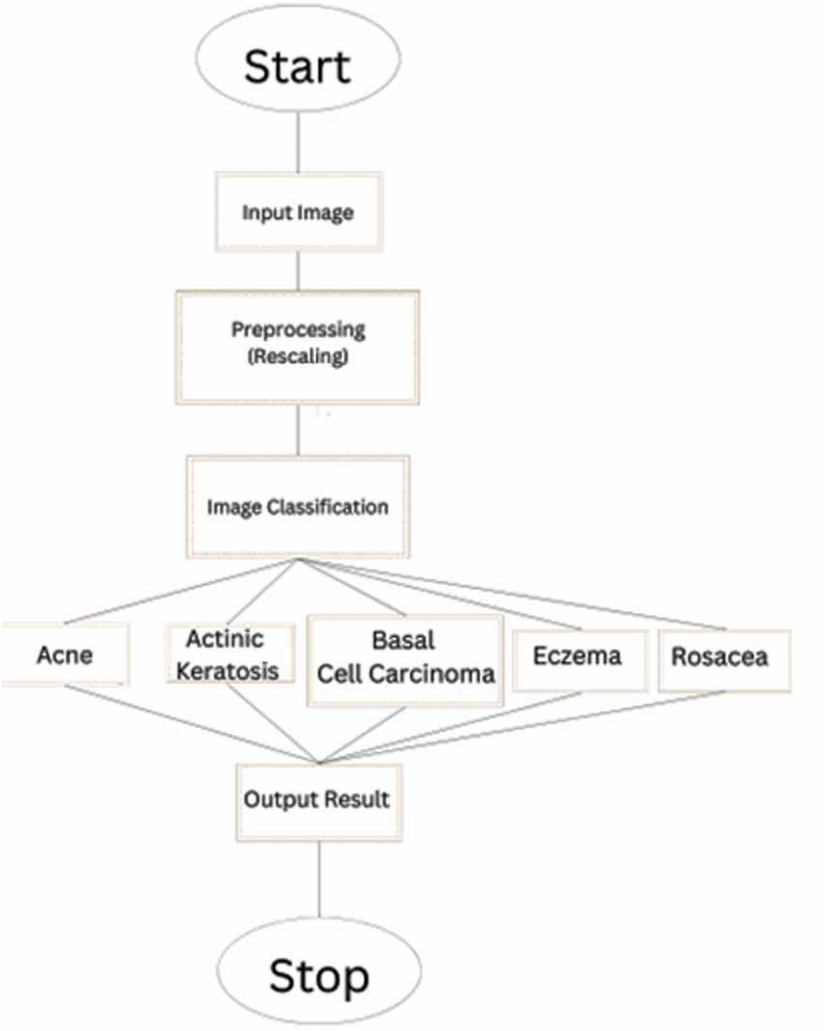


Figure 10 depicts the level 2 data flow diagram, in which the data flow is shown more in a detailed fashion. First the image dataset of skin diseases is gathered then. The dataset is passed through preprocessing of images in which image pixel is rescaled to value of [0, 1]. Then the images are used to train and validate the used models. Then the trained model can classify the facial skin diseases images into 5 diseases shown in Figure 10.

Flowchart

In Figure 11, image depicts the flow chart of the approach. First, the input image is taken from the patient then the image is gone through the prepossessing step, in which image pixel is rescaled to value of [0, 1]. After that using the trained model, the image is classified into acne, actinic keratosis, basal cell carcinoma, eczema, and rosacea. After the classification step it shows the output result to the patient.

Figure 11. Flowchart showing the skin disease classification using trained model



4. RESULTS AND DISCUSSIONS

Result Visualizations

Here are the results ofCNN model,

Figure 12, shows the graph between accuracy (Training and Validation) vs epochs. When the whole training dataset has been passed through the training phase of the model then we consider it a one Epoch. Here we have 30 epochs. The graph shows the model performance over 30 epochs. It plots the training accuracy and validation accuracy at each epoch.

In Figure 13, represents the confusion matrix of the model and here it is between the Predicted Label and True Label. Darker color represents a higher number of occurrences. Total 5 classes are labeled from 0 to 4 numbers. 0 represents Acne, 1 represents actinic keratosis, 2 represents basal cell carcinoma, 3 represents eczema, and 4 represents rosacea. Confusion matrix is used to easily visualize the performance of the model.

In Figure 14, there is a classification report of the model. It is the summary of the performance of the model. Here we calculated the performance using different metrics. The different metrics are precision, recall, f1-score and support.

In Figure 15, the calculated Test accuracy of CNN model is 56.21%. It is calculated after 30 epochs. The CNN model was trained and evaluated on a dataset using 30 epochs. After the training process, the

Figure 12. Training and validation accuracy vs. epochs

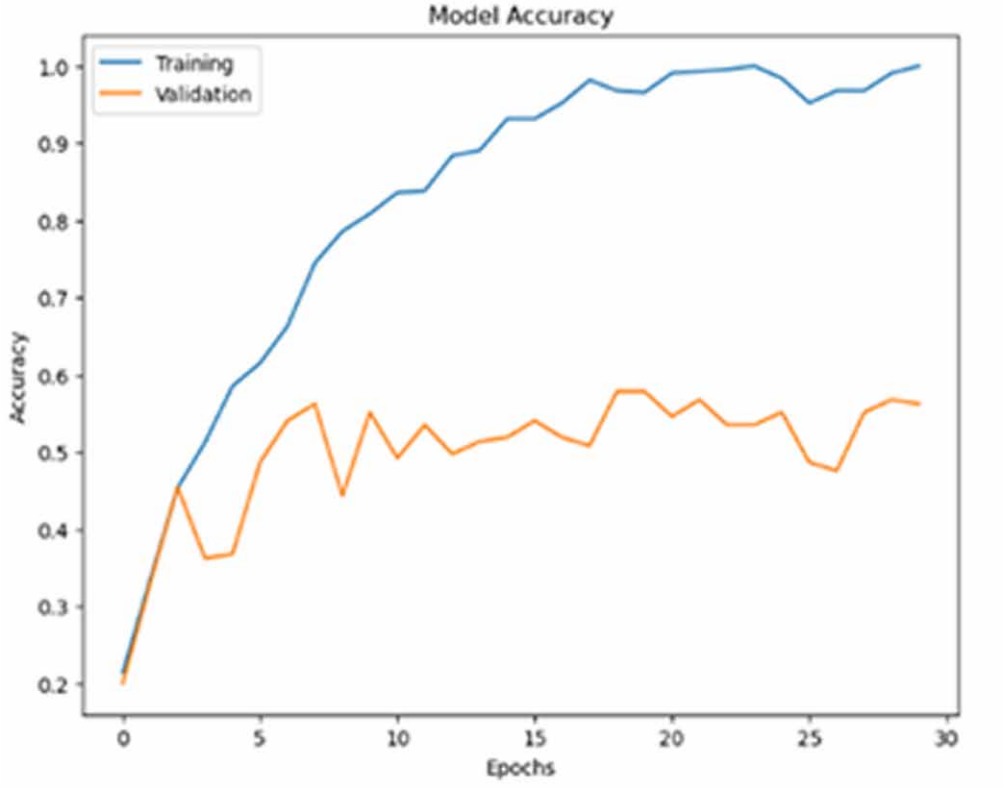


Figure 13. Confusion matrix

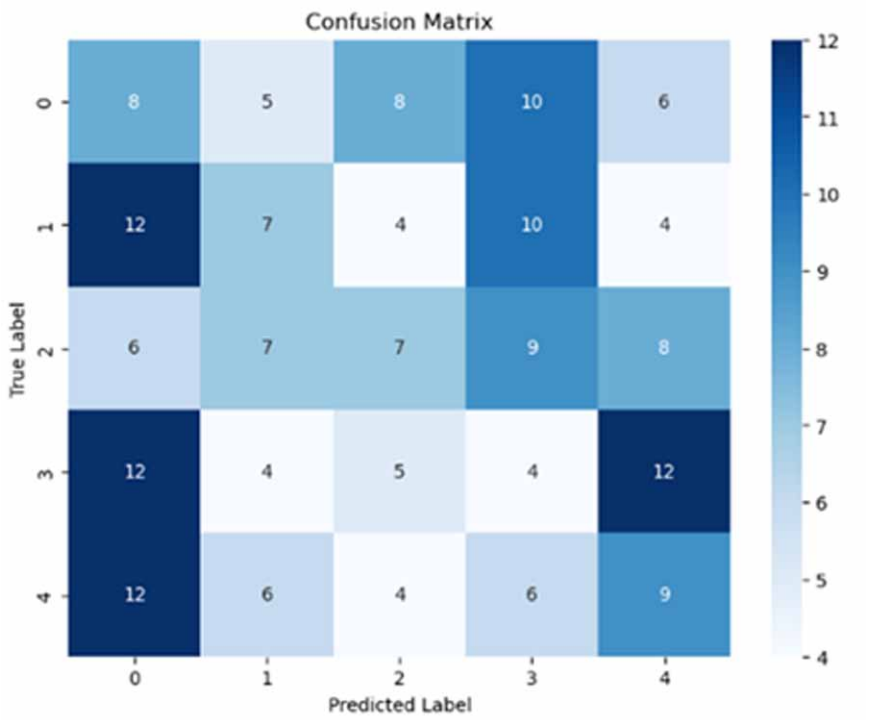


Figure 14. Classification report

	precision	recall	f1-score	support
Acne	0.16	0.22	0.18	37
Actinic Keratosis	0.24	0.19	0.21	37
Basal Cell Carcinoma	0.25	0.19	0.22	37
Eczemaa	0.10	0.11	0.11	37
Rosacea	0.23	0.24	0.24	37
accuracy			0.19	185
macro avg	0.20	0.19	0.19	185
weighted avg	0.20	0.19	0.19	185

model achieved a test accuracy of 56.21%. This accuracy value indicates the percentage of correctly predicted labels on the unseen test data.

Here are the results of **Deep CNN with Random Forest** model,

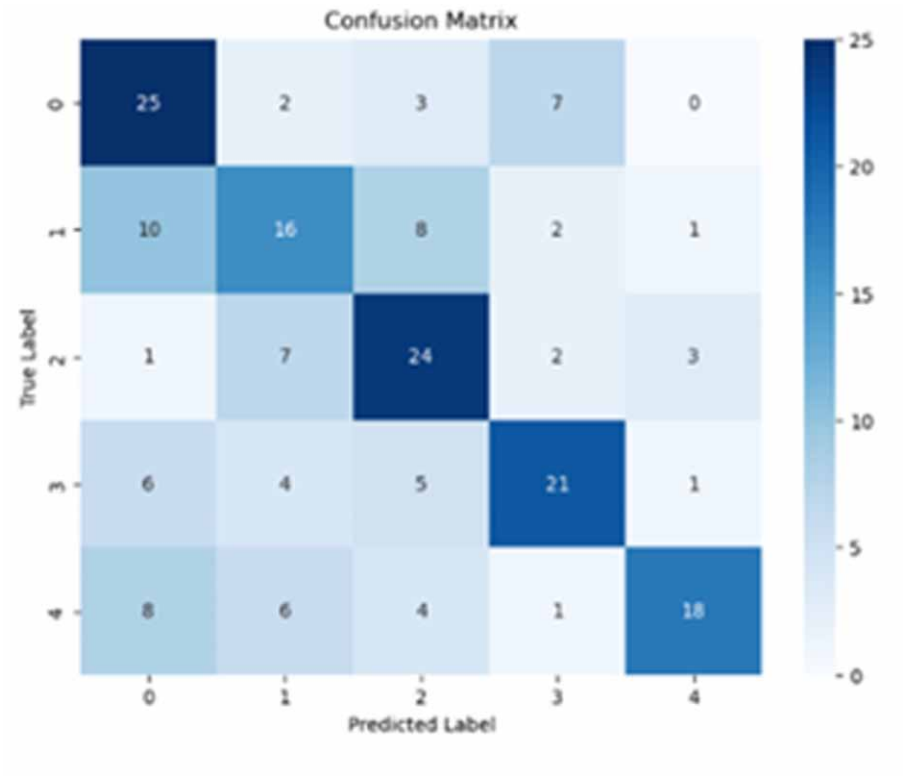
In Figure 16, represents the confusion matrix of the model and here it is between the predicted Label and True Label. Darker color represents a higher number of occurrences. Total 5 classes are labeled from 0 to 4 numbers. 0 represents Acne, 1 represents actinic keratosis, 2 represents basal cell carci-

Figure 15. Test accuracy report

```
Epoch 30/30
14/14 [==============================] - ETA: 0s - loss: 0.0134 - accuracy: 1.0000
Epoch 30: val_loss did not improve from 1.43871

14/14 [==============================] - 11s 778ms/step - loss: 0.0134 - accuracy: 1.0000 - val_loss: 5.0245 - val_accuracy:
0.5622
6/6 [==============================] - 3s 432ms/step - loss: 5.0245 - accuracy: 0.5622
Test Loss: 5.02449893951416
Test Accuracy: 0.5621621608734131
```

Figure 16. Confusion matrix



noma, 3 represents eczema, and 4 represents rosacea. Confusion matrix is used to easily visualize the performance of the model.

In Figure 17, the testing accuracy is shown in bar graph format. The testing accuracy here is 56.21%. To visualize the testing accuracy of the Deep CNN with Random Forest model, we can create a bar graph. The graph will represent the accuracy value on the y-axis and the model on the X-axis.

Here are the results of **Random Forest** model,

In Figure 18, represents the confusion matrix of the model and here it is between the predicted Label and True Label. Darker color represents a higher number of occurrences. Total 5 classes are labeled from 0 to 4 numbers. 0 represents Acne, 1 represents actinic keratosis, 2 represents basal cell carci-

Figure 17. Accuracy bar graph

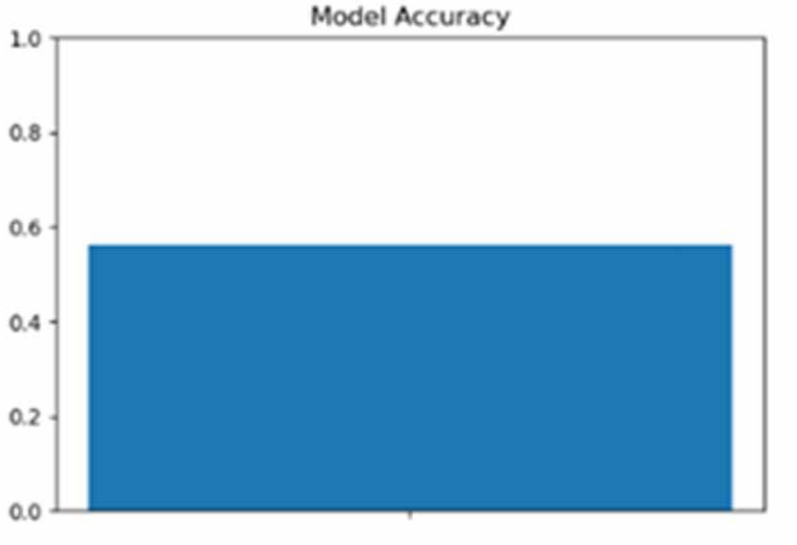
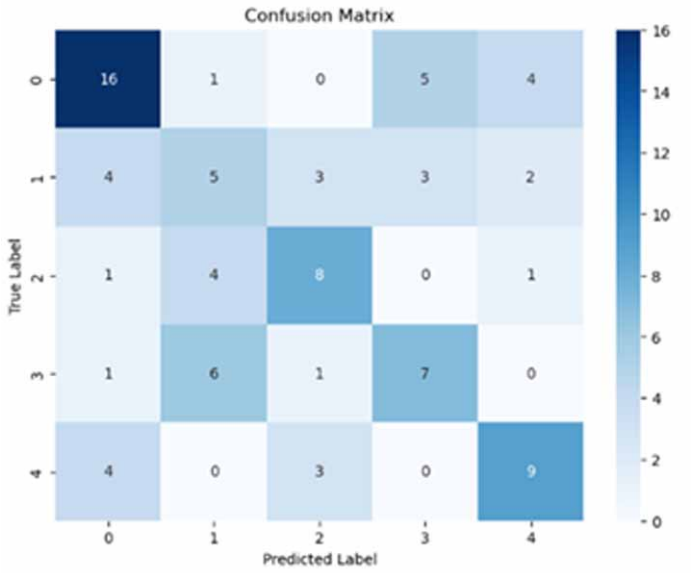


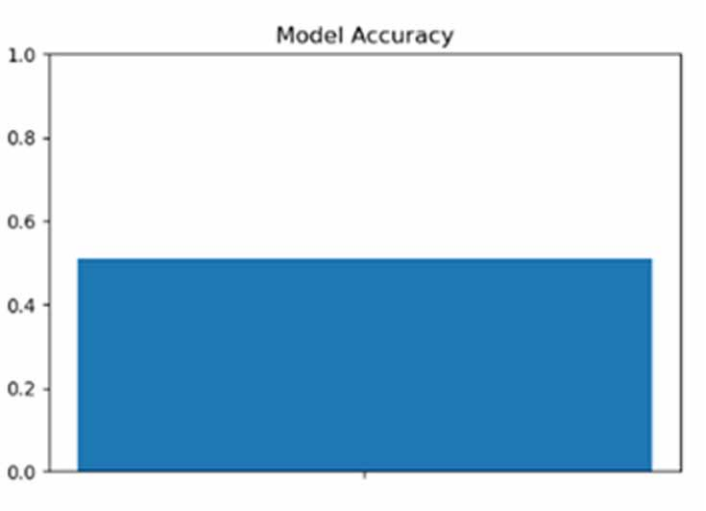
Figure 18. Confusion matrix



noma, 3 represents eczema, and 4 represents rosacea. Confusion matrix is used to easily visualize the performance of the model.

In Figure 19, we have shown the testing accuracy in bar graph format. The testing accuracy here is 51.13%. To visualize the testing accuracy of the Random Forest model, we can create a bar graph. The graph will represent the accuracy value on the y-axis and the model on the X-axis.

Figure 19. Accuracy bar graph



Discussions

In Figure 20, the comparison of accuracies has been depicted in the form of a bar graph. On the X-axis we have all the used models and on the Y- axis we have the accuracy. The bar graph clearly shows the accuracy values for each model, allowing for a visual comparison. Both the CNN and Deep CNN with

Figure 20. Comparison between testing accuracy of used models

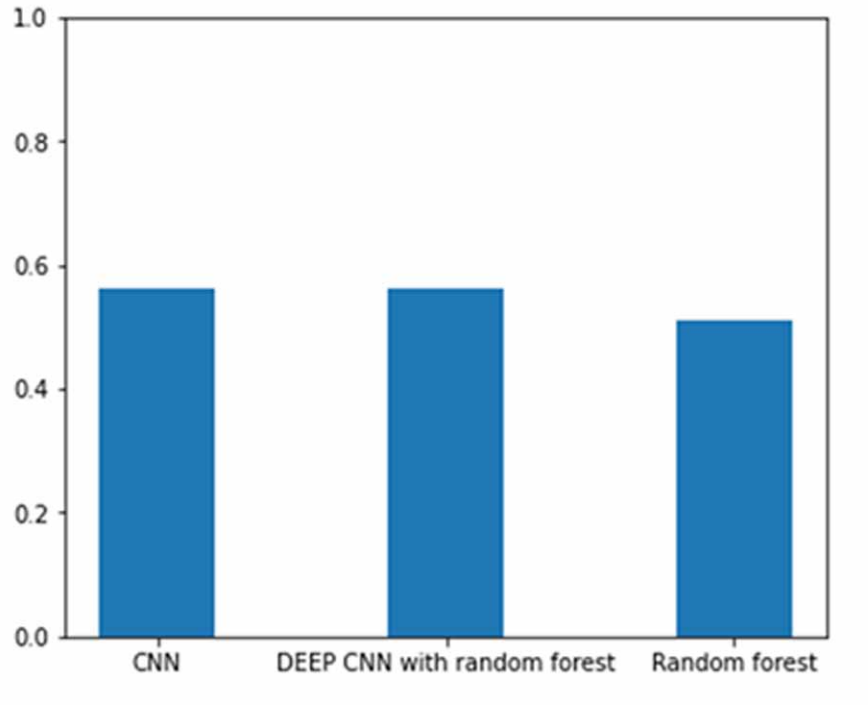


Table 2. Comparison of presented result with existing state of arts

Approach	Algo Used and Methodology	Findings/ Concluding Remarks
A Method Of Skin Disease Detection Using Image Processing And Machine Learning (Nawal, S. et al., 2019)	First, extract image features using pre-trained CNN and then classify image using Multiclass SVM	Helps in detection of skin disease
Machine Learning Algorithms based Skin Disease Detection (Shuchi, B. et al., 2019)	They used five algorithms, Random Forest, CNN, Naive Bayes, Logistic Regression, Kernel SVM to classify the skin image	Skin disease can be cured if it detected at an early stage
Skin Disease Detection And Classification (Pugazhenthi, V. et al., 2019)	The input image is first gone for preprocessing, then segmentation, then, feature extraction. After that it is classified into the disease using the Decision Tree.	Their system can be used by dermatologist for detecting Melanoma, Eczema or Leprosy skin conditions
Machine Learning Approaches to Multi-Class Human Skin Disease Detection (Ms. Seema K.et al., 2018)	They used ANN,KNN, Decision Tree, SVM and Random Forest to classify the image into 10 different diseases	They collected 10 different common skin problem samples and used that dataset for training purposes and achieved accuracy of 90%. Their system can be used by practitioners if they get a doubt.
Machine learning approaches to multi-class human skin disease detection (Suchi, B. et al., 2019)	The research focuses on CNN and an ensemble model using VGG16, DenseNet, and Inception for skin Disease detection.	Image processing techniques and highlights its potential to enhance diagnostic accuracy
Skin disease recognition method based on image color and texture Features (Wei, L.S. et al., 2018).	Texture and color features are then extracted using the Gray-Level Co-occurrence Matrix (GLCM) method	image processing techniques and highlights its potential to enhance Diagnostic accuracy.
Our Presented Approach	The accuracy of CNN, Deep CNN and Random Forest models With accuracy up to 56.21%.	The Accuracy is Low but to propose a new model with higher accuracy on test data compared to other Existing techniques.

Random Forest models have the same accuracy of 56.21%, indicating their similar performance on the task. On the other hand, the Random Forest model achieved a slightly lower accuracy of 51.13%. Please note that this comparison report is solely based on accuracy values.

Refer Table 2 for comparative Analysis of Approaches n findings.

5. NOVELTIES AND RECOMMENDATIONS

Novelties

- Deep Convolutional Neural Networks (CNNs):

- Transfer Learning
- Data Augmentation
- Ensemble Learning
- Attention Mechanisms
- Multimodal Approaches

Deep learning models are commonly perceived as black boxes because of their intricate internal representations. However, researchers are actively working on novel approaches to enhance the interpretability of these models and provide explanations for their predictions. One such technique involves the use of attention maps and saliency maps, which enable visualization of the specific regions or features that significantly contribute to the model's decision-making process. These visualizations can be valuable in assisting clinicians in comprehending and placing confidence in the model's outputs.

Recommendations

The proposed system works by taking an input from the user then using a trained model the image is classified into acne, actinic keratosis, basal cell carcinoma, eczema, and rosacea. To train the model our team used CNN, Deep CNN with Random Forest and Random Forest separately. This model can be used to classify facial disease of skin. Dermatologists can use this model for more accurate results in their diagnosis. It can help to detect the disease at an early stage so it will make it easier to treat the skin problem. People can use it at their home to verify the diagnosis also.

6. FUTURE RESEARCH DIRECTION AND LIMITATIONS

Limitations

- Limited Diversity in Training Data
- Generalizability to Unseen Cases
- Clinical Integration and Adoption
- Less Accuracy

Future Directions

- Data collection will be improved for better results
- Multimodals will be used to get more accurate classification
- Transfer Learning and Domain Adaptation
- Explainability and Interpretability
- Real-Time Detection and Feedback

7. CONCLUSION

Facial Skin Disease is very common in today's era. Due to pollution and other environmental factors it is very common to have a facial skin disease and sometimes it is very hard to visit a dermatologist on a very busy schedule. To treat these skin diseases it is very important to detect them at an early stage. This proposed approach can help the victims and dermatologist to detect the disease before it's getting more serious. These skin diseases are very much likely to spread and these skin problems can lower the self-esteem of the person which can cause them to live in a state of disharmony. These skin diseases can cause scars and hyperpigmentation which will remain on their skin permanently. This proposed approach can be used to avoid all of these problems.

The experimentation involved comparing CNN, Deep CNN with Random Forest and Random Forest models for skin disease detection. Both CNN and Deep CNN with Random Forest achieved similar testing accuracy, while Random Forest achieved lower testing accuracy compared to other models. The results highlight the advantage of utilizing deep learning models, such as CNN and Deep CNN with Random Forest, over traditional machine learning approaches like Random Forest for skin disease classification tasks. Both the CNN and Deep CNN with Random Forest models yielded identical accuracy rates of 56.21%. These results indicate comparable performances in accurately predicting labels on the test dataset.

It is plausible that these models share comparable underlying architectures or have been trained on similar datasets. Conversely, the Random Forest model achieved a marginally lower accuracy of 51.13%. Despite falling behind the CNN-based models, this outcome still represents a commendable performance, taking into account the distinct modeling approach employed by random forests compared to neural networks. In summary, both the CNN and Deep CNN with Random Forest models demonstrated comparable accuracy, outperforming the Random Forest model. Depending on the specific requirements and constraints of the problem, either of the two CNN-based models could be considered for further exploration and improvement.

Role of Authors

Dr. Rohit Rastogi played his role as project guide and mentored us on how to find the problem statement and contributed in project making with ensuring that the quality of the content written is profound. Mr. Mohd. Shahjahan took the task of collecting and analyzing the dataset and contributed to the technical part. Mr. Piyush did the interpretation of data and did the conception and design of the project. Mr. Mohd. Shahjahan handled the task of assembling the literature survey with all the graphical presentations. The team contributed to the results and remarks.

Deliverables

*This work takes an image from the user and walk the image through different algorithms and will detect the probable skin disease. The skin disease it can detect is:-*Acne, Actinic Keratosis, Basal Cell Carcinoma, Eczema, Rosacea

Stakeholders

This manuscript can be used by researchers, developers and dermatologists for classification of one of the five diseases, it can also be used by people who want to monitor their own facial skin. Some medical institutions can also use it for their need in workplace

Ethical Committee and Funding

The experiment does include human related experiments but it is ensured that no ethical constraints should be violated. Since the research work is related to the health of humans, thus their data has been collected by the author's team but it is ensured that the study doesn't violate any ethical laws. The research work only works upon the data collected through the survey; rather there was not any experiment which is directly performed on human beings. The Project is not funded by any agency.

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KEY TERMS AND DEFINITIONS

Convolutional Neural Network (CNN): A convolutional neural network (CNN or convnet) is a subset of machine learning. It is one of the various types of artificial neural networks which are used for different applications and data types. A CNN is a kind of network architecture for deep learning algorithms and is specifically used for image recognition and tasks that involve the processing of pixel data.

Deep Learning: Deep learning is a subset of machine learning, which is essentially a neural network with three or more layers. These neural networks attempt to simulate the behavior of the human brain—albeit far from matching its ability—allowing it to "learn" from large amounts of data. While a neural network with a single layer can still make approximate predictions, additional hidden layers can help to optimize and refine for accuracy.

Dermatologist: A specialist in dermatology, especially a doctor who specializes in the treatment of diseases of the skin.

Machine Learning: Machine learning is a branch of artificial intelligence (AI) and computer science which focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy.

Random Forests: Random forests or random decision forests is an ensemble learning method for classification, regression and other tasks that operates by constructing a multitude of decision trees at training time. For classification tasks, the output of the random forest is the class selected by most trees.