Journal of Innovative Image Processing (ISSN: 2582-4252)
www.irojournals.com/iroiip/

Computer Aided Diagnosis (CAD) and Classification of Microbial and other Wide Range of Dermal Diseases using AI and Medical Image Processing

M. Sujitha[1], N. Leela[2], B. Kanimozhi[3]

[1,3]Biomedical Engineering, G.K.M College of Engineering and Technology, Anna University, Chennai, India

[2]Electronics and communication Engineering, G.K.M College of Engineering and Technology, Anna University, Chennai, India

E-mail: [1]sujimurali2498@gmail.com, [2]leelagkm@gmail.com, [3]kani72312@gmail.com

Abstract

The human body's largest and most defensive organ is its skin. It covers internal organs and shields the human body from extraneous substances outside of it. Numerous illnesses can harm a person's skin caused by microbes such as bacteria, fungi, and viruses; for example, MRSA (methicillin-resistant Staphylococcus aureus) infection, Herpes zoster, Acne vulgaris, warts, eczema, psoriasis, and the fifth disease. It can also be damaged by carcinogenic and tumor-inducing agents, leading to skin cancer such as melanoma, which is more fatal and life-threatening to human life. Skin diseases can be diagnosed by blood tests, tissue sample collection (biopsy), and skin examination by dermatologists and experts. If non-expert doctors or laboratory technicians examine the skin, it can lead to medical errors and misdiagnosis. A proper and precise diagnosis and detection are required to treat the specific disease. This research aims to detect dermal diseases through sample images and classify and identify the cause of disease with greater accuracy and precision in a time- and cost-efficient way. This research uses medical processing algorithms such as pre-processing and segmentation of the

DOI: https://doi.org/10.36548/jiip.2023.3.006
Received: 14.09.2023, received in revised form: 02.10.2023, accepted: 16.10.2023, published: 31.10.2023

diseased image and image classification algorithms such as deep learning, part of a neural network, to classify the diseased medical images.

Keywords: MRSA, Microbes, Skin, Deep Learning, Skin Cancer

1. Introduction

The skin, which is the biggest organ in the body, is made up of minerals, lipids, proteins, and water. Your skin protects you from illnesses and regulates body temperature. You may feel temperature and other emotions thanks to skin nerves. Skin diseases include any issues that cause obstruction, irritation, or inflammation of the skin. Skin diseases are often the cause of rashes or other cosmetic changes over the skin. Skin problems can have a wide range of symptoms, depending on the disease a person has. Skin alterations are rarely the result of skin disorders. For example, blisters might occur from wearing shoes that are too small. However, when skin changes occur suddenly and without apparent cause, they may indicate an underlying illness. Specimens are collected with a blade or swab in order to diagnose skin disorders caused by bacteria. The pus or exudate is spread as thinly as possible on a transparent glass slide in order to prepare it for gram staining. First, 70% alcohol is used to clear the vesicles, followed by sterile saline. Viruses can be removed from vesicles by using a needle or scalpel blade to open the roof. The fluid is obtained using a swab or a tuberculin syringe fitted with a 26–27 gauge needle in order to diagnose viral skin infections. To obtain cutaneous samples, remove any infected nails or skin scales using a sterile Petri plate or clean envelope. To identify fungal skin disease in lesions of the deep skin and subcutaneous tissue, aspiration using a sterile needle and syringe is recommended.

The objective of the research is to design a model that can identify and categorize seven different types of microbial diseases brought on by bacteria, viruses, fungi, and parasites, and to classify melanoma and Merkel cell cancer using medical skin images with CNN. This model, which is based on CAD algorithms and medical image processing, will aid dermatologists in accurately and precisely diagnosing skin diseases. The use of computer-generated output as a tool to aid a clinician in making a diagnosis is known as computer-aided diagnosis (CAD).

The end diagnosis is not dependent solely on a computer algorithm, as is the case with automated computer diagnosis. Computer-aided diagnostic (CAD) systems have been widely

utilized in radiology for many years as an early type of AI. The most prevalent uses are for the diagnosis of pulmonary nodules on chest CT and the identification of cancer in breast on mammography. In the past, these systems relied on manually creating features based on domain knowledge, while more recent methods use machine learning to find hidden patterns in imaging data. Medical imaging, diagnostic radiology, and other medical sectors have made medical image processing one of the main study topics. The rationale and guiding principles behind the early development of CAD schemes are discussed, along with the state and potential future of CAD in a PACS setting. When utilizing CAD, radiologists use the computer result as a "second opinion" and make the final decisions. Computer-assisted diagnosis (CAD) is a concept, whereas automated computer diagnostic is a computer-based notion. With CAD, computer performance doesn't have to be partially equal to or superior to that of doctors; it just needs to be a useful addition to their work. A significant number of CAD systems have been used to aid doctors in the early detection of diseases using medical images generated from CT, X-ray, MRI, etc., as well as breast malignancies on mammograms. Deep learning greatly automates the feature extraction portion of the process, reducing the need for manual human intervention. Additionally, it permits the use of enormous data sets, earning the moniker "scalable machine learning." On investigating the usage of unstructured data further, that capacity is fascinating, especially given that it is estimated that over 80% of an organization's data is unstructured.

2. Related Work

1) “Skin disease classification using Machine Learning and Data Mining Algorithms” Dr. V. Vasudha Rani et al, 2022 decided to use features extracted from photos as their input. To obtain high classification accuracy, it is crucial to select appropriate feature extraction techniques along with appropriate Machine Learning (ML) approaches. The classification of skin diseases is discussed in this analysis using ensemble data mining approaches and ML algorithms. In this method, four distinct ML techniques are used to categorize the various kinds of diseases, while ensemble approaches are used to increase the classification reliability of skin diseases.

2) “Image-based skin disease detection using hybrid neural network coupled bag-of-features” Shouvik Chakraborty et al., 2017 utilized for ANN (NN-NSGA-II) training. Testing phase confusion matrix-based performance measuring metrics, such as accuracy, precision,

recall, and F-measure, have been used to further assess the proposed model against two other popular metaheuristic-based classifiers: NN-PSO (ANN trained with PSO) and NN-CS (ANN trained with Cuckoo Search). Based on experimental data, the suggested bag-of-features enabled NN-NSGA-II model was found to be superior.

3) "Multi-Class Skin Disease Classification Using Deep Convolutional Neural Network and Support Vector Machine" Nazia Hameed; Antesar M. Shabut; M. A. Hossain 2018 suggested a method for dividing skin lesion images into five groups: benign, malignant melanoma, eczema, acne, and healthy. The technique was then developed, put into practice, and tested. 9,144 Images from various sources were used for the experiments. The features were extracted using a pre-trained CNN model called AlexNET. The ECOC SVM classifier was applied for classification. The overall accuracy obtained using ECOC SVM is 86.21%. To prevent overfitting, a 10-fold cross-validation method was employed. The outcomes show that characteristics derived from the convolutional neural network can improve the way various skin lesions are categorized.

4) "Skin disease classification using Improved Bag of Features Algorithm" Ma. Christina et al. 2019 employed a variety of strategies and tactics, including k-means clustering, interest point detection, accelerated robust features algorithm, enhanced bag of features algorithm, and Gaussian filtering. The system's overall accuracy rate is 96%, its overall loss is (0.03), and its overall average confidence rating in terms of detection and classification across tests conducted with various test data is 98.48%. Additionally, the overall image precision/recall rate for the two categories is 99% on average. Acne received the most number of correctly predicted skin illnesses in the confusion matrix. Conversely, BOIL received the least amount of correctly classified. Furthermore, Acne achieved the greatest precision score of 98%, while BOIL achieved a high score of 97%.

5) "Skin disease classification using Machine Learning Algorithms" K. Veera Swamy; et al. 2021 this method analyses properties of Hue-Saturation-Value (HSV) are utilized to determine the entropy, variance, and maximum histogram value. Decision Tree (DT) and Support Vector Machine (SVM) algorithms are built employing these properties to create machine learning algorithms. The tree is divided at the first level using the entropy measure. Variance is employed at the second level to obtain textures for leaves. The greatest histogram

value of the HSV measure is utilized in color features to divide the tree. The suggested algorithm's performance is evaluated using accuracy.

6) “Skin disease Analysis using Digital Image processing” Ma. Christina et al 2019 employed the Speed-Up Robust Features (SURF) method in combination to extract features. The features of the test data derived from the actual taken image will be compared to these extracted features from the training dataset. The extracted features will be clustered using K-Means clustering to produce a visual dictionary, and LIBSVM will be used to classify the type of skin illness the patient has to prevent self-diagnosis and misinterpretation of the disease's early symptoms, which is a regular occurrence in the Philippines. This study provides a quick prediction. The expected outcome of this investigation is the anticipated kind of skin condition the subject possesses. Additionally, a percentage confidence result will be generated. This study can accurately detect the type of skin condition by using an upgraded BOF algorithm.

7) “Skin disease detection and classification and segmentation” Zaynab Habib R. et al. 2022 concentrate on identifying ill skin, categorising skin into one of the nine illnesses, and then dividing the lesion. There are two suggested convolution neural networks: one for classification and one for detection. Every suggested value for a network parameter has been chosen as the ideal value. A robust classification model was built through numerous experiments, and the overall accuracy of the suggested system was 95.315%. This idea offers the potential to diagnose nine different skin disorders, some of which are highly comparable, irrespective of where a lesion is located on the human body. Despite numerous obstacles that lower accuracy, the proposed model performs admirably. The suggested strategy produced good results when compared to other similar investigations.

8) Skin disease detection using Deep Learning Tarun Parashar Kapil Joshi Ravikumar R. N Devvret Verma Narendra Kumar K. Sai Krishna2022 describes how to predict the many kinds of skin problems using multiple PC vision-based approaches (deep understanding). The objective of this study was to assess the summaries of several popular calculations in order to create a useful PC-assisted framework for diagnosing skin and breast disorders that would assist both people and healthcare providers. This is why the deep learning and AI computations were performed on both the heart disease dataset and the therapy set. First, the UCI AI data bank's Coimbra dataset was used. By identifying highlights in the datasets, knowledge gain and

LBP were applied to improve the efficacy of characterization techniques. Svm Classifier, Free Timberlands, Repeated Neural Organizations, and CNNs Organization computations were used to carry out the layout experiments. Precision esteems are employed for execution measures. These results show that RNN has demonstrated the best narrative among some of the rivals, scoring 92% on both datasets. This indicates that deep learning algorithms, specifically RNN, could have a high success rate in identifying malignant tumors from the sample.

9) Mritunjay Kumar Ojha; Dilrose Reji Karakattil; Akshat Devendra Sharma; Sneha Mary Bency 2022 Created research that uses image data for image processing and skin disease classification. Convolutional Neural Networks and MobileNet, two classifiers in the field of deep learning, have been used to implement these. Thus, the research serves as an early warning system that uses computer assistance to notify people about skin problems they may be facing.

10)Dermatological disease diagnosis using color-skin images m.shamsul Arifini 2012 Proposes a system for automated dermatological diagnosis. Dermatology is the medical specialty that studies and treats skin abnormalities according to its etymology. Rather than relying on human involvement, the approach is a machine intervention into the traditional medical personnel-based paradigm of dermatological diagnosis. The two dependent steps of the system's operation are detecting skin anomalies and identifying illnesses. The system is driven by visual information, such as color, high-resolution pictures, and patient histories. In machine intervention, the system recognizes the sick skin by applying color gradient algorithms, k-means clustering, and color image processing techniques. The system uses feedforward backpropagation artificial neural networks for illness classification. When evaluated for disease, the system has a 95.99% accuracy rate in detecting sick skin and a 94.016% accuracy rate in identifying conditions.

From the above literature survey, it is seen that skin diseases such as acne, eczema, boils, impetigo, skin cancers are identified using SVM and CNN by Alexnet. SVM classification was done by detecting SURF, point features, GLCM, and LBP features. The overall average accuracy was found to be 70%–97%.

3. Proposed Work

The Proposed research pre-process the collected data and classifies the image using Google Net by CNN. The data is collected from google containing 50 sample images of each diseases. It classifies nine types of skin diseases, including MRSA, Cellulitis, Herpes simplex, Molloscum contagiosum, Ringworm, Athlete's foot, Scabies, Melanoma, and Merkel cell cancer. Finally, ROI is used to segment by marking wounds in the given image sample.

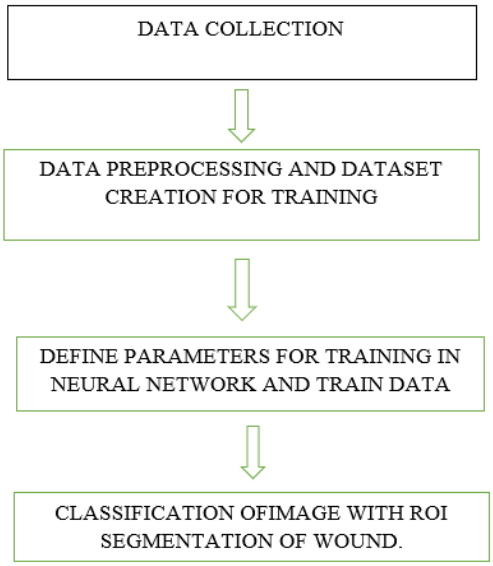

Figure 1. Proposed Flow Diagram

The data is pre-processed by applying filters to remove noise, and an image enhancement method is used to boost the image's contrast. Image preprocessing prepares data for a target workflow. Image preprocessing implements guided filter and sharpening algorithm to remove noises and enhance the image. Dataset is created by preprocessing the raw image and saved in a folder. Medical image preprocessing has two main goals: lowering image acquisition noise and achieving image uniformity throughout a data set.

The neural network receives the data, and each layer produces output based on the previous stage. It is called feedforward in this context. The error function measures the effectiveness of the network. The derivatives are then computed and backpropagated into the model. Using grid-like matrixes, convolutional neural networks (CNN), an enhanced version of artificial neural networks (ANN), are primarily used to extract features from datasets.

Comparing the GoogLeNet architecture to earlier state-of-the-art architectures like AlexNet and ZF-Net reveals how drastically different they are. It can build a deeper architecture since it employs a variety of techniques, including global average pooling and 1-1 convolution. The region of interest (ROI) function produces a region by specifying the size, location, and form of an ROI. It uses Google net with 6 epochs for training the data with split data ratio of 7: 3 out of 10 data samples for training and validation. MATLAB 2021 A is used to design the research.

Figure 2. Preprocessed Image

The classified diseases are

(i) MRSA

Methicillin-resistant bacteria such as Staphylococcus aureus (frequently known as" Staph") cause bacterial infections. Staph infections can beget lumps, rashes, and pocks on the skin, and in extreme cases, they can poison the blood.

(ii) Cellulitis

A bacterial skin infection called cellulitis makes the skin around the infected area red, blotchy, and painful. Serious health problems may result if it isn't treated. Cellulitis can be avoided by practicing applicable crack care and cleanliness habits. A variety of different microorganisms can also cause cellulitis.

(iii) Herpes Simplex

It's occasionally known as herpes and is a common illness that can cause pocks or ulcers. The mode of transmission is skin-to-skin contact. It can be treated, but it cannot be cured.Most people simply experience minor or no symptoms. Although they cannot treat the infection, drugs help lessen symptoms.Intermittent oral and genital herpes symptoms could include the disturbing experience of having oral and genital herpes symptoms constantly.

(iv) Contagious Molluscum

A more common skin infection called Molluscum contagiosum is caused by contagion. It results in effortless, globular, hard lumps with sizes ranging from a pinhead to a pencil eraser. An infection can be contagious if the pustules are scratched or hurt.

(v) Ringworm

Ringworm of the body (Tinea corporis) is caused by a fungus. It's round and prickly, with clearer skin in the center. No worms are present, as the name suggests.

(vi) Athlete's Foot

Fungal Athlete's foot starts between the toes. An itchy, scaled rash is one of an athlete's most worrying symptoms. It's Contagious and spreadable by infected shells, napkins, or apparel. An athlete's bottom is rigorously related to other fungal nails. Though treated with antifungals, the complaint returns.

(vii) Scabies

Scabies is an itchy, rash-like parasitic infection caused by bitsy devils that bury themselves beneath the skin to deposit their eggs. Skin blisters and significant side effects such as blood infections, heart problems, and order problems

(viii) Melanoma Cancer

Dermal cancer in which melanocytes, the cells that give skin its color, become nasty cells. Colorful cancers develop in the skin. Melanoma threats can be increased by unusual intelligence, UV exposure, and medical history.

(ix) Merkel Cell Carcinoma

MCC constantly occurs on face, head, or neck as a meat-colored or bluish-red bump. Merkel cell cancer is also called Neuroendocrine melanoma. Older people are most frequently affected by Merkel cell cancer.

4. Results and Discussion

The research for the detection and classification of microbial dermal diseases has been developed and tested with large data sets of medical images to check for accuracy and precision. Thus, this research detects and classifies skin diseases with above 95% accuracy and precision, which will be helpful in diagnosing common and harmful skin diseases from the point of view of patient skin image data acquired and fed through medical image processing algorithms successfully.

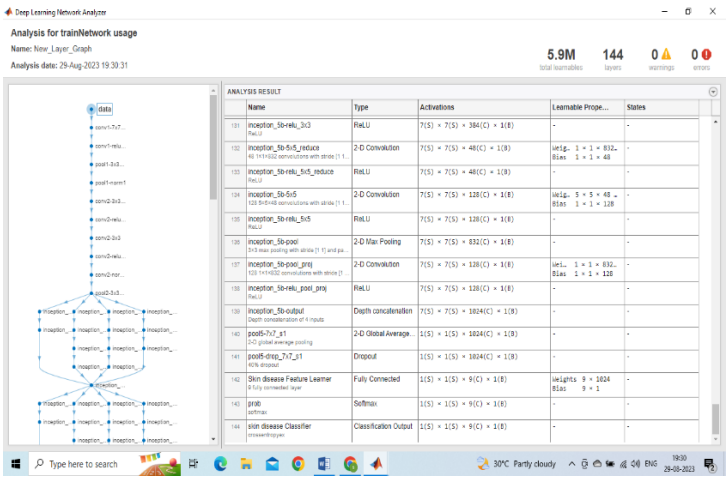

Figure 3. Training Phase

The fig.3 shows the training phase of the proposed model with Google Net by CNN for the 50 samples of images collected for the nine types of skin disease that are classified. It uses Google net with 6 epochs for training the data with split data ratio of 7: 3 out of 10 data samples for training and validation. The proposed model is implemented using the MATLAB 2021 A.

The fig.4 and 5 shows the percentage of Accuracy and the loss acquired for 1 and 6 epochs of training cycle with maximum 18 iterations, with frequency of 3 iterations per epoch and learning rate of 0.0003

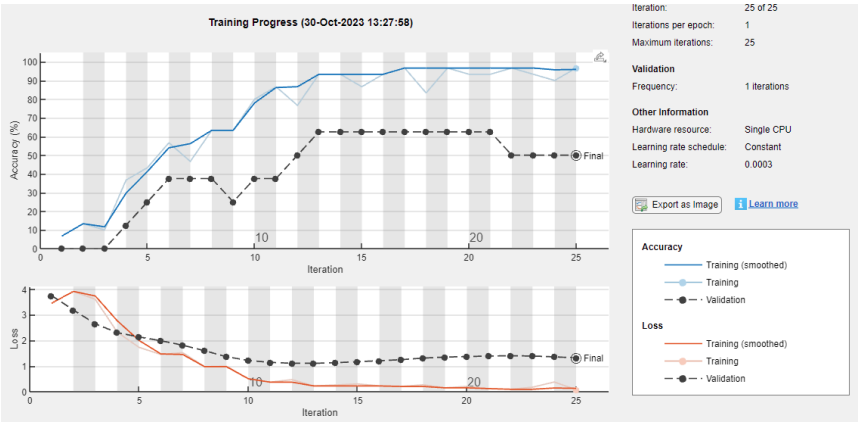

Figure 4. Training and Validation Accuracy with 1 Epoch

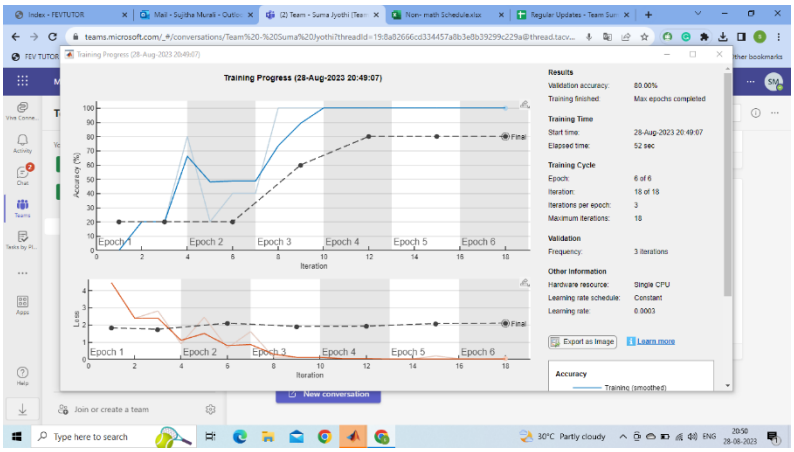

Figure 5. Training and Validation Accuracy with 6 Epoch

From the training phase it was observed that there was an increase in the accuracy and decrease in the loss with the increase in the number of epochs. The proposed model has achieved a validation accuracy of 80 %. The training and the validation results prove that the model has learned its pattern well and it is capable of performing well on new data.

Table 1. Accuracy of Classification

S.No	Disease name	Microbe/ causes involved	Accuracy in detection and classification
1.	MRSA	Stappyloccocus aureus-Bacterium	99.6%

2.	Cellulitis	streptococcus and staphylococcus-Bacteria	95.5%
3.	Herpes Simplex	HSV-1 virus	98%
4.	Molluscum-contagiosum	Poxvirus	97.7%
5.	Ringworm	Microsporum, trichophyton Fungi	99.5%
6.	Athlete's foot	Dermatophytes Fungus	96.5%
7.	Scabies	Parasitic infection	99.7%
8.	Merkel cell cancer	Carcinogens	97.3%
9.	Melanoma	Carcinogens	96.3%

The table.1 and the results acquired in Fig .6 – 13 shows the accuracy and resutls observed in the testing phase of the proposed model.

Figure 6. Scabies Classified with 99.3% Accuracy

Figure 7. Ringworm Classified with 99.7% Accuracy

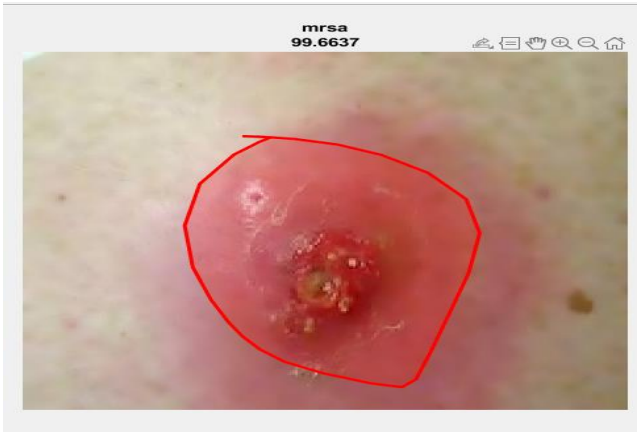

Figure 8. MRSA Classified with 99.6% Accuracy

Figure 9. Melanoma Classified with 96.3% Accuracy

Figure 10. Scabies Classified with 97.7% Accuracy

Figure 11. Simplex Classified with 98.3% Accuracy

Figure 12. Athlete's Foot Classified with 96.5% Accuracy

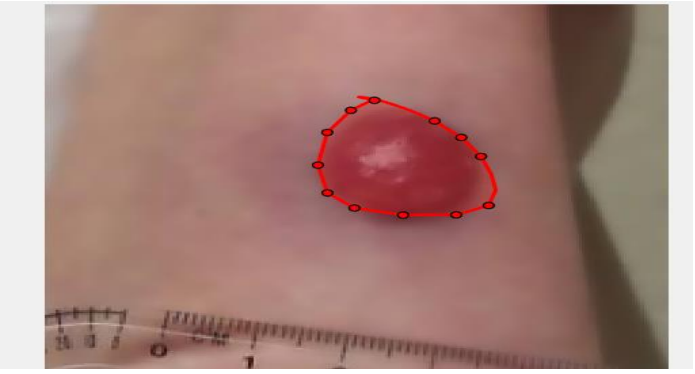

Figure 13. MCC Classified with 97.3% Accuracy

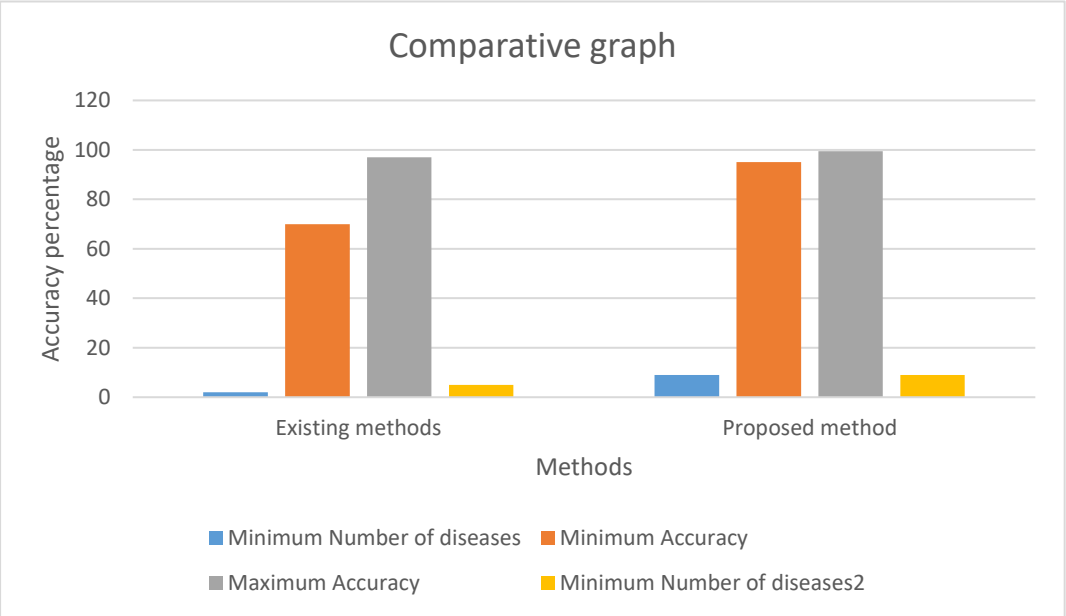

Figure 14. Comparison of Existing and Proposed Method.

Table 2. Comparison Table

Criteria	Existing Methods	Proposed Method
Accuracy	70 to 97%	95 to 99%
Diseases Classified	Boils, Acne, Skin cancers, Scabies, Herpes.	Herpes, Scabies, MCC, Skin cancer, Athlete's foot, Molluscum, MRSA, Cellulitis, Ringworm
Features Used	GLCM, LBP, SURF.	Guided Filter nd sharpening.
Overall Performance	Faster and accurate.	Very Faster, reliable and accurate and precise.
Classifying Method	SVM, CNN(RCNN, Alexnet.)	CNN(Googlenet.)

The fig. 13 and table.2 illustrates the comparison of the proposed method over the existing methods based on the number of datasets used and the approaches used in preparing the dataset, training and classifying.

5. Conclusion

The proposed methodology in the research has enabled to detect and classify microbial and other dermal diseases with above 95% to 99.9% accuracy. This research can be implemented in dermatology labs and clinics to aid in the diagnosis of certain skin diseases and infections that can be diagnosed using patient skin image data rather than blood tests, biopsies, and other invasive procedures with high efficiency, high sensitivity, and less time and a good precision rate

References

[1] M. Binder, M. Schwarz, A. Winkler, A. Steiner, A. Kaider, K. Wolff,and H. Pehamberger, “Epiluminescence microscopy. A useful tool forthe diagnosis of pigmented skin lesions for formally traineddermatologists,” vol. 131, no. 3, pp. 286-291, 1995.

[2] S. Chakraborty, S. Chatterjee, N. Dey, A. S. Ashour, A. S. Ashour, F.Shi and Kalyani Mali, "Modified Cuckoo Search Algorithm inMicroscopic Image Segmentation of Hippocampus", MicroscopyResearch and Technique, 00; pp. 1-22, 2017

[3] S. Chakraborty and S. Bhowmik, “Job Shop Scheduling usinSimulatedAnnealing”, In Proc. 1st International Conference IC3A 2013, JISCollege of Engineering, Kalyani, India, pp. 69-73, McGrawHill Publication, January 2013.

[4] S. Chakraborty and S. Bhowmik, “Blending Roulette Wheel Selectionwith Simulated Annealing for Job Shop Scheduling Problem”, In Proc. Michael Farady IET International Summit MFIIS 2015, Kolkata, India,vol. 2, IET, September 2015.

[5] S. Chakraborty, S. Bhowmik, "An Efficient Approach to Job ShopScheduling Problem using Simulated Annealing", International Journalof Hybrid Information Technology, Vol. 8 No. 11, pp. 273-284, 2015.

[6] S. Chatterjee, R. Nag, N. Dey and A. S. Ashour, “Efficient EconomicProfit Maximization: Genetic Algorithm based Approach". WorldConference on Smart Trends in Systems, Security and Sustainability(WS4 2017) At London, UK, Volume: Springer LNNS series, February 2017. (In press)

[7] Michal Antkowiak. Recognition of skin diseases usingartificial neural networks. In Proceeding of USCCS'05,pages 313-325, 2005.

[8] Monika Gniadecka, Peter Alshede Philipsen, SigurdurSigurdsson, Sonja Wessel, and et al. Melanomadiagnosis by Raman spectroscopy and neural networks:Structure alterations in proteins and lipids in intact cancertissue. J Invest Dermatol, 122:443--449,2004.

[9] Nisha Yadav, Virender Kumar Narang, Utpal shrivastava,"Skin Diseases Detection Models using ImageProcessing", International Journal of ComputerApplications (0975 – 8887) Volume 137 – No.12, March2016.

[10] Shrinidhi Gindhi, Ansari Nausheen, Ansari Zoya,Shaikh Ruhin, "An Innovative Approach for Skin DiseaseDetection Using Image Processing and Data Mining",

Author's biography

M.Sujitha, M.E, Department of Biomedical Engineering, G.K.M College of Engineering and Technology, Anna University, Chennai, India

N.Leela, Head of the department, Department of Electronics and communication Engineering, G.K.M College of Engineering and Technology, Anna University, Chennai, India

B.Kanimozhi, Assistant professor, Department of Biomedical Engineering, G.K.M College of Engineering and Technology, Anna University, Chennai, India