# Image based Skin Disease Detection using Hybrid Neural Network coupled Bag-of-Features

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***Abstract*—The current work proposes a neural based detection method of two different skin diseases using skin imaging. Skin images of two diseases namely Basel Cell Carcinoma and Skin Angioma are utilized. SIFT feature extractor has been employed followed by a clustering phase on feature space in order to reduce the number of features suitable for neural based models. The extracted bag-of-features modified dataset is used to train metaheuristic supported hybrid Artificial Neural Networks to classify the skin images in order to detect the diseases under study. A well-known multi objective optimization technique called Non-dominated Sorting Genetic Algorithm - II is used to train the ANN (NN-NSGA-II). The proposed model is further compared with two other well-known metaheuristic based classifier namely NN-PSO (ANN trained with PSO) and NN-CS (ANN trained with Cuckoo Search) in terms of testing phase confusion matrix based performance measuring metrics such as accuracy, precision, recall and F-measure. Experimental results indicated towards the superiority of the proposed bag-of-features enabled NN-NSGA-II model.**

***Keywords— Skin disease detection, bag-of-features, neural network, hybrid methods***

## I. INTRODUCTION

In the field of medical image analysis, skin disease analysis is one of the major do-main of interest. Skin cancer is one of the major disease and many people suffers and dies due to this image throughout the world every year. In order to support dermatologists, machine learning based methods are used for detection and classification. Image processing accelerates the process by computing different feature from the mages. Different dermoscopy methods have been proposed to improve and enhance the diagnostic performance. Dermoscopy is a method for skin imaging which is noninvasive in nature. Magnified and illuminated picture of a certain region of skin can be obtained and it helps to clarity the spots on the skin [1]. It increases the visual effect of skin lesion by eliminating reflection of the surface. Hybrid neural based bag-of-features approach has been employed for analyzing skin images. In this work we have considered two categories of diseases namely Basal Cell Carcinoma which is malignant in nature and Angioma which is benign in nature. Images have been obtained from International Skin Imaging Collaboration (ISIC) dataset.

In this work, we have employed ANN that is trained using NSGA-II. It has been trained with the bag-of-features obtained by employing the SIFT algorithm. We have compared the result with some other methods line ANN trained with Cuckoo Search and PSO.

## II. METAHEURISTIC SUPPORTED HYBRID NEURAL NETWORK

The ANN is one of the most used modeling approaches [2-3]. It achieves accurate classification even with very small dataset. It can handle imprecise relationships during its training stage. The ANN structure is consists of interconnected computational neurons, which involved in the mathematical mapping through the learning process, which attempt to adjust the weight value. Initially, the training phase is started by a part of the dataset to classify its inputs along with its class label to create the classification model. Afterward, the validation phase is performed to confirm the effectiveness of the trained model using another dataset. Finally, the evaluation phase is used to test the classification model accuracy using another set of test data. In general, the artificial neuron uses the input signal (x) and their equivalent weights (w) to form the input ($N_J$). This input is then surpassed to a linear threshold filter till it exceeds the output signal (y) to another neuron. If $N_j$ exceeds the threshold of that neuron, the neuron is inspired. The net input ($N_j$) is calculated by the following equation:

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$$N_j = \sum_{i=1}^{n} w_{ij} x_i \quad (1)$$

Where, n is the number of the input signals, w is the weight and x is the strength of each signal. Consequently, the output (y) is computed as follows:

$$\begin{aligned} y &= 1, \, if \; N_j \geq \theta_j \\ &= 0, if \; N_j \leq \theta_j \end{aligned} \quad (2)$$

Here, ($\theta_j$) is the bias. The sigmoid and logistic functions can be used as an activation functions. The perceptron learning rule is assures optimal weight vector for ANN in finite number of iterations [4]. For the MLP-FFN experiments, two-layer perceptron feed-forward network can be conducted. It has been proved to be capable of approximating almost every polynomial function with any degree of complexity. Among different training algorithms back-propagation based gradient descent strategies [5] are quite popular. However, this particular algorithm is not immune to the local optima convergence problem, where the algorithm is often unable to find the optimal set of weights of ANN for which certain error function is minimized. Recent advancements in metaheuristics [6-10, 20 - 43] motivated the authors to train the ANN using metaheuristic algorithms such as Cuckoo Search (NN-CS), Particle Swarm Optimization (NN-PSO) which minimizes one error function in order to find the optimal weight vectors of ANN. The performance can still be improved by employing multi objective versions of metaheuristics. A well-known multi objective Genetic Algorithm called the Non-dominated Sorting Genetic Algorithm – II (NSGA-II) [11] is employed to train the ANN (NN-NSGA-II) as well. The potential of NSGA-II trained ANN has already been found in real life applications such as [12].

The objective functions used in the optimization process is root mean squared error (RMSE) for single objective versions and RMSE along with Maximum error for NN-NSGA-II [12]. A general flow of training the ANN is given in Fig.1.

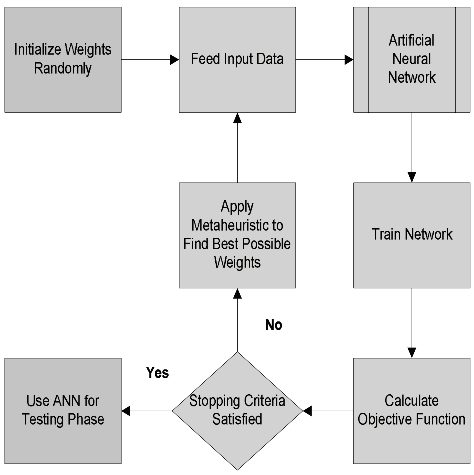



Fig. 1. Flowchart of Metaheuristic trained ANN.

## III. Feature Extraction

Feature extraction refers to the process of extracting some meaningful information from some initial set of data. It should be informative and non-redundant. It helps us to reduce the volume of resources needed to describe an object. An analysis of different feature extraction methods and their applications are given in [13-15]. One of the major problems related with data analysis is the number of variables involved. Good amount of memory as well as time is needed to analyze a large number of variables. We also need high computation power to perform such kind of analysis. In some cases it may overfit a classifier and reduces its efficiency. Feature extraction helps us to bypass these issues by forming some combinations of these variables in such a way that it can convey come information. In this paper, Scale Invariant Feature Transform (SIFT) has been used to detect interest points and find the corresponding descriptors. SIFT has been proved as a robust method and effective in different images [13]. After that Bag-of-Features concept has been implemented to reduce the number of points that can be used to train the ANN that described in section II.

## IV. Proposed Method

In this work, a bag-of-features based model has been proposed with NN-NSGA-II to detect and classify skin diseases. In this approach, Scale Invariant Feature Trans-form (SIFT) [16] method has been employed to detect key/interest points and ex-tract features. SIFT mainly generates some key points from which it generates a descriptor for that point. Point like features are very useful and it should be invariant of geometrical transformations like rotation, scaling. SIFT algorithm proved to be very efficient on different types of images with different transformations. Now, SIFT can generate a large number of key points. Now from these key points, SIFT eliminates some redundant points. After elimination, it gives accurate points of interest. But still, after elimination, it can generate thousands of key points and a descriptor of 128 dimensions associated with it. In Fig. 2, an image of basal cell carcinoma has been shown along with its detected key points where after elimination of redundant key points, 1423 number of useful key points has been generated. Now, to handle large number of key points is a problem and it may again lead to the problem of overfitting and can cause poor results. Therefore, we have applied the k-means clustering algorithm so that we can get some representative interest points. These interest points are the cluster centers where each cluster consists of some feature points. This concept is generally known as bag-of-features. We have selected 8 clusters (on the basis of experiments) where squared Euclidean distance is used to compute the distance during the clustering process. Here each centroid denotes the mean of the points in that cluster. The clustering process has been repeated 5 times with different initial cluster centers to get the minimum within-cluster sums of point-to-centroid distances. These representative feature points of different images have been used for training and testing purposes as described in section 2. The overview of the proposed method is given in Fig. 3. The ISIC dataset has been used for training and testing purposes.

## V. Results and Discussions

The proposed method utilizes NN-NSGA-II model to classify two different skin diseases namely Basel Cell Carcinoma and Skin Angioma respectively. The proposed method using NN-NSGA-II is compared with NN-CS and NN-PSO in terms of performance measuring metrics such as accuracy, precision, recall and F-measure [17]. The experimental setup of NN-PSO is as in [18], NN-CS is as in [19] and NN-NSGA-II in [12]. The performance metrics are given in (3) to (6) and are calculated from confusion matrices of testing phases of different methods. A comparative study is reported in Table 1 and graphical representation of the results is given in Fig. 4.

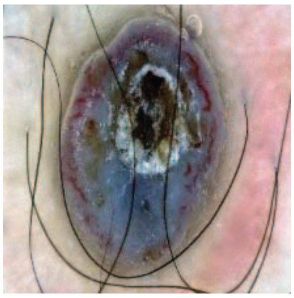
$$Accuracy = \frac{TP + TN}{TP + FP + TN + FN} \quad (3)$$

$$\Pr ecision = \frac{TP}{TP + FP} \quad (4)$$

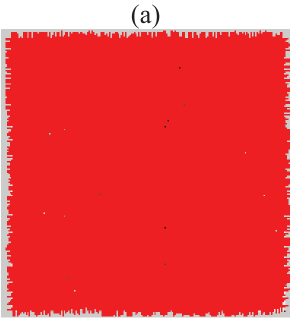
$$\text{Re}\,call = \frac{TP}{TP + FN} \quad (5)$$

$$F - Measure = \frac{2\ X \Pr ecision\ X\ \text{Re}\,call}{\Pr ecision + \text{Re}\,call} \quad (6)$$

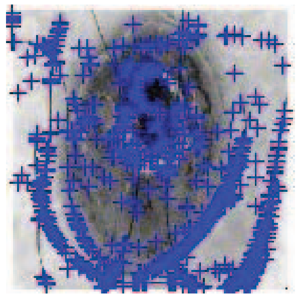
Here, TP means true positives, TN is the abbreviation for true negative, FP stands for false positives and FN is for false negatives.



(a)



(b)



(c)

Fig. 2. (a) Original image of basal cell carcinoma (b) Detected key points (c) Reduced key points (1423).

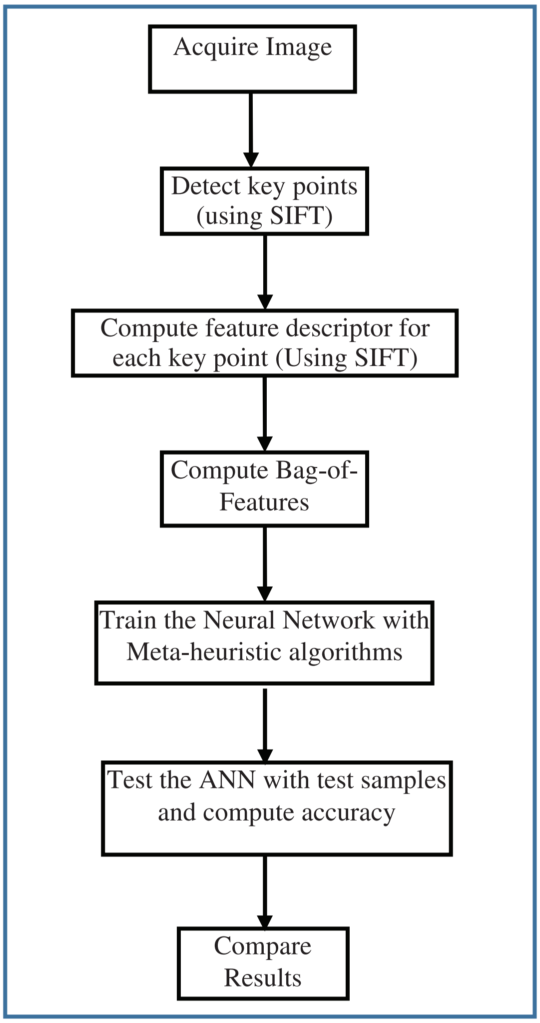



Fig. 3. Overview of the proposed method.

TABLE I. COMPARATIVE ANALYSIS OF NN-NSGA-II WITH OTHER MODELS

| | NN-PSO | NN-CS | NN-NSGA-II |
|---|---|---|---|
| **Accuracy** | 86.67 | 88.24 | 90.56 |
| **Precision** | 78.79 | 82.56 | 88.26 |
| **Recall** | 83.87 | 88.87 | 93.64 |
| **F-measure** | 81.25 | 85.6 | 90.87 |

Table 1 reveals that the NN-PSO model performed moderately with an accuracy of 86.67%, while it achieved 78.79% of precision, 83.87% recall and 81.25% F-measure. On the other hand NN-CS performed better than NN-PSO with an accuracy of 88.24% and achieved 82.56% precision, 88.875 recall and 85.6% F-measure.

Significant improvement can be observed in terms of precision. However, the NN-NSGA-II model is superior to all other models in the current study, as it secured 90.56% accuracy with a precision of 88.26%, 93.64% recall and 90.87% F-measure. As indicated by F-measure, NN-NSGA-II is far more trustworthy in classification of two skin diseases under study.

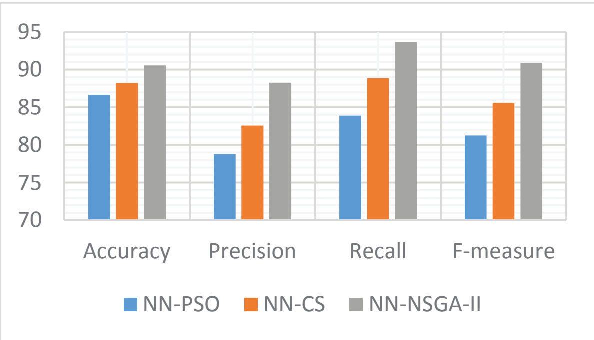



Fig. 4. Graphical analysis of the obtained results.

## VI. CONCLUSION

Skin cancer is one of the global threats and needs serious attention. Automated detection is extensively needed not only to reduce the work load; it is also required for early stage detection. The proposed method seems to be effective and can be employed in real world applications. Moreover, SIFT based bag-of-feature method can be employed in different modality of bio-medical image analysis as well as other domains like satellite imaging etc. Other metaheuristc methods can be integrated to train the artificial neural network.

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