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Computer-Aided Diagnosis Of Skin Cancer From Dermoscopy Images

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Abstract
The development of cancerous cells in skin tissues is a characteristic of skin cancer. It poses severe health issues, and effective treatment relies on early detection. This paper introduces an automated computer-aided approach for early detection of skin cancer. The performance of a new image segmentation technique that utilizes a convolutional neural network optimized by satin bowerbird optimization (SBO) following image noise reduction is shown through a confusion matrix. To obtain relevant information from the segmented images, feature extraction is subsequently performed. In order to eliminate redundant data, an SBO algorithm-based optimal feature selection process is utilized. The pre-processed images are further split into two sets based on a support vector machine classifier: healthy or malignant. The system is tested based on the performance indicators accuracy, sensitivity, negative predictive value, specificity, and positive predictive value in relation to American Cancer Society database through running the simulations and against 10 assorted techniques in the existing literature for comparison.
Keywords: *skin cancer, image segmentation, feature extraction, feature selection*

INTRODUCTION

Skin cancer is a common illness in the United States that primarily targets the skin, the body's largest organ [1]. On the surface of the skin, it most often presents itself as a bump, growth, or other irregularity. Of all the aggressive and deadly skin cancers worldwide, melanoma is one of them. Although they make up only approximately 1% of all skin cancer cases, melanoma is still the number one killer of skin cancer. Clark's nevus and melanoma, for instance, are basically identical skin lesions, but Clark's nevus is benign while melanoma is malignant and can cause death. It is thus critically important and highly beneficial to come up with a trusty method of melanoma early diagnosis [9]. The rapid and precise detection of melanoma with dermoscopy images has been the focus of a number of research works in the past 20 years, with diagnostic accuracies between 70% and 95%. Machine vision and artificial intelligence have emerged as widely used non-invasive medical methods in recent years. Image processing also assists radiologists and physicians in reducing complicated problems and accelerating early disease detection in medical applications [2]. Artificial neural networks (ANNs) are a valuable medical tool in the diagnosis of cancer. ANNs are a widely applied technique within artificial intelligence, which mimics the synapse-to-neuron interactions of the human brain [3].

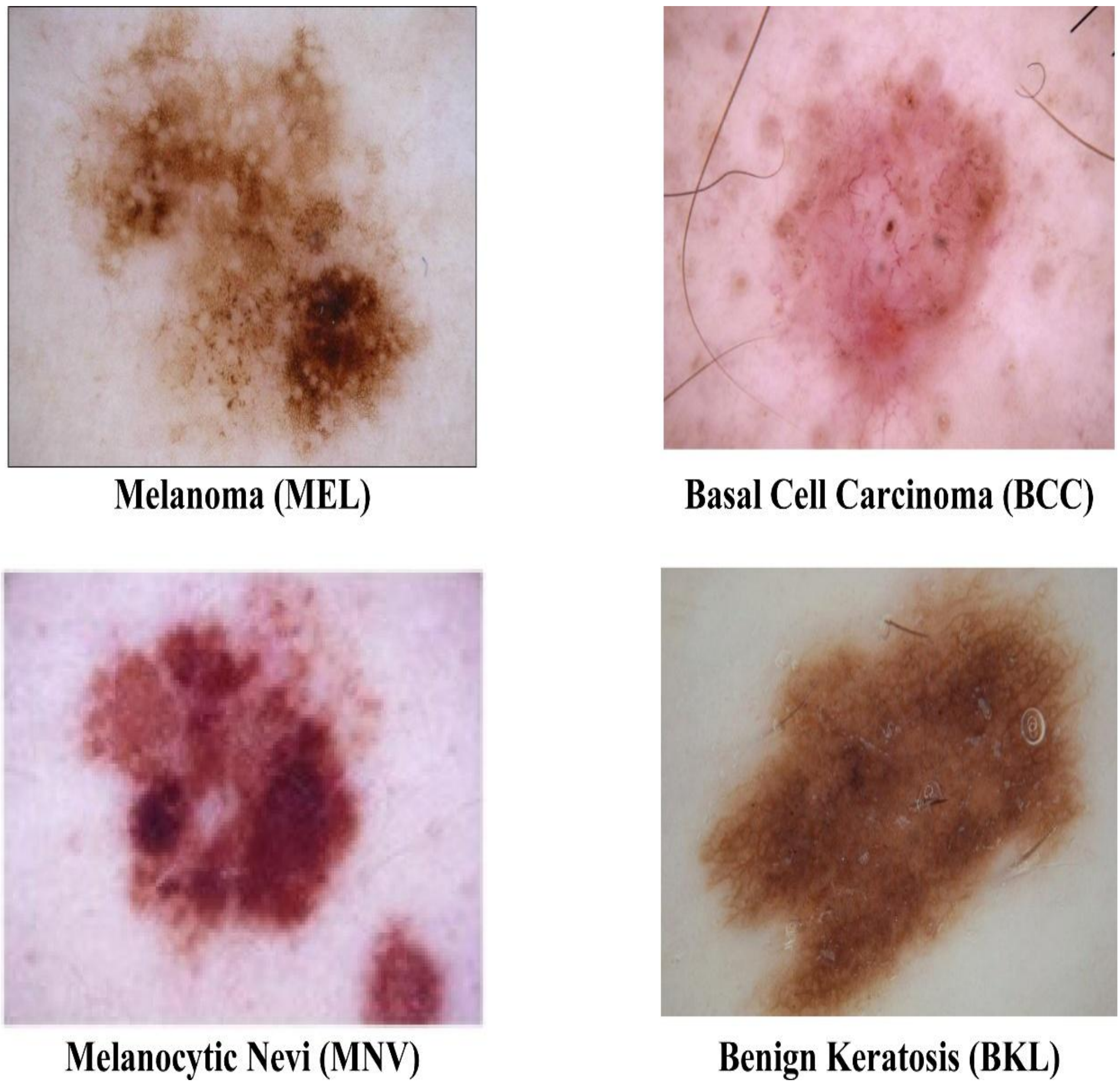

Figure 1: Types of skin cancer (Source: web)

Materials and methods

The hierarchical levels of the neural network use different portions of the image as inputs, and each layer applies digital filters to extract information. Convolutional layers apply different kernels to convolve the image[6]. This convolution process is characterized by three key features. Given the advantages of convolution, a number of studies have looked into using it in place of fully connected layers to speed up learning [7]. Each of these layers is in charge of specific tasks. Multiple convolutional layers that use filters to convolve the input image are part of a CNN's design; these layers' outputs can be taught [8]. Each of these filters creates a unique set of features as it passes over the image, so n filters are applied across the feature set. Weights, denoted by w, are linked to each filter and can be changed as filter coefficients [4]. The network operates in a sequential fashion throughout the training phase, and the convolution operation's output is computed together with a bias term, which is then noted in the feature plane [10].

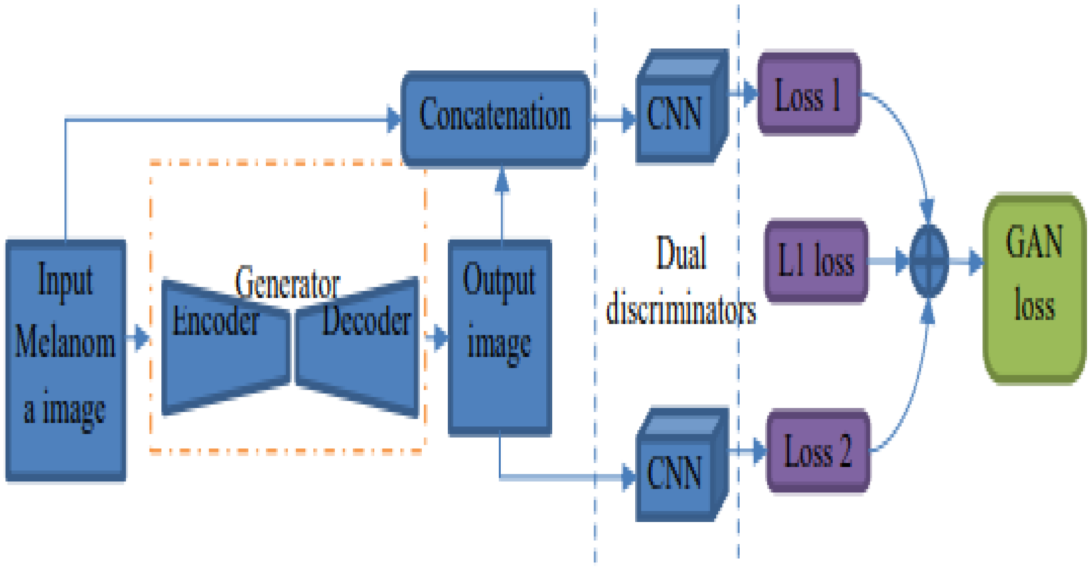

Figure 2: Design flow

The layer of pooling is typically followed by the convolution layer, which decreases the dimensionality of the network parameters and the features. Similar to the convolution layer, the layer of pooling processes data with adjacent pixels. There are other types of pooling but the most common type of pooling used is the maximum pooling process. The highest value is calculated and passed on to the next layer by calculating 2 × 2 blocks and moving them along the image in 4-pixel steps, reducing the number of features but keeping it constant, reducing their size [13]. The network's output is then tested. In an attempt to train the network (i.e., adjust the network parameters), this output is utilized to estimate the network's error rate. The backpropagation (BP) algorithm is then used to determine the error rate. Here, the parameter gradient is at this point measured using the chain rule, providing changes depending on the impact of the error on the network [11]. Feed-forward computation is subsequently carried out after parameter adjustments until a satisfactory amount of training iterations is reached. At this point, local feature extraction is utilized to get the local features of the input image[14]. Learning is utilized to obtain a set of kernel matrices that are used to obtain the salient features of dermoscopy images related to skin cancer [12]. The BP method is utilized in this study to optimize the connection weights of the network. The convolution is performed with a sliding window as a vector, which allows for the dot product and summation of weights [15].

RESULT AND DISCUSSION

Numerous approaches to system modification utilizing bio-inspired techniques have been explored in recent years. Metaheuristics are a class of optimization techniques inspired by various natural phenomena that exhibit higher effectiveness in locating global optimal values in less time. A number of metaheuristic techniques have surfaced recently. For example, the genetic algorithm mimics Darwinian selection principles to determine optimal solutions, the grass fibrous root optimization algorithm emulates the behaviour of fibrous roots, the butterfly optimization algorithm reflects the migration patterns of butterflies from colder to warmer regions during winter.

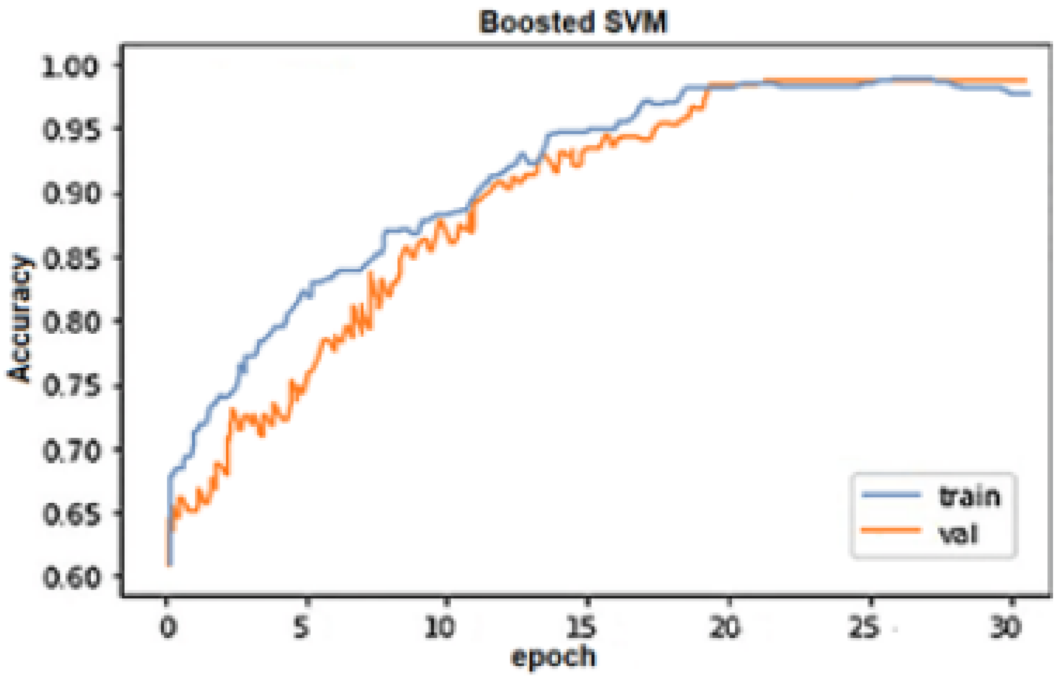

Figure 2: Accuracy Vs epoch plot for convergence analysis

In order to improve CNN efficiency, this paper presents a unique metaheuristic technique called the SBO algorithm. Every stage's best solution is considered elitist. During the mating season, each male satin bowerbird builds its bower naturally, using its innate instincts and the similarities between other birds to improve and adorn its structure.

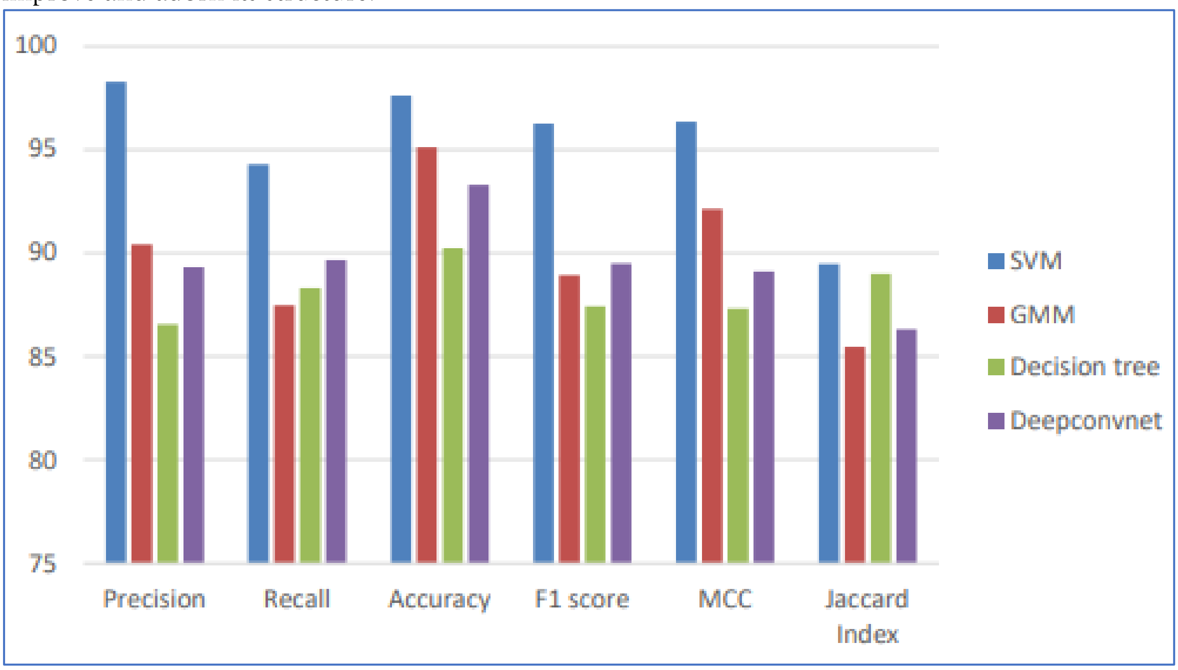

Figure 3: Performance analysis graph of ML/DL models

In essence, while each male satin bowerbird employs various materials for decoration, its experience plays a crucial role in attracting attention to its bower.

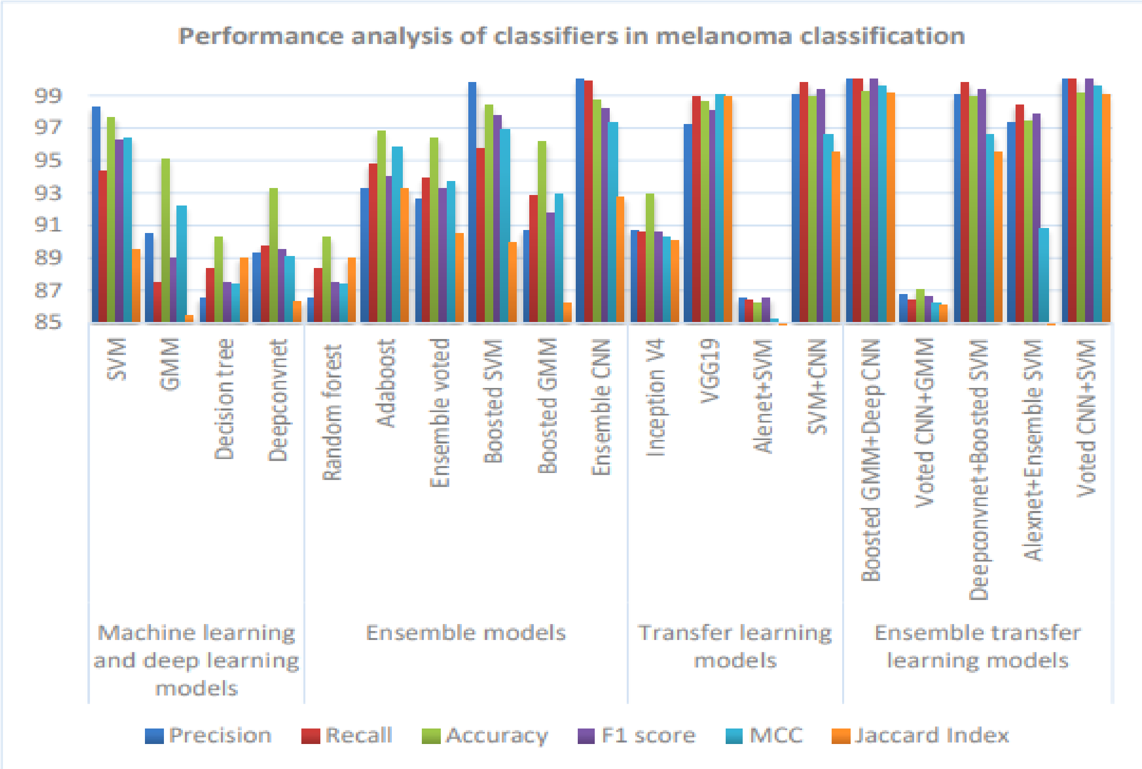

Figure 4: Performance analysis of melanoma classification

Therefore, it can be said that experience has a major role in both the bower's structure and the dramatic displays, making older guys more noticeable.

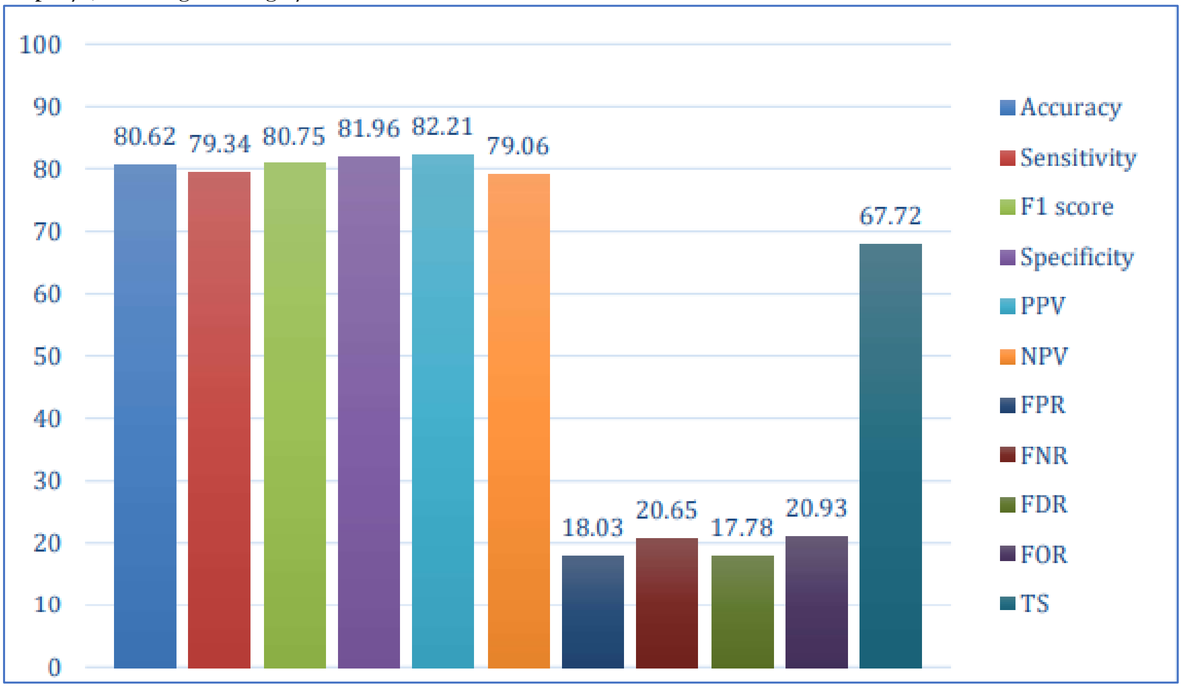

Figure 5: Performance analysis of DL classification

The most advantageous bower's position is regarded by the algorithm as the iteration's elite, with the power to affect other positions.

CONCLUSION

This work presents an automated computer-assisted method for using dermoscopy images to diagnose skin cancer. A median filter was first used to denoise the input images in order to improve diagnostic accuracy. Next, in a novel optimized process for malignant region segmentation, the cancer patches were isolated from the background through a convolutional neural network (CNN) based on the SBO algorithm. Several features were then derived from the segmented images. In order to reduce the data dimensionality and hasten the classification, the SBO algorithm was the best to be used for feature selection. Employing an optimized support vector machine classifier that was similarly founded on the SBO technique, the features extracted were investigated for the purpose of final classification. The framework was evaluated on the ACS database and compared to ten state-of-the-art methods to assess system efficiency. The final results indicated that the proposed strategy was more accurate, specific, sensitive, negative predictive value (NPV), and positive predictive value (PPV) compared to the contrasted methods. Future studies will focus on enhancing the proposed model to diagnose breast cancer more effectively.

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