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NEW APPROACH TO IDENTIFY SOME SKIN DISEASES

Annotation: *Dermatology is one of the most common health problems in all parts of the world because it is easily transmitted from one person to another, so it must be controlled in the initial stages to prevent its spread, as poor guessing of skin diseases leads to complications and for this reason there was an urgent need to develop a system that helps doctors to diagnose dermatology in its early stages, after study and practical application on several methods used in machine learning we relied on deep convolution neural networks in building an intelligent system with 100% accuracy to identify some skin diseases. The deep convolution neural network has been improved* *by applying the particle swarm optimization algorithm for an optimal solution and reducing the detection time of skin disease.*

Keywords: *Dermatology, Skin Cancer, deep convolution neural network, Particle swarm optimization, Optimal Solution Algorithms.*

НОВЫЙ ПОДХОД К ВЫЯВЛЕНИЮ НЕКОТОРЫХ КОЖНЫХ ЗАБОЛЕВАНИЙ

Аннотация: *Дерматология - одна из самых распространенных проблем со здоровьем во всех частях мира, потому что она легко передается от одного человека к другому, поэтому ее необходимо контролировать на начальных этапах, чтобы предотвратить ее распространение, поскольку неправильное определение кожных заболеваний приводит к осложнениям и по этой причине возникла острая необходимость в разработке системы, которая поможет врачам диагностировать дерматологию на ее ранних стадиях, после изучения и практического применения нескольких методов, используемых в машинном обучении, мы использовали нейронные сети глубокой свертки при создании интеллектуальной системы с 100%точности для выявления некоторых кожных заболеваний. Нейронная сеть глубокой свертки была улучшена за счет применения алгоритма оптимизации роя частиц для оптимального решения и сокращения времени обнаружения кожных заболеваний.*

Ключевые слова: *Дерматология, Рак кожи, Нейронная сеть глубокой свертки, Оптимизация роя частиц, Оптимальные алгоритмы решения.*

1. Introduction:

Skin diseases are among the most common diseases all over the world, and human skin is one of the most difficult to predict areas due to the difficulty of analyzing it due to its high complexity, texture, presence of hair, and others ... just as epidemics of skin diseases cause huge losses to people all over the world [1, C. 49].

It is difficult to know the main cause of skin disease because the symptoms of most skin diseases are close to each other, and poor guessing of skin diseases leads to complications and usually people tend to suppose a treatment for skin diseases and if the treatment is not appropriate, the matter will get worse.

The use of a system based on specific rules and symptoms is not possible due to the different manifestations of a single skin disease and thus we need a system that has the ability to adapt and learn from the basic pattern found in the skin disease that can be inferred from the picture.

2. This study aim to:

- develop a system to diagnose skin diseases in early stages.
- help dermatologists to provide better treatment for patients through appropriate diagnosis of disease cases.
- it may be useful for dermatologists to reduce diagnostic errors, while on the other hand, it can act as the first bed for patients in rural areas where there is a dearth of good medical professionals.

3. Research Methods:

We present two methods used in machine learning, the deep convolution neural networks, where input is the images of skin diseases. This helps us in encoding certain characteristics in the image and thus training and classification.
and the Particle Swarm Optimization algorithm for the optimal solution to improve the structure of the neural network and reduce the time to discover the disease.

3.1. Deep Convolution Neural Network (CNN) [2, C. 303**]:**

A Convolutional Neural Network (CNN) is the foundation of most computer vision technologies. Unlike traditional multilayer perceptron architectures, it uses two operations called ‘convolution’ and pooling’ to reduce an image into its essential features, and uses those features to understand and classify the image.

The basic building blocks of CNN are:

- Convolution layer: a “filter”, sometimes called a “kernel”, is passed over the image, viewing a few pixels at a time (for example, 3X3 or 5X5). The convolution operation is a dot product of the original pixel values with weights defined in the filter. The results are summed up into one number that represents all the pixels the filter observed.

- Activation layer: the convolution layer generates a matrix that is much smaller in size than the original image. This matrix is run through an activation layer, which introduces non-linearity to allow the network to train itself via backpropagation. The activation function is typically ReLu.
- Pooling layer: "pooling" is the process of further down sampling and reducing the size of the matrix. A filter is passed over the results of the previous layer and selects one number out of each group of values (typically the maximum, this is called max pooling). This allows the network to train much faster, focusing on the most important information in each feature of the image .
- Fully connected layer: a traditional multilayer perceptron structure. Its input is a one-dimensional vector representing the output of the previous layers. Its output is a list of probabilities for different possible labels attached to the image.The label that receives the highest probability is the classification decision.

There may be multiple activation and pooling layers, depending on the CNN architecture

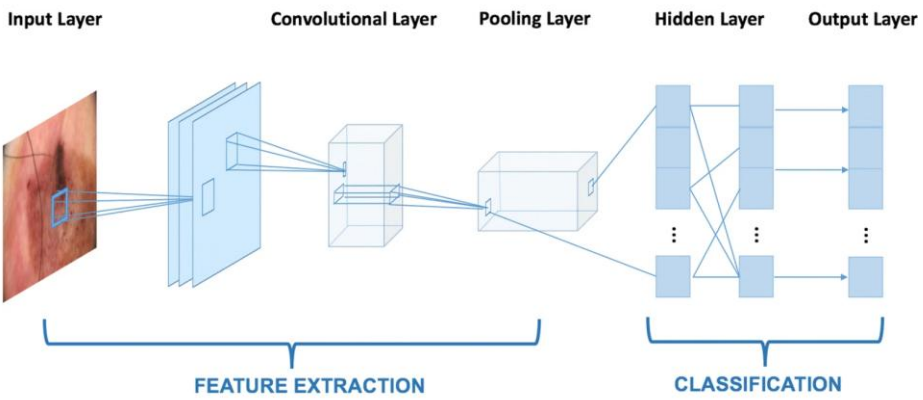


Figure (1) define CNN architecture

3.2. Particle Swarm Optimization Algorithm (PSO) [3, C. 55**]:**

Particle Swarm Optimization is an evolutionary computation technique originally developed by Kennedy and Eberhart (1995). The PSO is motivated from the simulation of social behavior instead of evolution of nature as in the other evolutionary algorithms (genetic algorithms, evolutionary programming, evolutionary strategies, and genetic programming). PSO is sociologically inspired, since the algorithm is based on sociological behavior associated with bird flocking. It is a population based evolutionary algorithm. Similar to the other population based evolutionary algorithms. PSO algorithm consists of the following steps:

Step 1: Initialization: Initialize a population of particles with random position and velocities in d dimensional problem space. Confine the search space by specifying the lower and upper limits of each decision variable. The populations of points are initialized with the velocity and position set to fall into the pre-specified or allowed range and satisfying the equality and inequality constraints.

Step 2: Velocity updating: At each iteration, the velocities of all particles are updated according to the equation (1) which is:

equation (1)

$$V_{id}^{(t+1)} = w\, V_{id}^{(t)} + c_1\ rand_1\ (p_{best\ id}^{(t)} - X_{id}^{(t)}) + c_2\ rand_2\ (g_{best\ d}^{(t)} - X_{id}^{(t)})$$

where $V^{(t)}_{id}$ and $X^{(t)}_{id}$ are the velocity and position of particle i, in d dimensional space respectively. $P^{(t)}_{bestid}$ best position of individual i in d dimensional space until generation t; $g^{(t)}_{best\ d}$ is the best position of the group in d dimension until generation t; w is the inertia weight factor controlling the dynamics of flying; c1 and c2 are accelerating constants; rand1 and rand2 are random variables in the range [0,1].

The first part of the equation (1) is the momentum part of the particle. The inertia weight w represents the degree of the momentum of the particles. The second part of the equation (1) is the cognition part which represents the independent thinking of the particle itself. The third part of equation (1) is the social part which represents the collaboration among the particles.

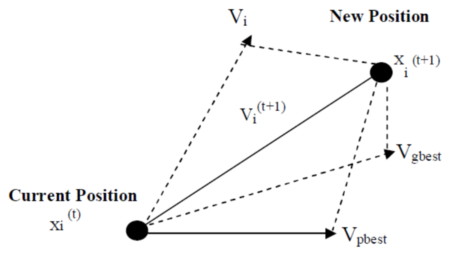


Figure (2) concept of changing particle position in PSO

Step 3: Position updating: Between successive iterations, the position of all particles are updated according to the equation (2) which is

$$X_{id}^{(t+1)} = X_{id}^{(t)} + V_{id}^{(t+1)} \qquad \text{equation (2)}$$

where $id^{(t+1)}{}_X$ is the new position and $X^{(t)}{}_{id}$ is the previous position and $V^{(t+1)}{}_{id}$ is the new velocity.

Step 4: Memory updating: Update particle best position $P^{(t)}{}_{best\ id}$ and global best position $g^{(t)}{}_{best\ d}$ using equation (3).

$$\left.\begin{array}{l} P_{best\,id}^{(t+1)} \leftarrow X_{id}^{(t+1)} \text{ if } \; f(X_{id}^{(t+1)}) < f\left(P_{best\,id}^{(t)}\right) \\ g_{best\,d}^{(t+1)} \leftarrow X_{id}^{(t+1)} \text{ if } \; f(X_{id}^{(t+1)}) < f\left(g_{best\,d}^{(t)}\right) \end{array}\right\} \qquad \text{equation (3)}$$

where f(X) is the objective function to be minimized. Compare particles fitness evaluation with particles $p^{(t)}{}_{best\ id}$. If current value is better than $p^{(t)}{}_{best\ id}$ then set $p^{(t+1)}{}_{best\ id}$ value equal to the current value and the $p^{(t+1)}{}_{best\ id}$ location equal to the current location in d dimensional space. Compare fitness evaluation with the population's overall previous best. If the current value is better than $g_{best\ d}$ then reset $g^{(t+1)}{}_{best\ d}$ to the current particles array index and value.

Step 5: Termination criteria examination: The algorithm repeats Step 2 to Step 4 until a sufficient good fitness or a maximum number of iterations/epochs are reached. Once terminated, the algorithm outputs the points of $g^{(t)}{}_{best\ d}$ and $f(g^{(t)}{}_{best\ d})$ as its solution.

4. practical application:

4.1. Identifying skin diseases:

Skin cancer is one of the most common forms of cancer affecting humans and early diagnosis is extremely vital in curing the disease [1, C. 49]. So far, the human knowledge in this field is very limited, thus, developing a mechanism capable of identifying the disease early on can save lives, reduce intervention and cut unnecessary costs, so we developed a system to classify skin caner.

Skin cancer can be of three types:

- Basal cell carcinoma
- Squamous cell carcinoma
- Melanoma cancer

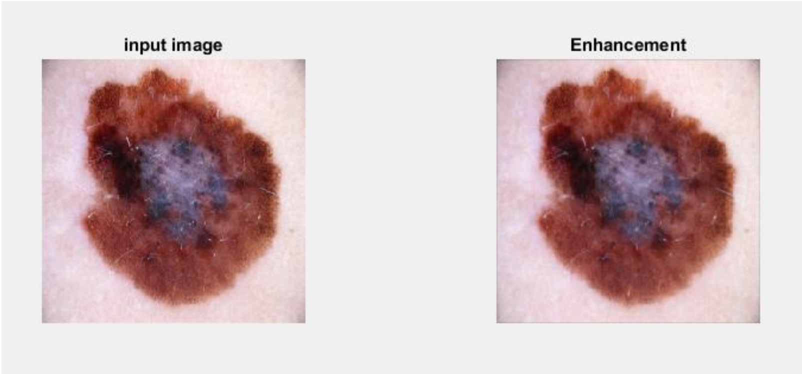
4.2. Collecting pictures of diseases:

Pictures of skin diseases were collected under the supervision of a specialist, 3000 color pictures as follows:

- Basal cell carcinoma: 1,000 images
- Squamous cell carcinoma: 1,000 images
- Melanoma cancer: 1,000 images

4.3. Image Processing :

Usually skin pictures or digital photos taken from regular camera contain noises like hair, air bubbles etc. This noise may result in inaccurate classification and will give the system a false prediction result. In order to avoid this, the images are subjected to various image processing techniques. We applied gaussian filter to remove the noise as in Figure(3).



Figure(3) melanoma cancer after applying the filter

4.4. Deep Convolution Neural Network:

Using the 80/20 rule for training and testing, for each disease, 800 pictures are selected for each disease in the training phase and 200 pictures in the testing phase.

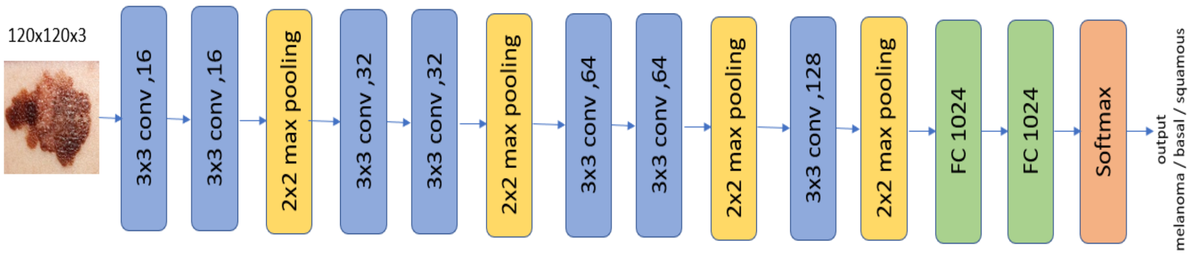
table 1. Specifications of the device on which the network was trained and tested:

Processor	Intel® Core™ i5-7200U CPU @ 2.50GHz
RAM memory	4 GB
Operating System	Windows 10 Pro 64 bit
Software	Matlab 2019b

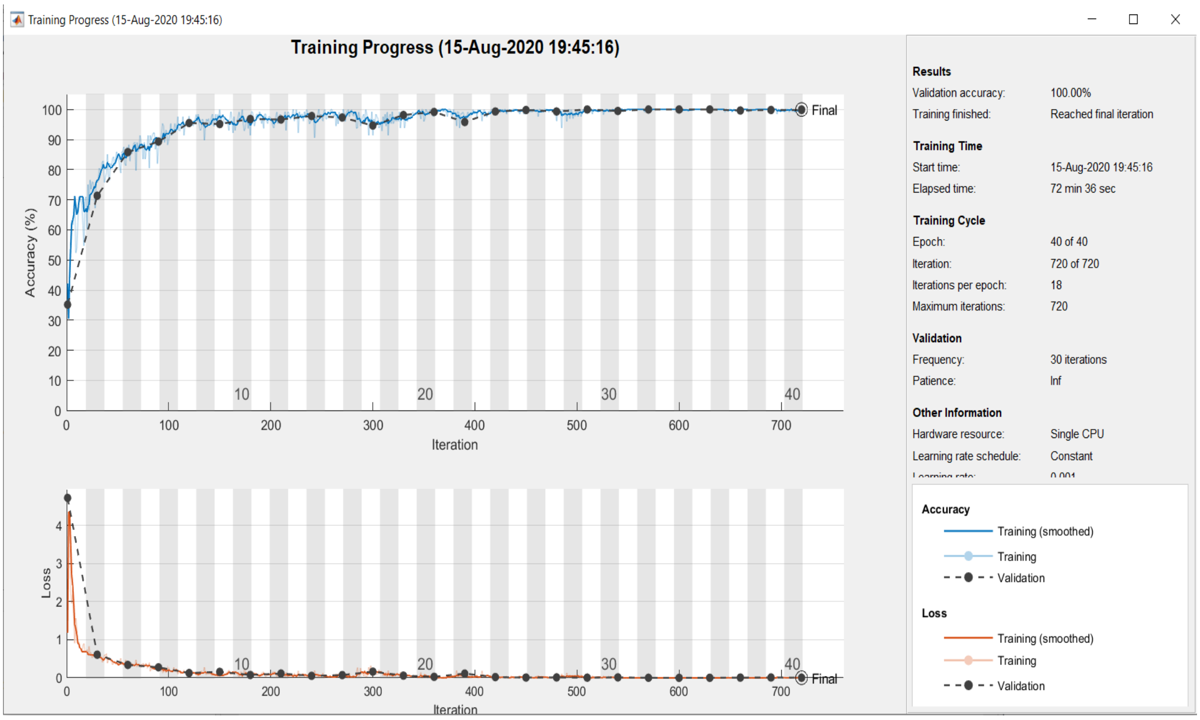
The arrangement of the network layers is as follows:

After training the network, the results were as follows:

- Accuracy :100%



- ➢ Training time : 72 minutes 36 seconds



4.5. Using the Particle Swarm Optimization algorithm to find the optimal structure of Convolution Neural Network:

define the lower bounds and upper bounds of each layer parameters which have been optimized to get the optimal CNN structure :

Filter size = [3 - 5]

Filter No = [8 - 32]

Neurons No = [1024 – 2048]

Population size =1000

table 2. The arrangement of the CNN layers:

Filter size 1st conv	Filter No 1st conv	Filter size 2nd conv	Filter No 2nd conv	Neurons No 1st FC	Neurons No 2nd FC

After apply Particle Swarm Optimization algorithm depending on above layer parameters, we get the optimal solution:

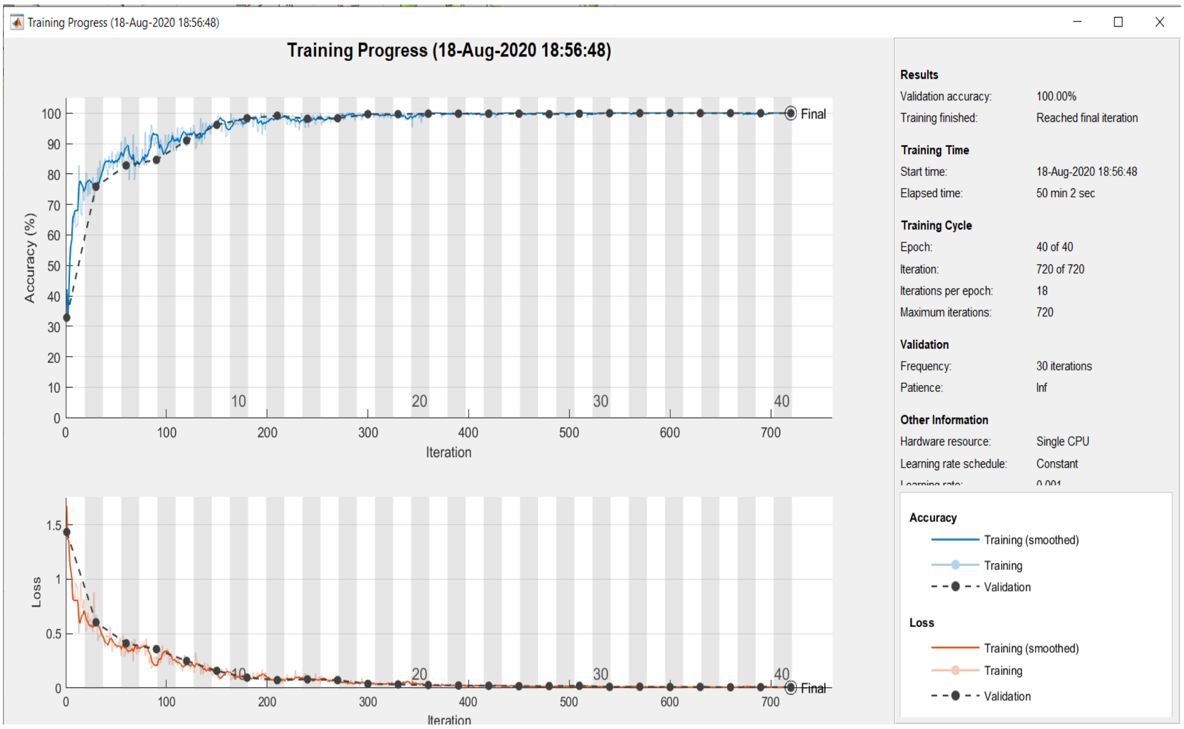
```
best_variables =

         5          32           5          21        2011        1142

*****************************************************************
Elapsed time is 854.485293 seconds.
```

After get the best solution ,apply this on CNN and we get the result :

- Accuracy :100%
- Training time : 50 minutes 2 second



We notice that when applying the Particle Swarm Optimization algorithm, the time decreased to about 20 minutes.

5. Compare Results:

There are different research works which have been introduced for skin cancer detection. Each of these methods have their own difficulties and shortcomings. Introducing all of these methods is not possible. Therefore 4 methods have been selected for comparison with our proposed method. Some deep learning based systems like AlexNet[4, C. 1101] ,VGG-16[5, C. 1410], ResNet[6, C. 95], and Inception-v3[7, C. 2820].

table 3. illustrates a accuracy comparison between the proposed system and the aforesaid methods.

method	accuracy
proposed CNN/PSO method	100%
Alex-Net	84%
VGG-16	89%
ResNet-50	86%
Inception-v3	88%

Table 1 Comparison of the accuracy for skin cancer detection

As can be observed, the CNN/PSO method is most accurate when compared with the other 4 aforesaid methods.

6. Conclusions:

In this paper, a new method is proposed for skin cancer detection. The proposed method uses a meta-heuristic based algorithm for optimization the structure of the Convolutional neural network. In this study, a recently introduced algorithm called particle swarm optimization algorithm where accuracy reached to 100%, The proposed method is called CNN/PSO, Final results show the accuracy prominence of the proposed system toward the compared classifiers.

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