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COLOR IMAGES CLASSIFIER OPTIMIZATION

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ABSTRACT
Digital color images are widely used in various classification and recognition systems. Many methods are used to represent color image with a set of numbers called image features. Some times the extracted features are very big which cause to un-optimized classification system, which has a high mean square error between the calculated outputs and the targets, and to overcome this problem a data normalization process is required. In this paper research a method of image features values normalization will be presented, the normalized data will be used as an input data set to train and build a classifier based on ANN to achieve the optimal classifier.

Keywords:
ANN, digital color image, features, MSE, normalization.

INTRODUCTION
Color digital images are one of the most common types of data [1], [2]; they are used in many vital and important applications such as medical, banking, security and many more [3], [4], [5].
Most of the images now have high resolution, which makes their size large, which will increase the time required to identify and retrieve the image in the image classification and recognition system, due to the complexity of the structure of the neural network used as a classification tool (see figure 1)[6].

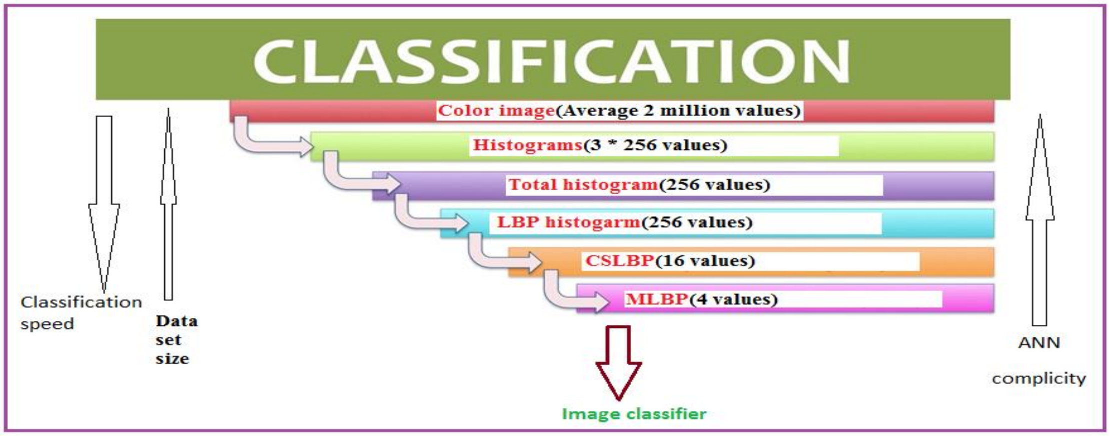

Figure 1: Image classification

Digital color image can be represented by a 3D matrix (2D matrix for each color (red, green and blue colors)), each color channel contains a 2D matrix of pixels with values from 0 to 255 as shown in figure 2,

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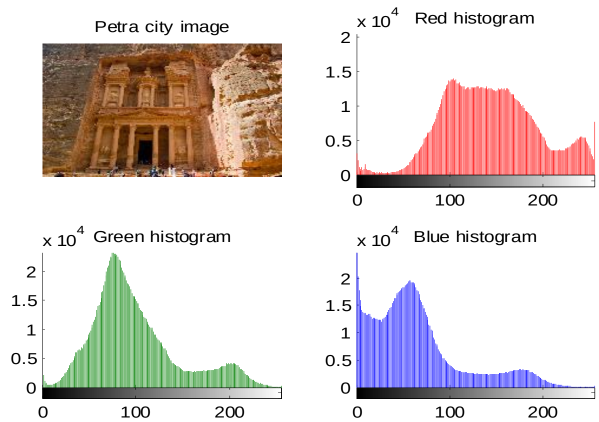

Figure 2: Color image example (size=1071*1600*3=5140800 bytes)

Color image can be represented by a set of unique features, these features can be used to build, train and run the classifier, to reduce the classifier architecture and to increase the classification speed [7], [8], [9].

Many methods were introduced to create a feature victor for each image [10], [11], some of these methods were based on statistical calculations and others were based on clustering [12], [13]. Many features extraction method were based on local binary pattern (LBP) such as modified LBP (MLBP) method [14], [15], [16], figure 3 shows the extracted features for 10 images using MLBP method.

Image 1	image 2	image 3	image 4	image 5	image 6	image 7	image 8	image 9	image 10
54652	53327	47689	56979	37264	54971	63647	56902	57483	52831
13120	13437	17487	16205	16354	15982	13819	15739	18066	19290
9671	10515	13517	15978	12097	14652	12041	14101	16746	15960
74428	73455	72353	61584	85256	66071	62004	64229	58919	62923

Figure 3: MLBP extracted features

Artificial neural network as a classifier

Artificial neural network (ANN) is computational model which is consisted of a set of fully connected neurons arranged in one or more layers as shown in figure 3[17], [18]:

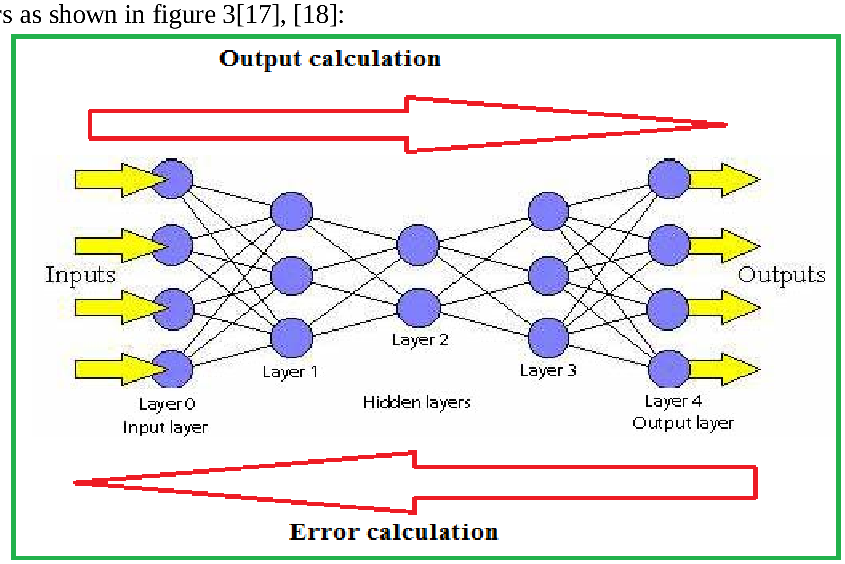

Figure 4: ANN architecture

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Each neuron acts as a computational cell by finding the summation of each input multiplied by the associated weight[19], [20], these summation then will be used to generate the cell output depending on the cell activation function(see figures 5 and 6).

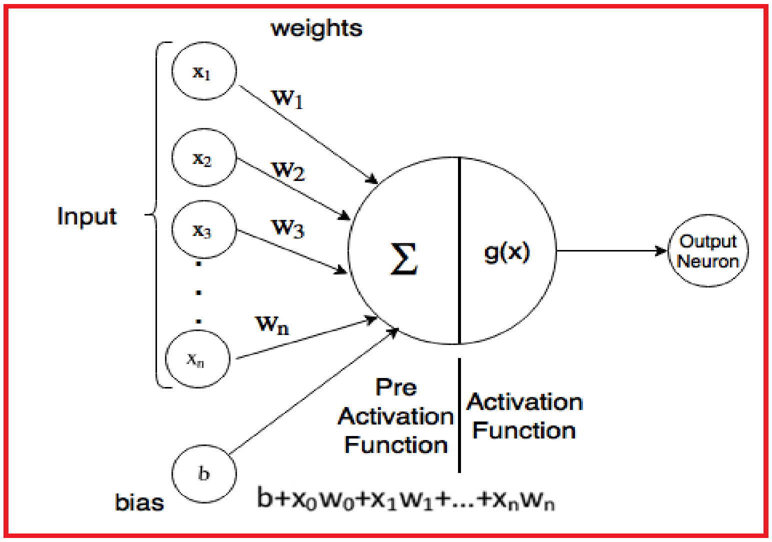

Figure 5: Cell (neuron operations)

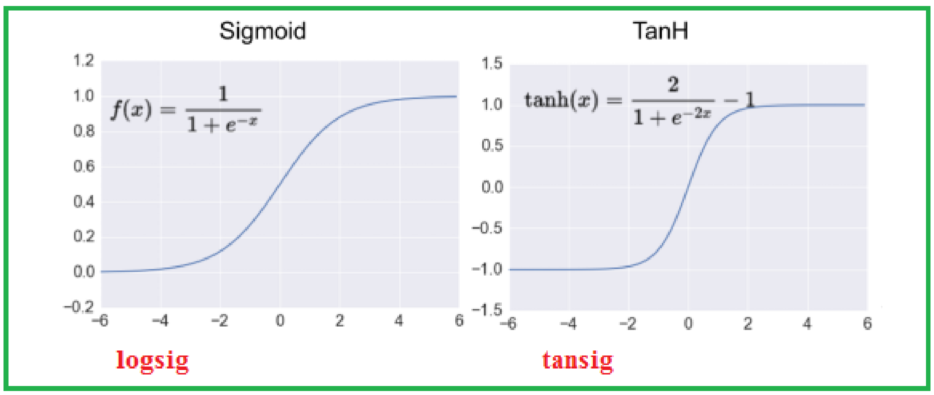

Figure 6: Using activation function to calculate output (x is the summation)

ANN are usually feed by an input data set (images features) to be trained, the target calculated outputs will depend on ANN architecture, selected activation function and selected number of training cycle. Each training cycle as shown in figure 4 will be implemented using 2 phases: Calculating the neuron outputs, then calculating the error. If the error is not acceptable then the training process will be repeated by updating the weights and using the updated weights to execute a new training cycle as shown in figures 7 and 8.

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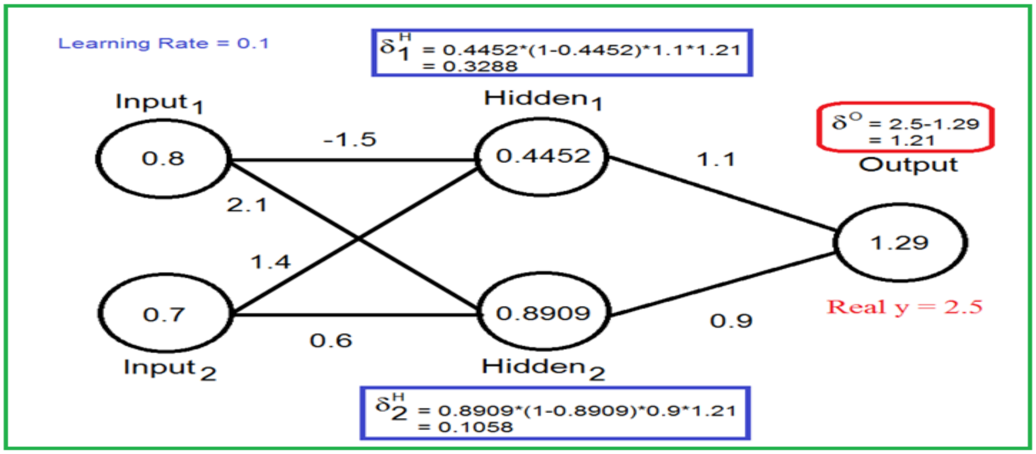

Figure 7: Training cycle

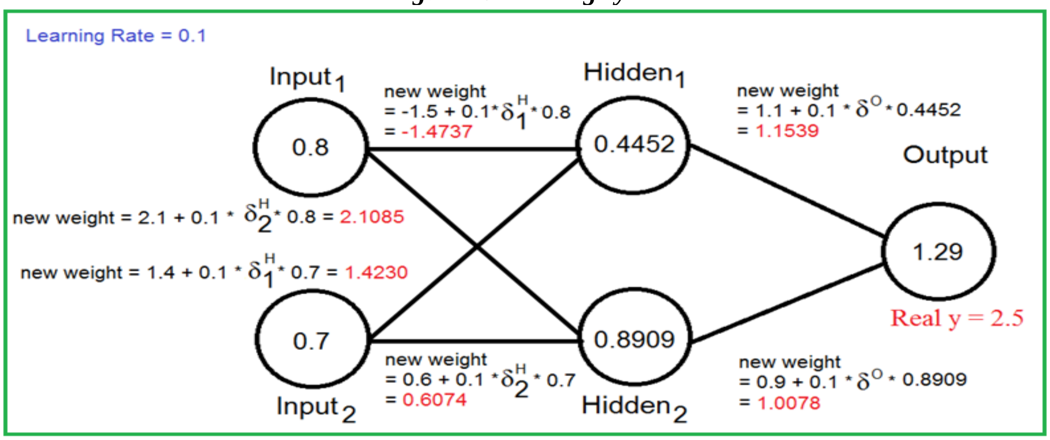

Figure 8: Training cycle (weights updating)

The proposed method

The proposed method of building ANN as image classifier is based on the extracted features database normalization, this process as shown in figure 9 can be implemented applying the following steps:

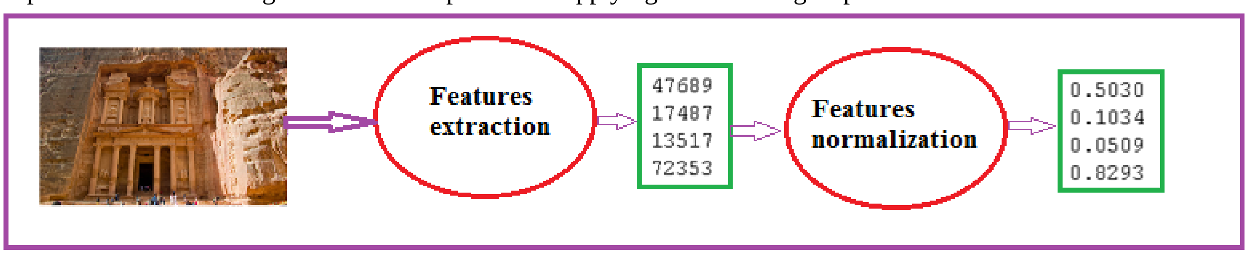

Figure 9: Features normalization

1) Select the minimum value (m1) from the features data base (equation 1).
2) Select the maximum value (m2) from the features data base (equation 2).
3) Apply equation 3 to find the normalized features.

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$$m_1 = min(F) \quad (1)$$

$$m_2 = max(F) \quad (2)$$

$$N_{i,j} = (F_{i,j} - m_1)/(m_2 - m_1) \quad (3)$$

Implementation and experimental results

The normalization process was implemented using the features database shown in figure 4; figure 10 shows the obtained normalized features:

Image 1	image 2	image 3	image 4	image 5	image 6	image 7	image 8	image 9	image 10
0.5951	0.5776	0.5030	0.6259	0.3651	0.5993	0.7141	0.6249	0.6326	0.5710
0.0456	0.0498	0.1034	0.0864	0.0884	0.0835	0.0549	0.0803	0.1111	0.1273
0	0.0112	0.0509	0.0834	0.0321	0.0659	0.0314	0.0586	0.0936	0.0832
0.8567	0.8439	0.8293	0.6868	1.0000	0.7462	0.6924	0.7218	0.6516	0.7045

Figure 10: Normalized features

The following matlab code was used to build and train ANN classifier using the original feature database:

```
clear all,clc,close all
load features
in=features;
tar=[1,2,3,4,5,6,7,8,9,10];
imagenet=newff(minmax(in),[4 1],{'logsig','purelin'});
imagenet=init(imagenet);
imagenet.trainParam.goal=0;
imagenet.trainParam.epochs=1000;
imagenet=train(imagenet,in,tar);
sim(imagenet,in)
save imagenet.mat
```

The mean square error between the calculated outputs and the targets was very high (average 8.25), which means that the classifier does not predict the image number correctly, because the values of the input dataset are very high and it will lead to generate a neuron output with output always equal one(see figure 11).

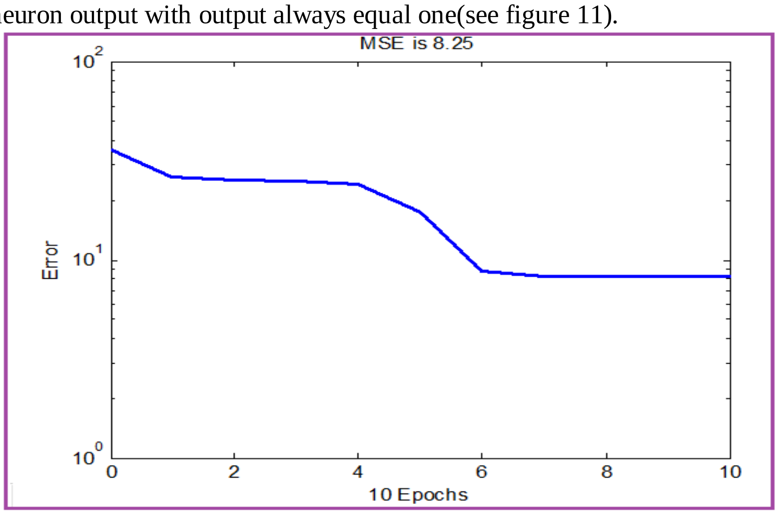

Figure 11: Estimated error using features

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The following matlab code was used to build and train ANN classifier using the normalized features:

```
clear all,clc,close all
load features
m1=min(min(features));
m2=max(max(features));
in=(features-m1)/(m2-m1);
tar=[1,2,3,4,5,6,7,8,9,10];
imagenet=newff(minmax(in),[4 1],{'logsig','purelin'});
imagenet=init(imagenet);
imagenet.trainParam.goal=0;
imagenet.trainParam.epochs=1000;
imagenet=train(imagenet,in,tar);
sim(imagenet,in)
save imagenet.mat
save m1
save m2
```

The mean square error between the calculated outputs and the targets was closed to zero (average 7.96055e-27), which means that the classifier predicts the image number correctly (see figures 13 and 14).

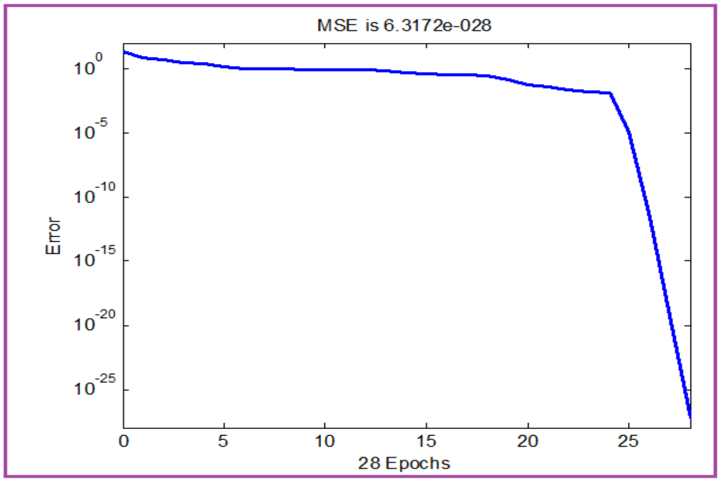

Figure 12: Estimated error using normalized features

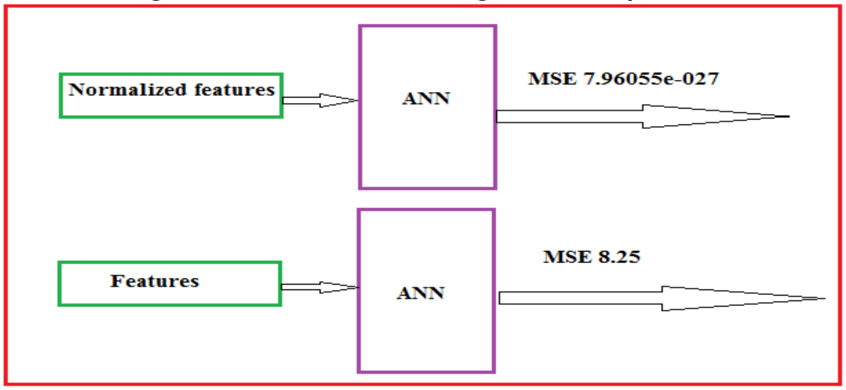

Figure 14: Average estimated error

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Conclusion

Minimizing the classification error is very important to get an optimized classifier based on ANN. The proposed method was implemented and tested and it was shown that the proposed method will decrease the high features values, which cause a high classification error. The range of the features was reduced to [0, 1], and this reduction affects the ANN performance by getting and calculating the required image classifier making the classification error very closed to zero.

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