Image classification using vector Quantization &Neural Networks

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Abstract

Image processing science reached today a very special standing. It is one of the modern and important applications in many fields. The research aims to design and build algorithms for image classification using Vector Quantization technique (VQ) and Neural Network (N.N).In the first stage of this work the data are collected from (30) different images. It is required that these images to be segmented into matrix of (8×8) dimension. These segments will be used collectively in the generation of reference sets for the purpose of classification. It is required next to obtain a codebook of size (2) using VQ algorithm. These two codeword are used in the clustering of the database. As a result a (20) reference segments are obtain. These references were numbered as 1 up to 20 for the purpose of labeling.

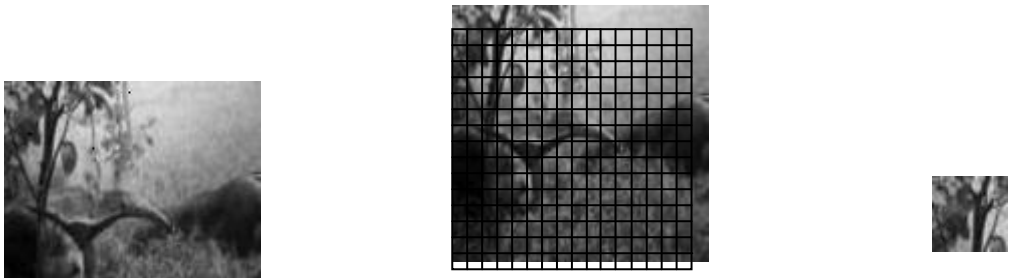
Next, the classification has been achieved by two methods, once the labeling of the reference set and next on the neural network. In the testing, 5 images are tested by the proposed system. An overall accuracy of 75% was achieved correctly for neural network methods.

1. Introduction

In almost every area of science and technology, signals must be processed to facilitate the extraction of information. Thus, the development of signal processing techniques and systems is of great importance. These techniques usually take different form of converting a signal into another signal that is in some sense more desirable than the original [1]. The novel idea of using synthetic images as a possible source of patterns for the VQ process is also discussed. Vector quantization can be viewed as a form of pattern recognition, where a vector approximates an input pattern contained in a stored set of codeword. For all these reasons, vector quantization schemes have been developed to take advantage of the inherent redundancies in digital images. [2]

2-Image Preprocessing:

This segmentation process the frame size of the image is not important. Because the aim here is to divide the given image into segments of equal length of size (8×8) pixels. For example if the given image is of (128×128) pixels, then the segmentation process results in 256 sub images of mentioned (8×8) size. Figure (1) shows this segmentation process.



(a) Original image (b) Grid of segmentation into 256 sub-image
(c) Zooming of one image (8*8)

Figure (1): Image of a given sub image into 256 segmentation

3. Feature Extraction Process:-

The successes of any algorithm depend firstly on the selection of feature. The better this selection the higher the performance of the rebuild algorithm. It was found by several researchers elsewhere that some times leaving the spatial domain and replace it with its transformation mostly give a better result when dealing with image signals. In this feature extraction process the Vector Quantization (VQ) was selected. Hence, after image segmented it was subjected to (VQ). The aim here is to reduce the huge data that is not including in classification process to be done on it. The resulting images of interest are known as the references to be stored for future analysis. [٣]

4. Implementation VQ Algorithm:-

There are two types of generation of references, namely the Deterministic and the Probabilistic. In this thesis, the deterministic generation of reference is used. The purpose of these two methods is to generate two references, when one has always one reference. [٤]

5. Algorithm for Determination of Codebooks:-

The procedure used in codebook generation is as follows: - Initialization: initialize a codeword of size 2 in the form of reflection coefficient vectors. The two initial codeword used here are obtained by the following steps:

a. Calculate the average of the training vectors.
b. Obtain the reflection coefficient vector for this average vector.
c. Multiply the reflection coefficient vector by (1.01& 0.99) to produce the initial codeword. Note that these values of the multiplying factors were chosen after several testing.

2. Classification: classify the training vectors into the bins of the codeword by the nearest neighbor rule.
3. Check for the empty bins and if there are any then replace them through the following procedure:

a. Find the most popular bin, which is the one that possesses the highest number of training vectors that are classified to its codeword.
b. Form two new bins whose initial codeword are obtained by multiplying the reflection coefficients of the most popular bin by 0.99 and 1.01, then delete the previous popular and the empty bin.
c. If there are more empty bins, then find the second most popular bin and replace its codeword together with the second empty bin codeword following step (b) above.
d. Repeat procedure (c) above until all the codeword of the empty bins has been replaced.

e. Repeat step (2) for the new bin positions (the new codeword, which are in the form of reflection coefficients).

4. Updating: update the codeword for each bin by computing the average of training vectors in its bin through the following steps:
   a- Calculate the average of vectors that are classified to the bin.
   b- Calculate the reflection by solving the LBG equation for average vector.
   c- Use the new reflection coefficient vectors as the current codeword, and branch to (2).
5. Optimization: repeat (2) through (4) until the average distortion drop below a preset threshold, or when some other stopping criterion is met (i.e., when the number of iterations exceeds a limit).
6. If the maximum desired size of codebook is reached, stop the process; if not, proceed to (7).
7. Termination: initialize codeword for the next codebook stage by perturbing each codeword (in the form of reflection coefficient vector) with two multiplication factors, then go to (2). Different values of multiplying values are possible and those that are used here are (0.99 and 1.01). The above method of splitting is called the binary- spilt method. Show the flowchart of the codebook in Figure (2)

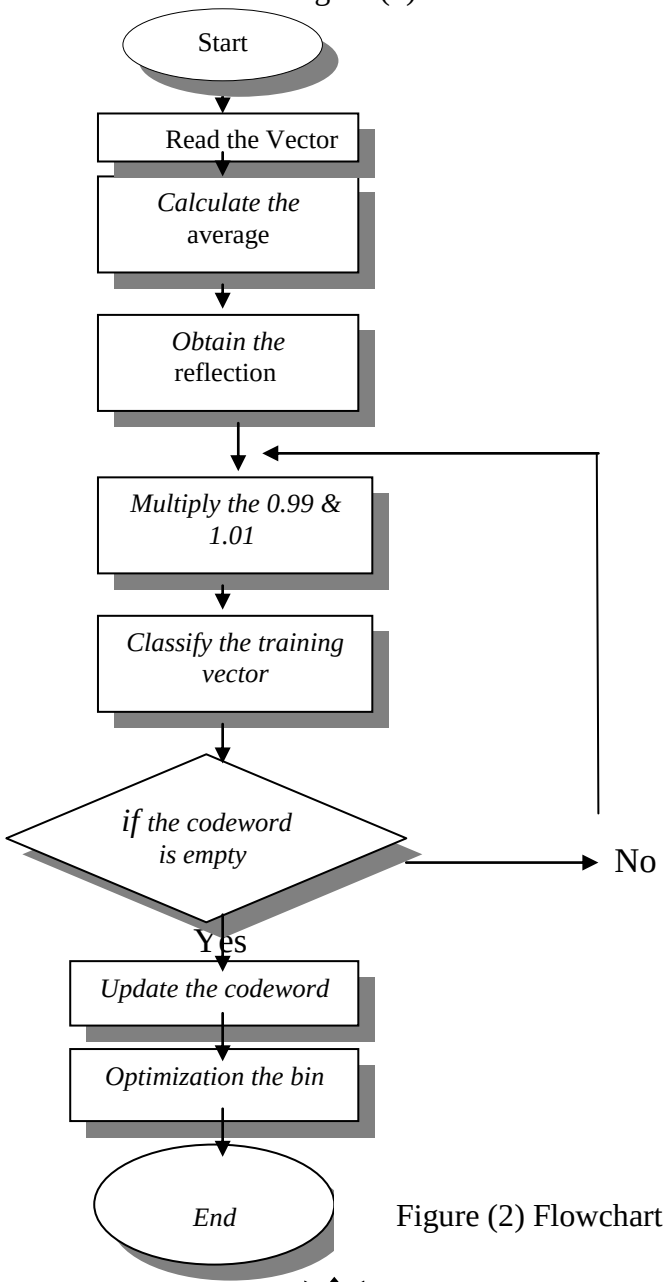


Figure (2) Flowchart of Codebook Generation

6. Classification of VQ:-

The classification requires no bits more to describe than those required for compression alone, an important feature in low memory or low bandwidth situations. Such combination can be used to highlight regions in the reconstructed image belonging to a specific class or to provide an efficient front end to more sophisticated full frame recognition algorithms. If the VQ output is intended for classification, the compression design can provide better performance than if the quantization and classification algorithms were designed independently. The notion of using VQ to classify is implicit in the classical nearest neighbor (NN) classification algorithms [5]. The NN classifier is constructed by labeling every training vector by its class and then using the entire training set with the corresponding classes as a VQ for future vectors. A new vector is classified by finding its nearest Euclidean neighbor in the training set and then assigning the label of that nearest neighbor to the new vector. The entire training set is the codebook, which can be extremely large. Although this can be considered as an application of VQ classifier construction, little compression of the input is realized if the training set is large. One can reduce the codebook size by eliminating a subset of codeword whose removal causes the least damage to the classifier performance. Instead of applying explicit clustering to minimize the squared error of a reduced set of labeled templates, the nearest neighbor literature considers classification error when reducing the codebook size [6]

7. The proposed technique Vector Quantization & Neural Network)

7.1 .Image Database:-

A database of ٣٠ pictures are collected which consists of wide spread a different pictures. These images are first divided into (8*8) frames. These pictures are labeled as im١ till im٣٠. As a result, many of ٧٩٥٠ segments are frames. These will be used for generation of the image and as well as testing proposed algorithm. This size is preferred here since the (8×8) size was used in several standard applications like image compression using only JPEG and in image transmission.

7.2 General of the Proposed Algorithms:-

Natural images are well characterized as a linear combination of vector quantization. It can be used in signal classification. Here, an algorithm that based on image VQ that used in the classification is proposed. Based upon the above classification a method a procedure is given for this purpose. The integrated flowcharts of the proposed algorithms are given in Figure (3)

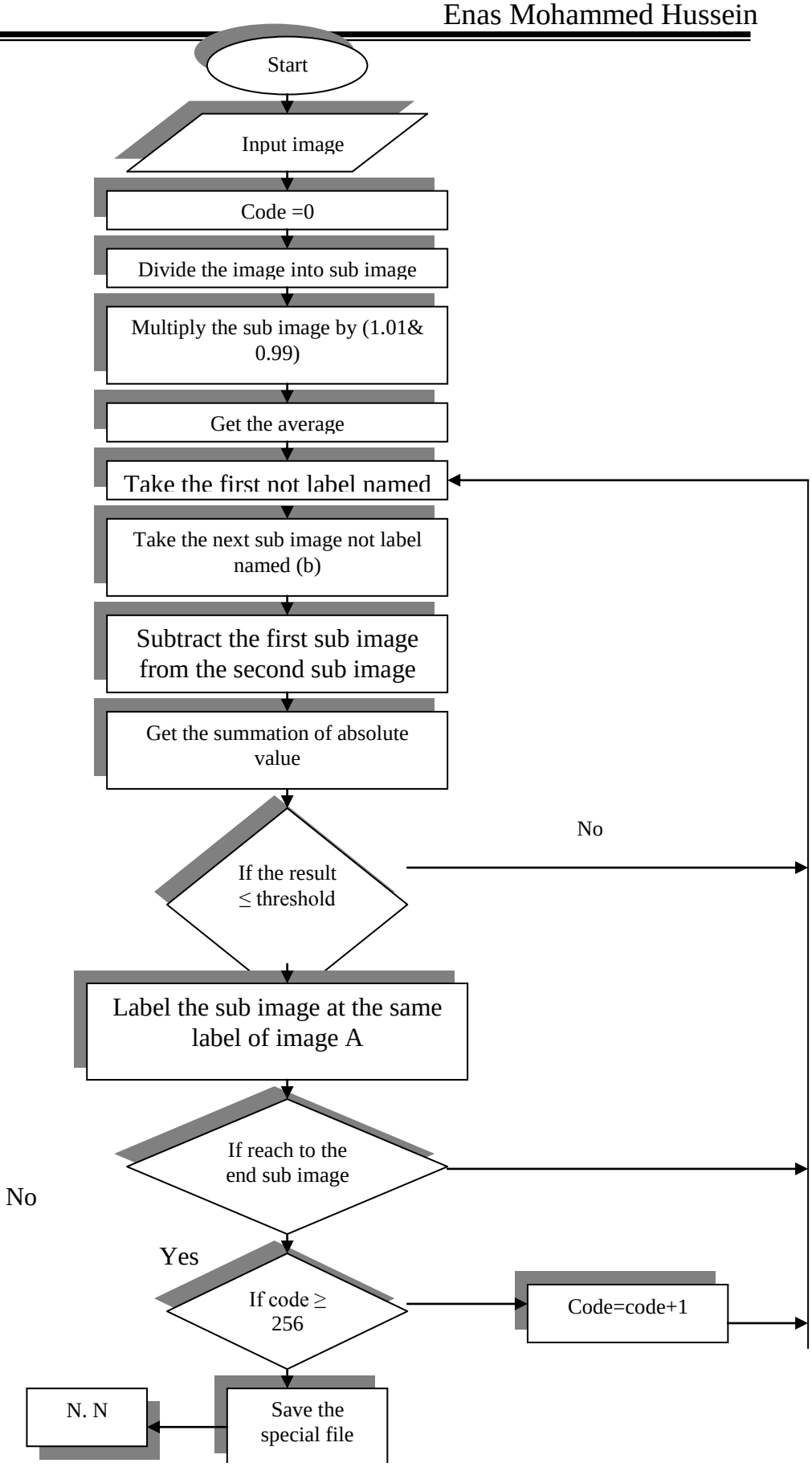


Figure (3): Flowchart the Proposed of Algorithm

7.3 Image Classification using Labeling Technique:-

After generating the ٢٠-reference segments fir the 8 training image, a labeling process is conduct for the test images using these segments. The aim here is to classifier image using these labels. The reference segments are numbered from 1 up ٢٠ and those segments that are similar to these take these corresponding numbers. The classify process was achieved through the following procedure.

Step-1- Give a test image it is first required to divide it into segments of (8×8) pixels

Step-2- Compute the VQ of each (8×8) segments.

Step –3- Start classifies each segments of the test image into one of the 10 reference segments. The same absolute distance measure was used.

The result of this step is labeled version of the test image.

Network. Show segments of the test image into one of the 20 reference segments. The same absolute distance measure was used.

7.4 Classification Algorithm Based on Neural Network:-

This algorithm consists of two phases the training phase and the classification phase. For each phase several steps are required that based on the feature extraction and the neural network classifier. The following procedure is used in the training phase: -

Step-1- Segment the given image into sub-image of equal length of (8×8) pixels.

Step-2- Compute the VQ of each segment.

Step-3- Input the segments of the given image to the neural network.

In the classification phase it is required to apply the following steps to achieve this function.

Step-1- For the given test image, it should be divided into (8×8) Segments.

Step-2- Obtain the VQ for each segment.

Step-3- It is now required to input these segments to the neural Networks that were trained before.

It is important here to mention that after several experimental tests it is necessary to supply only the different segments that were obtained using the proposed algorithm for labeling. Therefore, in all the testing phases those segments that are of different feature will be given to the neural network. Shown the Figure (4).

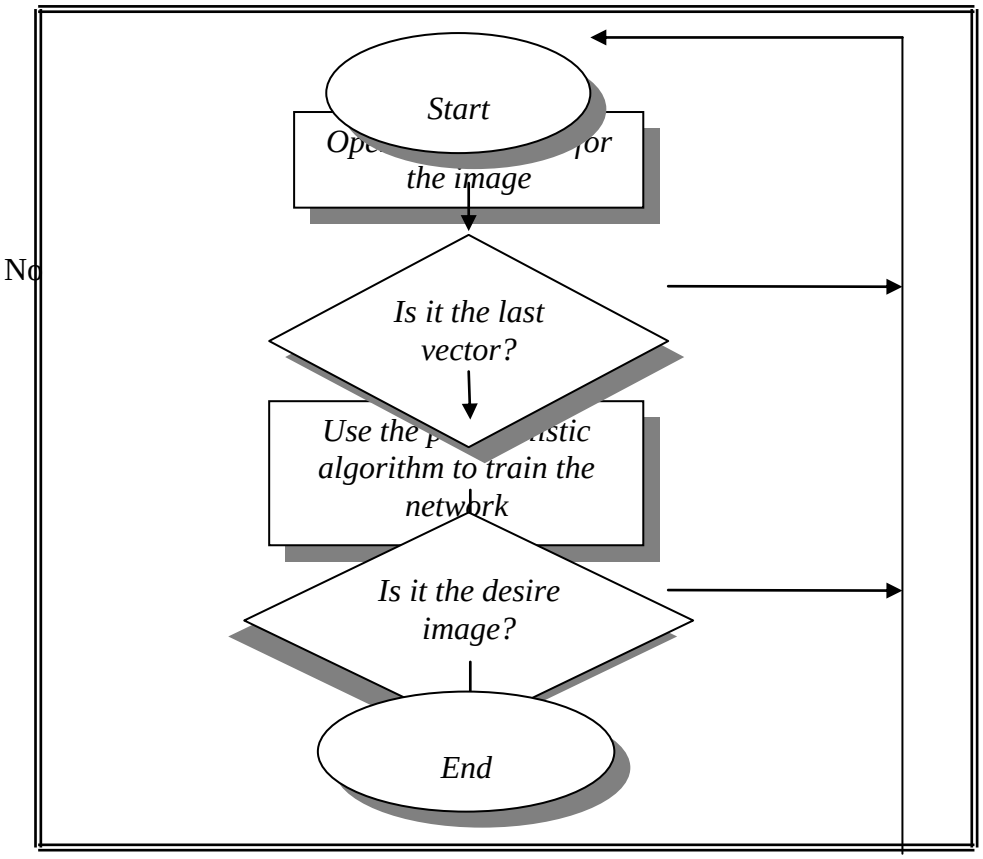


Figure (4) Flowchart of Training

7.5 Evaluation Test of the Result:

Several experimental tests were carried out to evaluate the performance of the proposed algorithms. The data based mentioned before were used and here only the results of 5 images are given here. Using the proposed algorithm of generation of reference segment and using them in the labeling of these segments result. The numbers are corresponding to the segment sequence in the reference set. The sequences of the segments of the given image are remaining the same. To examine the power of this algorithm a part of the test image is removed and entered classification test .Successfully classified although a part of the image is removed. It was found that removing up to 35% of the image the classification work without any error. However, it was failed up this level of removing. Now, let us examine the second proposed classification algorithm, which based on the neural network. Given the 30 images data under consideration test give a perfect score of 100%. Using the full 256 segments of each image. As another test only the different segments of the test image will enter the classification of the neural network. . The first column is the sequence of the test image. The second column corresponds to the number of different segments in

the test image. The third column corresponds to the test result. If the symbol is (Ok) this means it is a successful test and (Not) corresponds to a fail classification therefore, only 1 out of these 5 images is failed in this test. Thus the classification score is 75%.

.Conclusion:-٨

In this work the vector quantization has used an algorithm for image classifier. The proposed algorithm of image classification based on vector quantization in the selection of different segments from a sufficient image database. Two different methods are used in the classification phase namely the direct distance measure and the neural network. A summary of some conclusions could be the following: -

1. Selection of (8×8) size for the segment is an excellent choice, which resulted in the important of the classifier performance.
2. Splitting blocks into classes reduces the computation complexity rapidly in the codebook design and in the encoder process.
3. Vector quantization codebooks are an efficient representation of the training database from
4. The reference images selected by the proposed techniques are of an excellent representation, such that their codebook achieved the smallest average distortion.
5. The classification procedure was not only able to classify the image but also to label its individual segment successfully.
6. The proposed method needs only those different segments with a better result than those conventional methods which need all the image.

References

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Img1 **Img2** **Img3**



Img6 **Img5** **Img4**



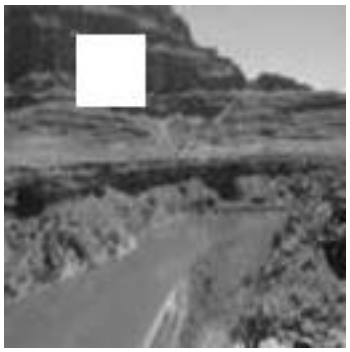
Img7 **Img8** **Img9**



Img10 **Img11** **Img12**



Img13 **Img14** **Img15**


تصنيف الصور باستخدام تكميم المتجهات والشبكات العصبية

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الخلاصة:-

وصل اليوم علم معالجة الصور إلى مرحلة متطورة جدا. ويعتبر من أهم العلوم التطبيقية المتطورة في عدة حقول. يهدف هذا البحث إلى بناء خوارزمية تصنيف الصور باستخدام تكميم المتجهات والشبكات العصبية. في المرحلة الأولى من الخوارزمية نأخذ (30) صورة مختلفة الأشكال. ونقطعها إلى صور صغيرة حجمها (٨*٨) . تستخدم هذه المقاطع لتوليد مراجع لغرض تصنيفها. ويتطلب الحصول على كتاب التشفير الذي حجمه(٢) باستعمال تكميم المتجهات. حيث يستعمل كتاب التشفير في تجميع المعلومات وكنتيجة لذلك سوف يتم الحصول على (٢٠) مرجع وهذه المراجع مرقمة من (١-٢٠) لغرض عنونتها.

يتم التصنيف بطريقتين وهما: (عنونة المراجع) و (الشبكات العصبية). حيث كانت نسبة النجاح في التصنيف (٧٥%) بطريقة الشبكات العصبية.