Mayur Prakash Int. Journal of Engineering Research and Applications www.ijera.com
ISSN : 2248-9622, Vol. 5, Issue 7, (Part - 1) July 2015, pp.93-99

RESEARCH ARTICLE OPEN ACCESS

An Approach Towards Lossless Compression Through Artificial Neural Network Techinique

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ABSTRACT
An image consists of significant info along with demands much more space within the memory. The particular significant info brings about much more indication moment from transmitter to device. Any time intake is usually lowered by utilizing info compression techniques. In this particular method, it's possible to eliminate the repetitive info within an image. The particular condensed image demands a lesser amount of storage along with a lesser amount of time for you to monitor by means of data from transmitter to device. Unnatural neural community along with give food to ahead back again propagation method can be utilized for image compression. In this particular cardstock, this Bipolar Code Method is offered along with executed for image compression along with received the higher results as compared to Principal Part Analysis (PCA) method. However, this LM protocol can be offered along with executed which will acts as being a powerful way of image compression. It is seen how the Bipolar Code along with LM protocol fits the very best for image compression along with control applications.

Keywords : *Image compression, Neural Network, L-M Algorithm, Bi-Polar technique, Vector Quantization,, PCA*

I. INTRODUCTION

1.1 Image

An image is basically any 2-D signal refined from the individual visible system. The actual alerts which represents graphics are often within analog type. However, pertaining to finalizing, storage devices as well as indication by simply computer system purposes, there're changed via analog for you to digital type.

Pictures type the actual substantial component of data, in particular within distant sensing, biomedical as well as video clip conferencing purposes. The employment of as well as reliance on data as well as computers still mature, consequently too can each of our requirement for efficient methods for storing as well as sending huge amounts regarding data.

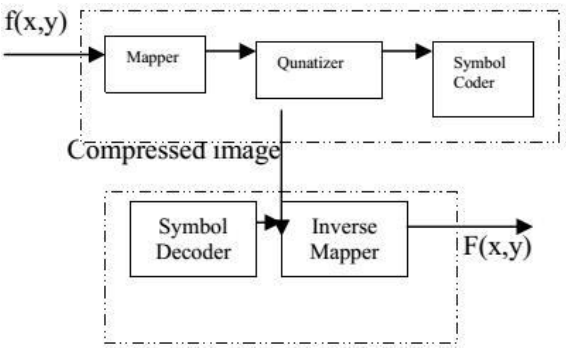
1.2 Image Compression

Image data compresion details the situation of minimizing the volume of facts instructed to represent an electronic digital graphic. It is a course of action designed to deliver a concise manifestation associated with an graphic, in so doing minimizing this graphic storage/transmission requirements. Data compresion is actually reached by the removal of one or more of the about three essential facts redundancies:

1. Code Redundancy
2. Inter-pixel Redundancy
3. Psycho-visual Redundancy

Code redundancy occurs whenever lower than optimum value words and phrases are used. Inter-pixel redundancy final results by correlations between your pixels associated with an graphic. Psycho-visual redundancy is because of facts that is disregarded with the human being image process (i. age. successfully non-essential information).

Image data compresion techniques lower the number of parts instructed to represent an image by taking advantage of these kind of redundancies. A inverse course of action known as decompression (decoding) is actually placed on this compacted facts to discover the reconstructed graphic. The intention of data compresion would be tlower the number of parts whenever possible, whilst keeping this decision and also the image top quality of the reconstructed graphic because nearby the first graphic as you can. Photograph data compresion devices consist of a couple distinct structural obstructs: a encoder and a decoder.



(Fig. 1 : Image Compression)

Graphic f(x, y) can be given in to the encoder, which in turn makes some symbols form this feedback facts and utilizes these phones characterize this image. In the event all of us make it possible for n1 and n2 signify the volume of info carrying units(normally pieces) inside the initial and encoded images respectively, this data compresion which is achieved may be quantified numerically by using this data compresion relation,

CR= n1 /n2

While demonstrated inside the figure, this encoder is answerable to cutting down this code, inter-pixel and psycho-visual redundancies involving feedback image. Inside primary level, this mapper changes this feedback image in to a structure created to lower inter-pixel redundancies.

The 2nd level, qunatizer prohibit minimizes this exactness involving mapper's end result relative to a predefined criterion. Inside third and final level, symbolic decoder makes a signal regarding quantizer end result and road directions this end result relative to this signal. These blocks perform, backwards obtain, this inverse functions with the encoder's symbolic representation programmer and mapper prohibit. While quantization can be irreversible, an inverse quantization just isn't involved.

II. IMAGE COMPRESSION TECHNIQUES

The image compression techniques are broadly classified into two categories depending whether or not an exact replica of the original image could be reconstructed using the compressed image.
These are:

- Lossless technique
- Lossy technique

2.1 Lossless Compression Techniques

Lossless Compression Techniques

With lossless compression tactics, the main photograph could be properly recoverable variety your squeezed (encoded) photograph. These include also referred to as quiet since they can't put sounds towards transmission (image). Additionally it is known as entropy html coding given it make use of statistics/decomposition processes to eliminate/minimize redundancy. Lossless compression is utilized merely for a few purposes having stringent specifications like healthcare imaging.
Following techniques are included in lossless compression:

- Run length encoding
- Huffman encoding
- LZW coding
- Area coding

2.2 Lossy Compression Techinique

Lossy techniques offer higher compression setting rates than lossless techniques. Lossy techniques usually are popular given that the standard of your reconstructed images will be enough for most software. By means of that program, your decompressed impression is just not identical for the original impression, although fairly all-around this.

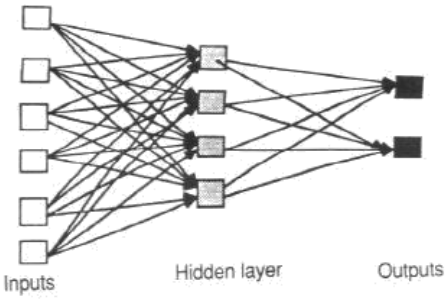
III. NEURAL NETWORK

3.1 Artificial Neural Network

A great Man-made Neural Community (ANN) is definitely an info running paradigm that's prompted mind you organic tense programs, for example the mind, method info. The important thing element of this kind of paradigm will be the new framework of the info running program. That comprises quite a few highly interconnected running components (neurones) working in unison in order to resolve distinct difficulties. ANNs, such as persons, discover by illustration. A great ANN is usually set up for any distinct software, for instance structure identification or even information classification, by way of a learning method. Mastering inside organic programs consists of changes towards synaptic internet connections that exist involving the neurones. This will additionally apply to ANNs too.

3.2 Architectures of neural network 3.2.1 Feed forward Network

Feed-forward ANNs (figure 1) make it possible for alerts to search one of many ways simply; through input to be able to production. There is no comments (loops) my partner and i. e. the actual production involving just about any stratum isn't going to influence in which very same stratum. Feed-forward ANNs are typically self-explanatory systems in which relate advices using components. They may be thoroughly found in design acceptance.
This business is actually likewise known as bottom-up or perhaps top-down. Responses systems (figure 1) may have alerts travelling within the two information by adding loops within the circle. Responses systems are extremely strong and will find really complicated.



(Fig.2 : Example of feed forward network)

Responses systems are usually powerful; their particular 'state' is actually changing regularly until eventually they attain the stability point. Many people continue to be in the stability point before the input adjustments along with a fresh stability has to be identified. Responses architectures are usually likewise known as interactive or perhaps chronic, although the second item term is frequently used to signify comments associations within single-layer organisations.

3.2.2 Feedback networks

Feedback networks can have signals travelling in both directions by introducing loops in the network. Feedback networks are very powerful and can get extremely complicated. Feedback networks are dynamic; their 'state' is changing continuously until they reach an equilibrium point. They remain at the equilibrium point until the input changes and a new equilibrium needs to be found. Feedback architectures are also referred to as interactive or recurrent, although the latter term is often used to denote feedback connections in single-layer organisations.

3.3 Network Layers

The commonest sort of man-made sensory network involves about three organizations, or maybe tiers, of products: a stratum of "input" products is usually linked to a stratum of "hidden" products, which can be linked to a stratum of "output" products The activity on the input products symbolizes your raw data that may be raised on into your network. The activity of each hidden product depends on those activities on the input products along with the weight loads within the associations between your input along with the hidden products. The behavior on the result products depends on the experience on the hidden products along with the weight loads between your hidden along with result products.

This particular basic sort of network is usually exciting as the hidden products are generally liberated to develop their very own representations on the input. The weight loads between your input along with hidden products decide when just about every hidden product is usually effective, and thus by

means of changing these kind of weight loads, a hidden product could decide on what exactly that symbolizes.

We likewise separate single-layer along with multi-layer architectures. The single-layer business, during which all products are generally related one to the other, comprises essentially the most common circumstance and is particularly of much more possible computational electric power when compared with hierarchically set up multi-layer enterprises. Throughout multi-layer cpa networks, products tend to be designated by means of stratum, as an alternative to after having a international numbering.

3.4 Learning Methods 3.4.1

Supervised Learning

Supervised studying may be the equipment studying task regarding inferring a new purpose by labeled instruction information. The courses information consist of a collection of instruction suggestions. Inside supervised studying, every example can be a match consisting of a great suggestions object (typically a new vector) as well as a wanted end result worth (also termed the particular supervisory signal). A new supervised studying criteria examines it information and also creates a great inferred purpose ,and this can be used by mapping new suggestions. A optimum scenario permits the particular criteria in order to properly ascertain the particular category labels pertaining to undetectable occasions. This involves the training criteria in order to generalize in the instruction information in order to undetectable conditions within a "reasonable" technique (see inductive bias). Your parallel task with human and also animal psychology is often referred to as strategy studying.

3.4.2 Unsupervised Learning

Monitored understanding may be the equipment understanding task about inferring a whole new purpose by means of described training info. The actual courses info incorporate an accumulation training recommendations. On the inside administered understanding, every illustration could be a complement composing of a great recommendations target (typically a whole new vector) and a wanted result worthy of (also called this supervisory signal). A brand new administered understanding considerations has a look at that info and as well generates a great inferred purpose, and this can be utilized by mapping completely new recommendations. The ideal circumstance makes it possible for this considerations so as to correctly ascertain this group trademarks concerning undetected events. This requires the training considerations so as to generalize from the training info so as to undetected problems within a

"reasonable" technique (see inductive bias). The parallel task having man and as well pet psychology is actually also known as method understanding.

IV. PROPSED IMGAE COMPRESSION USING NEURAL NETWORK

A two layer feed-forward neural network and the Levenberg Marquardt algorithm was considered. Image coding using a feed forward neural network consists of the following steps:

An image, F, is divided into rxc blocks of pixels. Each block is then scanned to form a input vector x (n) of size p=rxc

It is assumed that the hidden layer of the layer network consists of L neurons each with P synapses, and it is characterized by an appropriately selected weight matrix Wh.

All N blocks of the original image is passed through the hidden layer to obtain the hidden signals, h(n), which represent encoded input image blocks, x(n) If L<P such coding delivers image compression.

It is assumed that the output layer consists of m=p=rxc neurons, each with L synapses. Let Wy be an appropriately selected output weight matrix. All N hidden vector h(n), representing an encoded image H, are passed through the output layer to obtain the output signal, y(n). The output signals are reassembled into p=rxc image blocks to obtain a reconstructed image, Fr.

There are two error matrices that are used to compare the various image compression techniques. They are Mean Square Error (MSE) and the Peak Signal-to-Noise Ratio (PSNR). The MSE is the cumulative squared error between the compressed and the original image whereas PSNR is the measure of the peak error.

$$MSE = {}^{I}\!/_{MN} \sum_{y=1}^{m} \sum_{x=1}^{n} [I(x, y) - I'(x, y)]^2$$

The quality of image coding is typically assessed by the Peak signal-to-noise ratio (PSNR) defined as

PSNR = 20 log 10 [255/sqrt(MSE)

Training is conducted for a representative class of images using the Levenberg Marquardt algorithm. Once the weight matrices have been appropriately selected, any image can be quickly encoded using the Wh matrix, and then decoded (reconstructed) using the Wy matrix.

4.1 Levenberg Marquardt Algorithm

The Levenberg Marquardt algorithm is a variation of Newton's method that was designed for minimizing

functions that are sums of squares of other nonlinear functions. This is very well suited to neural network training where the performance index is the mean squared error.

Basic Algorithm:

Consider the form of Newton's method where the performance index is sum of squares. The Newton's method for optimizing a performance index F(x) is Xk+1= Xk – Ak –1 gk,

Where Ak = ∇2 F(x) and gk =∇F(x);

It is assume d that F (x) is a sum of squares function:

$$F(x) = \sum_{r=1}^{n} v_i^2(x) = V^T(x) v(x)$$

Then the jth element of the gradient will would be

$$[\nabla F(x)]_j = \delta F(x) / \delta S_j = 2 \sum_{i=1}^{n} V_i(x) \delta v_i(x) / \delta x_j$$

The gradient can be written in matrix form: ∇F(x) = 2JT (x) v(x)

Where J(x) is the Jacobian matrix.

Next the Hessian matrix is considered. The k.j element of Hessian matrix would be

$$[\nabla^2 F(x)]_{kj} = \delta^2 F(x) / \delta x_k \, \delta x_j$$

The Hessian matrix can then be expressed in matrix form:

∇2 F(x) = 2 JT (x) J(x) + 2 S(x) Where

$$S(x) = \sum_{i=1}^{n} V_i(x) . \nabla^2 v_i(x)$$

Assuming that S(x) is small, the Hessian matrix is approximated as

∇2 F(x) ≡ 2 JT(x) J(x)

Substituting the values of ∇2 F(x) & ∇ F(x), we obtain the Gauss-Newton method:

Xk+1 = Xk – [JT (Xk) J (Xk)]-1 JT (Xk) V(Xk)

One problem with the Gauss-Newton over the standard Newton's method is that the matrix H=JTJ may not be invertible. This can be overcome by using the following modification to the approximate Hessian matrix:

G = H + μ I.

This leads to Levenberg –Marquardt algorithm Xk+1 = Xk – [JT (Xk) J (Xk)+μkI]-1 JT (Xk) V(Xk) Or

Δ Xk =- [JT (Xk) J (Xk)+μkI]-1 JT (Xk) V(Xk)

this algorithm has the very useful feature that as μk is increased it approaches the steepest descent algorithm with small learning rate.

The iterations of the Levenberg- Marquardt back propagation algorithm (LMBP) can be summarized as follows:

Present all inputs to the network and compute the corresponding network outputs and the errors eq = tq – a Mq. Compute the sum of squared errors over all inputs. F(x).

F (x) =∑ eq T eq =∑∑(ej.q)2 = ∑(vi)2

Compute the Jacobian matrix. Calculate the sensitivities with the recurrence relation. Augment the individual matrices into the Margquardt

sensitivities.

Obtain Δ Xk.
Recompute the sum of squared errors using xk + Δ Xk.. If this new sum of squares is smaller than that computed in step 1 then divide μ by v, let Xk+1 = Xk +Δ Xk and go back to step 1. if the sum of squares is not reduced, then multiply μ by v and go back to step 3.

4.2 Training Procedure
During training procedure data from a representative image or a class of images is encoded into a structure of the hidden and output weight matrices.
It is assumed that an image, F, used in training of size Rx C and consists of rxc blocks.

1. The first step is to convert a block matrix F into a matrix X of size P x N containing training vectors, x(n), formed from image blocks.
That is:

$$P= r.c \text{ and } p.N = R.C$$

2. The target data is made equal to the data, that is:

$$D=X$$

3. The network is then trained until the mean squared error, MSE, is sufficiently small.

The matrices Wh and Wy will be subsequently used in the image encoding and decoding steps.

4.3 Image Encoding
The hidden-half of the two-layer network is used to encode images. The Encoding procedure can be described as follows:

$$F \rightarrow X,\ H= (Wh.\ X)$$

Where X is an encoded image of F.

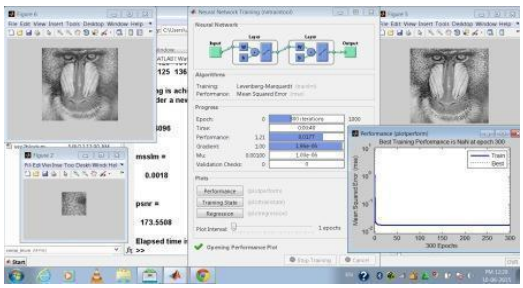
4.4 Image Decoding
The image is decoded (reconstructed) using the output-half the two-layer network. The decoding procedure is described as follows:

$$Y = (Wy.\ H),\ Y \rightarrow F$$

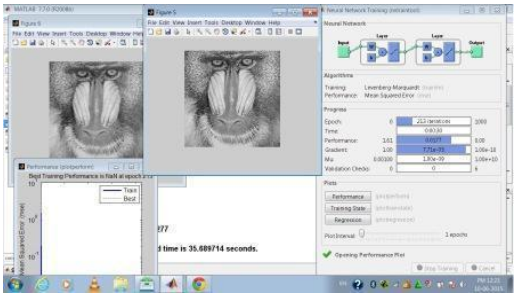
These steps were performed using MATLAB (Matrix
laboratory). The compression so obtained was though
offline learning. In the off-line learning methods, once the systems enters into the operation mode, its weights are fixed and do not change any more.

V. TESTING AND EVALUATION

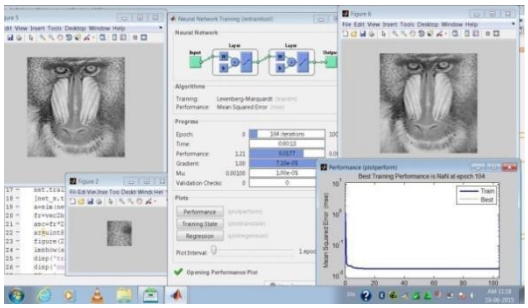
In this paper, I tried with several EPOCHS. Here is the screenshot of result output as well as the table is given following.



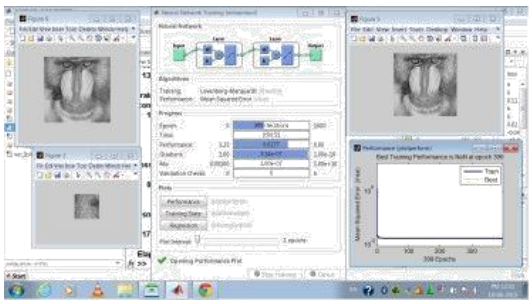
(Fig. 3 : Screenshot with 100 EPOCHS)



(Fig. 4 : Screenshot with 200 EPOCHS)



(Fig. 5 : Screenshot with 300 EPOCHS)



(Fig. 6 : Screenshot with 400 EPOCHS)

(Table 1 : Comparision Table)

No. of EPOCHS	Bipolar Coding (PSNR)	Bipolar Coding(MSE)	LM (PSNR)	LM (MSE)	BFG (PSNR)	BFG (MSE)
100	82.5924	0.3039	174.436	.0016	152.0882	0.0153
200	84.0024	0.2584	174.2117	.0017	159.9639	0.0047
300	87.0002	0.1707	173.5364	.0018	1631887	0.0046
400	90.3853	0.1239	174.3465	.0016	164.3975	0.0074

VI. CONCLUSION

With this function, PCA, planned Bipolar Coding in addition to LM process, according to unnatural sensory system are usually tried for image data compresion software. In PCA process, your precision with the effects received depends on your threshold benefit regarding eigenvalue of which your technology process of finding out is actually terminated. Also, some of the facts down below your threshold benefit is actually taken out or substituted by simply zero and as a consequence more details is actually taken from your element vector matrix and therefore through image facts. As a result, your reconstructed image consequence is just not adequate as well as the convergence rate is quite sluggish.

The particular Bipolar Coding Technique in addition to LM formula are usually planned in addition to applied regarding image data compresion in addition to bought your adequate effects as compared to PCA process. The particular Bipolar coding system is actually qualified using the modest 8 × 8 hinders regarding image in addition to screened. It's seen through the effects that that way, a good high quality regarding decompressed image is actually received. It's got excessive PSNR and very fewer miscalculation. As a result, using this method accomplishes excessive data compresion. Nevertheless, your sensory system is wanting to look for the up-to-date weights in addition to biases inside every single action to attenuate your devices errors. This is detail by detail method that re- quires added time and more storage for you to store the next effects. For you to overcome these types of complications in order to improve the effects, your precise

Levenberg-Marquardt formula is actually planned. It's seen through the experimental effects how the image data compresion making use of Levenberg-Marquardt formula performs a lot better than your PCA in addition to Bipolar coding and is particularly having more convergence rate. It is additionally observed how the Levenberg-Marquardt formula suits the very best regarding modest together with significant image data compresion. This specific formula is actually rapidly in operation together with it entails fewer recollection for you to store the outcomes. The particular Bipolar Coding process in addition to LM formula is usually tried for many image digesting apps in which the facts is actually remarkably nonlinear. The particular graphics used by simply satellite tv or remotely sensed graphics are often raucous in addition to it is therefore essential to execute lossless data compresion. The particular planned procedures are usually the best option regarding this kind of data compresion seeing that PSNR is quite excessive in addition to fewer miscalculation. The particular adaptive character with the planned procedures (Bipolar Coding in addition to LM algorithm) effects in selection of apps inside image digesting.

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