J.Basrah Researches (Sciences) VoI.31.Part.3.28-32 (2005)

A Hybrid System for Image Compression

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Received 22/3/2004, Accepted 2/10/2004

Abstract

A hybrid system for image compression that combines both the run length encoding (RLE) method and neural network is proposed. This system is used to compress the image efficiently. The RLE method is used to compress the image and the neural network compress it again. An example is given to show the effectiveness of the proposed approach.

Introduction

The goal of compression is to obtain an image representation while reducing as much as possible the amount of memory needed to store the image, and the amount of data needed for transmitting the image over a communication channel [1].

The right way to accomplish image data compression is to start with the investigation of fundamental issues of image encoding system. In an encoded image, the image is encoded in a much smaller number of bits than the total required to describe it exactly. Thus, encoding is directly linked to image compression. The encoded or “compressed” image must then be decoded at a receiver into a full size picture. In [1], a complete reference to image encoding system, and in [2], good classifications of compression techniques are given. A recent approach to image compression introduced in [3] uses the techniques of neural networks.In this paper, an effective image compression technique that uses both the run length encoding method and the neural network is developed. At the first step of our approach, the traditional RLE method for compression is used to compress the image, and then, in the second step, the compressed image is used as an input to the neural network. A multilayer feedforward neural network is used for the compression of the output of the first step. The neural network is trained with the output data from the first step. The neural network is trained with the output data from the first step. After training, the compressed image will be stored in the network.

Image encoding

There are three abstraction levels for the specification of an image in the computer as shown in figure (1). The continuous image, the digital image, and the encoded image. In an encoded image, the digital image is transformed into a set of symbols, which are organized according to some data structure, and encoded by using strings of bits [4-7].

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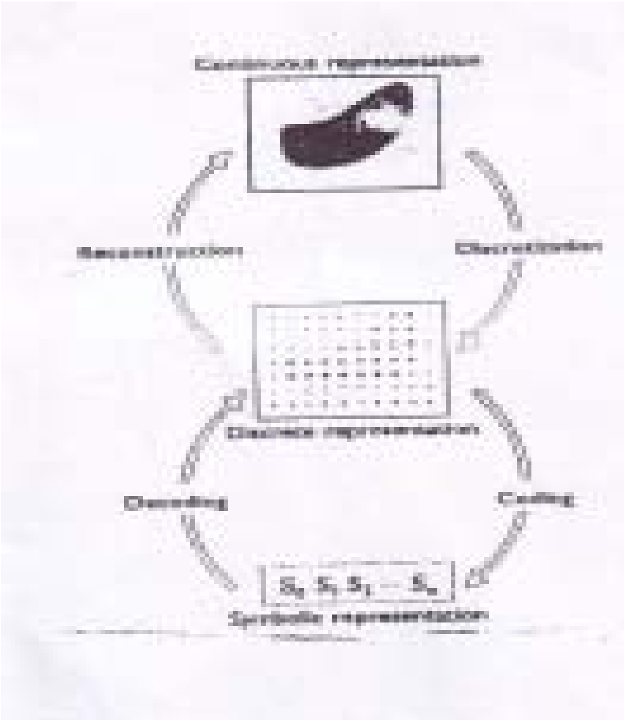

Figure (1): Abstraction levels of an image in the computer.

1- Run-Length Encoding

Run length encoding method is an image compression method that works by counting the number of adjacent pixels with the same gray level value. A digital image is made up of small dots called pixels. Each pixel can be either one bit indicating a black or a white dot, or several bits, indicating one of several colors. Compressing an image using RLE is based on the observation that if we randomly select a pixel in the image, there is a good chance that its neighbors will have the same color. The idea behind this approach to image compression is; if a data item d occurs n consecutive times in the input stream, replace the n occurrences with the single pair nd, n consecutive occurrences of a data item are called a run length encoding or RLE.

2- Entropy Encoding

The techniques of this area apply to the encoding of any information and not only to images. Generally, we can regard the information to be encoded as a “message” to be stored or transmitted. The message is encoded using symbols from a fixed, finite alphabet A={ f_0, f_1, f_2, … , f_{L-1}}, with L elements. It is natural to associate the alphabet a probability measure P. The value of P attach symbol $f_i \in A$ gives the probability of occurrence of the symbol in a message. The message itself is modeled as a random function F defined over the alphabet. The probability of the symbol f_k occurring in a message is $P(F=f_k)=P_k$; for k=0, 1, 2, …, L-1.
The amount of information in the message I is measured by
$I(f_k) = \log (1/P_k)$
The amount of information carried by the message is the sum of the amount of information carried by each symbol in the message. That is,

$$E = \sum_{k=0}^{L-1} P_k I(f_k) = \sum_{k=1}^{l-1} P_k \log_2 \frac{1}{P_k} = -\Sigma P_k \log_2 P_k$$

The number E is called the entropy of the message.

3- Neural Network Technique

Image compression can also be performed using neural networks. To implement the mapping function F and G as have shown in figure (2). The encoded image is given by function G performing mapping from input space R^d to a lower dimensional feature space R^m

(hidden layer), and the decoding is given by the function F mapping from R^m back to the original space R^d (output layer).

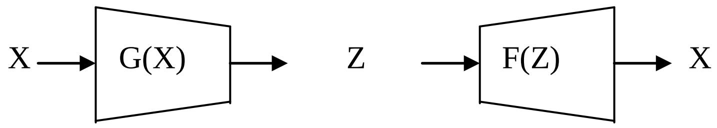

Figure (2) : Process of the mapping function F and G.

Neural Network for Image Compression

A neural network is a system with input layer, hidden layer, and output layer. Each layer is composed of many simple and similar processing units. The processing units, each have a number of internal parameters called weights, changing weights of a unit will alter the behavior of the unit and, therefore, will also alter the behavior of the whole network. The goal here is to choose the weights of the network to achieve a desired input\output relationship. These weights are adjusted via a learning process. Learning is accomplished by adjusting these weights step by step (typically to minimize some objective function) and, then, storing these best values as the actual strengths of the interconnections. The interconnections and their strengths provide the memory, which is necessary in a learning process.

The ability to learn is one of the main advantages that make the neural networks so attractive. They also have the capability of performing massive parallel processing, which are in contract to the Von Neumann machine- the conventional digital computers in which the instructions are executed sequentially. Neural networks are characterized by their network topology; that is, by the number of interconnections, the node characteristics that are classified by the type of non-linear units used and the kind of learning rules implemented. A clear and concise general introduction to neural networks is given in [8-10].

With the rapid development of neural network research used as motivation, there is a renewed interest in image data compression using techniques of neural networks. The work in [3] is representative of image encoding using neural networks. They develop an algorithm based on back-propagation with a fully connected feedforward neural network. It is an auto association network with a single hidden layer of m units and n input\output units. This network was originally proposed for image compression. The image may have the size of n. So that, both the input layer and output layer will have n units. If the hidden layer has much fewer units m, then, data compression is achieved with $m<n$, when both the input and output layer are clamped by the same image, the network performs auto association through back-propagation learning. After completion of learning, the connection weights are believed to have captured the characteristics of the input data. When an image is presented to the input layer, the activation pattern appearing in the hidden layer is the compressed representation of the input image, which allow a reduction in the memory used to store the images. The compressed representation of an image used as input to the hidden layer to achieve the desired output. This reduces the overall amount of memory needed to store the image.

Image Compression using Hybrid System

A hybrid compression system consists of two parts A, and B. They play different important roles for image compression. Part A (RLE method) is used to store the length of the intervals, where the pixels of the image have the same value, together with the constant value in that interval. This part compresses the size of an image, and gives output normally, a restricted region of the input pattern. This restricted region is considered as the input to the following part B (neural network). Part B uses feedforward neural network with a single hidden layer to perform the learning process. This part is used for the final compression of the image. The compressed image from part A is presented to the input layer. The output layer of the neural network takes the source image. After training, the state of hidden layer represents the compressed representation of the input compressed image.

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Simulation Study

In order to show the ability of the proposed system. The arabic numerals from 0 to 1 as shown in figure (3) were provided one after another to the input of both the proposed hybrid compression system, and the algorithm in [3].

The hybrid compression system, which consists of two parts; RLE and neural network, is used to compress the image. The RLE part compresses the size of the images from 64 units to $20 \subseteq N \subseteq 30$, where N is the number of units of images after the first compression. The neural network part receives N units as input. The feedforward neural network consists of 30 input units, 12 hidden units, and 64 output units. In this approach, the number of input units and hidden units is much fewer than that in [3] which uses feedforward neural network with 64 input\output units and a single hidden layer consists of 16 hidden units.

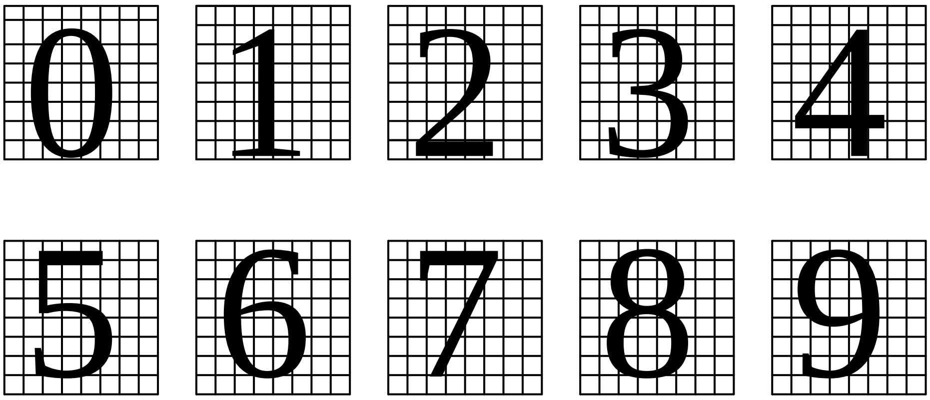

Figure (3) : Typical examples of Arabic numerals.

Conclusions

In this paper, the idea of using neural networks for image compression is discussed. Feedforward neural network approach attempts to reduce the amount of memory needed to store images. In order to reduce the amount of memory needed to store images more efficiently, we have presented a new approach to the image compression that combines both the RLE method and feedforward neural networks. The RLE method reduces the number of the input units to the network. Then, feedforward neural network is used for further compression of the image.In this approach, the size of the neural network needed for image compression is smaller than that of using only neural network. Also, the number of hidden units, which are used for storing image data will be less.

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نظام هجين لتقليص الصور

عبدالكريم يونس عبدالله و عدالة مهدي جياد

فزل عكلطكحئزائـ ة/ قكي بطكعكل

طكا شنب/طكعف

طك لكخ ش

في هذا البحث، تم اقتراح نظام هجين لتقليص الصور يدمج كلا من الشبكات العصبية وطريقة RLE . استخدم هذا النظام بطريقة كفوءة لتقليص الصورة اولا باستخدام طريقة RLE ، ثم يتم تقليصها مرة اخرى باستخدام الشبكات العصبية. تمت ملاحظة كفاءة النظام المقترح من خلال استخدامه في تقليص مجموعة من الصور.