A SURVEY ON DIGITAL IMAGE COMPRESSION

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Keywords: Image encoding wavelet transform JPEG.

Abstract: Image compression enencoding is one of the key techniques in modern multimedia and communication field. The methods of image encoding are of a great variety currently every kind of encoding methods all exist respectively merit and shortcoming. This paper summarizes the traditiona image compression enencoding methods and the modern image encoding methods and the hybrid image encoding methods. The paper presents the direction of researching image compression enencoding next step.

1 INTRODUCTION

Image compression technology is in the field of modern multimedia and key technology of communication. Since 1948 digital TV signals to the idea of proposed, science instant began after of image compression research, has been 60 years of history. In recent years, with the advent of the information age and digital multimedia computer technology development, no matter be traditional air broadcast, cable TV companies or digital STBS, television, mobile multimedia, makes people face the various data quantity increased, signal is transmitted by bandwidth when the restriction, especially the wide application of computer network, the more promoted the image compression technology and related theory research and development. In 1988, formed the ITU - T h. 261 draft, the draft to pass in 1990, marks the image encoding the important step towards practical. This paper mainly introduces the development history and image encoding encoding method, introduced the main technical image encoding.

2 THE RESEARCH STATUS OF IMAGE ENCODING

Image encoding is present information science research, one of the most active areas in pixels or pixel blocks for encode entity image encoding technology (such as the entropy encoding, transform encoding, forecast encoding, motion compensation

mature gradually, etc) has been widely used in JPEG, MPEG - 1, mpeg-2,, 261, h. h. 263 and other international standards. Along with the development of multimedia communication, computer, communication, and consumer electronics, promoted the crossover fusion image encoding technology research, the new image encoding method are continuously emerging.

Image compression technology from the time development can be divided into two generations. the first generation is based on statistics, removving redundant data compression method l; The second generation is based on the content, remove the content is redundant, which are based on object method called middle-level compression encoding method based on grammar, senior encoding method as the method.

2.1 The First Generation of Image Encoding Technology

(1) Predictive Encoding
Predictive encoding predicts the current values with transmited pixels, to encode the difference between values and the actual value. Predictive encoding is the earliest image encoding technology with motion compensation frames between forecast encoding for computational complexity is lower, facilitate real-time realization and often for various image encoding adopted by the international standard.
(2) Statistical Encoding
Statistical encoding say entropy encoding, classical statistics encoding have Haffmann encoding, arithmetic encoding and run-length encoding etc.

Hoffmann encoding method is based on the source of various symbols appear the probability of encoding, the encode is simple and effective. The arithmetic encoding is completely abandoned with special characters instead of input characters thoughts, it is to the data with 0 to 1 between the floating-point number for enencoding, when the source of the probability of symbols is more adjacent, arithmetic encoding efficiency than hoffmann encoding, but the realization of the arithmetic encoding than hoffmann encoding is more complex. The run-length encoding is relatively simple encoding technology, it is a zero called run-length, convert instead of special character, reducing the amount of data, mainly used in image quantified appear under the condition of the continuous zero.

(3) Transform Encoding

Transform encoding is a certain function transform, from a representation space change to another representation space, then transform domain, on the transformation of signal encoded. This transformation encoding essence is to pass transform the way of the original image energy mainly concentrated in a few parts of the coefficient, so can more easily to do image compression.

2.2 The Second Generation of Image Encoding Technology

The traditional encoding method has many shortcomings, such as high compression ratio restore images appear serious square effect, the human visual characteristics not easy is introduced to the compression algorithm. To overcome the shortcomings of traditional compression method have been put forward several new coding method based on wavelet transform, compression method, fractal compression method and neural network method, etc..

(1) Wavelet Transform Method

The theory of wavelet transform in recent years is the emergence of new branch of mathematics, which is the Fourier transform again after a landmark development. Now, wavelet analysis method has been widely used in signal processing, image processing, pattern recognition, speech recognition, seismic exploration, CT imaging, computer vision, aviation and aerospace technology, fault monitoring, communication and electronic systems and so on themultitudinous disciplines and related technology research. Wavelet image compression is by using wavelet transform and has good spatial resolution and the frequency resolution character, make the energy and transform coefficient in frequency and

space, so as to achieve the concentration of removing pixel redundancy role.

(2) Fractal Compression Method

In various multimedia services and digital communication and other fields of application, image compression/coding is crucial technology. The vast literature published in recent years in display, image coding has made important progress, many new ideas are proposed. Fractal coding is among them one of the most prominent technology, it opened a new image compression coding ideas. Since the early 1990s, fractal coding has more than ten years in short has made remarkable achievement.

Barnsley fractal coding is put forward by the first iteration function system, from the fractal geometry theory (the important composition part). In fractal coding, an image from a make it approximate constant compression affine transformation said reconstruction images is compressed transform fixed point, compression affine transformation of the parameters of the original image fractal yards. Therefore, an image fractal coding is looking for a suitable compression affine transformation, its fixed point is the original image possible good approximation. Fractal decoding is a relatively simple rapid iteration process, decoded image fractal codes by compressed transform iterative function said in any initial image to approach.

Fractal image coding is the search for the basic ideas of image among different regions under different scales similarities. Therefore, and usually, as the image coding method of fractal coding system design of the first step is for image segmentation, which divided into some taller image for coding regions (R block), each branch area in the images of the corresponding to an object or object, the next part of the main steps of each branch area is its affine similar for large area (D block). As such, each for a group of block R affine transform coefficient, regardless of the segmentation information and if, then nearly yards coding coefficient fractal codes is proportional to the file size. The number of pieces of R Therefore, partition is the key factor than determines compression.

Segmentation is to determine the decoded image quality and a key factor, a good segmentation scheme should reflect the image similarity across the scale. Image both smooth uniform regions (brightness constant or slow-moving area), and have high contrast area (such as edge regions). In uniform regional part, use large can achieve good collage, meanwhile, high contrast area are need to use small size block just might come to hope the image quality. To achieve this, must adopt more flexible

segmentation method (variable size block division). Contains coded quardtree segmentation, the various variable size block segmentation method has been widely adopted by the fractal coding literature.

Fractal coding (a compressed affine transformation description) is a division of information and quantitative transform parameter of different segmentation scheme, the size of the segmentation occupies information is different. From compressed perspective, segmentation scheme possession of information has been jumped over lesser, but if an irregular segmentation brings good subjective and objective coding quality, spending a little coding cost is worth it. Therefore, in the influence of fractal image coding performance of various factors, part should be one of the most important factors. Choose which segmentation scheme need to weigh the compression ratio (or digital rate) and coding quality and then selecting a compromise plan.

(3) Neural Network Method

PCNN (pulse coupled neural network) is a kind of irregular segmented regions based on the image compression method. PCNN itself to the image details have better keep characteristics, blurred image after still can reach good segmentation effect.

The role of local connected domain PCNN and threshold means that has similar properties, make attenuation of gray-scale characteristics can simultaneously in near pixels, constitutes the activated PCNN segmentation characteristics of the foundation. Through the various parameters PCNN model adjust, can make the image segmentation results can better contains the original image detail information, and can avoid some meaningless small segmentation pieces of produce. In keeping the detail of image PCNN has incomparable advantage over traditional coding, but its reconstruction effect is not good, so this method is also a recent research hot spot of experts and scholars.

Another is worth mentioning, in recent years, the application of mathematical morphology covering the image processing almost all areas, including character recognition, medical image processing, image compression, visual inspection, materials science and robot vision, etc. Mathematical morphology is a new nonlinear image signal processing and analysis theory, it rejected traditional numerical modeling and analysis of the Angle of view and set to depict and analyze image, with a complete theory, method and algorithm system. Mathematical morphology is a comprehensive multidisciplinary intellectual crossover science, its theoretical basis is quite deep, but the basic principle

is simple. So far, there is no one way to like as mathematical morphology both solid theoretical foundation, concise, simple, unified basic idea, but also has so extensive practical application value. Therefore, someone will morphology and wavelet transform combined with DCT transform or application in image compression, also made a surprising results, this undoubtedly for image coding method to develop the field of the ideas and direction, more enriched image coding method.

3 THE IMAGE COMPRESSION TECHNOLOGY RELATED BASIC THEORY

3.1 Information Measure

The basic principle of image compression originated from the 1940s Shannon (Shannon) information theory. Shannon's coding theorem tells us, in not any distortion, through before the coding, for every reasonable distribution of a source code words differ long symbols, average code length can be arbitrary close to source entropy.

In information theory with the "entropy" to measure the size of the information. For individual events (such as a character) speaking, its entropy defined as:

$$H(i) = -\log_2(Pi) \text{ (bit)} \qquad (1)$$

Type (1) says the probability of occurrence in the event for Pi (characters) has the information. Measure the size of the unit is "information from" (bit). Its physical meaning for said the event (characters) need at least digits.

Although shannon, discusses the information coding should follow the rule, but did not give a specific.

A message queue average information entropy defined as:

$$H(i) = -\sum_{i=1}^{n} p(x_i)\log_2(p(x_i)) \qquad (2)$$

Type (2) the p (xi) says an event, xi the probability of occurrence in. The probability of one incident, the smaller the information entropy, the higher the amount of information contained.

3.2 Data Coding and Compression Concept

Say simply, so-called compression is trying to remove all sorts of redundancy, keep really useful information. To signal compression called encoding. Restoration of compression information process called decoding.

Data compression was originally an important topic in the study of information theory, in information theory called the source coding, shannon information theory tells us that source entropy is source code without distortion of the limit. That is to say, no matter what compression algorithm, which compressed digital rate is not less than the data of entropy, if less than words, this compression is necessarily distortion, and a distortion of source code, and to follow the information rate-distortion function in relationships.

3.3 The Classification of Data Ompression

Although shannon, discusses the information coding should follow the rule, but did not give a specific coding method. Therefore, the coding researchers continuously put forward various coding method. Several forms of the space because a signal is correlated, such as storage space reduce also means transmission efficiency and occupy bandwidth saves, that is, as long as adopt some methods to reduce a signal space, can compress data.

Data compression method of classification, and yet many unified. Data compression is consisted with entropy encoding and entropy compression. Among them, Huffmann encoding and LZW coding is relatively commonly used, wavelet transform coding, fractal coding for relatively frontier compression technology.

3.4 The Basic Principle of Image Compression

Judging from the perspective of the information theory, compression is to remove the redundant information uncertainty, namely reserves, remove the information to determine the information (know), and it is more close to information in a description of nature to replace the original redundancy description.

Image compression implementation principle of two aspects:

(1) The original image data (stationary or exercise) exist great redundancy, such as still images

between adjacent pixels in spatio-temporal correlation between before and after the moving pictures and temporal correlation are large, source have redundant.

(2) The second is the application of the multimedia system in the field, who is a major recipient of image information, the eyes are receiver, so it might be possible to use visual drastic changes to edge is not sensitive (masking effect) and eye vision of image information sensitivity, but for brightness color resolution weak etc physiology characteristic to realize high compression ratio, and make by compressed data recovery image signal still have satisfactory visual quality.

Develop multimedia application system, meet the greatest obstacle to progress is the multimedia information huge data quantity of data acquisition, storage, processing and transmission. Among them, the largest amount of data is digital image information. For example: a picture of a resolution color images 640 x 480 (24 bits per pixel), the amount of data about 0.92 MB. If again with 30 frames per second, the video signal speed playback volume of data as high as 27.6 MB. If the cd-rom 650M in again, without considering audio signal, each piece CDS also can only play and 24 seconds. Obviously, image compression technology is one of the key technology of multimedia technology.

4 THE IMAGE COMPRESSION STANDARD JPEG

4.1 JPEG Background

JPEG (Group) is a Photographic has or by ISO and IEC two organizations together, an image panel, be responsible for making static digital image data compression coding standard, this Group developed algorithm called JPEG arithmetic, JPEG image has become common international standards of its applicable scope, is gray image, image with color, the compression of still images, video sequence frame image compression; JPEG can adjust big range code-rate and quality image.

The core of JPEG is mainly DCT and DPCM.

4.2 JPEG Operating Mode

For an image component, JPEG stipulated the four operating mode:

(1) The order of dct-based coding mode (baseline CODEC).

The order of dct-based coding mode is the single

time scanning to complete a image component coding, scanning the order from left to right, from the top down. Its algorithm basic steps as follows:

A. Will with original image brightness, chromatism says (component image sampling 4:1:1)

B. Into 8 x 8 pieces of data [0 to 255], [- convert 128 ~ 127]

C. Positive discrete cosine transform (FDCT)

D. Quantification (quantization)

E.Z Glyph quantitative results (zigzag arranged scan)

F. Use of DC coefficient DPCM code (DC)

G. Use to exchange coefficient trip coding code (AC)

H. Entropy entropy coding (for): hoffmann or arithmetic coding

(2) Based on DPCM (difference pulse code modulation) nondestructive coding mode

Based on DPCM nondestructive coding model mainly adopts three neighborhood two-dimensional forecast coding and entropy coding, fig.1 shows:
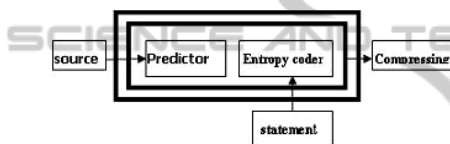

Figure 1: DPCM Predicting coding.

This mode and sequence model coding steps, basically the same differs each image of increasing mode to weight after multiple scanning coding to finish. The first scan only a rough compression, then according to the data reconstruction a picture first, the image quality is low after scanning to make fine scanning, make the reconstructed image quality enhances unceasingly, until satisfaction, nondestructive coding compression ratio can reach 2:1.

(3) The gradual dct-based coding mode

The gradual dct-based coding mode is through multiple scanning an image component coding, provides a from coarse to fine gradual streaming structure. Mainly divided into the following two modes:

A. Press band: a scan, gradual only to the certain frequency conversion DCT coefficients of the code

Transmitted, and then to other band of progressive way encoded and transmitted, until the end of all coefficient relay

B. Bitwise gradual: according to its digital of DCT coefficients from high to low into segments, which in turn into to paragraphs

Do compression coding, first on the most effective bit code of N a transmission, until the transfer over. All coefficient

(4) Dct-based coding mode of layered

Dct-based coding model algorithm of layered basic step as follows:

A. Reduce spatial resolution of the original image.

B. Has been reduced to the resolution of the image according to order coding mode compression and stored or transmitted.

C. On low resolution image, then use by decoding the improvement of image interpolation method of resolution.

D. Will increase as the image resolution have predictive value of original image, and put it and poor value of original image dct-based coding.

E repeat steps c, d until achieve full resolution images.

5 IMAGE MIXED ENCODING

Currently image compression algorithm sort is various, classic compression algorithm theory has more mature, as people in these traditions coding method of thorough research and application of these methods, found many shortcomings, such as high compression ratio restore images appear serious square effect, the human visual characteristics not easy is introduced to the compression algorithm, in order to overcome the shortcomings of traditional compression method, puts forward a new coding method except outside, another important solution is take different coding method combining now, many of the ideas in mixed domestic and foreign scholars have the image coding method research attempts were made, and made a lot of achievements. It should be noted that many international codec standards also USES a hybrid coding scheme introduced here several typical hybrid image coding algorithm of principle, implementing methods and research status.

5.1 Dct-based Transform Hybrid Coding

5.1.1 Dct-based Transform the Fractal Image Coding

Fractal image coding is mainly the mathematical basis of fractal geometry iteration function system theory, the theory of fixed point and collage theorem. Iterative Function System (IFS) are Iterated views, and its research group in Barnsley's proposed Hutchinson 1981 Iterated Function Theory (Iterated

guys) are developed on the basis of. Fixed point theory is an important branch of functional analysis, it ensures that any of the iteration function system exists only attractor, and this iteration function system with initial set the attractor is irrelevant. Collage theorem is Banach fixed point theorem for coding the simple inference, problems are times optimal solution provides an answer. The task of fractal image coding is to seek for code iteration function the parameters of the system image, fractal image decoding is according to the parameters of the iteration function system to find out the attractor. Iterative function system is to use a mathematical system to construct a categories analytical man-made or natural, has the similar structure since affine fractal, i.e. use simple iterative function system (IFS) coding can generate and natural scenery similar has boundless complex graphics, and for a given any an image, fractal coding thoughts are looking for a IFS makes attractor is original image or the approximation of the original image.

Dct-based transform the flow of fractal image coding as shown in figure 4 shows.

5.1.2 Based on the Forecast Coding and DCT Combination of Image Coding

And the forecast method is the most simple and practical video compression coding method, through coding not pixels after transmission, but the sampling value itself the sampling forecast value and the actual value difference. Because the same image of adjacent pixels with correlation between, so take advantage of these strong relevance to forecast coding.

Frame forecast coding method mainly have the best forecast coding, considering subjective visual effect quantizer and linear predictor, predictive coding. The most commonly used difference pulse code modulation (DPCM), its coding model shown in figure 5 shows.

5.1.3 Wavelet Transform And Out of Combining Neural Network Mixed Encoding

Because neural network has massively parallel processing and distributed information storage advantage, good adaptability, self-organizing and fault tolerance, a strong learning and associative memory function, and artificial neural network has many brain and a similar information processing capability, with strong data compression ability, can put the neural network theory applied to image coding. In 1985, Hinton etc who first Ackley and the multilayer neural network models for data

compression transform. In 1990, Z.H e and H.L I use multilayer feedforward neural network nonlinear predictive coding for image. At present, according to the neural network in the image compression, the application of the model and the algorithm can be applied types concluded to the following four:

(1) Use of data compression characteristics with neural network, namely direct implementation image compression using neural network realization vector quantization algorithm. If Kohonen self-organizing feature mapping (SOFM) neural network for code book design vector quantization approach has not easily affected by the influence of initial code book, and can keep the topological structure of image data etc.

(2) Neural network is applied to compression, indirect based on neural network coding method, the image transformation in the existing algorithm used to implement a local stage, some of these steps. If use neural network to realize the orthogonal transformation of orthogonal transform code Hofield neural network operation, including image transformation coding. In addition, neural network transform code are not limited to the orthogonal transformation, can be extended to the orthogonal, nonlinear, dimension reduction or fractal transform, can make the image in the transformation process directly compressed.

(3) Principal component analysis neural network coding. Principal component analysis (PCA) is a linear transform feature space dimension reducing feature selection method, it only retains the data, the main components of the dropped relatively minor component, achieved the purpose of data compression. Principal component analysis (PCA) is a kind of effective image transformation coding algorithm, it can draw the main characteristics of image data in reducing weight, and therefore, can input data dimension image of compressed image but also to minimize distortion. In addition to the principal component analysis and Kohonen self-organizing feature mapping (SOFM) algorithm combining used in image compression.

(4) Neural network and the existing some combination of image compression algorithm coding method, i.e. put some advanced algorithm developed into learning algorithm and establishing neural network model. Such as wavelet neural network by network and nature.these, cent predicted neural networks.

The principle mixed encoding scheme is shown as shown in figure 9.

5.2 Other Types of Mixed Image Coding Method

Based on the genetic algorithm is this image fractal compression encoding.

Based on genetic algorithm is fractal image compression with matching block the coordinates (x, y) and the regional blocks of rotation transformation (consists of eight kinds of rotating), chromosome in fractal coding algorithm, each need to match with genetic algorithm to search, according to defined blocks of chromosome and fitness function (such as regional blocks and matching block matching mean-square error) to search for, when chromosome maternal convergence optimal individuals when as determined from the matching block position and transform parameter is matching result i.e. coding. In addition, there are a lot of genetic algorithm based on image fractal compression of improvement, such as searching for optimal use of domain block domain block two parameters is relative to the range block horizontal and vertical displacement of the weight, will the improved genetic algorithm is applied to fractal coding, the improved genetic algorithm search speed, overcome fractal compression classification matching algorithm, the local optimal and random search problem.

GA used in fractal image compression, enhance the compression ratio and compression precision, because in high compression ratio descend signal-to-noise ratio has been greatly improved, so it can be used in low bit rate image compression. Moreover, GA has can parallel computation of fractal features, and can reduce the computation time, quickly find optimal solutions. But the control parameters, experiment, most will depend on experience many, therefore, how to get adaptive to control these parameters, further improve the compression ratio and decoding quality, still remain in research and exploration. Because the good properties, it GA: s combined with fractal image coding method broad prospect of application.

The image based on neural network 4.3.2 fractal compression encoding.

Image coding technology, fractal image compression has higher compression ratio and low attrition, but the biggest shortage is iterative function system (IFS) automatic fractal image coding method to calculate the amount is large, thus limiting its practical application, and artificial neural network is learning, memory, identification and reasoning features, using neural network method to parallel waycompletes fractal image compression coding, plenty of calculation for fractal image compression application provides a new solution.

For the first time, the application of neural networks is presented Stark IFS Hopfield neural network based on the fractal image coding method, can effectively solve the problem of linear accumulative total, but meanwhile neural network method are only used for IFS unzip process. The application of neural networks with fractal image compression encoding principle is compressed using neural network model, make the fractal codes automatic acquisition, specifically is one neuron in the images of the a pixel, representing the weight and threshold as fractal codes, appropriate weight and threshold value can be obtained in the compression process, the initial image compression process in solution can be constructed out. This method is put forward two different neural network model with fractal image compression solution compress, these two models of the architecture is same, mainly adopts define different linear model and the nonlinear model of functions. The results show that, with the basic automatic fractal image coding method compared, in the basic guarantee for the quality of reconstructed image premise, the operation time and bit rate decreased, visible neural network technology used in fractal image compression and unzip the feasibility and efficiency.

At present, the neural network in the research of fractal image coding are not much, but neural network of parallel

Computation ability to solve the fractal image compression of calculation problem is very important and deserves further study.

6 SUMMARY

The existing various image compression method, any kind of coding algorithm is not perfect. Wavelet transform existing wavelet base selection and its calculating complex and difficult high compression ratio Gibbs effects exist the problems to be solved; Fractal coding also exists matching operation problem; DCT coding exist block effect, etc. Only make full use of the advantages of different coding method to use it to its mix of win-win results. This paper introduces the traditional encoding method and modern coding method, and the emphasis on the hybrid coding various technical, future will further study of image coding, truly realize image compression ratio and reconstruction quality win-win.

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