Comparative Research of Video Compression Algorithm for Mobile Device

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Abstract

The current video transmission based on mobile devices become more and more frequent, in order to meet the requirements of real-time and sharpness, and constraint satisfaction network speed, the video is to be compressed by right compression algorithm before transmission. This paper first introduces several traditional video compression algorithms, and the characteristics of them were compared and analyzed, finally the simulation comparison experiment is be carried out. Aimed at the problem of video transmission for mobile devices, select a better video compression algorithm, so as to be able to in the network speed is limited conditions, as far as possible without distortion of video transmission.

Keywords: Video Compression; MPEG; H.264; M-JPEG; Mobile Device.

Introduction

With the development of the times, with the progress of the society and the intelligent of our life, The real-time video transmission has become an intelligent way of life in our life, especially mobile devices bases on real-time video transmission and monitoring is becoming more and more popular. Realizing the real-time video transmission, we can monitor our home with real-time, and realize the intelligence and security of furniture. Then, the key technology of this process is handling video, the most important in the video processing technology are the video compression and transmission. The video compression is coming true through some of arithmetic, encoding a terminal of video streaming, and then transmitting another terminal of video with the video transport protocol. This paper firstly introduces some traditional video compression algorithms, such as M-JPEG, MPEG, H.264, and then the contrastively analyzing their advantages and disadvantages, finally conducting the simulation comparison experiment. Through the experiment, choosing a more suitable video compression algorithm for mobile devices.

Video Compression Algorithm

Video compression is the core of video processing. Now most of young people use the Tencent QQ video instantly chat, it also requires real-time video compression, but here is just a simple video compression, however the compression is also accompanied by lossy compression. For images of video, it has a great time and space redundancy. And here the temporal redundancy refers to two frames adjacent images in the same position's pixels value having great correlation. Space redundancy refers to the same frame image; two adjacent pixels also have a certain correlation[1]. For video compression, if the time and space redundancy does not have, then the video squeezed out will very poor.

In the algorithm of video compression, the most important algorithm is motion estimation to remove the temporal correlation [2]. Assuming the t moment of moving object pixel value b_t, it is represented by the previous value $b_{t-\tau}$ after time interval τ, that is:

$$bt(z) = bt - \tau(z - D) \quad (1)$$

Among them, the t the pixel value (brightness, color), $z=(x, y)^T$ represents the position vector, T said the vector transpose, D is the motion`s displacement vector time interval in theτobjects. Type T is a time of image representation (t-τ) moments of the image after the results of proper displacement. So, by comparing the time apart of t can be estimated in addition to the displacement of the D objects in the interval of the two frame image. In the motion estimation algorithm implementation process, macro block using the algorithm to find the most matching position through the current image in the last frame, then recording the coordinates of the macro block, so it can save a lot of codes, and also improve the compression ratio. Removing the spatial correlation is implemented by using the DCT transform, the time domain data mapping to the frequency domain, then the DCT coefficients are quantized treatment. Basically, all of the lossy compression, there will be quantified, it improves the compression ratio of the most obvious[3].

As the basic unit of the encoder of DCT transform is the luminance block or chrominance block, assuming that the size of 8 * 8, in the type to M and N=8, and then by the two-dimensional Discrete cosine transform formula available

$$F(u, v) = \frac{1}{4}E(u)E(v)[\sum_{x=0}^{7}\sum_{y=0}^{7} f(x, y) \cdot \cos(\frac{(2x+1)}{16}u\pi) \cdot \cos(\frac{(2y+1)}{16}v\pi)] \quad (2)$$

After such treatment, the two-dimensional DCT transform is decomposed into 1 row and 1 columns of the DCT change, making X from 0 ~7 each DCT coefficient to calculate as a constant in program, then using the above formula to calculate the coefficients of the transformed successively.

High compression ratio can make the resulting image occupies less space, which is conductive to the network transmission and storage file, but the higher compression ratio often result in reducing image quality. The small compression ratio can be as far as possible to ensure the quality of the image. Now the compression ratios on the market`s camera are mostly 5:1, it is equivalent to a 100MB video compressed size becomes 20MB.

In these video compression technology, some of the main algorithms include: MPEG, H.264, Wavelet (wavelet compression), and AVS etc. Here, focusing on MPEG are simply introduced, and then a main introduction and Discussion on the H.264 algorithm.

MPEG is a transform-based image coding of loss compression. Optical signal can be converted into video signal which can be said as frame image by sampling the video. The linked frame images are called as video images. And then these frame images are divided into many small pieces as a transform coding, and then quantizing, and finally subjecting to entropy encoding. MPEG-1, MPEG-2, MPEG-4 actually uses the momentum estimate and momentum compensation technology. In the frame (image) which used the momentum compensation, encoded by the reference frame is a momentum compensation and the current image difference[4]. Different from general image coding, MPEG is measured in units of time compare image unit of time, for the majority of the video images, the background changes little, while the change of the body is larger. Therefore, MPEG technology takes one image as the main image by using this concept and records some changing data of other images, recording dynamic image more effective.

But in fact, it is very difficult to segment the image into the static and different motion area, especially when the real time requirement of work. A simplified method is to divide the image into sub blocks, each block is treated as an object, according to the methods described above to estimate the motion vector of each sub block, will be through the displacement compensation inter frame prediction DFD and displacement vector D is transmitted to there receiving end. The receiver can press type from the previous frame information has been received to restore the sub block:

$$b_k(z) = b_{k-1}(z - D) + DFD(z, D) \tag{3}$$

Horizontal component of motion vector in MPEG 4 and the vertical component are integer or half integer value.

MPEG standards include MPEG-1, MPEG-2, MPEG-4, MPEG-7 and MPEG-21 and so on. However, nowadays existing version only includes MPEG-1, MPEG-2, MPEG-4, And MPEG-4 is the mainstream of compression coding in MPEG.

H.264 is a new generation of digital video compression after MPEG4 format come up with by The International Organization for Standardization (ISO) and the International Telecommunication Union (ITU). H.264 is one of the video code technology standards which named after H.26x series of ITU-T[5]. H.264 is a highly qualified video compression technology. The area of such coding algorithm is relatively wide, including: low-bit-rate wireless application, standard definition and high definition TV broadcast application, and video streaming application on the Internet, transmission of high-definition DVD video and application and high-quality video applications of digital cameras.

H.264 is more competitive than other coding algorithm for its higher data compression ratio. In other words, H.264 encoded video is more economical than other algorithm in video compression, through which need video transmission process of H.264 compression bandwidth less, so also save resource space.

Figuratively speaking, for the same ship goods, MPEG can reduce the goods weight into its half, while the H.264 can reduce the goods weight into its 3/4; if carrying the same cargo weight, H.264 allows more than one times ship cargo capacity than MPEG.

H.264 core technology processing steps are shown in Figure 1。

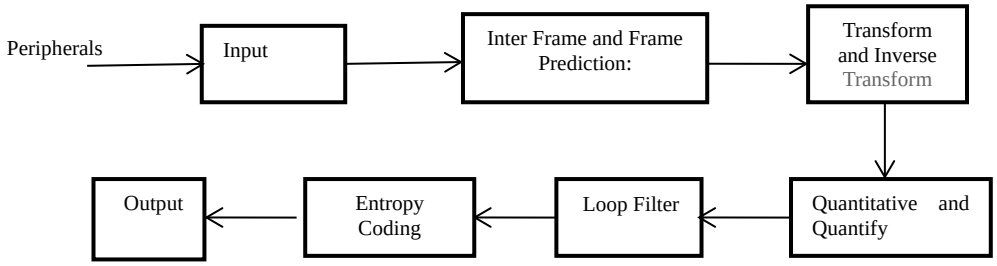

Fig.1 Video Compression Process

Improved motion estimation algorithm is interring frame prediction. As the name implies, "motion estimation", so the algorithm is used to eliminate and confirm the temporal redundancies exists among different images in the video stream. When searching images by motion estimation algorithm through the direction of time, the last picture is coded as "P-frame picture"; past and future pictures would be encoded as "B-frame picture" [6]. H.264 divides macro blocks into more small pieces which are more flexible to improve the prediction accuracy.

Intra prediction of frame [7] is an algorithm for eliminating the redundant space when motion estimation is unable to be used for inters frame prediction. And it predicts the coding of current block and the real block at various points through the motion estimation algorithm. The following is the intra prediction improvement scheme of fast algorithm:

Rate distortion theory is defined with the distortion - rate function, that is:

$$\mathrm{D}(R^*) = \min_{Q:I(Q)\leq R^*}\{d(Q)\} \quad (4)$$

Under the condition of the given maximum average rate R, D (R^*) represents the average distortion degree lower bound. The function is the instruction for bit rate control, namely in the case of a certain rate R, source code can achieve the minimum, and the minimum distortion is the goal the bit rate control want to achieve.

Transformed coefficients are quantized to reduce the amount of integer coefficient of prediction and eliminate the high frequency which is not easy to perceive. The following relationship between rate and quantization parameter in the above obtained between:

$$\mathrm{R(QP)} = \alpha + \frac{\beta}{QP^{\gamma}} \quad 0 < \gamma \leq 2 \quad (5)$$

Where alpha, beta, gamma is the parameters of the model, and can be through the curvature function curve parameter gamma control.

Loop Filter[8]: H.264 algorithm defines a filtration process, the filtering process can be on the 16X16 and 4X4 block boundary solution block; at the same time the purpose of filtering is to eliminate due to the compression time for

different motion estimation caused by type or different quantization parameters of artificial traces.

Entropy Coding[9]: Entropy coding is designed to use a smaller number of bits to represent the frequently used symbol, a larger number of bits to represent the symbol not frequently used.

Compared with MPEG4, H.264 is more superior. H.264 has following advantages:

Many kinds of better motion estimation: Half-pixel estimation is adopted in H.263, while H.264 is using quarter-pixel motion estimation, but some use 1/8 pixel; That is to say, taking 1/4 or 1 / 8 pixels as the basic unit is a true motion vector. Obviously, for the motion vector, the higher the accuracy of the displacement is, the smaller the inter frame residual error will be, and the higher the compression ratio will be.

The small size of the integer transforms 4X4: Relating to previous compression coding based on 8X8 units, H.264 algorithm adopts 4X4 compression coding. Because the transform block size becomes small, the division of the object becomes more accurate. For size becoming small, which can be also expressed as the amount of calculation becomes small, connect error is greatly reduced as a result.

More accurate intra prediction: Each pixel of each 4X4 block in H.264 can be predicted by the different weighted sum of 17 closest to previously coded pixels.

Unified VLC: Unified VLC (UVLC: Universal VLC). UVLC codes by using an identical code table, and the decoder can easily identify the code word prefix, UVLC can quickly obtain resynchronization when the bit error occurs.

Simulation Experiment of Compression Algorithm

In achieving H.264, the most widely used open source encodes-- X.264 is the basis. Comparing with JM series encoder and T.264 encoder, X.264 has excellent performance and good effect. Since there is no direct development X.264 API, so in this system, the coding section repackaged X.264 API for the convenience of software system design and use [10].

The following is the specific implementation process of H.264 in this system.

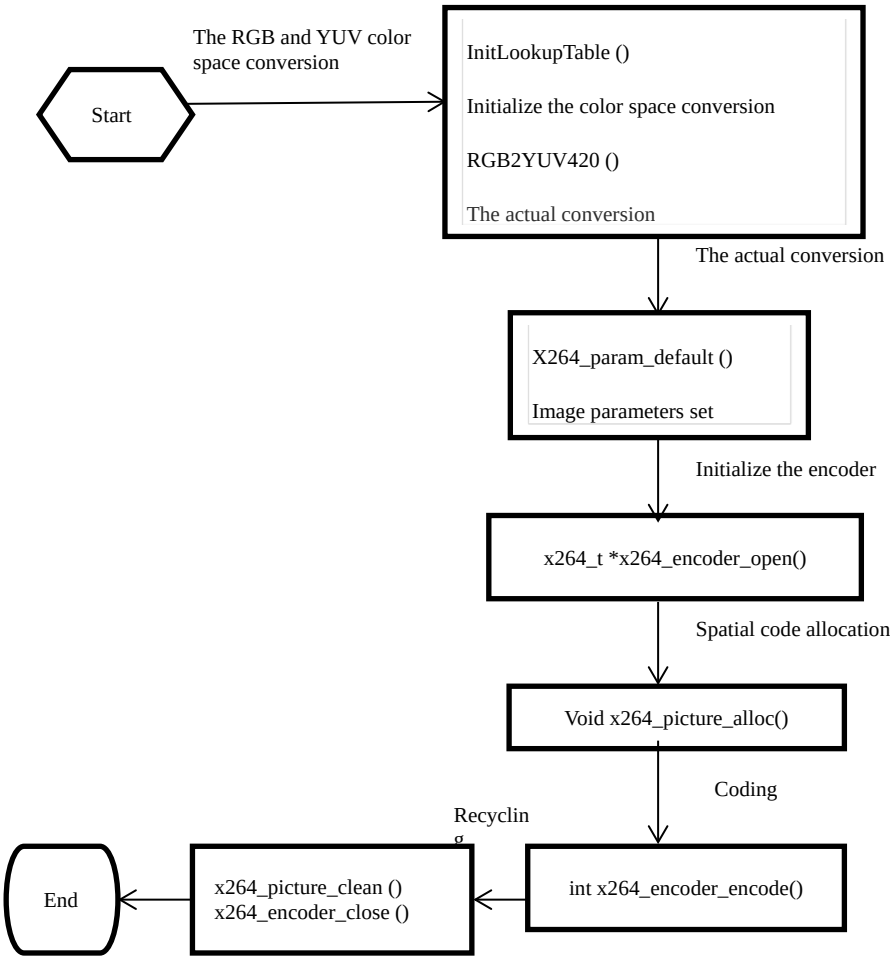

Fig.2 H.264 Coding Process

The above process is the realization of a video encoding; the encoded data quantity will be greatly reduced, resulting in our encoded data we can use.

Here, using the MPEG algorithm and H.264 algorithm for video compression, the results as shown below:

a) Original b) H.264 Compression c) MPEG Compression

Fig.3 Comparative Image

From the above results we can see that the compression:

The image size is 600MB, but the H.264 compressed size is 113MB, after MPEG compressed size is 147MB. H.264 total bit after compression rate of 1622kbps, MPEG after the total bit rate for 2104kbps compression. After the compressed image, H.264 image better than MPEG image.

The following table for the MPEG and H.264 image compression technology comparison:

Table 1 MPEG and H.264 Comparison

Compression technology	Compression ratio	The total bit rate
MPEG	24:100	2104kbps
H.264	18:100	1622kbps

As can be seen from the table, the compression rate of H.264 than MPEG low, which is compressed by H.264, occupies less space; H.264 video bit rate than the total bit rate of the MPEG to low.

Conclusion

The above analysis view, after analysis and comparison of two kinds of algorithm and simulation, we can know, in the same conditions of video format, through the H.264 algorithm of compressed video size and resolution are better than MPEG, it can save much more use of memory space, to achieve the desired effect, to avoid large distortion of the objective. Therefore, this is also the reason why H.264 coding is used widely now.

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