

## Research Article

# Application of Low Bit Rate Coding Based on Nonlinear Data Prediction in Wireless Network Multimedia Communication

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Received 14 June 2022; Revised 2 July 2022; Accepted 8 July 2022; Published 3 August 2022

Academic Editor: Marvin Webb

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In order to realize the application of low bit rate video coding in wireless multimedia communication, this paper analyzes the principle of video coding and highlights the importance of low bit rate in wireless multimedia communication. For this, the iterative optimization method of contour height map contour, B-spline curve approximate contour, and control points is carried out to ensure that hearing and vision can achieve the clarity of video under appropriate conditions. The results show that compressing the original video to a suitable size for decoding and completing the output in a compatible format can realize the operation efficiency of the encoder and improve the coding speed.

## 1. Introduction

In the development of multimedia technology, a variety of moving image compression algorithms have emerged, which are mainly used in digital audio-visual systems with high definition. The redundancy of image data mainly includes spatial redundancy caused by the correlation between adjacent pixels in the image, the time redundancy caused by the correlation between different frames in the image sequence, and spectral redundancy caused by the correlation of different color planes or spectral bands. The purpose of data compression is to reduce the number of bits needed to represent data by removing these data redundancy. Video coding is a way to convert a video format file into another compatible video format file through specific compression technology. This compression technology may be slightly different from but very close to the original data. This compression belongs to lossy data compression, which discards as much data as possible to ensure that the file size is as small as possible. It is often used to compress sound, image, and video. Image compression can be lossy data compression or lossless data compression. Lossless compression is preferred for technical drawings, charts, or cartoons, because lossy compression methods, especially at

low bit rates, will cause compression distortion. The compression ratio of audio can be achieved without perceptible quality degradation, and the compression ratio of video can be achieved across a large compression ratio with slight observation of quality degradation. When you observe carefully, you will notice the decline of visual and sound quality. The file itself is still largely similar to the original file, but the more compressed the file is, the worse the quality will be. Intraframe compression is also called spatial compression. When compressing a frame of image, only the data of this frame is considered without considering the redundant information between adjacent frames, which is actually similar to static image compression. The lossy compression algorithm is generally used in intraframe compression. Since there is no correlation between frames during intraframe compression, the compressed video data can still be edited in frames. Intraframe compression is generally not very high compression. In visual color, clarity and overall picture sense will also be reduced. Based on this, all kinds of audio and video signals are stored digitally. At the same time, the technologies of information compression coding, multimedia storage, and graphics synthesis and synchronization have developed rapidly. Multimedia communication has become an important means of information exchange. The

feasibility of multimedia data compression includes space redundancy and time redundancy existing in multimedia video signals. There are certain boundaries between the human eye's perception of image detail resolution, motion resolution, and contrast resolution. Multimedia conference and videophone have become popular means of communication. Under the condition of limited bandwidth, low bit rate video coding scheme is obviously the key to realizing high-quality multimedia communication. There will be some difficulties in high-speed transmission and real-time storage of a large number of images and data. With more and more innovative technologies and the demand for high-quality video in wireless communication, low bit rate video coding is an effective rate allocation algorithm. The video bit rate refers to the number of data bits transmitted per unit time during data transmission. In a popular sense, it is the sampling rate. The larger the sampling rate per unit time, the higher the accuracy, and the closer the processed file to the original file.

Guo et al. (2022) discussed that, in order to further improve the compression performance of efficient video coding, a quadratic coding optimization algorithm combining rate distortion dependence and rate distortion characteristics is proposed. The original video coding method is used to encode the current frame for the first time, so as to obtain the number of bits consumed by the current frame and the rate distortion model parameters of each coding tree unit. Video coding includes motion compensation, motion representation, and motion estimation. Motion estimation is a set of techniques to extract motion information from video sequences. Combined with time-domain-dependent rate distortion optimization, significant rate distortion performance improvement is obtained [1]. Jia et al. (2021) found that, compared with the previous standard methods, the efficient video coding standard improves the compression efficiency. On the premise of not affecting the quality of video coding, the application of multilayer feature transfer convolutional neural network greatly reduces the complexity of video coding [2]. According to Zhao and He (2022), there are relatively few data hiding schemes suitable for efficient video coding. Through the video data hiding method, the new video coding elements are embedded in different types of video frames. It has better embedding imperceptibility and higher embedding capacity and has little impact on the bit rate of video stream. Encrypted video has higher visual quality and smaller bit rate increase [3]. In order to improve the reliability of visible light communication link, Ding et al. (2022) actively explored the use of distributed light sources to construct repeated coding multi-input multioutput visible light transmission configuration. Through the simulation test, the transmission power is greatly improved [4]. Note that, compared with the wireless LAN, the "visible light communication" system can use indoor lighting equipment to replace the wireless LAN base station to transmit signals. Its communication speed can reach tens to hundreds of megabytes per second. In the future, the transmission speed may exceed the optical fiber communication. Using dedicated computers and mobile information terminals capable of receiving and transmitting

signals, high-definition portraits and animation data can be downloaded and uploaded for a long time as long as they are in the place where the indoor lights shine. The system also has the characteristics of high security. According to Wengang and Feng (2021), today's highly developed social information makes the development of various network technologies more mature and perfect, and various intelligent work has obtained more new development space and power. Aiming at the practical application of multimedia communication technology, this paper deeply expounds the demand, current situation, and key technologies of wireless multimedia communication and explains in detail the application direction of wireless multimedia communication technology in real life [5]. Hu and Zhao (2021) pointed out that the storage and transmission of massive data put forward higher requirements for video coding technology. The application of video compression coding has gradually become a new research direction, which has injected vitality into the development of video coding field [6]. Ning (2022) pointed out that people's requirements for video transmission quality are constantly improving. Through video coding, data compression can be realized, so that video can be transmitted efficiently. In the information age, video codec standards are also constantly updated. This paper discusses the application and performance of new coding technology and looks forward to its future development prospect [7]. According to Song et al. (2021), real-time video communication has become an important research content in the video industry, providing better user experience and lower delay. Low delay video coding is a key part of real-time video communication applications. Reducing the coding delay can effectively reduce the overall delay of the system. The principle and model of rate distortion optimization technology are used to optimize the technical means of coding delay [8]. Image coding methods can be divided into two generations: the first generation is based on data statistics, and the data redundancy is removed, which is called low-level compression coding method, and the second generation is content-based, which removes the content redundancy. The object-based method is called the middle-level compression coding method, and the semantic-based method is called the high-level compression coding method.

## 2. Principle of Video Coding

The concept of coding is widely used in the field of communication and information processing. Its basic principle is to use some form of code stream to represent and transmit information according to certain rules. The commonly used information to be encoded mainly includes text, voice, video, and control information. For video data, the main purpose of video coding is data compression. This is because the amount of pixel representation data of dynamic images is extremely huge, and the storage space and transmission bandwidth cannot meet the needs of storage and transmission. Starting from an original video, the video is composed of a large number of continuously playing pictures. The content of one second contains 60–70 similar pictures. It needs a large storage space, which is unbearable

for its memory and bandwidth. At this time, we need video coding. Generally speaking, if the dynamic image data is used without compression, the amount of data is very large, which is easy to cause communication line failure and tight data storage capacity. Therefore, codecs must be used when sending dynamic images, when saving video content on DVDs, and when taking images with digital cameras or camera phones with small storage media capacity. Now all the videos we see are compressed by the computer, and the size will not be as exaggerated as the picture. This compression process is the process of video coding. Now the flowchart framework of this process is analyzed as shown in Figure 1.

The flowchart of video coding is shown in Figure 1. The video is divided into images, the image is divided into regions, and the data is intracoded and intrapredicted by the encoder. At this time, there will be some deviation between the predicted data and the original data. At this time, the obtained intraresidual signals are processed through transformation and quantization, and the obtained data are fused into intraprediction. The segmentation prediction image frame appears, and finally the intraframe signal and the processed residual signal are output through the communication road. Image segmentation is the technology and process of dividing an image into several specific regions with unique properties and proposing interesting objects. It is a key step from image processing to image analysis. The existing image segmentation methods are mainly divided into the following categories: threshold-based segmentation methods, region-based segmentation methods, edge-based segmentation methods, and segmentation methods based on specific theories.

### 3. Importance of Low Bit Rate Video Coding in Wireless Multimedia Communication

People's eyes have different sensitivity to difficulty and color. The change of brightness has a greater impact on the eyes than the change of color. It is difficult to intuitively feel a small amount of color changes in video images. Through multimedia computer technology, according to the visual characteristics of the eyes, a certain color distortion is used to extract the compression of data, and most of the bandwidth is allocated to brightness and a small part to color. In this way, the eyes are comfortable to see these pictures. The interval between two adjacent frames of an active image is very short. Under the premise of a certain error range, most pixels remain unchanged, and the activity has great correlation in time. Therefore, when the image motion is small, using the pixels at the corresponding position of the previous frame to predict the current frame picture can obtain a good effect, in other words, the background picture at the adjacent time point in a video. Many contents in the two frames are the same. When the background picture is not moving and there is only the microwave animation surface of the main picture, the recording can be slightly relaxed when storing or transmitting the video. The complete information of the two frames only needs to retain the recording part. At the same time, the image is composed of pixels, and a large number of

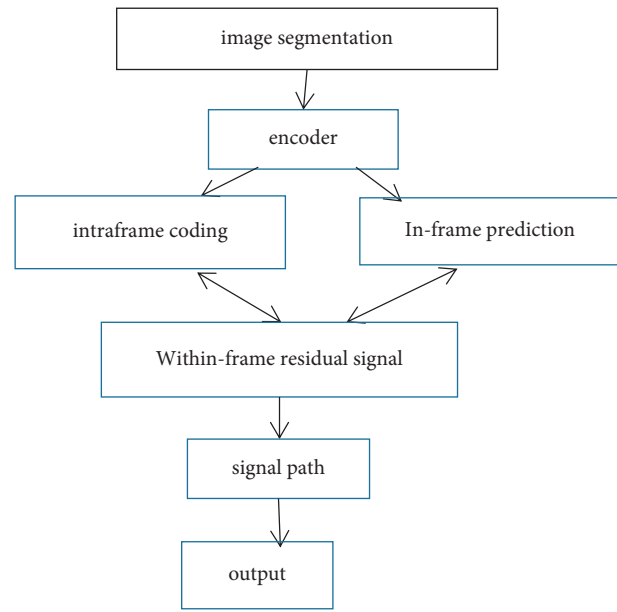


FIGURE 1: Flow framework of video coding.

repeated pixels will appear for these pixels. When an object is moving rapidly, when the image seen by the human eye disappears, the human eye can still retain its image for about 0.1–0.4 seconds. This phenomenon is called visual persistence, a property of the human eye. When the human eye looks at an object, it is imaged on the retina and input into the human brain by the optic nerve to sense the image of the object. At this time, one pixel can be used to replace most of the same pixels, which can be more convenient in video compression. Transform coding is used to eliminate the redundant information of pixels in the image to release the storage space. The flow frame diagram of this process is analyzed, as shown in Figure 2.

Figure 2 shows the extraction of important information of your picture when using change coding. When the background picture is the same, according to the video with small change in the main content of the picture, when the picture distinction between each frame is very small, you cannot keep the record of this time but you only need to encode the changed part in the adjacent video frame, so as to reduce the storage capacity.

The latest development of low bit rate video coding and video compression combines the elements of coding, which is mainly based on the principle of segmentation. The basic idea of region growth is to assemble pixels with similar properties to form regions. Specifically, first find a seed pixel for each region to be divided as the starting point of growth, and then merge the pixels with the same or similar properties in the neighborhood around the seed pixel into the region where the seed pixel is located. Region growth needs to select a group of seed pixels that can correctly represent the desired region, determine the similarity criteria in the growth process, and formulate the conditions or criteria to stop the growth. Allowing the decoder to reproduce the required information shape from the previously received information, a low bit rate video coding technology is

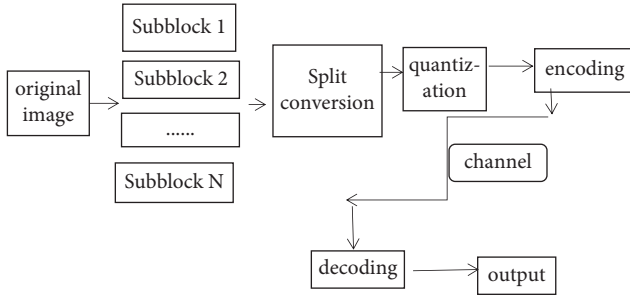


FIGURE 2: Flowchart of the transformation encoding.

adopted. The efficiency of low bit rate video coding technology compared with other methods in compression efficiency is shown. The principle of low bit rate coding stipulates that the time information can be used to further reproduce the bit rate of the contour information. In wireless multimedia communication, the assets of multimedia objects can be decoded and low bit rate video coding technology can be used to retain useful information.

In wireless multimedia communication, video coding is an indispensable part. To realize the real-time transmission and processing of video and audio signals, its powerful function and broad application prospect are worth popularizing. It can effectively store and transmit the information required by multimedia, and the fusion of voice and audio, image, video, text, and data can retain and record useful information according to the fluctuation of code rate. For the auditory perception correlation of this composite information, the real-time performance requirements are higher. To ensure the quality and normal progress of communication, it is necessary to effectively compress the multimedia data. The development of information technology is to realize big data sharing, which can actively promote the continuous development of social economy, produce immeasurable value for social development, comprehensively promote social progress, and improve people's quality of life. Data comes from all aspects and data formats are diversified. In the era of information technology, low bit rate video coding plays an important role in wireless multimedia communication. The trends of big data include the resource of data, the deep integration with cloud computing, the breakthrough of scientific theory, the establishment of data science and data alliance, and data management becoming the core competitiveness.

#### 4. Method and Verification

According to the contour height map contour, the contour effect is directly created to realize the interactive feedback of animation and pictures. The digital contour can be accurately defined as an ordered set of eight connected pixels located on the object boundary. Contour coding techniques and methods need to be universal as much as possible. Bit rate allocation makes it possible to effectively allocate it to various types of information, which can be encoded as texture, motion, or contour. The lossy algorithm or approximate algorithm can be retained according to the

mentioned required features, less dependent on the symbol and position of the contour in the contour direction, and will not affect the starting point. Specifying the contour quality according to the maximum value of the approximate contour is not always appropriate to deviate from the original error. The method must be flexible enough to adapt to a wider variety of contours that may be encountered in the model failure region of natural objects and code rate coding features. The main image area is drawn according to the image segmentation, and then the corresponding image processing is carried out to effectively remove the interference signal, which directly simplifies the calculation complexity and saves the operation time and storage space. Compared with other image segmentation methods, histogram-based methods are very effective image segmentation methods, because they usually only need one passing pixel. In this method, the histogram is calculated from the pixels in the image, and the peaks and troughs of the histogram are used to locate the clusters in the image. Color and intensity can be measured.

Based on B-spline curve contour approximation, a discrete contour can be well approximated by using a polynomial of two-dimensional  $p(i) = [x(i), y(i)]$ . Describe a uniform cubic B spline, which can continuously run through the first and second derivatives. To a large extent, the largest  $S$  control term and points  $(C_i, x, C_i, y)$  ( $i = 1, s$ ) ( $I = 1, s$ ) are required. The initial definition of B-spline curve is based on difference quotient. This definition method contains complex mathematical formulas, and the results are numerically unstable. Deboor uses the recurrence relation of B-spline as the starting point to define B-spline, which is a definition formula completely different from the difference quotient method. B-Spline can be divided into uniform B-spline basis function and periodic B-spline basis function according to different nodes. Each segment shares at least three main control points with the segment of  $N$ , and it is easy to obtain the main contour in the locally available spline. The best definition of B-spline cubic spline is the formula:  $x(i) = 1/6 [C_i - 1(1 - u)^3 + C_i(3u^3 - 6u^2 + 4) + C + 1(-3u^3 + 3u^2 + 3u + 1) + C_1 + 2u^3]$ , where  $(i)$  approximates the number of segments required for a given counter and the relationships existing between the subsets of samples collected on the original profile. The attitude measurement is made by the approximate contour and the original contour in the outline given by the formula. A B-spline assessment for the maximum deviation was obtained, as shown in Table 1.

Table 1 shows the B-spline evaluation with a maximum deviation of 1 pixel for the external object encoded by the condition chain and the internal object of the external object. In the low bit rate video coding of wireless multimedia communication, transmission to the decoder occurs, and the approximate spline does not need to be manufactured to pass through the original contour points starting from the endpoint of the line segment. The continuity of nonuniform rational splines includes position continuity, tangent continuity, curvature continuity, and geometric continuity.

The data signal can be divided into single-pixel mode and double-pixel mode. The data is divided into two transmission processes: odd pixels and even pixels. At

TABLE 1: A B-spline assessment of the maximum deviation.

Objects	Chain codes which are conditional	Best spline cases (with and without VLC)	Best case for splines (with and without)	Best spline cases (with and without the VLC)
Block	1.07	0.8/0.56	0.62/0.53	0.76/0.17
Model area of failure	1.64	1.75/1.32	1.51/1.76	0.19/1.23
Hand	1.54	0.92/0.78	0.87/0.73	0.77/0.57
Contour	1.32	1.09/0.16	0.65/0.56	0.67/0.76
Average over 16 objects	1.50	1.05/0.87	1.02/0.53	1.02/0.67

present, the block, contour, model area failure, and hand object of single-pixel and double-pixel data are compared, as shown in Table 2.

Table 2 shows the values of single-pixel deviation and double-pixel deviation of different objects. The deviation value of a single pixel widens the gap on the fault model area and the average of more than 16 objects, and other deviation values are not obvious. There are little differences between the deviation values of two pixels. In order to better observe the failure of single-pixel deviation and two-pixel deviation in blocks, contours, model areas, and the comprehensive comparison of hand objects, the above table data is visualized, as shown in Figure 3.

Figure 3 shows the comparison of data information of single pixel and double pixels in different modules. It can be seen more clearly and intuitively that there is no obvious difference between data in block and contour module. The gap is opened in the area module of fault model. Block coding is a method defined in the protocol for web users to submit data to the server. When the server receives data in chunked coding, it will allocate a buffer to store it. If the size of the submitted data is unknown, the client will submit data to the server in a negotiated block size.

For the iterative optimization of control points, it is necessary to adopt a more carefully considered method to take the average of the square distance between the approximate value and the original B-spline. When dealing with the new low bit rate video coding technology, we need to more carefully consider making the contour adapt to the specific characteristics of local objects, highlight it more, and ensure higher definition. The deviation of approximate contour is usually so significant, and rapid and more intensive sampling is used. When the deviation between the original contour and the approximate contour is obvious, the sampling rate can be quickly captured. In adjacent frames, the previous frame and the next frame may lead to the deviation between the original contour and the approximate contour. Finally, merge the main screen in the guarantee screen.

In wireless communication systems, due to distortion, it is easy to obtain high bandwidth signals and a large amount of bandwidth availability, that is, in optical networks. For wireless communication, the great availability of different spectrum limits many service providers to encoding at a constant low bit rate to meet the huge demand of customers in the increasingly limited bandwidth frequency range.

## 5. Discussion

In recent years, with the rapid development of digital communication and computer technology, multimedia services have further developed. When transmitting video information, we will face a large amount of original image signal data, which will further promote the innovation of memory storage capacity, communication channel bandwidth, and computer processing speed. Using advanced video compression technology, we can improve the accuracy of captured motion compensation, improve the pixel accuracy, make full use of the correlation of motion vector to improve the prediction quality, reduce the fast module effect, and simplify the coding of some additional information. It saves storage space and improves the transmission efficiency of communication, which can meet different users in network communication, speed up the algorithm, and further speed up the coding efficiency of the encoder to realize the real-time transmission of video. Yuan et al. (2021) proposed a fast search algorithm based on rate distortion optimization to improve the speed of video coding and reduce the computational complexity, so as to significantly improve the coding speed without sacrificing the rate distortion performance [9]. Wang et al. (2013) proposed a real-time transmission and compression scheme of low bit rate remote monitoring video based on fixed background in view of the existing signal transmission problems in the case of extremely narrow wireless communication channel. The moving object extraction and interframe motion compensation under fixed background are improved to improve the compression and transmission efficiency of video image and realize the real-time transmission of remote monitoring video [10]. Gong et al. (2021), aiming at the problem of low coding efficiency encountered by the rate control algorithm in the efficient video coding standard, proposed an efficient video coding image level rate control algorithm considering the reference dependence of the whole frame. According to the reference dependence between frames, a distortion model of surveillance video considering the reference dependence between frames is constructed, the optimized target rate allocation weight corresponding to each image is obtained, and an image level rate control algorithm suitable for surveillance video is proposed [11]. According to Cheng (2022), with the development of social economy and science and technology, people have ushered in the Internet information age. In this era, modern communication

TABLE 2: Module object comparison between single pixels and two pixels.

Object	Deviation of a single pixel (with and without VLC)	The deviation of double pixels (with and without the VLC)
Block	0.7/0.61	0.65/0.51
Model area of failure	1.97/1.25	1.23/0.95
Hand	1.05/1.09	0.61/0.63
Contour	0.96/0.75	0.53/0.52
Average over 16 objects	1.15/0.87	0.84/0.75

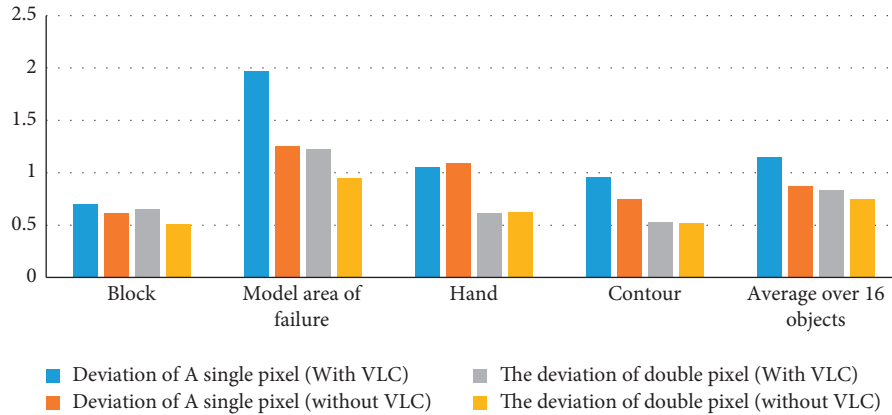


FIGURE 3: Visualization of module objects between single pixels and two pixels.

technology has been popularized and applied in many industries and has also become an indispensable part of people's life and work. With the popularization of wireless technology, it not only breaks through the limitations of traditional technology in time and space but also facilitates people's communication and interaction, which also promotes the development of communication technology to a great extent. It not only improves the problems of single communication application form and small coverage but also meets the diversified needs of people's information exchange [12].

## 6. Conclusion

Based on the wide application of video coding, the demand for video and audio has increased sharply, which has brought certain pressure to data storage and network transmission. Based on this, higher requirements are put forward for the stable and efficient storage and transmission of massive video data, so as to integrate sound, text, and image and provide users with a better sense of experience. This paper studies the application of improving the coding efficiency of video encoder under low bit rate in wireless communication. Through the iterative optimization method of contour height map contour, B-spline curve approximate contour, and control points, it is concluded that low bit rate video coding is a very profitable field in multimedia communication. In order to improve the compression of video coding and improve the technical guidance for future video coding standards, with the support of communication technology, we better promote the development of high-quality compression of video signals and have broader development prospects in wireless communication technology.

## Data Availability

The data underlying the results presented in the study are available within the manuscript.

## Conflicts of Interest

There are no potential conflicts of interest regarding the publication of this paper. All authors have reviewed and approved the final manuscript. The authors confirm that the content of the manuscript has not been published or submitted for publication elsewhere.

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