



Research on Intelligent Estimation Model of BER for High-Speed Image Transmission Based on LVDS Interface

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Abstract. The high-speed image signal of LVDS interface is easy to be interfered by the outside world in the process of transmission, which results in packet loss and distortion of high-speed image communication, and the output error is high. Therefore, the lossless coding of high-speed image signal is needed. Intelligent estimation of bit error rate (BER) for high-speed image transmission is needed. The intelligent estimation model of high-speed image transmission bit error rate based on LVDS interface is proposed. The network structure model of high-speed image signal transmission is constructed to estimate the error code distortion of image transmission and the key frame feature extraction method is used to estimate the error rate of image transmission. The intelligent estimation of bit error rate (BER) of high-speed image transmission is realized in LVDS interface. The simulation results show that the proposed method has low bit error rate (BER) for high-speed image transmission and achieves lossless transmission of images.

Keywords: LVDS interface · High speed image · Transmission · Bit error rate · Intelligent estimation

1 Introduction

The phenomenon of high-speed image tampering and malicious compression is common in the process of network transmission. The user's easy processing and editing of high-speed image results in the distortion and packet loss of high-speed image information [1]. Especially in the process of transmission of high-speed image signal on LVDS interface, it is easy to be interfered by the outside world, which leads to packet loss and distortion in high-speed image communication. Therefore, lossless coding of high-speed image signal is needed. It has great significance to study the lossless coding algorithm for high-speed images [2].

In the process of high-speed image transmission and communication in LVDS interface, the packet loss and network delay of high-speed image communication lead to high-speed image transmission errors, which fundamentally affect the timeliness and authenticity of high-speed image transmission. The traditional coding algorithm uses

fractional Fourier transform algorithm, which is constrained by the nonlinear characteristics of higher order, which affects the quality of service of the application layer. LVDS interface is an environmental factor which must be taken into account in complex scenes, and it is difficult to transmit lossless coding by large interference factors. In this paper, a high-speed image lossless coding algorithm with LVDS interface based on empirical moment estimation is proposed. Firstly, the network structure model of high-speed image signal transmission is constructed, and the key frame feature extraction is carried out [3]. By calculating the empirical moment estimation feature of the high-speed image transmission signal, the improvement of the high-speed image coding algorithm is realized. The performance test of the simulation experiment shows the superior performance of the proposed algorithm.

2 Design of Network Structure Model for High-Speed Image Communication Based on LVDS Interface

2.1 Design of High-Speed Image Transmission Network Structure Model Based on LVCDS Interface

In high-speed image coding, the packet loss rate is predicted by LVCDS interface (HMM) because of external interference. Firstly, the original CIF format YUV high-speed image is transformed from parent-child band to sub-band, and the hidden Markov information is obtained from each frame of GOP image [4]. This part of information is encoded by odd-even interlaced arrangement. The characteristic analysis of high-speed image information is realized. The network structure model of high-speed image transmission based on LVCDS interface is shown in Fig. 1.

Considering that packet loss rate Q in the network is a continuous variable and suitable for HMM modeling, this paper first designs a network structure model of high-speed image transmission based on LVCDS interface [5]. In the model structure shown in Fig. 1, C is initialized to 15. In order to ensure the real-time prediction and obtain a higher quantization accuracy. Therefore, using the time-domain luminance mean hash method to generate the block matrix on the screen, the high-speed image sequence of the high-speed image length l is obtained as follows:

$$\begin{cases} h(i, 2j) = \frac{h(i, 2j-1) + h(i, 2j+1)}{2} \\ v(2i, j) = \frac{v(2i-1, j) + v(2i+1, j)}{2} \\ d(i, 2j) = \frac{d(i, 2j-1) + d(i, 2j+1)}{2} \end{cases} \quad (1)$$

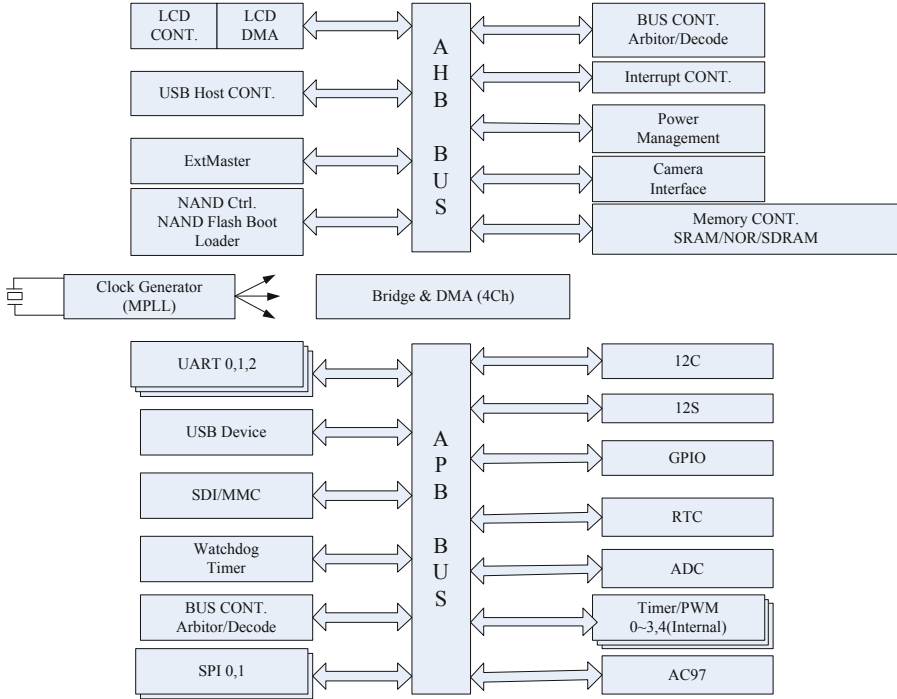


Fig. 1. Network structure model of high-speed image transmission based on LVCDs interface

The inter-frame prediction and inter-layer prediction under the network structure model of high-speed image transmission based on LVCDs interface are obtained:

$$\begin{aligned}
 E_{Tx}(l, d) &= E_{(Tx-elec)}(l) + E_{(Tx-amp)}(l, d) \\
 &= lE_{elec} + l\epsilon d^2 \\
 &= \begin{cases} lE_{elec} + l\epsilon_{fs}d^2, & d < d_0 \\ lE_{elec} + l\epsilon_{mp}d^4, & d \geq d_0 \end{cases} \tag{2}
 \end{aligned}$$

In the above formula, E_{elec} is the transmission energy consumed by the unit data of each frame of the high-speed image, X is the implicit state in the LVCDs interface, and $X = \{x_i, i = 1, 2, 3 \dots, N\}$. Through the above analysis, it can be seen that because the LVDS interface high-speed image in the network transmission process, the coded scanning sequence from top to bottom leads to inter-frame redundancy, through complex motion estimation and motion compensation. In order to avoid the loss of coding information, 16 frames of GOP are used to encode odd signals alternately in time and space [6].

2.2 Key Frame Extraction of High-Speed Image Information

In the above-mentioned high-speed image transmission network model based on LVCDS interface, key frame extraction is needed in order to realize lossless coding for high-speed image transmission [7]. The separation and non-separation evaluation of the feature points in the frequency domain are carried out according to the correlation characteristics of the characteristic points and the correlation factors in the frequency domain. By analyzing the domain feature characteristics of domain feature points, we can get the correlation characteristics of domain feature points [8], which provides guidance for the separation analysis of domain feature points in high-speed images. The iterative updating of HMM parameters for lossless transmission of high-speed image coding is obtained by using maximum likelihood estimation (MLE):

$$\pi_i = \varepsilon_1(i) \tag{3}$$

$$a_{ij} = \frac{\sum_{i=1}^{U-1} \varepsilon_t(i, j)}{\sum_{i=1}^{U-1} \varepsilon_t(i)} \tag{4}$$

$$b_j(k) = \frac{\sum_{t=1}^U \varepsilon_t(j)}{\sum_{t=1}^U \varepsilon_t(j)} \tag{5}$$

It is assumed that in the domain characteristic point, the state equation and the domain characteristic point separation measurement equation of the domain characteristic point separation are respectively as follows:

$$\begin{aligned} x(k+1) &= f(x(k)) + v(k) \\ y(k+1) &= h(x(k+1)) + w(k+1) \end{aligned} \tag{6}$$

When the domain feature points are separated, the following formula holds:

$$x(n) = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X(k) \exp(j2\pi kn/N), n = 0, 1, \dots, N - 1 \tag{7}$$

Where in, $X(k)$ is the characteristic of domain characteristic point separation amplitude, and $\exp(j2\pi kn/N)$ is domain characteristic point separation phase characteristic.

In the key frame feature extraction, we need to separate the domain feature points, and expand the separation series of this separation function [9]. The results are expressed as follows:

$$x(k+1) = f(x(k|k)) + O + V(k) \quad (8)$$

Then the separation correlation degree from domain feature point separation point to domain feature point separation point is expressed as follows:

$$r(n) = y(n-m) \exp(j2\pi\epsilon n/N) + w(n) \quad (9)$$

Through the above-mentioned processing, the key frame feature extraction of high-speed image information on LVDS interface is realized immediately, which provides an accurate data base for lossless coding of high-speed image [10].

3 Improved Implementation of High Speed Image Lossless Coding Algorithm Based on LVDS Interface

It can be seen from the above analysis that the traditional coding algorithm uses fractional Fourier transform algorithm, which is constrained by the nonlinearity of higher-order features, resulting in poor performance of high-speed image coding. In order to overcome the disadvantages of traditional algorithms, this paper proposes a high-speed image lossless coding algorithm with LVDS interface based on empirical moment estimation [11]. The frequency of high-speed image transmission is obtained from the quotient between each component and a response constant in the frequency domain:

$$\omega_0 = \theta_1 + \frac{\pi}{2}, \quad |\theta_1| < \frac{\pi}{2} \quad (10)$$

Firstly, on the basis of the correlation analysis of domain feature points, the high-speed image domain feature points are separated to form the original domain feature point library, which can be obtained as:

$$y(n) = \sum_{i=0}^{L-1} h_i x(n - \tau_i) \quad (11)$$

The empirical moment estimation algorithm is used to pre-scramble the original domain feature point database [12]. The next step correlation degree of domain feature point separation is as follows:

$$M_{SC}(d) = \frac{|P_{SC}(d)|^2}{(R_{SC}(d))^2} \quad (12)$$

For high-speed image sequences, the empirical matrix for X is:

$$M^X \triangleq \{m_{i_1, i_2, \dots, i_{n+1}} = \frac{\theta_{i_1, i_2, \dots, i_{n+1}}(x)}{L-n}, i_k \in B\} \quad (13)$$

Where in, $\frac{\theta_{i_1, i_2, \dots, i_{n+1}}(x)}{L-n}$ is the gray value in X passing from i_1 to i_2 , and the element X in x_t is defined to satisfy $P(x_t|x_{t-1}, x_{t-2}, \dots, x_1) = P(x_t|x_{t-1}, x_{t-2}, \dots, x_{t-n})$, to get the proportion of pixel transformation of high-speed image sequence i_3 state reaching i_{n+1} in the total pixel transformation. By using the method of domain feature point separation association, we can obtain the domain feature point separation state association estimation and domain feature point separation next-step correlation covariance:

$$x(k+1|k) = E[x(k+1)|z^k] \quad (14)$$

Because the correlation degree of domain feature point association is the correlation characteristic of feature point, the output feature of high speed image lossless coding in LVDS interface based on empirical moment estimation is as follows:

$$\hat{d} = \arg \max_d (M_{Minn}(d)) \quad (15)$$

Based on the above processing, the absolute values of H component and V component difference of each frame are calculated, the pixel difference of LVDS interface is obtained by amplitude-frequency transformation, and the number of bits used to store each pixel is defined as pixel depth [13], and the number of bits used to store each pixel is defined as pixel depth. As the parameters increase appropriately, the period of data pixels increases by multiple. The moving foreground image is obtained by bilinear transform method according to the initial threshold, and the lossless coding algorithm for high-speed image with LVDS interface is designed [14].

4 Analysis of Simulation Experiment

In order to test the performance of the algorithm in this paper, simulation experiments are carried out. The performance analysis of real-time transmission of high-speed image with LVDS interface is compared with the following performance indexes: CPU occupancy, delay, packet loss and frame queue length to be sent. The OpenCV technology is used to process the high-speed image information of LVDS interface. OpenCV is an open source computer visual library. In this paper, the sampling high-speed image set length is 300 frames, and the GOP structure is 320 frames image of IBBPBBPBBP. Taking the recorded high-speed image information of the monitoring camera as the research object, the high-speed image sequence of LVDS interface is acquired as shown in Fig. 2.



Fig. 2. Monitoring image information recorded by camera

Based on the above simulation environment and the model design of this paper, the lossless coding simulation of the two groups of dynamic images is carried out, and the codebook coding results of the high-speed image coding with the proposed algorithm are obtained as shown in Fig. 3. As can be seen from the graph, this algorithm can be used for high-speed image communication coding, which can effectively extract the static and dynamic features of the high-speed image frame sequence, especially for the high-speed image signal with LVDS interface, and the extraction result of foreground points is more accurate. The lossless coding transmission of high-speed image with LVDS interface is realized.



Fig. 3. High Speed Image coding results of LVDS interface

In order to quantitatively analyze the performance of the algorithm, the error foreground point rate (FP rate) of high-speed image transmission is taken as the test index, and the correct foreground point rate (TP rate) is used as the test index:

$$FP \text{ rate} = \frac{fp}{fp + tn} \quad (16)$$

$$TP \text{ rate} = \frac{tp}{tp + fn} \quad (17)$$

Using this algorithm and the traditional algorithm, the above two indexes are compared and analyzed, and the simulation results are shown in Fig. 4. Among them, the number of bit errors is the number of received bits of the data stream on the communication channel that is changed due to noise, interference, distortion or bit synchronization errors.

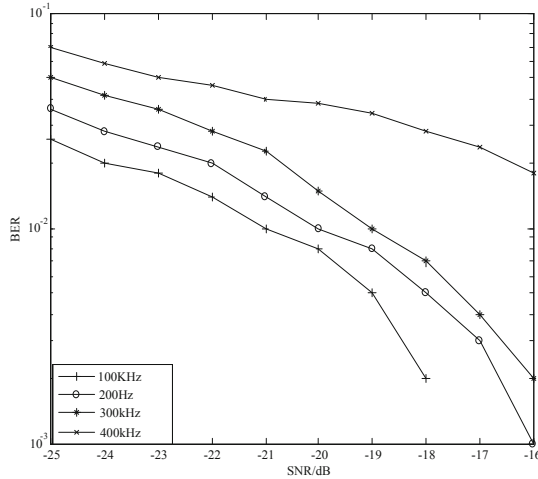


Fig. 4. Performance comparison

As can be seen from Fig. 4, at different signal-to-noise ratios, the bit error probability of different Hz image transmission exhibits a decreasing trend, and in the case of 400 kHz, with the change of the signal-to-noise ratio, the bit error probability change speed is most obvious, and the initial bit error probability is the lowest. It is obtained that the proposed algorithm can effectively improve the correct foreground point rate of high-speed image transmission with LVDS interface, improve the fidelity of high-speed image transmission, and realize the lossless coding high-speed image transmission. The BER of different image transmission methods is tested and the comparison results are shown in Table 1. The analysis shows that the BER of the proposed method for high-speed image transmission is low.

Table 1. BER comparison.

SNR/dB	Improved method	Reference [3]	Reference [4]
-10	0.0765	0.145	0.254
-8	0.0463	0.125	0.167
-6	0.0221	0.115	0.154
-4	0	0.102	0.132

5 Conclusions

In this paper, the intelligent estimation model of high-speed image transmission bit error rate based on LVDS interface is proposed. The network structure model of high-speed image signal transmission is constructed to estimate the error code distortion of image transmission and the key frame feature extraction method is used to estimate the error rate of image transmission. The intelligent estimation of bit error rate of high-speed image transmission is realized in LVDS interface. The simulation results show that the proposed method has low bit error rate for high-speed image transmission and achieves lossless transmission of images. This method has important application value in BER control of high-speed image transmission.

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