The Basic Principles of the Compact Video Frames Representation Technology, Which are Presented in a Differential Form in Computer Systems

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Abstract

In order to reveal regularities in sequences of series lengths, it is necessary to justify an informative attribute possessing the following properties:

1) is informative for the lengths of the binary series, taking into account the adaptation to the peculiarities of the formation of arrays of the binary mask of the differential frame.

Here, it is required to provide a potential opportunity for reducing redundancy for arbitrary content of the bit plane;

2) do not require significant computational costs for estimating and detecting regularities that do not exceed order $O(n)$;

3) to ensure that there are sharp structural differences for the binary indicators of the stationary and dynamic components of the differential frame represented.

The compression ratio of the differential-represented frame's binary mask varies from 3 to 21 depending on the correlation coefficient between adjacent frames. The most preferable method for constructing the compact representation technology of the binary masks of frames represented in a differential form is the approach.

It will be developed an approach for reducing redundancy in arrays of a binary mask of a differential frame based on the requirements advanced.

Keywords

Binary series, binary mask, differential frame, redundancy, indicator, component, Bodo code, compact representation.

1. Introduction

In order to take into account the proposed requirements, it is proposed to use the approach for code representation of the sequence of binary mask series lengths. Which is based on the discovery of regularities in the alphabet's power Ω. The data source alphabet is a set of values that message elements can accept. Then the power Ω of the message source alphabet is the number of different elements in the alphabet. One of the simpliest and at the same time effective codes that take account of restrictions on the alphabet's power are Bodo codes. The Bodo code corresponds to the first two requirements.

A simple Bodo element-by-element code provides information about:

- the size of the computer memory;
- the maximum value r_{max} of the series length in the arrays of the differential frame's binary mask [1,2].

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If a lengths sequence of binary series is given, i.e., $\Theta = \{r_1, ..., r_\Phi\}$ then a simple Bodo code is formed from three stages:

Stage 1. The maximum value of the length of the binary series is sought, for which the formula is used:

$$r_{\max} = \max_{1 \le i \le \Phi} (r_i) . \quad (1)$$

Stage 2. The determination of the number of bits $L(r)$, which is required to represent the maximum value of the binary series $r_{\max}$ length, which is given by the relation:

$$L(r) = [\log_2 r_{\max}] + 1 . \quad (2)$$

Step 3. The value $L(r)$ is writing at the beginning of the code representation and is the service information, which is indicating the code's description boundaries of the neighboring image elements [3-7]. After that, for every length of the binary series, a bit $L(r)$ is assigned to the code representation [8-10]. The total number of bits $L(r)_\Sigma$, which is required to represent all the lengths of a binary series is given by the expression:

$$L(r)_\Sigma = \Phi \cdot L(r) . \quad (3)$$

Bodo's simple block code consists in representing in each code word several elements of the original image fragment. For example, this situation occurs when several elements of the encoded sequence are represented in one computer word (one external memory register).

2. Research of a compact representation of a differential-represented frame's stationary component's binary mask array

The Bodo method is mono-alphabetic. In this case, all elements of the processed sequence belong to the same alphabet. Such sequences are called mono-alphabetic [11-13].

However, the Bodo code does not meet the third requirement. This is due to the fact that the differential-represented frame's binary mask, under conditions of removal by a stationary camera, has a significant heterogeneity of the structural content. Under the heterogeneity of the structural content is understood that the stationary component can occupy a considerable space, cut by small elements of the dynamic component. In this case, the lengths $r(0)$ formed for the zero sequences will prevail over the length relative to the lengths $r(1)$ of the individual element sequences [14-17]. For such situation, the use of a power code in one alphabet will lead to the formation of code redundancy. Indeed, in accordance to the power code of one alphabet for all series lengths, regardless of their origin, code sequences of the same length $L(r)$ are formed. In this case, the total number of bits $L(r)_\Sigma$ per representation of the entire sequence of binary series lengths will be equal to:

$$L(r)_\Sigma = \sum_{i=1}^{\Phi} L(r)_i$$

Here are

$L(r)_i$ - the number of bits per representation of the i-th element of the sequences of the mask's binary series lengths;

Φ - the number of the binary series lengths, which are formed for the binary mask array of the differential frame.

At the same time, due to the heterogeneity of the structural content, the actual number of binary bits necessary to represent the entire sequence of binary series $L(r)'_\Sigma$ lengths will be much less than the value $L(r)_\Sigma$, ie:

$$L(r)'_\Sigma <<< L(r)_\Sigma$$

This leads to the presence of code redundancy:

$$R = L(r)_\Sigma - L(r)'_\Sigma$$

This situation is due to the fact, that for the code representation of the units' series lengths, a significantly smaller number of bits is required in comparison with the code representation of the zeros' series lengths, ie:

$$L(r(1)) <<< L(r(0))$$

Here are

$L(r(1))$ - the number of bits for the code representation of the zeros series lengths;

$L(r(0))$ - the number of bits for the code representation of the units' series lengths.

In order to eliminate the code redundancy, it is proposed to use two alphabets for the sequence Θ of binary series lengths [18]. The first alphabet Ω_0 is defined for the zeros series lengths, respectively the second alphabet Ω_1 is defined for the lengths of the one sseries. This approach allows to take into account the presence of a sharp heterogeneity in the structural content of the binary mask array. Accordingly, the generation of a power code for such sequences will be realized using a two-alphabet scheme [19].

The essence of the scheme is that:

1. The lengths of the zeros and ones series are formed, which are based on the array of the binary mask.

2. The entire sequence of binary series lengths is divided into two sub-sequences.

The first sub-sequence is formed on the basis of the zeros' series lengths:

$$\Theta^{(0)} = \{r(0)_1, ..., r(0)_{\Phi_0}\}$$

The second sub-sequence is formed on the basis of the units' series lengths:

$$\Theta^{(1)} = \{r(1)_1, ..., r(1)_{\Phi_1}\}$$

Then the total number of bits per representation of the subsequences of the zeros' series lengths will be:

$$L(r(0))_\Sigma = \Phi_0 \log_2 r(0)_{\max}, \quad (4)$$

And the total number of bits per sub-sequence representation of the units' series lengths will be:

$$L(r(1))_\Sigma = \Phi_0 \log_2 r(1)_{\max}. \quad (5)$$

3. For each subsequence, own alphabet is forming, respectively, Ω_1 and Ω_0.

4. The power code is constructed in accordance with the constructed alphabets [20].

The power code is constructed according to the scheme, which is considered above, is called a two-halftone code. In other words, a two-alphabetic power code is a power code generated for two-alphabetic sequences.

Here, the sizes of the binary regions are taken into account as a result of identifying the binary series lengths. It will be shown, that for a two-index power code relative to the binary series lengths of the differential frame's binary mask, the condition holds, i.e. provides a degree of compression:

$$\eta_M = \frac{m_M n_M}{\Phi_0 \log_2 r(0)_{\max} + \Phi_1 \log_2 r(1)_{\max}} = \frac{\sum_{i=1}^{\Phi} r_i}{\log_2 (r(0)_{\max}^{\Phi_0} \cdot r(1)_{\max}^{\Phi_1})}$$

Here are

Φ_0 -the number of the zeros' lengths for the binary mask of the differential-represented frame;

Φ_1 - the number of units' series lengths for the binary mask of the differential-represented frame.

Example. Let's calculate the number of digits $L(r)_\Sigma$ in order to represent the entire sequence of series lengths for the binary mask of the differential-represented frame Q due to a one-rate power code.

First, let's define the maximum value of the binary series length $r_{\max}$ in a sequence of binary series lengths $\Theta = \{r_1 = 19; r_2 = 1; r_3 = 4; r_4 = 5; r_5 = 1; r_6 = 3; r_7 = 3\}$, which is based on expression $r_1 = 19$; $L(r)_1 = 5$ bits; $r_2 = 1$; $L(r)_2 = 1$ bit; $r_3 = 4$; $L(r)_3 = 2$ bits; $r_4 = 5$; $L(r)_4 = 3$ bits; $r_5 = 1$; $L(r)_5 = 1$ bit; $r_6 = 3$; $L(r)_6 = 2$ bits; $r_7 = 3$; $L(r)_7 = 2$ bits.

The maximum binary mask series length of a differential-represented frame $r_{\max} = 19$. Then, on the basis of expression (2), the number of bits required to represent the maximum binary mask series length is equal to $L(r) = 5$ bits.

The number of the binary series lengths is formed for the differential frame's binary mask's array $\Phi = 7$. Then, on the basis of the expression (3) the total number of bits on the representation of the binary series lengths sequence will be equal to a $L(r)_\Sigma = 5 \cdot 7 = 35$ bits.

At the same time, 36 digits are required for the code representation of the original image fragment (the image fragment is classified as highly saturated with details having different dynamic components) [21]. Consequently, by applying a single-alphabetic power code for all sequences of series lengths, the binary mask size of the differential-represented frame will be reduced by 3%.

At the same time, 36 bits are required for the code representation of the original image fragment (the image fragment is classified as highly saturated with details having different dynamic components). Therefore, due to the use of a double-alphabetic power code for the subsequences of the lengths of zeros and ones series. The differential-represented frame's binary mask volume will decrease by 20%. Also, due to the double-alphabetic power code, the volume of the differential-represented frame's binary mask is relative to the single-alphabet code will decrease by 17%.

3. Conclusions

1. As the correlation coefficient between adjacent frames increases, the compression ratio of the differential-represented frame's binary mask increases.

2. The compression ratio of the differential-represented frame's binary mask varies from 3 to 21 depending on the correlation coefficient between adjacent frames.

3. Estimation of the bit representation's information content of the differential-represented frame's binary mask on the basis of accounting for the nonequilibrium of the bases of the lengths of the binary series does not require an increase in the complexity of the software-hardware implementation.

4. Due to the double-alphabetic power code, the differential-represented frame's binary mask is relative to the single-alphabet code will decrease by 17%.

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