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IEEE EAST-WEST DESIGN AND TEST SYMPOSIUM 2012 COMMITTEE

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10th IEEE EAST-WEST DESIGN & TEST SYMPOSIUM (EWDTS 2012)

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The main target of the **IEEE East-West Design & Test Symposium** (EWDTS) is to exchange experiences between scientists and technologies of Eastern and Western Europe, as well as North America and other parts of the world, in the field of design, design automation and test of electronic circuits and systems. The symposium is typically held in countries around the Black Sea, the Baltic Sea and Central Asia region. We cordially invite you to participate and submit your contributions to EWDTS'12 which covers (but is not limited to) the following topics:

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CONTENTS

The Positional Structural-Weight Coding of the Binary View of Transformants

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Abstract

This paper investigates the peculiarities of the coding transformant bit view taking into account the observed regularities of binary structures based on the positional structural-weight (PSW) coding. It is proved that the technology of the PSW coding has two mechanisms for compensation of the influence of structural characteristics of a transformant binary format (the quantity of bits of compressed views per one element in average). The mechanisms of compensation are a formation of lengths for binary series and a building system of PSW number bases for each array of lengths of binary series.

1. Introduction

The development of InfoComm systems is realized in accordance with the conception of creating next-generation nets (NGN). The bulk of expansion of services is linked to providing of multimedia information [1; 2]. The conducted analysis of characteristics of video-information providing using InfoComm systems has shown that the given time of a transfer is provided only for images with the low spatial allowing. To overcome the current imbalance between the time of giving images and necessary time, the reduction of the rate allowing of video stream using compression systems should be provided.

The analysis of approaches of building video compression systems in the infocommunications has revealed that they are based on using JPEG oriented technologies [3-4]. Owing to the fact that using compression systems for a transfer of images with normal SD quality for high-rate communication channels, if there is a loss of quality of the reconstructed images at the level of the peak signal-to-noise ratio equal to 30 DB.

The existing image compression technologies using the JPEG-oriented technologies do not provide the required level of bit rate of compressed video stream. Therefore, lowering of the bit rate of the compressed video data to improve the quality of telecommunication services is the relevant scientific-applied task.

Lowering of the bit rate of transformed images is requested to provide improving technology of the coding of a binary view. This technology has the potential to reduce bit stream and time of processing transformants in condition of the given quality of image reconstruction for various degrees of a saturation of small objects.

The process of compressing of the transformant $Y_{m,n}$ (transformant is examined at the bit level of descriptions) is contained in identification of regularities of binary structures. Therefore, it is necessary to justify the conceptual approach to a system of changes consisting of the following components [5]:

1) making components $y_{\xi,\chi}$ of a transformant by binarization;

2) identification of structural regularities for the binary view of a transformant $[Y_{m,n}]_2$;

3) coding of a bit view of a transformant taking into account the observed regularities of binary structures.

It is also required to provide:

- lowering of the bit rate (v_c) of compact transformant view without making additional distortions;
- decreasing the quantity of transactions to process of a transformant.

The aim of this research is to develop the coding of a bit view of a transformant to increase the compression degrees of images (in consider of conservation of the specified image quality) intended for a transfer in InfoComm systems in real-time.

2. Building a positional structure-weight coding of a binary view of transformants

Selecting of the coding technology is required to identify structural characteristics for binary planes of a transformant. It is necessary to consider that the description of one-dimensional structures of identical binary elements in the lengths of their series reduces the quantity of processed data and lowers the bit rate. While one-dimensional structures of identified restrictions do not take into account the existence of 2D regularities.

Therefore, it is necessary to apply coding technology of sequences lengths of binary series in accordance with the following principles:

1) reducing of the bit rate for different frequencies of binary differentials in BST planes;

2) taking into account of the redundancy resulting from two-dimensionality of structural regularities, which is not identified in the case of one-dimensional binary series;

3) providing the sustainability to the uncontrollable distortions in transmission of code combinations with mistakes for communication channels;

4) coding should not lead to increasing of the quantity of operations. An increase in the quantity of operations should be in linear dependence from growing of the quantity of processed data.

Among the various strategies of coding the highest decrease of redundancy is achieved as a result of the identification of spatial constraints in the sequence lengths of binary series.

The realization of this approach is possible if considering an unevenness of dynamic range of binary series lengths located as within one plane and in the various planes of the BST. Possibility of such a peculiarity registration is formation of polyadical numbers (PN) [5] for sequences of binary series lengths.

The polyadical number A is a number $\{\ell_1,...,\ell_\theta,...,\ell_\Theta\}$, which bases of elements g_θ are any arbitrary integers, so that to carry out the inequalities:

$$\ell_\theta < g_\theta, \quad \theta=\overline{1,\Theta}. \quad (1)$$

The ratio between elements of polyadical number bases should match the criteria:

$$g_\xi \neq g_\gamma, \text{ where } \xi\neq\gamma, \ \xi,\gamma=\overline{1,\Theta}. \quad (2)$$

The inequality (1) should be carried out (by the definition of a polyadical number base). And it should be satisfied a condition for the magnitude g_s :

$$g_s > \max_{1\le p\le P}\{\ell_{s,p}\}, \quad s=\overline{1,S}.$$

Consequently, the smallest possible value of a polyadical number base is calculated as follows:

$$g_s = \max_{1\le p\le P}\{\ell_{s,p}\}+1 \text{ for } s\le s';$$

$$g_s = \max_{1\le p\le P-1}\{\ell_{s,p}\}+1 \text{ for } s> s'$$

If to use the generalizing function $P' = P - (1-\operatorname{sign}(\operatorname{sign}(s'-s)+1))$, then

$$g_s = \max_{1\le p\le P'}\{\ell_{s,p}\}+1 \cdot$$

As a result we get:

$$P' = \begin{cases} P, & \rightarrow s\le s'; \\ P-1, & \rightarrow s>s'. \end{cases}$$

Thus one-dimensional system of bases G is formed for the array $A_{k,u}$ included S components namely $G=\{g_1,...,g_s,...,g_S\}$. The weight coefficients W_s of polyadical number elements (for the proposed system of bases) are defined as collected products of bases of low elements, i.e. $W_s=\prod_{\xi=s+1}^{S} g_\xi$. A weight coefficient of a PN element depends on its position in number and (unlike polyadical number) has nonequilibrium increment depending on the value of bases between the considered elements. For example, on the one hand, weight add-on for s-element concerning (s-1)-element is equal to g_{s+1},

$$g_{s+1} = W_s / W_{s+1} = \prod_{\xi=s+1}^{S} g_\xi \Big/ \prod_{\xi=s+2}^{S} g_\xi \cdot$$

On the other hand, weight add-on for (s-1)-element concerning s-element is equal to g_s,

$$g_s = W_{s-1}/W_s = \prod_{\xi=s}^{S} g_\xi \Big/ \prod_{\xi=s+1}^{S} g_\xi \cdot$$

Consequently, in accordance with condition (2) we get $g_s \neq g_{s+1}$.

Therefore, a polyadical number is generally treated as a position-nonequilibrium number (PNN). The weight coefficient of elements depends not only on their positions, but also on the values of bases of low elements.

The code display C_p of a polyadical number is calculated using the following formula (3):

$$C_p = \ell_{1,p}\prod_{\xi=2}^{S} g_\xi + ... + \ell_{s,p}\prod_{\xi=s+1}^{S} g_\xi + ... + \ell_{S-1,p}\, g_S + \ell_{S,p} = \sum_{s=1}^{S}\ell_{s,p}\prod_{\gamma=s+1}^{S} g_\gamma$$

$$\text{or } C_{p,1} = \ell_{1,p}\prod_{\xi=2}^{S} g_\xi;$$

$$C_{p,2} = C_{p,1} + \ell_{2,p}\prod_{\xi=3}^{S} g_\xi;\ C_p = \sum_{\xi=1}^{S-1} C_{p,\xi} + \ell_{S,p}.$$

On each step of coding summand $C_{p,\xi}$ is formed on the basis of the high raw element of a PN. This leads to the conclusion that the coding of polyadical numbers is carried out according to the scheme of coding of the high elements of position-nonequilibrium number.

Let's formulate the interpretation of PNN coding for processing of binary structures of a transformant (BST). In the formula (3) magnitudes $\ell_{s,p}$ represent one-dimensional structural unit of the maintenances of the bits planes, namely the length of a binary series. So in this case, the polyadical coding can be considered as the integrated view of the exterior structural components of a transformant binary format. Thus, weight characteristics of the structural components are dependent on their positioning in the BST. Therefore, such coding can be interpreted as the positional structural-weight coding.

For a fixed quantity of binary elements of a transformant binary structure (in this case, the PSW number of variable-length is formed) the value of PSW code, on the contrary, will increase with growing of frequencies of binary overfalls. If we will fix a length of a machine word for variable length of a PN we will lay the more BST elements there, the more will be lengths of binary series than lengths constructed for them.

The volume $V(C_p)_c$ of the column compressed view of the binary series array is estimated as quantity of categories per views of appropriate polyadical code C_p,

$$V(C_p)_c = [\ell og_2 C_p]+1 = [\ell og_2(\sum_{s=1}^{S} \ell_{s,p} \prod_{\gamma=s+1}^{S} g_\gamma)]+1$$

Value of code of a polyadical number is limited from above by value of saved-up product of bases of its elements, i.e.

$$C_p \le (\prod_{s=1}^{S} g_s) - 1,$$

where the magnitude $\prod_{s=1}^{S} g_s$ is the saved-up product of bases of PN elements.

Maximum value $v(\max)_c$ for volume of column code view of BST array is evaluated according to the following formula:

$$v(\max)_c = [\ell og_2(\prod_{s=1}^{S} g_s - 1)]+1 \le [\ell og_2(\prod_{s=1}^{S} g_s)]+1 = [\sum_{s=1}^{S} \ell og_2 g_s]+1$$

Average of volumes ($V(C_p)_c$ and $v(\max)_c$) per one item of the BST is measured by the formulas:

$$\bar{v}_b = V(C_p)_c / S\sum_{s=1}^{S} \ell_{s,p} = ([\ell og_2(\sum_{s=1}^{S} \ell_{s,p} \prod_{\gamma=s+1}^{S} g_\gamma)]+1)/S\sum_{s=1}^{S} \ell_{s,p}$$

$$\bar{v}(\max)_b = ([\sum_{s=1}^{S} \ell og_2 g_s]+1)/S\sum_{s=1}^{S} \ell_{s,p},$$

where magnitude $\bar{v}_b$, $\bar{v}(\max)_b$ are average and maximum quantity of bits per one binary element of a transformant binary format .

The analysis shows that:

1) On the one hand with growing of the lengths of the binary series the code value of a PSW number will increase. But on the other hand (by increasing of the lengths of the binary series) the average quantity of bits per one item of a transformant binary structure will decrease, i.e. there will occur compensation of the increase of PSW number code volume.

2) Reducing of the binary series length brings to reducing of values of PSW number bases (and as a result the value of its code reduces), resulting in compensation of growth in the average quantity of bits per one item of the BST.

It means that the proposed technology of the PSW coding has two mechanisms for compensation of the influence of structural characteristics of a transformant binary format (the quantity of bits of a compressed view per one item of the BST in average), namely:

- formation of lengths for binary series;
- building of a system of PSW number bases for each array of lengths of binary series.

As a result, it reduces the bit rate of the BST compressed view for different structural contents of a transformant binary format (i.e. for various frequencies of binary differentials).

Thus, the basic components of the conception of a compressed view of a transformant binary format have been developed, namely:

1) making of transformant elements by binarization is carried out on the basis of their decomposition using polynomial by base two;

2) identification of structural characteristics in the transformant binary view is carried out by the way of formatting of lengths of binary series;

3) reduction of spatial redundancy in the bit view of a transformant (without making errors, but with taking into account the observed structural regularities) is organized on the basis of the positional structural non-equilibrium coding.

3. Conclusion

First, coding of the transformant bit view with taking into account the observed regularities of binary structures is organized on the basis of the positional structural-weight coding. In this case, the integrated view of weight structural components of a transformant binary format is realized. Thus, weight characteristics of the structural components are dependent on their positioning in the BST. It allows considering the dynamic ranges irregularities of binary series lengths located as within one binary plane and in the various planes of the BST.

Second, the built technology of the PSW coding has two mechanisms for compensation of the influence of structural characteristics of a transformant binary format (the quantity of bits of a compressed view per one item of the BST in average), namely: a formation of lengths for binary series; a building of PSW number bases system for each array of lengths of binary series. As a result, it reduces the bit rate of the BST compressed view for different structural contents of a transformant binary format (i.e. for various frequencies of binary differentials).

Compression of images (as a result of the positional structure-weight coding) is reached for the account of reducing of the following types of redundancy: structural redundancy caused by existence of binary series in a transformant binary format; combinatorial redundancy caused by the presence of the unevenness in lengths of binary series as for binary planes and between them.

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