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CREATION OF THE RULE FOR POSITIONAL STRUCTURAL AND WEIGHT NUMBERS FORMATION IN CONDITIONS OF CODES FORMATION WITH GIVEN LENGTH

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Abstract. *It is carried out the reasons for abbreviation of code redundancy quantity it is necessary to create positional structural and weight numbers of variable length. Creation of the rule of formation of positional structural and weight numbers with variable length that provides potential for implementation of the principle of a codes formation on the code word's maximum filling of the given length in the conditions of an exception of options of its overflowing and codes quantity redundancy minimization is explained. As a result of this approach it is possible to eliminate redundant code and reduce the processing time.*

***Keywords**: image compression, codes forming, structural and positional weight number, code redundancy, codeword, positional number.*

Introduction

Development of communication technologies on the one hand and the increased needs for receiving video information services on the other hand dictate need for further compression technologies for digitized images [1,2]. In this connection improvement of compression methods for video data makes relevance of scientific applied researches.

The widest use in the modern multimedia industry was received by technologies of a compression on a JPEG platform. Therefore creation of the modern methods is perspective to realize with use of basic components of JPEG technology. One of options here is improvement of strategy for biadic transforms processing. In article [3] it is shown that such improvement is allowed to be carried out on the basis of creation of positional structural and weight (PSW) numbers for the binary description of transforms. In work [4] efficiency of reverse coding development for expanded PSW number is justified. At the same time the important compressions process condition is equal length codes formation for PSW numbers with variable length. It will allow to low in addition the bit speed of images segment compressed representation and to increase code constructions resistance to errors in communication link. That is why the **purpose of researches** consists in development of rules system of formation of positional structural and weight numbers in the codes formation conditions with given length.

Development of the rule of positional structural and weight numbers creation for codes formation with given length

We will consider possibility for developed technology of coding concerning elimination of the code quantity redundancy R_c, caused by existence of a large number of insignificant (zero) bits in the code word with given length. Thus it is required to provide, implementation of the codes formation principle consisting in formation of the code word with in advance set length V_{ic}.

For abbreviation of code redundancy quantity **is offered** to create PSW number with variable length, i.e. $S' = var$. It is caused by two properties of positional structural and weight coding, namely that:

1) length of a code increases with growth of quantity S elements in PSW number. Here the PSV numbers index u with variable length constructed for an array of lengths for binary series $u = \overline{1, U}$. And $U \neq P$, where P - quantity of columns in the DBC array;

2) the most admissible code value $C(S)_{max}$ of PSW number length S will not exceed value $\prod_{s=1}^{S} g_s$ of stored work of the bases g_s of the appropriate elements $s = \overline{1, S}$, i.e. $C(S)_u \leq C(S)_{max} \leq (\prod_{s=1}^{S} g_s) \quad 1$.

We will consider the first property. Let's say that length of PSW number is equal S', where $S' = S + \Delta S$ ДS ≥ 1. If ДS = 1, the code $C(S')_p$ is calculated as

$$C(S')_p = \sum_{s=1}^{S'} \ell_{s,p} \prod_{\gamma=1}^{s\ 1} g_\gamma = \sum_{s=1}^{S} \ell_{s,p} \prod_{\gamma=1}^{s\ 1} g_\gamma + \ell_{S+1,p} g_S \prod_{\gamma=1}^{S\ 1} g_\gamma, \quad (1)$$

where $\sum_{s=1}^{S} \ell_{s,p} \prod_{\gamma=1}^{s\ 1} g_\gamma$ - a code component for the first S elements of PSW number; $\ell_{S+1,p} g_S \prod_{\gamma=1}^{S\ 1} g_\gamma$ - code component for an added element.

Taking into account that $C(S)_p = \sum_{s=1}^{S} \ell_{s,p} \prod_{\gamma=1}^{s\ 1} g_\gamma$, $C(\Delta S = 1)_p = \ell_{S+1,p} g_S \prod_{\gamma=1}^{S\ 1} g_\gamma$, we will receive $C(S')_p = C(S)_p + C(\Delta S = 1)_p$. From here it is possible to conclude that $C(S')_p > C(S)_p$. Therefore, the quantity of bits on representation of PSW code are grow, i.e. $V(C(S')_p) = [\ell og_2 C(S')_p] + 1 > V(C(S)_p)$. Here

$$V(C(S)_p) = [\ell og_2 (\sum_{s=1}^{S} \ell_{s,p} \prod_{r=s+1}^{S} g_r)] + 1 ;$$

$$V(C(S')_p) = [\ell og_2 (\sum_{s=1}^{S'} \ell'_{s,p} \prod_{\gamma=s+1}^{S'} g_\gamma)] + 1 .$$

We will consider the second property. As a result of increase in length of PSW number also the components quantity in a vector G' of the its elements bases respectively increases. From here the range of admissible values of PSW code namely if to increase in length of PSW number the upper bound of a code value is defined as $C(S)_p \leq (\prod_{s=1}^{S} g_s) \quad 1$, after its extension we will receive

$$C(S')_p \leq (\prod_{s=1}^{S'} g_s) \quad 1 = (g_{S+1} \prod_{s=1}^{S} g_s) \quad 1 .$$

In this formula value g_{S+1} is that gain in tolerance range of code values which will be formed as a result of increase in length of PSW number on one element.

Respectively the quantity of bits increases by representation of the maximum code value in case of PSW number extension. Really, if before extension of PSW number it was required to spend quantity of bits for representation of its code maximum value $v(S)_{max}$ equal

$$v(S)_{max} = [\ell og_2 (\prod_{s=1}^{S} g_s \quad 1)] + 1 \leq [\sum_{s=1}^{S} \ell og_2 g_s] + 1 .$$

That after extension on ΔS elements is required to expend $v(S')_{max}$

$$v(S')_{max} = [\ell og_2 \prod_{s=1}^{S} g_s + \ell og_2 \prod_{\gamma=S+1}^{S'} g_\gamma] + 1 = [\sum_{s=1}^{S} \ell og_2 g_s + \sum_{\gamma=S+1}^{S'} \ell og_2 g_\gamma] + 1. \quad (2)$$

From where it is possible to conclude that due to extension of PSW number the maximum length of its code will increase by value, equal $\sum_{\gamma=S+1}^{S'} \ell og_2 g_\gamma$ bits.

On the basis of the analysis of expression (2) it is possible to conclude that determination of code maximum length which can be created for the current length for expanded PSW number, doesn't require existence of prior information on its finite length. It allows defining value $v(S')_{max}$ on the information basis on the bases of earlier processed expanded PSW number elements. This property of reverse PSW coding provides potential for principle implementation of a codes formation on the code word with given length V_{ic} maximum filling.

Therefore increase of code length, and respectively the code word length at its representation it is possible to achieve by increase of PSW number length.

In the conditions of code formation value for PSW number with variable length it is necessary to determine length S[?] of expanded PSW number so that the condition of code redundancy R_c quantity minimization R_c was satisfied, i.e.

$$R_c = V_{ic} \quad v(S')_{max} \rightarrow \min .$$

From here value S' is defined as $S' = \arg\{\min(V_{ic} \quad v(S')_{max})\}$ or taking into account the ratio (2) we will receive $S' = \arg\{\min(V_{ic} \quad [\sum_{s=1}^{S'} \ell og_2 g_s] + 1)\}$.

Thus for an exception of the code word overflowing with selected length it is required to provide in addition condition execution $v(S')_{max} \le V_{ic}$, i.e. length of PSW number must be such that the quantity of bits $v(S')_{max}$ on representation of its code $C(S')_{max}$ greatest possible value didn't exceed the given length of the code word V_{ic}. At the same time for abbreviation of processing time we will agree to create PSW number only from adjacent array cells of binary series lengths (i.e. gaps in line items of elements are excluded).

Then generally condition of expanded PSW number length choice, so to exclude overflowing of the code word with given length will assume the following view:

$$S' = \arg\{\min_{v(S')_{max} \le V_{ic}} (V_{ic} \quad [\sum_{s=1}^{S'} \ell og_2 g_s] + 1)\}. \quad (3)$$

For S' value determination according to a condition (3) it is offered to use the recurrent diagram

Development of recurrent reverse uniform coding of expanded PSW numbers with variable length

Determination of the required length S' of PSW number is offered to be realized on the basis of the recurrent diagram. The recurrent diagram of processing allows.

To consider non-uniformity of PSW number bases elements values, i.e. after each adding of an element the maximum quantity of bits by its representation will increase no uniformly (with different bit speed).

Therefore adding directly groups of elements, i.e. $\Delta S \ge 2$, can lead to overflowing of in advance set code word, i.e.

$$v(s)_{max} + v(\Delta S)_{max} > V_{ic}.$$

In this formula value $v(\Delta S)_{max}$ means a gain in length of the most admissible code value in case of adding to the current PSW directly ΔS elements.

Then on each step of processing it is required to check a condition on validity of adding next s'- th element to the current PSW number, i.e. to check extension possibility of the PSW number current length D on one, so to exclude overflowing of the code word with given length. Let's say that before PSW next element adding the number contains D elements. The quantity of bits $v(D)_{max}$ on code representation of the most admissible code value $C(D)_{max}$ is determined by a formula $v(D)_{max} = [\sum_{\xi=1}^{D} \ell og_2 g_\xi] + 1$. Then adding of the next element with the base equal $g_{s'}$ will be possible if the inequality

$[\sum_{\xi=1}^{D} \ell og_2 g_\xi + \ell og_2 g_{s'}] + 1 \le V_{ic}$ is executed.

In this case length of PSW number increases by unit, and will be equal $(D+1)$. Otherwise, if the inequality $[\sum_{\xi=1}^{D} \ell og_2 g_\xi + \ell og_2 g_{s'}] + 1 > V_{ic}$ is executed, adding of such element can lead to overflowing of the code word with given length. Therefore the element having such base will not be admissible, and extension of PSW number comes to an end and its finite length will be equal $S' = D$.

Such processing is reduced to execution of the expressions following system:

$$D = \begin{cases} D+1, \to [\sum_{\xi=1}^{D} \ell og_2 g_\xi + \ell og_2 g_{s'}] + 1 \le V_{ic}; \\ D = S', \to [\sum_{\xi=1}^{D} \ell og_2 g_\xi + \ell og_2 g_{s'}] + 1 > V_{ic}, \end{cases} \quad (4)$$

where $\ell og_2 g_{s'}$ - quantity of discharges by which length of PSW maximum code representation number length $(D+1)$ of elements increases;

$\sum_{\xi=1}^{D} \ell og_2 g_\xi$ - assessment of quantity of bits which is required to be spent for representation of the maximum code value for PSW number consisting of D elements;

s' - base line item in a vector G' for an added element.

If the line item of the base of the high element of PSW number in a vector of the bases is equal in a vector of the bases, line item of the next added element base is determined on a formula

$$s' = \begin{cases} s+1, \to s \le S \quad 1; \\ 1, \quad \to s = S, \end{cases}$$

where S - length of a column of an binary series lengths array.

As a result of use of recurrent approach the rule of expanded PSW number with variable length formation, considering non-uniformity of their elements bases, and providing opportunity (potential) **is developed** for: elimination of code redundancy; exceptions of code world with given length overflowing options; creations of code words with uniform length.

Concerning lowering of bit speed and uncontrollable losses exception of information it is necessary to develop for implementation of the had opportunities reverse coding of PSW numbers with variable length in the conditions of code quantity redundancy abbreviation and elimination of code word with given length overflowing options.

Conclusions

1. It is justified that for abbreviation of code quantity redundancy of PSW number with variable length needs to create.

2. The rule of PSW numbers with variable length formation is constructed on:

- determination of the code maximum length which can be created for the current length of expanded PSW number, doesn't require existence of prior information on its finite length;

- for abbreviation of processing formation time for PSW number is carried out only from adjacent array cells of binary series lengths (i.e. gaps in line items of elements are excluded).

It provides potential for implementation of the code formation principle of the code word with given length maximum filling in the conditions of an exception of its overflowing options and minimization of code redundancy quantity.

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Баранник В.В., Красноруцкий А.А. Построение правила формирования позиционных структурно-весовых чисел в условиях кодообразования по заданной длине

Анотация. *Проводится обоснование того, что для сокращения количества кодовой избыточности необходимо формировать позиционные структурно-весовые числа переменной длины. Излагается построение правила формирования позиционных структурно-весовых чисел переменной длины, что обеспечивает потенциал для реализации принципа кодообразования по максимальному заполнению кодового слова заданной длины в условиях исключения вариантов его переполнения и минимизации количества кодовой избыточности. В результате использования данного похода обеспечивается возможность устранения избыточности кода и сокращение времени обработки данных.*

Ключевые слова: *компрессия изображений, формирование кодов, позиционное структурно-весовое число, кодовая избыточность, кодовое слово, позиционное число.*

Бараннік В.В., Красноруцкий А.А. Побудова правила формування позиційних структурно-вагових чисел в умовах кодоутворення за заданою довжиною

Анотація. *Проводиться обґрунтування того, що за для скорочення кількості кодової надлишковості необхідно формувати позиційні структурно-вагові числа змінної довжини. Викладається будування правила формування позиційних структуро-вагових чисел змінної довжини, що забезпечить потенціал для реалізації принципу кодоутворення по максимальному заповненню кодового слова заданої довжини в умовах виключення варіантів його переповнення і мінімізації кількості кодової надлишковості. У результаті використання даного підходу забезпечується можливість усунення надлишковості коду та скорочення часу обробки даних.*

Ключові слова*: компресія зображення, формування кодів, позиційне структурно-вагове число, кодова надлишковість, кодовое слово, позиційне число.*

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