Modeling of Structure of the Specialized Processor on the Basis Ryabenko's Splines for Signal Processing

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***Abstract*—The paper is devoted to problem of spline approximation. A new method of nodes location for curves and surfaces computer construction by means of B-splines, of Reyabenko's splines and results of simulink-modeling is presented. The advantages of this paper is that we comprise the basic spline with classical polynomials both on accuracy, as well as degree of paralleling calculations are also show's.**

***Index Terms*—Signal, Basis, Fast transformation algorithm, Model, Cubic splines.**

I.INTRODUCTION

DEVELOPMENT of computer facilities is characterized by that at each stage of new workings out of the requirement to productivity possibilities considerably exceed of elementbase. [1,5,6]

It is caused by problems of difficult control systems in the real time, the centralized decision of problems in networks, imitating modeling of difficult processes (for example, in the nuclear physics), operational planning and management and the decision of other research problems of the operations overcoming "a dimension of damnation". [1,5,6,8]

The term a spline has come from English spline that in translation means a core – the name of the device which was used by draftsmen to carrying out of smooth curves through the set points. [1,5,9]

As spline they say functions which are stuck together from various pieces of multinomial on the fixed system. Turning out thus smooth piecewise – multinomial functions with homogeneous structure (drawing up of multinomials of the same degree) are called a spline – as functions or is simple splines. The elementary and historical sample of a spline is – a broken line.[1,2,4, 10,11]

Splines-functions are developing area of the theory of approach of functions and the numerical analysis. Having been extended in the sixties, mainly as means of interpolation of difficult curves, splines became further an important method for the decision of various problems of calculus mathematics and applied geometry.[1]

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II. THE BASIC THEORETICAL DATA

The analysis of the existing literature has shown that the overwhelming majority of works are devoted studying of properties of cubic splines and their possibilities of practical application in various areas. A class of cubic splines is little studied. At the same time researches of the author show that, cubic splines can be used for approximation and restoration of the majority of almost used elementary functions, geophysical and seismic dependences.[1,2,3]

Wide popularity of methods of spline-approximation speaks that they serve as the universal tool of modeling of functions and in comparison with other mathematical methods at information with them information and hardware expenses provide the big accuracy of calculations.

As a whole development of the theory of splines goes in two directions:

1. Interpolation splines of certain boundary conditions satisfying to system and conditions in internal points of areas.
2. Smoothing splines are considered when questions of any optimization of functional.

In technical appendices the most common are splines of low degree, in particular parabolic and cubic. Process of construction of such splines is much easier, than process of construction of splines of higher degree.

Classical polynomial splines badly parallelized, the algorithms received on their basis aren't hardware-focused. Unlike polynomial basic splines give the chance to present initial dependence in the form of the sums of pair products of constant factors on values of basic functions. It gives a basis for essential parallelization functions evaluations. [1]

Local cubic Ryabenko's spline which on a piece $[x_i, x_{i+1}]$ looks like:

$$S_3(f;x) = \sum_{j=1}^{3} \psi_j(t) f(x_{i+j-1}), \qquad (1)$$

where

$\psi_2(t) = t(1+2t-2t^2)$, $\psi_3(t) = -t^2(1-t)$,

here $t = (x - x_i)/h$, $h = \frac{b-a}{N}$, $N = 1,2,...$

Further, this spline is denoted.

As an example, consider the interpolation using the Ryabenko'sspline analytically given function on the interval [0,1]. Table 1 shows the results of the interpolation of this function.

TABLE 1.
THE RESULTS OBTAINED FROM THE ANALYTICAL FUNCTION $f(x)$ NODAL POINTS x AND THE SPLINE RYABENKO $S_3(x)$ AND THEIR ABSOLUTE DIFFERENCE $|R_n(x)|$

x	$f(x)$	$S_3(x)$	$\lvert R_n(x)\rvert$
0	3	3	0
0,04	3,003264	3,010944	0,00768
0,08	3,013312	3,015232	0,00192
0,12	3,030528	3,022848	0,00768
0,16	3,055296	3,043776	0,01152
0,2	3,088	3,088	0

where $R_n(x) = S_3(x) - f(x)$.

As is evident from the first graph Ryabenko'sspline has high accuracy. This can be seen from the values. Especially the values at the nodal points are identical. And it proves the possibility of achieving high accuracy in recovering data signals. The values of the graph shown in fig1. The process of constructing such splines is considerably simpler than the process of constructing splines of higher degree.

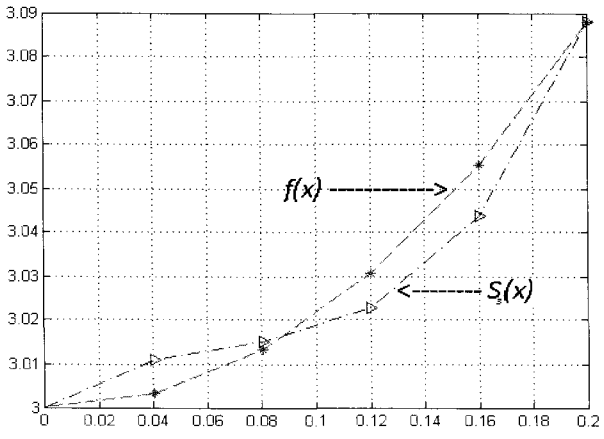

Fig. 1. Graphs of functions $f(x)$ and $S_3(x)$.

III.MODELING STRUCTURE OF THESPECIALIZED PROCESSOR FOR SIGNAL RESTORATION ON THE BASIS OF CUBIC SPLINES

The structure of special processor-based third-degree polynomial. Third-degree polynomial by Horner's scheme can be:

(2)

Consider the block diagram of special processor for signal restoration Ryabenko's splines.

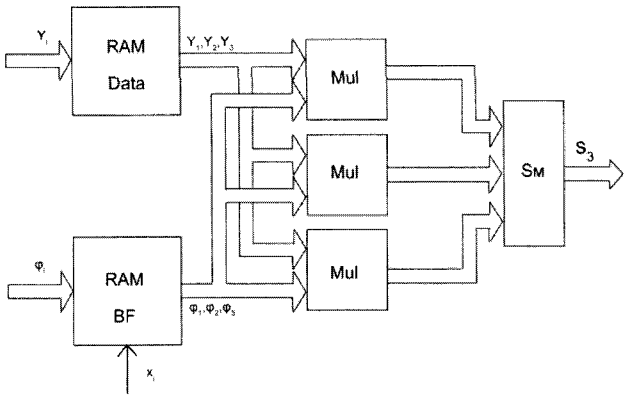

Fig. 2. The block diagram of special processor signal restoration based on Ryabenko'sspline

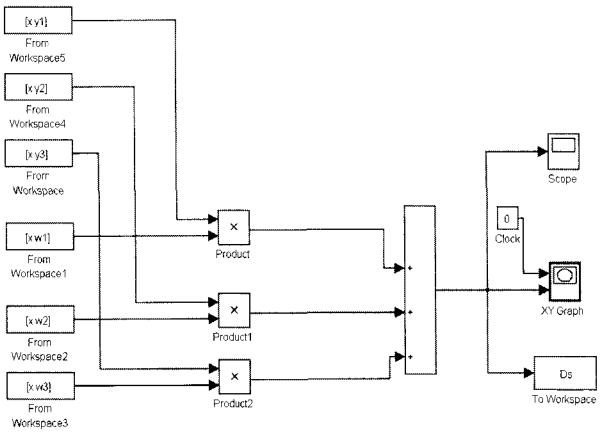

Fig. 3. Simulink - model of specialized processors based on the Ryabenko's spline

The block diagram of special processor signal restoration based on splines Ryabenco (Fig 2) consists of a data storage device (RAM Data), the basic functions (RAMBF), three multipliers (Mul) and one adder (Sm). Itching for storing function values RAM BF used to store the values of splines.

The values of the spline is introduced into RAM BF in tabular form.

With the help of the developed Simulink - model have been processed by the real geophysical signals resultingfrom magnetic prospecting. Results of processing of geophysical signals using Ryabenko's spline shown in Fig 5.

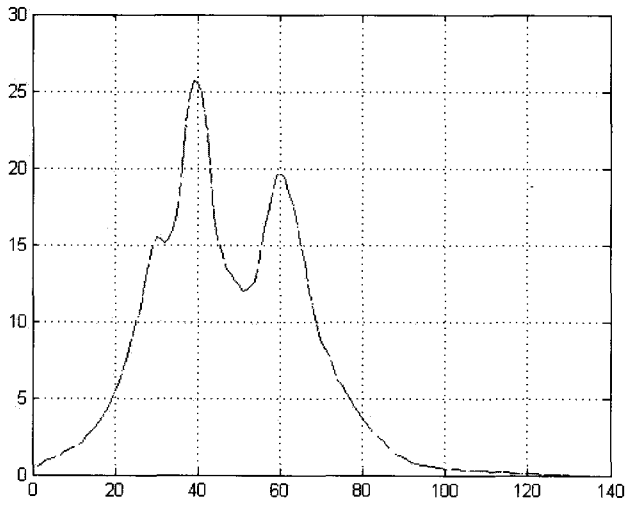

Fig. 4. Results of processing of geophysical signals using Ryabenko's spline.

Generalization of polynomial splines are rational splines, which in some tasks, such as the approximation of functions with large gradients, resonant peaks, emissions, give better results in terms of accuracy and a minimum number of coefficients. But their analytical description and hardware implementation are more complex.

Signal reconstruction algorithm based on spline Ryabenko looks. Because here the number of variable $[\psi_j]$ is made up of 3. This in turn facilitates the calculations, and requires little time. First, the formula is determined $[t]$. x - a number obtained in relation to, x_i, т.е. $[x_i, x_{i+1}]$ intermediate number. A $[x_i, x_{i+1}]$ refers to the gap $[a,b]$. Equal part ofthe gap $[a,b]$ canbedivided into one part N and equal segments $[x_i, x_{i+1}]$. Using t computed ψ_j. $f(x_{i+j-1})$ in this case, the price signal, suitable to a particular value of x. Here is a block diagram of the algorithm to obtain the result, using the program Matlab (Fig5)

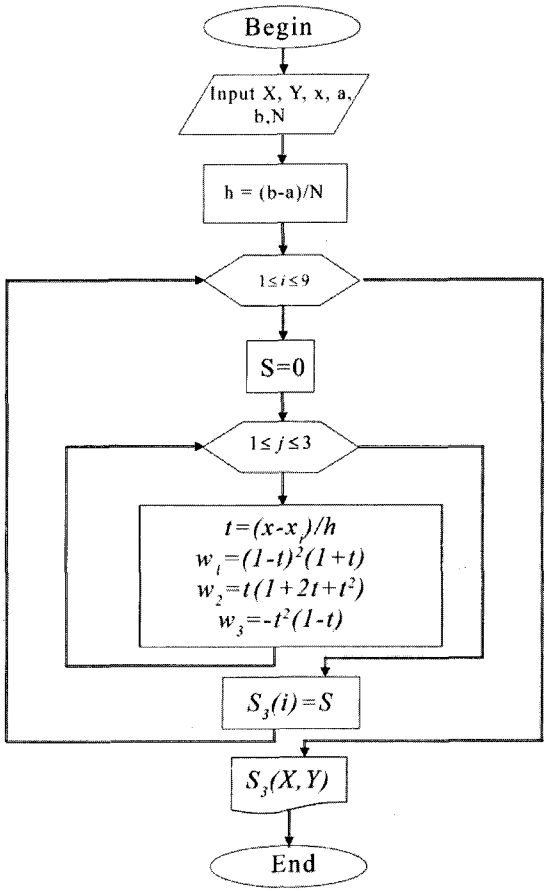

Fig. 5. The algorithm flowchart special processor signal restoration based on Ryabenko's spline.

IV. CONCLUSIONS

In contrast to the classical third-degree polynomial, Ryabenko'sspline exhibit such useful properties as high precision interpolation, finite, locality, regularity of the algorithms and hence algorithms based on them are hardware - oriented.

The proposed structure of the special processor based on cubic Ryabenko'sspline operates three times faster than the special processor based on the classical polynomials of the same degree.

REFERENCES

[1] Zaynidinov H.N. Methods for modeling high-performance computing structures processing of multidimensional signals in piecewise polynomial bases. Abstract of Thesis. for the degree of Doctor of Technical Sciences. Tashkent, 2005 p. 34

[2] Isroilov M. "Calculation metods" Part I. T.: Uzbekistan, 2003.

[3] Samarskiy A.A., Gulin A.V. "Computational methods" M.:Nauka, 1989.

[4] Zavyalov U.S., Kvasov B.I., Miroshnichenko V.L. "Methods of spline-functions" M.: Nauka, 1980.

[5] Barskiy A.B., "Architecture of parallel computing systems" http://www.intuit.ru/department/hardware/paralltech/1/1.htm

[6] "Basis splines". Abstract http://revolution.allbest.ru/mathematics/00278588_0.html
[7] Blayhoot R. Fast algorithms of digital signal processing. – M.: the World, 1989. – 448 p.
[8] Smith S.W.: The Scientist and Engineer's Guide to Digital Signal Processing. California Technical Publishing., San Diego. 2000.
[9] M.Unser, "Splines: A perfect Fit for Signal and Image Processing" IEEE Signal Processing Magazine, vol. 16, no. 6, pp. 22-38, November 1999.
[10] Madhusudan Singh, Dhananjay Singh, Zaynidinov H.N., and Hoon-Jae Lee, "Spline Method for Multi-dimensional Signal Processing", State Patent Department, Republic of Uzbekistan. Reg. No.: DGU 01833/ 30 Sep. 2009.
[11] Dhananjay Singh, HakimjonZaynidinov, Hoon Jae Lee: Piecewise-quadratic Harmut basis functions and their application to problems in digital signal processing. Int. J. Communication Systems 23(6-7): 751-762 (2010)

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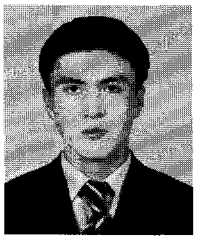

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