$$\operatorname{sign} f(s) = \begin{cases} 1 & \text{for all } s \text{ such, that } f(s) > 0, \\ 0 & \text{for all } s \text{ such, that } f(s) = 0, \\ -1 & \text{for all } s \text{ such, that } f(s) < 0. \end{cases}$$

Definition 3. *The system* (1) *is called uniformly globally controllable if there are the number* $\sigma > 0$ *and* $\delta > 0$, *what for all* $t \geq 0$ *and* $\xi \in R^n \setminus \{0\}$ *is fulfilled the inequality*

$$\xi^T \int_{t_0}^{t_0+\sigma} X(t_0,\tau)B(\tau) \cdot \operatorname{sign}\left(B^T(\tau)X^T(t_0,\tau)\right)d\tau\,\xi \geq \delta \,\|\,\xi\,\|.$$

where, as before, $X(t,s)$, $t,s \geq 0$, *– Cauchy matrix of system* (1) *with zero control.*

Fair of the following theorems:

Theorem 1. *Let the matrix* B *is integrable with a square matrix function. The system* (1) *with locally integrable and integrally bounded coefficients uniformly globally controllable by definition* 1 *(by Kalman) then, and only then when it is uniformly globally controllable in the sense of definition* 3.

Theorem 2. *Let the matrix* B *is not integrable with square. The system* (1) *with locally integrable and integrally bounded coefficients uniformly globally controllable by definition* 2 *(by Tonkov) then, and only then when it is uniformly globally controllable in the sense of definition* 3.

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FPGA USE FOR DIGITAL SIGNAL PROCESSING

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This article considers the possibility of increasing the performance of digital signal processing (DSP) using parallel computing techniques. The features of using FPGAs are given. The advantages of using FPGA to DSP processors are compared.

Introduction. The term "digital signal processing» (DSP) covers a wide area, the boundaries of which are difficult to determine. Often the hallmark of digital signal processors is the presence of hardware support for the "multiply-accumulate" operation (MAC). MAC is reduced to the computation of the sum of products:

$$y = \sum_{i=0}^{n} k_i \cdot x_i. \tag{1}$$

This amount can be considered approximately equal to the integral

$$\int_t k(t) \cdot x(t)dt, \tag{2}$$

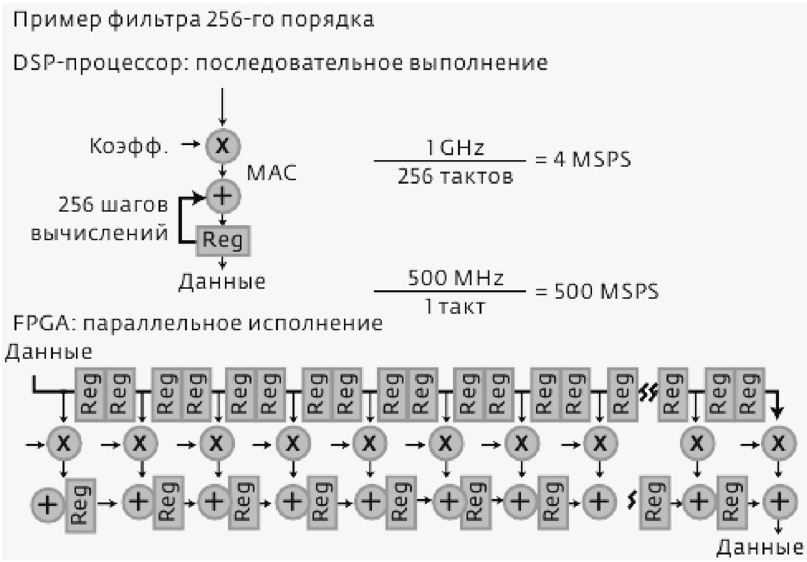
to which a large set of mathematical methods of signal analysis is reduced [1].

One of the main requirements for digital information processing systems is high performance. To achieve high speed computation is possible with the help of the techniques of parallel calculations, which in most cases use integrated circuits (ICs), such as Field Programmable Gate Array (FPGA).

ICs of this type are programmable logic array (PLA), between the elements of which electrically switched connections are laid. This allows you to configure the individual components and establish communication between them by loading the FPGA data stream including the required circuit and switching nodes. As a result the required digital circuitry is generated out of the available resources in the composition of the PLA. This digital circuitry can be easily modified. Modern FPGAs have a large amount of resources, reaching millions of equivalent logic gates that make up hundreds of thousands of logic cells, which allows the design of digital devices of any complexity [2].

Since its introduction FPGA devices have been positioned as superior signal processors in price / performance ratio. But compared to the relatively cheap microcontrollers and signal processors, FPGAs do not justify the use of the repetition of common processor architectures and single-threaded algorithms. Benefits of FPGAs in DSP systems are manifested only in case of realization of massively parallel computing architectures. In them high total memory bandwidth of FPGA, DSP blocks and high-speed serial transceivers are fully realized. Accordingly, the most effective for implementation on FPGA are techniques and algorithms using parallel processing of multiple data streams.

The signal processor created by comparable technologies on average has a higher clock speed, but the only flow of execution of commands reduces the overall performance. Although some signal processors allow the execution of two or four MAC operations simultaneously when calculating high-order filters, the overall computation speed is greatly reduced. However FPGA with large number of DSP blocks may provide a single-cycle execution of all operations using the parallel calculation (Fig.). For effective use of these advantages we should focus on algorithms and techniques implying parallelization of operations – higher order filters, fast Fourier transform, wavelet analysis, statistical data processing, etc.



Implementation of a digital filter in the signal processor and FPGA

Another important advantage of FPGA is the ability to provide continuous data processing with a stable rate. The fact is that the concept of "peak performance" has a different meaning for DSP and FPGA. The signal processor clock frequency conditionally corresponds to the amount of operations per second directly to the filter. However, in the program of processor there can be provided other activities, such as interrupt processing. Because of the need to perform additional operations peak rate may fall. Thus, the concept of "peak performance" is a statistical character, and actual performance can vary not only depending on the selected algorithm, but also in the process of the program when the relevant conditions.

However for FPGA, the "maximum clock frequency" term refers to the most favorable conditions tracing crystal - all connections are made using short circuits associated programmable cells arranged side by side, the maximum length of circuit fast transfer is limited (bit counter, usually small). Unsuccessful routing reduces the allowable clock frequency, but it is important that after completion of the design, it remains constant. Some problems with additional cycles of wait can make use of external memory. But the presence of high-speed synchronous resources and sufficient amount internal memory greatly facilitates the construction of standardized units of DSP. If necessary, in the projects on the FPGA processors can also be implemented (eg, processor on logic cells such as MicroBlaze), but thruogh this processor it is not necessarily to pass the entire flow of data. Moreover, it is recommended to implement a high-performance digital processing using independent from processor DSP resources. The processor can execute organization interface, load factors, and other operations that are difficult to implement in hardware. The only processor core can provide control of several hundreds of DSP-blocks that continuously perform processing input stream [1].

DSP programming for a specific task is usually done using a high-level language such as C, and the use of libraries oriented to a specific task, such as a library for use in wireless communication applications. This greatly reduces design time of devices based on DSP.

Until recently the development of devices based on FPGA has been a difficult time-consuming task. However, the situation has changed with the advent of new methods for the design of devices based on FPGA. One of the new methods is to write the algorithm of the device in a high level language with subsequent translation program for register transfer level. Another option to reduce design time is the use of embedded processors in FPGAs. At that algorithm is written in high level language, and the program runs in the embedded processor [3].

Using the FPGA digital processing today is the most effective solution to improve performance DSP devices. This solution allows realizing methods and algorithms using parallel processing of multiple data streams, thereby increasing the overall speed of computation. Also, due to new methods of designing devices based on FPGA design time is compared with the time of development of devices based on DSP. This suggests that the use of FPGAs to implement complex DSP algorithms looks more preferable than developing based on the DSP.

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STRATEGY AND TACTICS OF THE APPLICATION OF COGNITIVE-VISUAL APPROACH ELEMENTS FOR TEACHING MATHEMATICS TO ENGINEERING STUDENTS

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Methodology for the implementation of visual-cognitive approach through the use of algorithms and algorithmic requirements in the process of training engineering students to solve problems in mathematics is designed in the article. Didactic benefits and cognitive capabilities of the designed methodological tools for organizing and activating analytic-synthetic cognitive activity of students are emphasized. It is found that scientifically based and designed incorporation of allocated teaching tools in the process of problem solving allows accumulating the merits of problem and explanatory-illustrative methods of teaching mathematics. In addition, favorable conditions for methodically targeted assistance to students in linking studied topics and concepts to each other implicitly and indirectly contributing to the memorization, comprehension and students' mastering basic concepts and provisions are created in the pedagogical process. Using the potential of visual thinking is considered as an important parameter of influence on the optimization of the organization of students' independent cognitive activity.

Introduction. In recent years pedagogic science has been in search of new forms, methods and means of teaching, as well as specific methods of their usage in the educational process in order to improve learning efficiency. One such tool is a visibility of presenting information to be studied, which educational value is rather high. Particular attention should be paid to the issue of implementation of the visibility principle based on the development and usage of students' visual thinking reserves. In this connection, it makes sense to develop special methodical didactic means of presenting mathematical information, which would provide availability of its acquiring at all stages of the cognitive cycle, as well as facilitate its structuring, systematization and logical organization [1].

The overview of publications on the topic. We hold the view of those authors who defend the thesis that visual thinking is the kind of image thinking, but they don't coincide (N.V. Brovka, V.A. Dalinger, N.A. Reznik, O.O. Knyazeva, A.N. Chinin, M.A. Choshanov, etc.).

Accepting the existence of visual thinking as an indisputable fact, they point out the cognitive property of visualization. It is emphasized that when the visualization is integrated into the learning process not only it "helps" the learner in the organization of their analytical and mental activity, especially at the stage of perception and processing of studied information, but also provides meaningful knowledge by significantly affecting the depth of awareness of perception and understanding of specifically represented mathematical object, concept or a proposition.

Regarding our study we understand cognitive visual approach as the principle of formation of educational technology on the basis of the interconnection and unity of abstract and logical content of educational material and of methods with visual-intuitive ones. This approach involves the use of cognitive (cognitive-semantic) features of visual information (for example, when working with illustrations). Cognitive Visualization holds the key to solving many educational problems. This takes into account the role of color, enhancing the perception, memorizing and comprehension of educational information more than with black-and-white presentation of information. This approach encourages to widely use colors and shapes, graphs and drawings, complex visual cognitive tasks and animations in the process of learning [2].

In this article we will focus on the development of the skills of cognitive independence when using the particular algorithm approach for solving problems