Parallel-pipeline Implementation of Digital Signal Processing Techniques Based on Modular Codes

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***Abstract*—We consider the implementation of non-positional digital filters of parallel-pipeline type with the required accuracy, computational speed, and frequency response. The approaches suggested in the paper can be used for designing high-rate digital filters.**

***Keywords*—digital filtering, non-positional filter, parallel-pipeline type**

I. Introduction

The need for data processing in real-time has led to the extension of modular arithmetic applications. The analysis of this field allows us to divide all the areas of modular technology application into several main groups, where we can find the advantages of non-positional modular codes.

II. Application of Modular Codes

The first group includes classical methods and algorithms of digital signal processing, which use orthogonal signal transforms in the field of complex numbers [1–6]. Parallel data processing according to computational channels is determined by the base of the remainder class system. A small capacity of remainders allows us to improve signal processing rate. In [7] we can find an algorithm of secondary processing of navigational signals for reducing positional errors. This is caused by multiple measurement of pseudo-distance using the local area of increased ionization in the selected satellite constellation. Secondary signal processing in real time in performed using parallel computing in the remainder class system. Application of the remainder class system code allows us to increase the number of computations, which leads to a decrease of error of determining spatiotemporal coordinates of the user.

The second group includes methods and algorithms of digital filtering implemented using the residue class. In [8-11] we can find approaches to non-positional digital filter design whose functioning is based on algebraic structures with the properties of a ring and a field.

The third group includes digital signal processing techniques implemented using integer arithmetic of a polynomial ring. In [12–14] the authors recommend using the polynomial system of residue classes for high accuracy of digital signal processing algorithms. Reduction of the error of orthogonal transform performance is caused by the application of integer algebraic systems with the properties of a ring and a field.

In the last few years we can find many works where modular codes are used when performing large-scale signal analysis. Methods and algorithms of the wavelet transform in the remainder class system are the base of one more group [15, 16].

Nowadays all technical implementations of specialized digital signal processors use several mathematical models, which can be divided into the following groups. The first is based on mathematical models that use orthogonal signal transforms over the field of complex numbers, in particular discrete Fourier transform and fast Fourier transform. In wideband wireless access systems fighting with noise for multiray reception is based on the technology of orthogonal frequency multiplexing OFDM [17].

We illustrate the advantages of using parallel-pipeline computations using non-positional modular codes for digital signal processing implementation. Application of these codes due to independent parallel processing of low-discharge remainders reduces temporal costs for the main operations of digital signal processing in comparison with the positional specialized digital signal processing processor. When we increase the size of data the capacity gain improves. The paper discusses the developed algorithm of code error correction (for remainder class system) based on the positional characteristic - interval number. Application of parallel-pipeline computations allows us to reduce hardware costs by 7.2% when processing 2-byte data given in the remainder class system code. The main properties of the code provides fault-tolerance of high-rate digital signal processing systems.

Application of the remainder class system allows us to design high-rate computational structures of digital filters. Various tasks like representation of their negative coefficients can be solved efficiently.

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