Chapter 23
Spectral Algorithms for Signal Generation as Learning-Methodical Tool for Engineer Preparation

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ABSTRACT

In this chapter, a spectral method of deterministic signals simulation is proposed. The target is to solve the teaching methodological problem of individual tasks creation for students: future engineers in the field of real-time control systems' development and research. The tasks are related to the correlation theory. The method of simulation algorithms tuning with the help of specified spectrally correlation of signal characteristics and their parameters in the harmonic Fourier and Hartley basis is presented. To expand the set of task's variants for the independent student self-preparation the task of signals simulation has been formulated mathematically and solved in arbitrary complex and real systems of orthogonal basic functions. The requirements have been underlined on how teacher can teach basic functions for the practical applications. During such kind of decision task, the student will be able to counts the multiplicity, precision, and computational complexity of the resulting spectral simulation algorithms.

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RELEVANCE

Practical classes including course design, homework assignments and research works are important components of the teaching process in engineering field. The teaching efficiency depends on individual tasks for the student's independent work. These individual tasks should be prepared for the large number of students, should be multivariate and informative, as well as should cover a large number of competencies, which are specified in the curriculum.

Disciplines, which are related to the design of computer systems and real-time control systems, need training and methodological tools for student's independent work. This paper gives an example of such kind of methodological tool using signal's simulation methods and algorithms. The methodological tool set could be applied to the tasks of the subject on "Information's storing, processing and transformation" teaching.

INTRODUCTION

This paper proposes Science-Based Approach in Engineer's Preparation which is a continuation of Project-Based Approach. Students took part in a research project which been supported by Ministry of Education and Science of Russian Federation (Project Contract ID 2.7782.2017/BC). The project is concern to simulation algorithms, which use spectral representation of signal in different orthogonal bases. Such an approach allows students to produce simulation algorithms, which are differ in accuracy and computation complexity due to the proper basis function systems choice. The approach provides the multivariate tasks for the student's individual work. Moreover, the independent research on the variety of spectral representations will expand the scope of learner's knowledge and his skills in analog and digital signal spectral processing - theoretically and in practice. The results of the students work give statistical material for further ideas of the scientists.

From the large number of known base systems the most attractive ones to meet different authors' goals are parametrical bases containing changing parameters in the structure of their functions. They affect their properties. Examples of such bases systems are complex exponential functions, Vilenkin – Chrestenson functions, the generalized Hartley functions. The control over their properties is achieved by using variation of different bases.

In this paper the deterministic signals are under consideration only in the framework of the correlation wide sphere of practical applications because they are useful components of input signal processing in different control and management systems. The variation of such signal's frequency characteristics provides an extension for many options in simulation algorithms, which are helpful for student's individual task's creation from the side of teacher too.

The authors of the chapter develop an enrolled course named "Digital Signal Processing" (DSP) supported by industry enterprises working in the field of automation.

First part of the chapter is about how teacher could create variants of tasks for the individual student's work. The authors paid attention to the mathematical description of tasks assigned to students (see the Appendix) for performing laboratory work with the aim that teacher who carries on similar DSP course could use this mathematical device to create their own versions of tasks. The main emphasis in the paper is made precisely on the fact that this is a methodical material for conducting new form laboratory