# Music Computer Technologies in the System of Contemporary Education: Musical Programming

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***Abstract*—**Computer science covers today a wide, including illustrating the direct communication of knowledge in the research of music and computer science, who use in their work experts in the field of musical informatics, computer music creative work, digital arts, mediamusic, computer music, music and sound programming. As practice shows, it is the use, development and a wide range of functionality and, accordingly, the demand for software products and hardware-software complexes of music and computer use, their use in the musicological studies of musical science, and in the musical creative process and the system contemporary education, constitute an effective basis for the development of computer science itself. The discussion of these issues in an article.

***Keywords*—** Music Computer Technologies, Computer Science, Musical Programming, Media Education, Musical Informatics, Information Technologies in Education.

## I. Introduction

Currently, there are usually several main areas of research in the field of computer science: algorithms and data structures, programming languages, computer architecture, operating systems and computer networks, software development, databases and information retrieval systems, artificial intelligence systems, robotics, computer graphics, human-computer interaction, computational mathematics, bioinformatics, etc. The most promising areas of computer science development are associated with computational mathematics, theory of knowledge, library science, business informatics, bioinformatics, organization and management of industrial production, architecture. A number of directions have also been formed that illustrate the direct connection between knowledge in the field of music science and computer science, which are used in their work by specialists in the field of musical informatics, computer music creative work, digital arts, media music, computer music, musical and sound-timbral programming [1]. As practice shows, it is the use, development and the widest range of functionality and, accordingly, the demand for software products and software and hardware complexes for music and computer purposes, their use both in musicological research, music informatics, and in the musical and creative process, as well as in the system of modern media education, that constitute an effective basis for the development of computer science itself [2]. It is appropriate to recall fundamental research on the synergetics and nonlinear dynamics of computer networks, which determine the prospects for the development of musical media technologies and media education. In the monograph [3], based on the processing of a large statistical volume of data and the logistic model of global networks proposed by S.P. Kapitsa, their fractal properties, the results of mathematical modeling in the dynamics of the Internet are presented.

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## II. Music Computer Technologies in the Process of Working with Musical Sound: Muscal Programming

Modern musicians of various specialties have the opportunity to apply music computer technologies (MCT) in the process of working with sound - its creation, transformation and preservation on digital media; while working on a piece of music – when writing, performing, preserving and creating a sound component in the framework of multimedia projects; in the process of learning various musical disciplines and other musical-creative, scientific-research and educational directions. However, to effectively implement this feature, a user's level of proficiency in specialized musical software and hardware is not enough, deeper training in computer science and applied programming in the field of music is required - musical and sound–timbral programming, etc.

For the successful development of these software and hardware, it is not enough for computer science specialists to have only physical, mathematical and technical training, they require a fairly substantial level of knowledge of music theory and practical experience working with sound and music in digital format. We also note the increased interest of Russian scientists (musicians and programmers) in recent years to the problem of modeling the process of musical creative work [4]. A separate group of studies consists of practical research and development aimed at creating models for music recognition using a musical computer (MC), obtaining readable musical notation in MIDI format from mp3 and wave music audio recordings. In general, two classes of developments in this field can be distinguished today: systems that compare audio prints of melodies, and systems that work with the melody object format, which are usually aimed at the general user.

Approaches to the consideration, processing and structuring of statistical information obtained during the analysis of a musical text (a musical fragment in MIDI format (score))

Using standard methods, it is possible to identify a greater number of patterns, make modeling and interactive experiments possible, and, in the future, conduct a semantic analysis of the entire work as a whole. Such a research tool makes it possible to obtain specific results in the following theoretical and practical areas: •

• Building Models of Sound Sequences that Meet Specified Conditions;

• Studying The Peculiarities of Perception of Sound Signals as an Information Flow;

• Establishing The Affiliation of Various Sound Fragments to Certain Types;

• Establishing The Authorship of Sound Recordings;

• Recovery of Lost Fragments of Musical Recordings;

• Imitation of Sound Signals of a Given Character, Etc.

There is an objective need to improve the system of training specialists in the field of MCT – both developers and users – in Russian institutions of higher professional music, engineering, technical and pedagogical education, and the need to include in its goals the training of professionals capable of working at the junction of humanitarian and technical fields of knowledge

## III. Media Music Technologies

The rapid development of artistic and technical instruments of musical sound engineering, in particular, technologies for creating three-dimensional sound and the need to develop methods for their effective use in the process of creating sound components of a complex artistic image – a complex model of the semantic space of music [5] – are an organic part of the formation of spatial properties of the "sound picture" (Victor G. Dinov's term) space. As is well known, acoustic processes often have a decisive influence on various aspects of the creative activity of a musician, composer, or sound engineer.

The results of dissertation research carried out at the junction of technical sciences and musicology are of considerable scientific interest. Among them, we note the work of Ali R. Rustamov *The sound image of space in the structure of the artistic language of sound engineering* (2013), which reveals the main patterns in the process of creating a sound image of space.

The study of the relationship between the auditory assessment of a sound image and its objective properties, the implementation of aesthetically successful predictive control of the acoustic qualities of a space, and the classification of factors responsible for the formation of a listener's auditory sensations from listening to musical material in various acoustic conditions, which can serve as a guide in the creative activity of a modern musician and sound engineer in the process of creating musical compositions. Alexander V. Chernyshov summarized the practical, historical and theoretical experience of musical creativity in the media in his work *Media Music: Fundamentals of Theory, Practice and History*, 2014. Having outlined the problems of modern electronic media, the scientist developed a new direction in art criticism – media music, or media music technologies, which affected both purely informational forms of mass media and new artistic genres associated with the development of digital arts. The work of Nikolai Yu. Glazyrin *Algorithmic chord recognition in digital sound* (2015), devoted to the problem of chord sequence recognition in the sound recording process, allows us to conclude that the author has made a significant scientific and theoretical contribution to the development of chord sequence recognition methods and approaches to their software implementation, as well as the development of a software package corresponding to the tasks set in the study.

In the work of Sergey V. Chibirev *Research of Mathematical Models, Development of Algorithms for the Interface of a Software Package for Processing Sound Fragments in MIDI format* (2007) presented the result of applying a mathematical approach to the analysis of sound fragments in MIDI format as an abstract text, based on the analysis of statistical parameters, followed by modeling the process of musical creativity, developed using music computer technologies a tool for representing music recordings (sound events) as a set of statistical parameters, and a model, which allows you to synthesize a sound fragment that satisfies the specified musical parameters and characteristics. This work served as a starting point for the formulation of many subsequent research tasks and developments

## IV. Interactive Music, Audiovisual Installations and Performances

The relationship between music and the broader category of "sound art" is also one of the actively discussed problems of modern scientific research in the field of musical composition. There is no doubt, however, that the new musical and historical situation has clarified the importance of music as a sign system and has also contributed to the study of the interaction between different types of signification in the musical and historical tradition. For example, authors and performers of interactive music, audiovisual installations, and performances create their own original tools to realize their artistic ideas, allowing them to interact with the MC as a kind of partner with a certain range of capabilities within the framework of their ideas. This toolkit includes both software algorithms that regulate the behavior of a computer system in the process of interacting with performers, and various kinds of interfaces — sensors and controllers that allow information to be transmitted from the performer to the MC.

Modern audiovisual technologies, MCT and related applied research illustrate a wide range of new directions in the field of computer science and musicology, including contributing to the unification of different levels of musical semantics. The works [6-8] analyze the parameters of audiovisual synthesis, which are a means of emotional expression for a modern

composer and musical sound engineer; various directions of using synthesis in music theory and practice and in synthetic arts involving music are considered.; It contains recommendations for the use of these technologies in the science of music and practical musical composition.

The development of these artistic and technical fields would not have been possible without the active implementation of research results in the field of computer science, brought to the level of practical implementation in the relevant field of knowledge. As mentioned earlier, there are independent areas in the modern musical, educational and musical creative space - music programming and musical informatics.

## V. Conclusion

The results of the conducted research in these areas, which constitute one of the actively developing areas in the development of computer science, are used in the teaching of a number of academic disciplines that form the effective basis of the areas of "music computer technologies" and "information systems and technologies". Among such disciplines are the following: *Computer Music*, *Computer Musical Creative Work, Sound Timbral Programming, Musical Computer Science, Musical Sound Engineering, Computer Modeling of the Process of Musical Creative Work, Technologies of Music Creation for Visual Media, Technologies of Artistic Sound Processing, Mathematical Research Methods in Musicology, Musical Synthesizers, Computer Recording Studio and the Basics of Working in It, Intelligent Music Cataloging and Analysis Systems, Information Technology in Music*, etc. The results of the developments have also been introduced into the system of additional professional education and technologies for the implementation of inclusive musical education [9].

Learning the basics of music programming can also be relevant for musicians in order to expand and deepen their knowledge of the technical capabilities of digital musical instruments and other specialized software and hardware and their management capabilities, as well as for computer science specialists, such as programmers who want to master a new applied field of activity in order to create specialized musical instruments. software products or the implementation of a sound system in computer games at a high professional level. Among such new and widely sought-after areas are new educational programs such as "Information Technology in Music and Sound Design" (bachelor's degree) and "Digital Technologies in Music and Sound Design" (master's degree program), which are implemented within the framework of the educational direction "Information Systems and Technologies" (09.03.02 and 09.04.02 respectively).

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