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RESEARCH ON MUSICAL VISUAL DESIGN AND ARTISTIC SYNAESTHESIA IN THE VIRTUAL SPACE OF METAVERSE

Abstract: digital technologies are permeating more and more areas of human activity. With new technological advancements, the significance of music and its interpretation has shifted. This work aim and purpose is to show the possibility for making music in the meta-universe utilizing color qualities. The goal of the research is to evaluate and discover the shape of music utilizing meta universe properties. The novelty of this work is to use the synesthesia in modern meta- universe reality.

Keywords: synesthesia, music visualization, meta universe.

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ИССЛЕДОВАНИЕ МУЗЫКАЛЬНО-ВИЗУАЛЬНОГО ДИЗАЙНА И ХУДОЖЕСТВЕННОЙ СИНЕСТЕЗИИ В ВИРТУАЛЬНОМ ПРОСТРАНСТВЕ METAVERSE

Аннотация: цифровые технологии проникают во все новые и новые сферы человеческой деятельности. С развитием новых технологий значение музыки и ее интерпретации изменилось. Цель работы – показать возможность создания музыки в метавселенной с использованием цветовых качеств. Цель исследования – оценить и раскрыть форму музыки, используя свойства метавселенной.

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Новизна этой работы заключается в использовании синестезии в современной реальности метавселенной.

Ключевые слова: *синестезия, музыкальная визуализация, мета-вселенная.*

Colored hearing, according to academics, is the most prevalent type of synesthesia: sounds, music, or speech are perceived as colors. Most synesthetes claim to hear such noises internally, in their «mind's eye». Only a small percentage of people have visions that appear to be projected outside of their bodies, generally within arm's reach. The metaverse is a fictional incarnation of the Internet as a single, ubiqui-tous, and immersive virtual environment made possible by the usage of virtual reality and augmented reality headgear.

Based on different research results we can make the conclusion of the great opportunity for people with disabilities get the understanding of music and its creation. The theoretical study approaches utilized in this work yielded synesthesia results, which allow us to understand music through color. Using the mu-sic in meta universe is also very profitable business

Introduction.

Synesthesia can be characterized as a special way of perceiving when some states, phenomena, concepts and symbols are involuntarily endowed with additional qualities: color, smell, texture, taste, geometric shape, sound tonality or position in space. Synaesthesia is also a neurological phenomenon in which sensations emanating from one sense organ also manifest in another. And this phenomenon is very interesting for research because it gives us the understanding of imagination and music interpreta-tion. Music-color synaesthesia, also called color hearing, is a type of chromaesthesia (a type of Schereszewski syndrome) in which musical sounds evoke color associations in a person. It is about a cer-tain connection of the absolute pitch of musical sounds and/or tonalities with certain colors.

The use of meta universes in the music business will allow musicians and promoters to connect with their listeners on a far more intimate basis. While online music concerts are fantastic and allow music fans to listen to music from all over the world,

they are not the same as being physically present at the per-formance. It will allow musicians greater control over their works. You may have seen the surge in interest in non-fungible tokens (NFTs) and how artists have jumped in to commercialize their ideas. With digital things now selling like hotcakes, with some selling millions of dollars, it's natural for artists to want to join on board. It will allow musicians to elevate their brands to new heights. Creators have the last word on how their work is distributed throughout the metaverse.

Materials and Methods.

The work uses methods of theoretical research. Through the analysis and synthesis of basic data on synaesthesia and color perception we can predict the use and development of music in the me-ta-universe. Secondary research, often referred to as desk research, is a study approach that relies on previously collected data. Existing data is aggregated and collated to improve overall research efficiency. Secondary research is study information published in research reports and other comparable materials. These materials may be made available through public libraries, websites and data from pre-viously com-pleted surveys.

These methods were chosen because the purpose of this work is not to analyze such a phenome-non as synesthesis, but to propose an innovation for the meta-universe: the development of a color pal-ette tool for creating music. Many authors have accumulated enough knowledge to synthesize it in this work into a tool for controlling and creating music through advances in technology.

The main objectives of the study are: to determine the correspondence of the color scheme to mu-sic by summarizing the scientific knowledge obtained from secondary sources; to develop and propose a tool to create music using the obtained correspondences in the meta-universe.

Results.

Regarding the open statistics, we see that the meta universe is needed among those who listen to music. In a virtual environment, 45% of all people, 56% of Gen Z, and 61% of millennials would listen to live music.
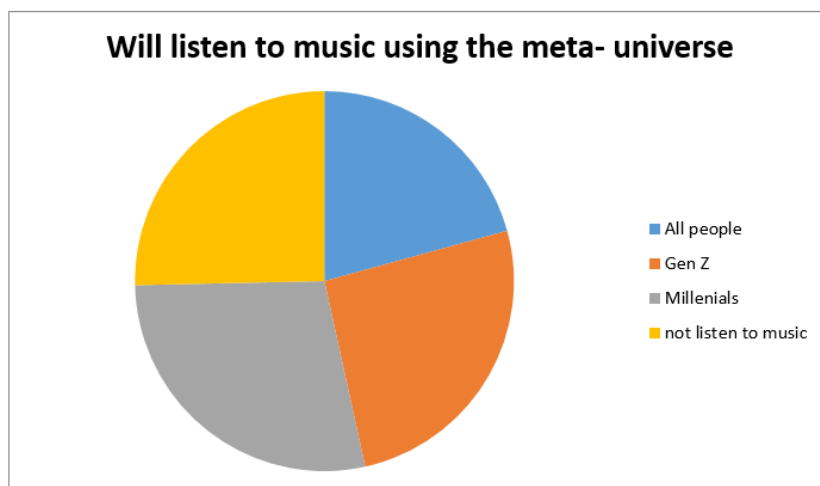
Pic. 1

Almost half of the general population (45%) expressed interest in watching live music in the metaverse, while 38% of individuals stated they would most likely attend a live sporting event. Among millennials, 61% indicated they would be in-terested in attending a live metaverse performance, while an identical number said they would be interested in having a digital avatar represent them. Another 56% stated they would want to see a live athletic event in the metaverse.

Meanwhile, 64% of Gen Z adults indicated they would like to have a digital ava-tar, and 56% said they would like to have one.

Many modern authors conduct the research about the music visualization [1,2]. The novelty of this work is in considering the visualization of music in the meta-uni-verse. Because music digital data can be supplemented with color and it will be possi-ble to create music in the meta-universe through the use of color fea-tures only. The synestesia was experienced by Liszt, Sibelius, Wagner, Olivier Messiaen, Duke Elling-ton, Jimi Hendrix, Stevie Wonder, and Prince. Though there is no agreement on what color each key is, the experience has spanned millennia, physically connecting great composers of the past with a plethora of songwriters today.

Some authors made the research [3] on synesthesia and got the results that shows that calm music could be interpreted as blue-green color and dynamic, rhythmic music is painted in red-yellow colors. Following this research [4] we can notice, that when students were immersed in the state of synaesthesia at the lesson of listening to the work of C. Debussy «Sirens» readings of heart rate correlated with readings of

Biometer and color selections of the blue-green spectrum in the drawings. The pulsation of the tranquil musical piece was reflected in the rela-tionship of heart rate and the intensity of bio-emission emanating from the fin-gertips: the correlation coefficient was r = 0.65 (p < 0.01), which is reliable in terms of significance. At the same time with children listening to «Sirens» there was a correlation between calm heart rate and the choice of blue-green shades (calm colors in terms of psychological impact): the correlation coefficient was r = 0.32 (p < 0.05), which is also statistically significant. The third pair of comparable prop-erties, Biometer measurements and colors of draw-ings, did not yield a statistically significant result. This is explained by the children's reaction to the device, during which there may be a temporary distraction from the lesson settings of listening to music and choosing colors.

Also [5] in his study provides a table of correspondence of tonal melodies and their color combinations.

tone	composer		
	A. N. Skryabin	H. A. Rimsky-Korsakov	B. V. Asafiev
C major	red	white	-
G major	orange and pink	light, frank, brownish-golden	Emerald of lawns after a spring rain or thunderstorm
D major	yellow, bright	Daylight, yellowish, regal, commanding	the sun's rays, shining precisely as an intense emission of light (if you look from Mount David to Tiflis on a hot day!)
A major	green	clear, spring, pink; it is the color of eternal youth, eternal youth	a joyful, intoxicating mood rather than a light feeling, but as such it approaches D major
E major	blue and whitish	blue, sapphire, brilliant, night, dark azure	night, very starry sky, very deep, perspective
B major	blue and whitish	gloomy, dark blue with a steely lead-gray cast; the color of ominous storm clouds	-
F-sharp major	blue-bright	grayish greenish	skin of a ripe orange (G-flat major)
D flat major	purple	darkish, warm	red glow
A-flat major	purplish-purple	temperament delicate, dreamy; color grayish purple	the color of a cherry, if you break it open

E-flat major	steel color with a metallic sheen	dark, gloomy, grayish-blue (the tone of «fortresses and hailstones»)	a sense of blue in the sky, even azure
B flat major	steel color with a metallic sheen	somewhat dark, strong	ivory feel
F major	red	clear green, pastoral; the color of spring birches	-

These experiments shows the possibility of creation the music with colors. For example, the key of A major has always seemed to be a brilliant, exultant key, and I saw it to be a vibrant red, a few degrees deeper than cherry red.

G major seems earthy and organic and it is a dark, brownish green.

D major appears bright and whitish-yellow. D minor, like its related major, F, is silvery-grey.

Returning to the question of meta-universe and creation the music, its visu-alization we should completely understand this term. The metaworld is a three-dimensional virtual environment that operates in much the same way as real world in terms of social and economic activity. The meta-universe is a digital image of society, the connection between the subjects of which takes place through the use of the avatar of the real user. In terms of visual and mental perception, the avatar of the user can be both a virtual image that repeats its owner, i.e. a «second self» without a real physical shell, and virtual images that do not correspond to the visual parameters and/or personal qualities of the real subject. Thus, by means of virtual reality it is possible to obtain a digital twin that will be a collective image of the user existing in the meta-universe, which allows him [the user] to exist as a split entity in both real and «unreal» worlds. In the meta-universe the user will be able to use colors and its combinations to create the melodies and in opposite, a person who has hearing disabilities will be able to interpret the music, because it will be encoded with colors and pictures.

The meta universe is not just a technological fantasy for now, but a real and valuable economic phenomenon. Using the meta universe features, we can col-laborate and control colors to create the music. According to reports, metaverse-related firms

raised more than \$10 billion in 2021, more than double their previous year's total. In the last year, Epic Games, the creators of Fortnite, not only raised \$3 billion to fund its long-term ambition for the metaverse but also announced a partnership with LEGO to construct a metaverse for children. The worldwide value creation opportunity from the metaverse might be measured in billions of dollars.

There are a number of examples of how the meta universe can be collaborated with music. For example, MetaCities is a startup that focuses on reproducing re-al-world locales in the metaverse and then delivering experiences such as music concerts, avatars, and holograms in those virtual settings.

Distant working since 2020 plays a huge role in all aspects of life, including music. The music business captured the attention of the public in April 2020 when a profitable virtual event starring an avatar of Travis Scott attracted 27.7 million unique players. Not to be outdone, Roblox booked Lil Nas X for a 33 million-view digital engagement. Remote interactions via smartphone or computer screen have become the standard, and with many music venues closing across the world, fans didn't have to be gamers or tech early adopters to enjoy a live broadcast. Two years later, the virtual-music future that was always supposed to be just around the corner looks to be approaching once more. Meta's Quest 2 VR headset has sold over 10 million copies; its Oculus app store has sold over \$1 billion; and Apple and Amazon are said to be working on their own headgear. According to Bloom-berg Intelligence, the metaverse, which is roughly described as an always-on in-ternet made up of 3D virtual environments in which users assume the shape of digital avatars, may be a \$800 billion business by 2024. Music appears to have a place in this virtual future: all those avatars will need something to dance to.

Discussion.

Some authors [6], drawing on the research of prominent scientists such as Newton, describe synaesthesia as a correlation of music and color perception by the human eye. There are 7 notes in the octave and the palette is divided into 7 primary colors. An interval has its own color and expressiveness. Intervals are the palette from which a piece of music comes.

Newton proved: to raise a note one octave up, multiply its frequency, by 2. If note A of the first octave has a frequency of 220 Hz, then note A of the second octave will have a frequency of 220 multiplied by 2, which is 440 Hz.

If we go higher and higher up the notes, we will notice that at 41 octave fre-quency will fall into the visible spectrum, which is in the range from 380 to 740 nanometers. This is where we begin to compare the note with a particular color. From this research and previous results we can make the diagram for the color and music tone interpreta-tion.

We can notice, that nowadays many traditional, arts lyes on multisubject arra. This is True for the music. The researchers under line the effective combination of technology in arts, especially music and its being in meta – universe [11, 12, 13, 14].
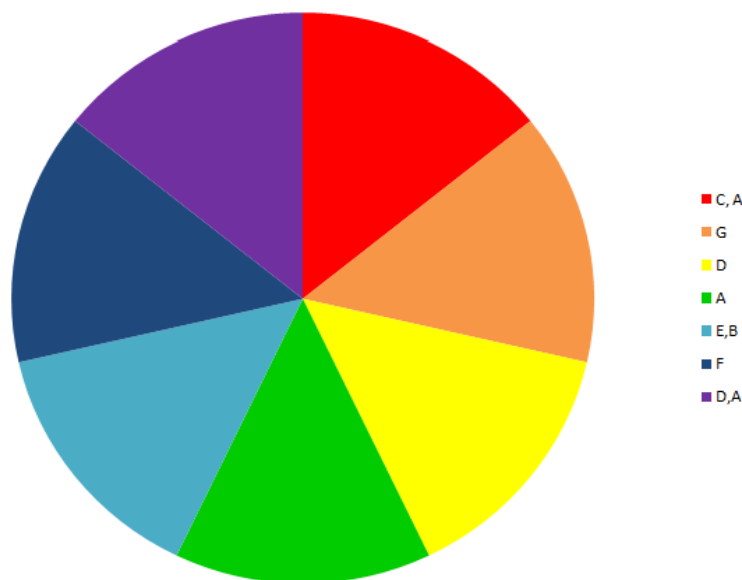
Pic. 2. Tone palette

This palette could be the virtual instrument in the meta universe for music crea-tion. Some authors [7] discuss the strong connection between music and color, and pictures as sonoristic analogies with Wassily Kandinsky's aesthetic principles, who compared painting to music and noted that abstract art is a means of extracting pure sound, understood as a Platonic «idea», but in a more irrational sense. «Sound», according to Kandinsky, may reflect the spiritual substance of any real experience, but only in abstract form. «Sound», like sonoristics, is an inseparable aspect of the universe, the ultimate «harmony of the spheres."

As we can see on the picture 2 some tones repeat in connection with the same color. Therefore, making the effective instrument for the meta universe requires the algorithm of decision making. This decision making algorithm may be created with machine learning of the music samples.

On the opposite side, such software can be used as interpretation of music and its Visualization. The idea of music Visualization is proposed in many sources [8, 9, 10].

Conclusion.

This work shows that every tone in music has its own color and its combinations. The meta-universe with color interpretation of music can give the people with disabilities the chance of understanding the music, its shape and tone.

We can conclude that every music tone can be associated to a color and shape and nowadays the meta universe gives huge opportunities for musicians with all abilities to create music and make performances.

A convergence of improved consumer technology, pandemic-era acceptance of distant experiences, and overall buzz surrounding the metaverse notion may have pushed virtual reality and music closer together than ever before. But, like with all things VR, the cultural moment that will catapult metaverse music into the public appears to be just inches away from our headset-squished faces. It will most likely be up to the next generation of musicians, fans, and technologists to devise the virtual equivalent of a sweaty night out at a local music dive, an introspective morning at home with a cup of coffee and a favorite record, or a plethora of other musical encounters as yet unimaginable.

The main result of this work is that the user in meta-universe can make the music with the color palette instrument which will be the intelligent software, where decision making algorithm will suggest user the perfect melody and tone combination.

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