The application of Artificial Intelligence on Computer Music Composition and Teaching-Learning

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Abstract

How can Artificial Intelligence be well applied to music education, music computer application, music industry, music stream-lining and so on, are many questions that seek answer. In order to answer these questions different works published on Artificial Intelligence on the internet was used to proffer answer. The questions were further streamlined to how can AI aid teaching and learning in computer music composition? What are the advantages and disadvantages of AI application? These formed the framework of the paper. Although many applications of AI in computer music composition and teaching-learning has been highlighted and enumerated there is still a wide gap between reality and fiction when situated to availability in the Nigerian tertiary institutions of learning. Secondly there is also the fear of teacher replacement and out of job to music composers and other human activities if these machines are made available. Therefore, there is need to make adequate alternatives for humans in the event of actual availability of AI machines. Thirdly there has been scanty available account on application of AI on computer music compositions algorithms relating to African melodic, harmonic and rhythmic structures including spellings in African languages. Therefore, more research efforts should be geared towards the above observation by

collaborations of programmers in Africa and Nigeria in particular to create models that would cater for these needs.

Keywords: Artificial Intelligence, Music composition, Music education

Introduction

Artificial Intelligence is a new technology that allows machines to perform human-like functions. Artificial Intelligence has permeated almost every sector since humans want their roles replaced with faster and more efficient machines. AI is applicable in music education and composition where the songs are not only from human input but also from machine contribution. Teaching and learning are like two-side coins that are incomplete without the other. On the other hand, computer music composition is the application of technological device to aid electronic music writing/composition through learning and understanding the workability of the computer device and applying such knowledge base to music composition with the aid of the machine. Commenting on the use of artificial intelligence to aid teaching and learning (Oyibo & Okafor 2023:2) said that globalization and curriculum development have enabled the use of internet facilities and tools for effective delivery of course content. Sidiq (n/d:75) said that AI is applied generally in developing music and musical instruments, it is also applicable in music composition and education, where composers and educators rely on algorithms to generate music that aligns with the times. Kai, W, Xiaofei Y, Ning M, Lei Z, and Licheng W. (2023:9) iterate that the continuous developments of information technology, advanced computer technology and information technology have been promoted and used in the field of music. As one of the products of the rapid development of information technology, Artificial Intelligence (AI) involves many interdisciplinary subjects, adding new elements to music education. According to Lopez-Rincon et al. (2018), AI applies in music composition where users rely on it for automatic song composition through computer systems. Also, there are multiple applications ranging from simple ones like declarative programming to complex ones, including deep learning, algorithms, and neural networks (Lopez-Rincon et al., 2018). It demonstrates that an algorithmic composition is not a new phenomenon but was born out of the desire to inculcate technology in music. (Lopez-Rincon et al. 2018). Corroborating Lopez-Rincon et al (2018), Lalit Kumar, Palash Goyal, & Rishav Kumar (n.d : 36)

quoting (Grount, 1996) that the ideas of using formal instruction set to generate music is from the time of the ancient Greeks. Even Pythagoras (around 500 B.C.) believed that the fundamental laws of nature have direct relation with music and harmony. And that the word music had a much wider meaning to the Greeks than it has to us. In the teachings of Pythagoras and his followers, music was inseparable from numbers, which were thought to be the key to the whole spiritual and physical universe. Thus, the system of musical sounds and rhythms, being ordered by numbers exemplified the harmony of the cosmos and corresponded to it. In another dimension Lalit, et al (n.d:36) said that Algorithmic composition is a process to create music using computer algorithms. We can define algorithms as a formal set of rules/instruction, in a proper sequence which tend to solve a particular problem. In composition, algorithms are used to combine different musical parts into a whole composition.

Conceptualizing Artificial Intelligence (AI)

artificial intelligence is a process of learning where a machine using a set of instructions (algorithm) is the tutor and also gives feedback of learning outcome to the learner (Oyibo et al 2023:3). Wang (2022) in Sidiq (n.d:70) aver that Artificial Intelligence technology is based on an intelligent system considering a combination of hardware and software to enhance music learning. Some of the technologies involved include database servers, drives, and memories. Sidiq (n.d:71) quotes Suh et al., 2021) that the developments of neural networks have enhanced AI's ability to work with humans to develop creative content. According to Nicole Laskowski, Artificial intelligence is the simulation of human intelligence processes by machines, especially computer systems. Specific applications of AI include expert systems, natural language processing, speech recognition and machine vision (Lawton, 2023). Holland (2000:1) quoted Self (1995), that AI is "*any computer-based learning system which has some degree of autonomous decision-making with respect to some aspect of its interaction with its users*" (Holland, 2000).

Computer Music Composition using AI

Lalit, et al (n.d:36-37) identified four models used in generating music computer composition with the aid of artificial intelligence namely; Translational Models,

Mathematical Models, Knowledge Based Systems and Grammars, which they also explained drawing inference from the views of other authors as follow;

- ***Translational Models***

To generate music from this approach, it involves translating information from an already existing non-musical data-source to new musical sound. The translation can either be rules based or random (stochastic). e.g. the translation of text into music in which text is used to extract sentiment and those sentiment can be used and as an input to music composition. Another e.g. is translating an image into new sound, in a jpeg image treating horizontal pixels line as a value of sound with constant pitch.

- ***Mathematical Models***

Mathematical models are based on random events (stochastic processes) and mathematical equations. Stochastic process is the most common way to compose music through the knowledge of mathematics. In stochastic methods multiple pieces of music is generated via the result of non-deterministic methods. Stochastic methods are used in combination of other decision-making algorithms like Markov chains and Gaussian Distributions. e.g. composer generated by Ames and Domino. Composer was able to generate music of different genres, e.g. standard jazz, Latin jazz, rock, and ragtime. A natural phenomenon is also used to compose music, chaotic models already being used to generate composition from harmonic as well as in-harmonic natural phenomena. Another example of deterministic compositions is the use of all-interval series for computer-aided music generation.

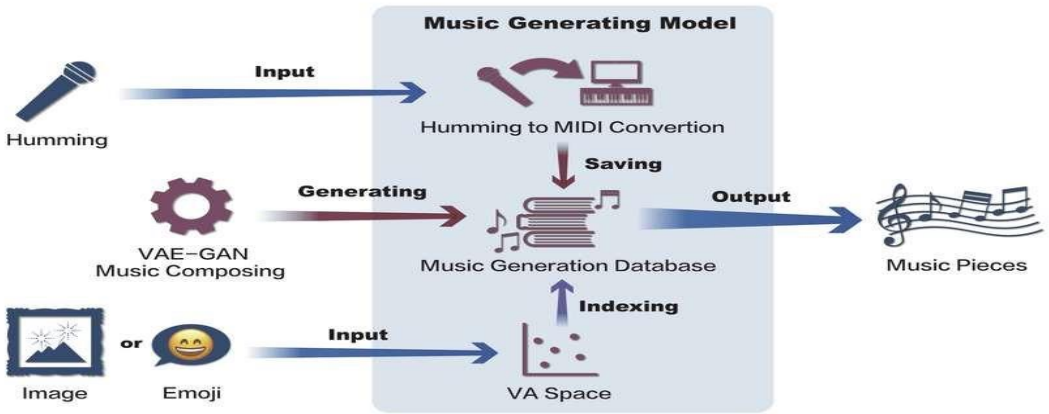
- ***Knowledge Based Systems***

Knowledge based systems (K-B-S) are programs that uses already provided/Incorporated knowledge base within the program to solve a set of problems. Knowledge based systems are based on pre-defined or pre-set of values that is used to generate new music pieces of the same genre and style. The use of KBS systems in music composition is very common, as in KBS systems we can model well defined domain of music pieces and can also introduce set of explicit structures and rules-set for music composition. As KSB systems generally tend to have a knowledge based on their own, but time and data required to generate such knowledge base is very large and complex.

- ***Grammars***

  Like computers have their own grammar (Theory of Computation), music can also be explained and examined as a language with a distinctive set of grammar. Different properties can be defined for music using its grammar set, and can be helpful for music composition. Compositions can be constructed by first developing a grammar for music, which is then used for generation of comprehensible musical pieces. Musical grammar generally uses rules like harmony and rhythm for macro-level composing rather than single nodes.

According to Qiu, Z., Ren, Y., Li, C., Liu, H., Huang, Y., Yang, Y., & Zhang, K. (2019), Mind Band is one AI platform that assists music composition using common elements like emojis, humming, and images. The music composition model is anchored on the valence arousal model using life elements to map them into music. The platform functions by uploading emojis and images and humming and generating emotionally related music, as evident in the figure below.

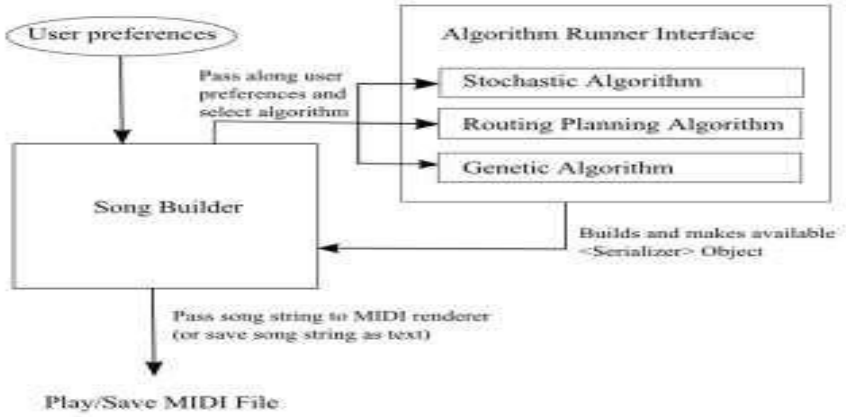


Music generation model in a mind band system (Qiu et al., 2019).

The platform does not require expertise, meaning anyone can compose songs using AI. Emojis and images are part of the actual world, which explains their use. Tahiroğlu (2021) explores how music emerges as a social construct even as it is a product of cooperation between AI and humans. Modern music performance is through technological equipment, and hence these affect the music and the social aspects. AI is applicable in the music industry where AI-entity musical instrument

helps produce real-time music synthesis audio samples. The technology is anchored on the generative adversarial network (GAN), which creates sample audios for musicians to ease music composition. Composers and musicians use AI to generate high-quality music and manage the sounds for different media.

Some AI technologies applied in music composition also include MAGMA which relies on stochastic, planning, and genetic algorithm approach anchored on Markov chains to generate songs (Fox & Khan, 2013). See example below;



MAGMA architecture (Fox & Khan, 2013)

Musicians have embraced music tools like BandLab, which suggests unique musical loops based on prompts as an escape valve for writer's block. The AI app Endel generates customized, constantly-mutating soundtracks for focusing, relaxing or sleeping based on people's preferences and biometric data (source: Andrew (2023)). Other AI technologies available to assist seasoned and beginners in composition include LANDR – an audio mastering application which helps in employing AI to help uses create better music. AI 'PhonicMind' uses AI algorithms to eliminate vocals from music. With this software, one can make professional-sounding karaoke mixes out of any song (source: https://www.cellstrat.medium.com)

Li et al. (2022) in Wang et al (2023:3-4) proposed the design of an intelligent piano performance system based on AI and studied the realization of the piano teaching system. The teaching system from the angle of the simulation of the teachers,

based on the piano teaching evaluation system was put forward. For the system as a whole, the function of the piano, including signal extraction, play interface, etc., through the experiment verified the feasibility of the teaching system. The system also can simulate teachers guiding students to play the piano, which is of great significance. By using this kind of software, students can detect the music they play in the process of piano practice at home, and more intuitively, see the problems in their playing mistakes. For some common mistakes, they can solve them directly without bringing them to the classroom. At the same time, for some mistakes, specific and correct playing positions will be provided on these software detection pages, which can help students to quickly find them on the piano, greatly improving the efficiency of piano practice and the quality of the class. At present, intelligent electronic instruments have been favored by consumers in the market, such as the intelligent electronic piano. They concluded that compared with the complex and expensive traditional piano, the intelligent electronic piano is cheap and easy to use. At the same time, it is also equipped with a self-study software app, which is more suitable for self-study at home.

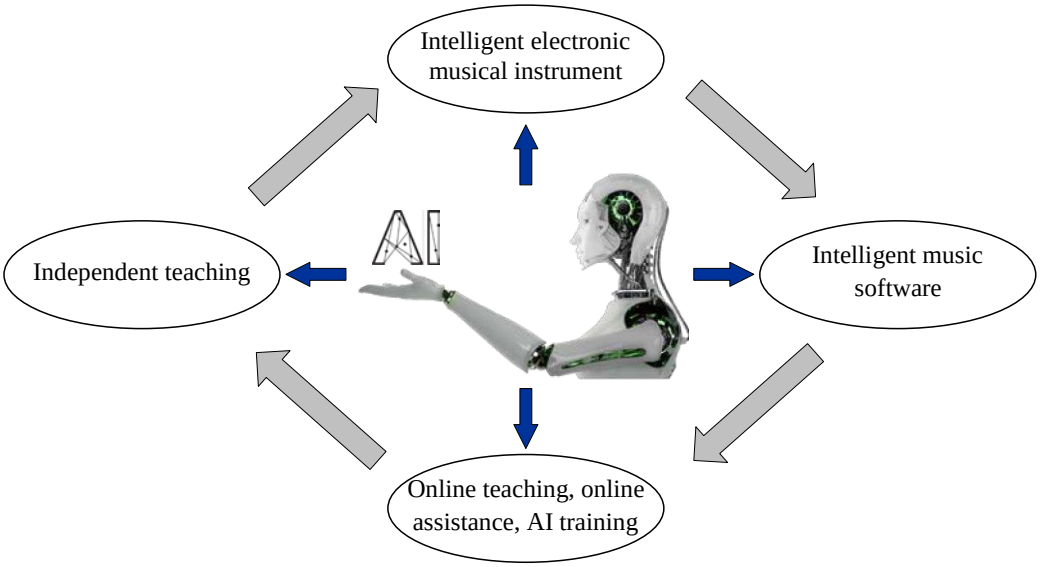
In addition, they said that the application of AI music software depends on the output of electronic equipment and whether the processing ability of music data has been restricted by conditions, however, the storage of music information is more stable. Users can edit, adjust, record freely, and process various music elements with AI. With the popularity of music teaching, AI music software provides an interactive platform for teachers and students to share learning resources, where teachers or students can find their own resources to improve. The traditional way of music teaching has undergone a huge change. The knowledge that the teacher teaches in the music teaching class and the content that the student is interested in expanding can be completed by AI music software. Advanced music software includes all kinds of music elements, which broadens students' music vision and deepens their music perception. At the same time as spreading the charm of music elements, it can provide a platform for teachers and students to communicate with each other, or leave feedback or play together, so that music teaching class is no longer limited to the interaction of imparting and absorbing, presenting a positive communication between teachers and students

Summarily, various models for computer music composition using artificial intelligence have evolved and still evolving, learners and experts in music composition are presented with array of choices to choose from although this could also lead to lack of creativity and ingenuity including too much reliance on the machine.

Applying Artificial Intelligence to Teaching-Learning

Various authors have contributed immensely to the emergence of computer and the development of artificial intelligence to the field of teaching and learning. Kai Wang et al (2023:1,2) sums together elaborately these views that the emergence of computers has promoted the development of modern electronic music technology. With the rapid development of computer multimedia technology and signal processing technology and its penetration into the field of appreciation and creation, modern music technology represented by electronic music has developed rapidly, and the field of technological innovation is gradually expanding, that when it comes to the application of AI in the field of music, music technology has to be mentioned. That music technology is an interdisciplinary subject, divided into art and technology parts and that the art part mainly studies the use of various audio softwares for music creation and production; the science and technology part mainly study the use of computer technology to provide technical support for music production. Due to the combination and development of music education, AI technology has become the future of music education, exerting a huge influence on traditional teaching concepts and methods and forming a diversified and multi-level development direction. In addition, the combination of audio big data and AI generates Music Information Retrieval (MIR) which is based on music acoustics and extracts audio features based on audio signal processing. With MIR, we can use music as a kind of information to carry out information retrieval, so that we can classify the huge music library and conduct more detailed study on the elements of music, such as pitch and rhythm. In addition to MIR, current music technologies include AI composition. Finally, the organic integration of AI technology and music education has enriched classroom teaching resources, expanded the functions of intelligent instruments and improved the technical means of music education.

Kai et al (2023:4) mentioned Xu, N., & Zhao, Y. (2021) that they studied the collaboration between electronic music creation and online performance of music education and wireless network under AI and that today, with the rapid development of science and technology, AI technology continues to progress, and the development of digital technology, electronic music online performance, and wireless network collaborative research is more important; that through the research of AI, an electronic music creation system was designed, which realizes the cooperation between electronic music, online education and wireless networks.



Dai (2021) in Sidiq (n.d:68) says that a new area of teaching music, called wisdom and intelligence teaching, is emerging due to the contribution of AI. He explains that Wisdom teaching combines new AI technologies to enhance music learning, including big data, machine learning, and the Internet of Things. Al shifts from traditional music teaching involving a classroom with chalk and blackboard to intelligent teaching. Students apply AI and smart devices to access music resources that align with their lessons and immediate needs before, during, and after class. Wisdom and intelligence teaching combine multiple elements in music education, including autonomous teaching, stimulation, cooperation, and experiences. Furthermore, he said that AI is instrumental in identifying the

students' psychological needs based on previous interactions creating tailor-made lessons. Corroborating Dai (2021), Wang (2022) said that Al can easily monitor the learners' artistic and aesthetic orientation progress and produce a new lesson every time they succeed in the different music-learning materials and render learning relevant and exciting. AI is increasingly applied in a wide range of problem-solving scenarios and is useful in creative problem solving but with human input, since machines are not creative thinkers.

Wang (2023:3) cited various authors' views that some online assisted teaching software has been put on the market. For instance, in China, the Little Leaf Piano application can identify and mark the wrong tone and wrong rhythm in real-time during piano practice, through the millisecond level of artificial intelligence piano sound recognition technology and the billion-level database, with high recognition accuracy. In India, a platform such as Atrium Academy, provides an AI-enabled music learning experience. Learners can track and improve their learning based on AI's immediate feedback and can perform regularly online in the Atrium community. For students majoring in music education, autonomous teaching using AI in the classroom is a huge challenge, because music is a field that requires students and teachers to constantly ask questions and discuss innovation. From original music education to innovative music education, teaching methods are combined with information technology to enhance the effect of education. In order for students to have a better educational experience, effective discussion and interaction between teachers and students will facilitate teachers to better understand students and help students make progress. Music teachers can continue to develop effective assessment methods, follow different methods, and evaluate students to continuously improve music knowledge.

Wang (2023:3) also mentioned that Guo, Y., Yang, D., Zhang, Y., Wang, L., & Wang, K.(2022) proposed a music education method based on AI, they thought that AI can make more optimized environments and professional music classes so that teachers and students can make the most of this and ensure smooth improvement in the network's teaching model. With the development of modern information technology, music education continues to improve. The use of AI in music education has broken the traditional mode of music teaching, greatly improving the level of music teaching and music education teaching mode. The

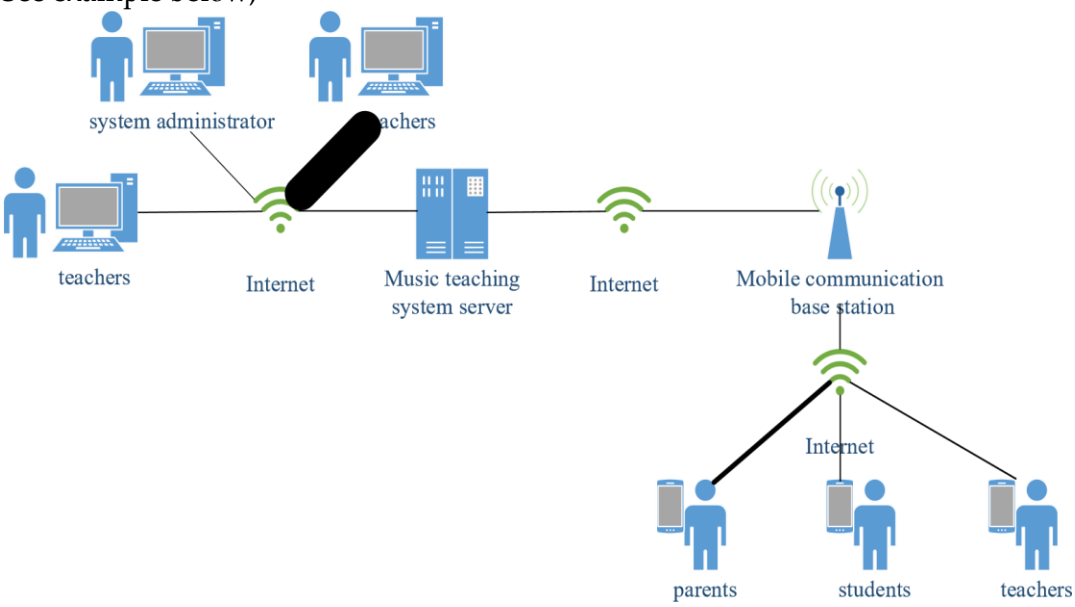
online teaching platform for music majors based on AI technology can provide a more optimized environment and more professional music courses, so that teachers and students can make full use of this and ensure the smooth improvement of the online teaching mode. In addition, the evaluation method is described in detail in the system framework to support the development of music education. By choosing the AI system instead of other machine learning methods, both teachers and students can obtain sufficient benefits and ensure the effective improvement of the network teaching mode. Music teachers are increasingly using technology to develop new student engagement strategies. Acoustic tools and pencils used to be the primary training tools. Now students can use technology like the iPad and educational apps for creative music learning.

Sidiq (n.d:68-69) states that music education captures the music enthusiast learning to play instruments and composing songs. However, Artificial Intelligence offers real-time lessons. Still on the application of AI in teaching-learning situation, Sadiq says that AI mostly applies to learning instruments where the machines identify the learners' pace and learning ability; that AI identifies when the learners have learned to play a specific instrument and propose another. Machines can easily know when learning occurs and present new, more challenging lessons and tasks and that the technology ensures a smooth transition from one musical lesson to the next based on the individual learners' perspective based on AI-generated and individualized information. Finally, he said that AI is useful in aggregating different elements of music education, including sound, images, and words, into one cohesive system enhancing learning and making the process interesting.

The application of Artificial Intelligence to teaching and learning can aid both music teachers and students in prioritizing explanatory decisions during teaching-learning situation; in terms of research AI can aid in providing transparency in dataset biases, and also help in establishing rigorous evaluation decisions. Whyte et al (2023: 3) cited Okolo (2018) that the combination of education and technology has been considered the key to human progress. That education feeds on technology which in turn forms the basis of education. Traditional chalk board setting has now evolved into digital projector, interactive board, physical library to virtual library. Books that have once burdened us for their volume and weight

can now be digitally squeezed into a hand storage device. Finding and retrieving of information became easier than ever (p.116). Some of these digital technology applications ranges from videos that can be found online in their numbers, others include U-tube, Zoom, Google meet to Facebook, and Microsoft teams; personalized music lessons are made available for aural training, and learning how to play instruments from the scratch are largely available for interested learners from the comfort of their homes and at their own convenience; teachers and students connect and share films and audios regardless of distance in a unique setting on WhatsApp. Every student is given the opportunity to ask questions, and unique tools are also used to administer assessments and evaluate students. There is now space for larger groups while maintaining the daily tailored learning method through the introduction of Zoom and Telegram media, instructions for instrument learning, and others. As a result, the field of music education has been broadened, and many teachers now have more varied means of connecting with a bigger target audience and making a living off of it. On the other hand, the advent of Artificial intelligence, a technology that employs algorithms, cognitive processes, and dynamics, has advanced digital music education because it has been designed to act like a teacher, interacting with students, assessing them, identifying their areas of weakness, and offering solutions.

See example below;



Advantages of AI to computer music composition and teaching-learning

- Al helps generate lyrics, tone and flow and enhances music creativity.
- Musicians use AI to compose quality music using any device, including a smartphone or laptop at a lower cost.
- Musicians and composers do not need to go to expensive studio and have all the instruments because they use AI to generate high-quality music and manage the sounds for different media.
- AI combines all required elements in composition including tone, tune, lyrics, and words which can be sourced from the internet and combined to compose a song.
- Amateur students do not need to rely on knowledge and skills but relies on AI to do all the works
- AI is beneficial to in educating music enthusiasts.
- Music Composition and Melody Generation Adjustable (MCMGA) helps construct music in real-time and reflect different moods. AI leads to the success of this approach through a combination of melody predictor and an emotional expression to compose music that captures the mood of the moment, improving the quality and effectiveness of songs. (Chen & Wen, 2021)
- In addition to the above, AI replaces manuscript copying of melody and harmony including lyrics which leads to wastage and loss of valuable time.
- AI supplements general human creativity and aids creativity by providing suggestions.
- AI proposes ideas in messaging, type of instruments, and arrangement of words unleashing high-quality songs thereby eliminating some errors invisible to humans and increases the scope in music development.
- In the music industry, AI is already being used by music producers for more mundane parts of their jobs. AI can help correct vocal pitch and allow engineers to mix and master recordings much more quickly and cheaply. (source: Andrew R. Chow)

Disadvantages of AI to computer music composition and teaching-learning

- The machine is emerging and disruptive, subject to ethical challenges
- AI cannot create new music from the scratch
- 'Garbage in, garbage out. AI machines are not creative thinkers

- Fear of replacement and inactivity for creative minds
- Job availability for human creative writers or composers is at stake
- AI technology can malfunction because they are not perfect, they have certain limitations
- AI machines are not spontaneous like human

Andrew R. Chow in raising some questions on the application and influence of AI creative ability (music), said some boosters argue that these advancements will further the democratization of music, allowing anyone with an idea to create music from their bedroom. But some artists have reacted with fury that something so personal as their voice or musical style could be co-opted and commodified for someone else's gain. Suggesting that there is the 'push-and-pull' between protecting artists, forging innovations, and determining the complementary roles for man and machine in music creation.

Suggestions

1. Availability of artificial intelligence machines and accessories for all are of import if achievable success must be recorded.
2. Teachers and students need training and retraining on the use of these machines in order to be able access the machines properly
3. Computer compliancy is very necessary
4. Personnel in music technology, software programmers and compilers are needed to be able to brand Artificial intelligence suitable for Nigerian brand
5. Algorithms and programmes suitable for teaching-learning music computer composition in Nigerian languages therefore experts in the field of artificial intelligence should be consulted by Music Association bodies in Nigeria to cater for these needs.

Conclusion

The application, advantages and disadvantages of artificial intelligence to computer music composition and teaching-learning were highlighted. But this innovation is not complete until in Nigeria various models by programmers and experts in artificial intelligence modelling captures the Nigerian peculiarities in

terms of language diversities, rhythmic structures, melodic structures, harmonic structures and instrumentation of various ethnic groups in Nigeria.

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