THE USE OF ARTIFICIAL INTELLIGENCE IN DANCE ARTWORKS IN THE DIGITAL ERA

Denta Mandra Pradipta Budiastomo
Faculty of Science, Engineering and Design.
Visual Communication Design Department. Trilogi University
denta.mpb@trilogi.ac.id / dentamandra@gmail.com

Abstract: Artificial intelligence (AI) has become one of the fastest-growing technologies and has transformed many sectors, including the arts. In dance, AI plays a vital role in creating innovative choreography, facilitating the creative process, and presenting dynamic interactions between humans and technology. This journal aims to explore how artificial intelligence is used in dance artworks in the digital era, with a particular focus on Indonesia. Based on a qualitative approach, this study examines the latest technologies used in dance movement analysis today, how artificial intelligence is used in the creative process of dance, the role of AI as a creative collaborator, the challenges faced by artists in integrating AI, and the response of the arts community to this technology. This study also explores the gap in research related to AI in dance in Indonesia, which offers insights into the potential and future of AI in the arts. The results show that although AI provides great opportunities for dance, its adoption still faces technical and aesthetic challenges.

Keywords: Artificial Intelligence, Dance, Choreography, Digital Technology, Collaboration

Introduction

The development of digital technology has had a significant impact on almost all aspects of human life, including the arts. One of the rapidly developing technologies is artificialintelligence (AI). AI allows machines to imitate human intelligence, including in decision- making, pattern recognition, learning, and creativity (Russell & Norvig, 2016). With these capabilities, AI has opened up new possibilities for artists, including choreographers and dancers, to create innovative works of art and explore new ways in the creative process. The positive use of AI in the fields of creativity and art is used to produce text, visuals, music, art,and other creative content and can help create interesting poems, stories, articles, and videos so that these examples provide significant benefits in various fields, increasing efficiency, accuracy, and quality of human life (Nugroho et al., 2024).

In the field of dance, artificial intelligence has offered tools and platforms that allow artists to create choreography that was previously difficult for humans to achieve. This technology cannot only process dance movement data but is also able to analyse, modify, and produce new, innovative choreography. Several international dance projects have demonstrated how AI can be used to autonomously create choreography, assist in the creativeprocess, and integrate directly with dancers in live performances (McCormack & d'Inverno, 2020).

In a global context, the use of AI in dance has achieved significant achievements. For example, British choreographer Wayne McGregor has collaborated with AI scientists to create a dance work that uses Machine Learning to generate new choreography based on human body movement patterns. This project is one example of how AI can be a creative collaborator in dance, allowing for aesthetic and technical exploration that goes beyond conventional boundaries, in addition, the use of artificial intelligence in dance can be for training by developing a generative dance movement system and using Motion Capture technology (Cook& Colton, 2018).

However, in Indonesia, the application of AI in dance is still relatively new and has notbeen widely explored. In various regions in Indonesia, several choreographers have begun experimenting with AI, but the adoption of this technology is still relatively limited. This is due to various factors, including limited access to technology, lack of training and education on digital technology in the arts, and cultural resistance to the use of technology in tradition- based arts (Yi et al., 2024).

Indonesia has a very strong cultural and dance tradition that has deep spiritual and symbolic values (Mangoensong and Yanuartuti, 2020), which are often considered at odds withthe use of modern technology in the creative process. This creates challenges for choreographers and dance artists in Indonesia who want to explore its use in their work. However, there is great potential for AI to be developed in dance in Indonesia, especially in contemporary dance, which is more open to technological exploration.

This research is important because it fills the gap in the literature related to the use of artificial intelligence in dance in Indonesia. Most of the existing research focuses on the use ofAI in dance in developed countries, while its application in developing countries such as Indonesia has not been widely studied and most of it is still on the traditional and spiritual aspects of dance, while the technological aspect has not been widely studied. In addition, thereare few studies on how AI can be used as a creative collaborator in dance, most of the existingresearch still focuses on the use of AI as an analysis or tool in the creative process. AI has thepotential to be an active collaborator in the art creation process, which can provide real-time feedback, interact with human dancers, and even create new, innovative movements. So this research gap also contributes to artists and choreographers who want to explore the potential of AI in their artwork.

Research Method

This study uses a qualitative descriptive approach with a case study method. This approach was chosen to explore the subject's experience in-depth and understand the dynamicsof the use of artificial intelligence in dance. The case study method was chosen because this study focuses on several specific dance works that use AI in their creative process (Creswell, 2013). The subjects of this study consisted of six successful collaborative projects between dance experts and technology in Indonesia and several similar projects that are currently underway. These works were selected based on the criteria that AI is actively used in the process of creating choreography and performances. Data collection techniques were interviews, activity documentation, observation, and literature studies. Data were analysed using thematic analysis methods.

This analysis was carried out by identifying the main themesthat emerged from the data, such as the use of AI in the creative process, technical challenges, and artists' responses to the technology. The results of these data collection techniques were then integrated to provide a comprehensive understanding of the use of AI in dance (Braun &Clarke, 2006)

Results and Discussion

Artificial Intelligence Technology in the Creative Process of Dance in the Digital Era

Artificial intelligence (AI) has been used in various forms of art, including visual arts,music, theatre and dance. According to McCormack et al., (2020), AI can analyse patterns in art, learn from existing data, and produce new, original works. In the field of dance, AI is usedto assist in the process of creating choreography, analysing human body movements, and evengenerating new movements based on existing data. AI can process large amounts of movement data, recognize movement patterns, and create new and unique movement variations. According to Choi et al., (2023), AI in dance can produce more complex and dynamic movements, which may be difficult for humans to achieve without the help of technology.

Some of the latest digital technologies used in dance movement analysis today are:

1. **Motion Capture**, according to Badaruddin & Nugraheni (2023), is a technology also calledMOCAP, which is used to create animated films using a motion-recording device. This technology is used to change body movements. This is done by combining new media, usually on parts of the body that can be modified/changed with technology.

Figure 1. Use of Motion Capture
Source: https://calgaryherald.com accessed September 22, 2024

The latest Motion Capture systems use infrared cameras and marker sensors that can track movements with high accuracy, producing rich 3D data for analysis. According to Sykes (2024), motion capture allows dance artists to record human body movements and convertthem into digital visuals that are then projected onto the stage. This technology has been widely used in modern dance productions, especially in contemporary dance. However, artificial intelligence offers more than just a tool for recording or modifying movement; AI can create new movements that are entirely based on the analysis of human movementdata.

2. **Wearable Sensor**, according to Park (2016), Interactive dance performances have becomean active field of research. The main idea is to use data from tracking the dancer's movements to direct the creation of musical or graphic effects in real-time. Usually, two motion-tracking technologies are computer vision-based and sensor-based embedded or placed on the dancer's body. The technology used usually includes features of the Max/MSP and JITTER software packages, which are among the most widely used.

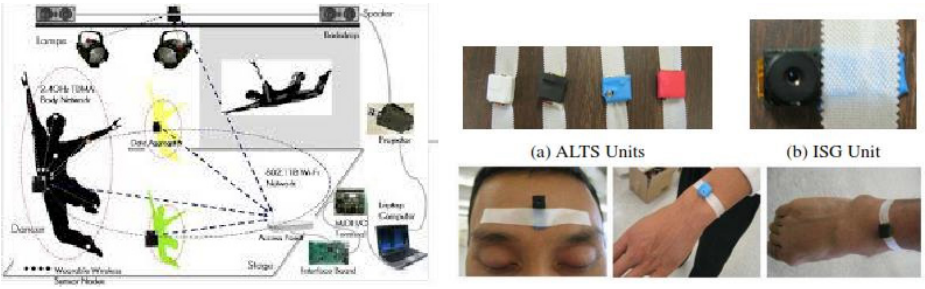

Figure 2. Simple Illustration of How Wearable Sensors Work for Dance Performances
Source: https://www.researchgate.net/publication/4228214, accessed September 21, 2024

Wearable Sensors are sensors that can be installed directly on the dancer's body, such as IMU (Inertial Measurement Unit) technology, making the sensor more sophisticated and accurate. Movement data collected from these wearable sensors can be analysed in real- time.

3. **A Depth Sensor Camera,**

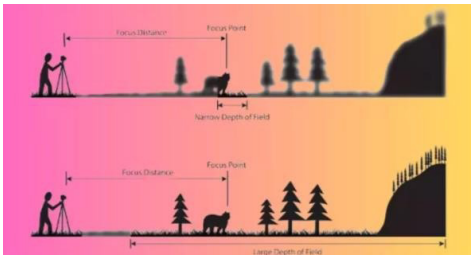

Figure 3. Simple Illustration of How Depth Sensor Cameras Work.
Source: https://gadgetaja.com, accessed September 21, 2024

According to Soon (2021), is a camera that uses sensing technology to measure the distance or depth of points in a scene and produces a series of images with depth images in each frame. Currently, the Depth Sensor camera is a technology that can analyse movements in a marker less manner, making the recording and analysis process easier. Depth Sensor cameras such as Kinect and RealSense can capture 3D information about dancer movements without the need for markers.

4. Deep Learning for movement analysis, According to Liu (2022), Deep Learning technology is a method in artificial intelligence (AI) that teaches computers to process data in a way inspired by the human brain. This technology can recognize complex patterns in images, text, and sound.

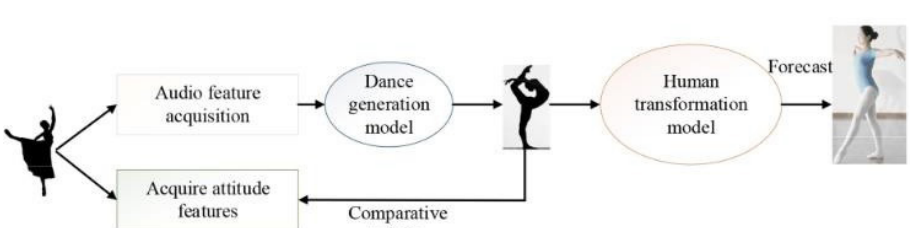

Figure 4. Process of Using Deep Learning Technology in Dance Movements.
Source: https://www.frontiersin.org/journals, accessed September 20, 2024

Other data to generate accurate insights and predictions and process movement analysis are namely as a digital assistant, automatic body and face detection. This method allows identification of complex movement patterns with better accuracy. The latest Deep Learning algorithms can automatically extract movement features from video and sensor data. OpenPose is one of the most popular multi-person pose estimation algorithms. Like many bottom-up methods, this method first detects the coordinates of the key points of allpeople in the image, and then assigns the detected key points to each associated person.

5. Interactive 3D Visualization, according to Calvert et al (2005), Interactive 3D Visualization is the process of creating a 3D model that allows users to interact with graphs and diagrams. Its visualization allows users to change variables in the visualization parameters to find new insights or access in-depth information. Calvert et al (2005) also said that currently pouring ideas in the form of dance could use DanceForm2 software fromCreado Interactive. This software is designed for dance teachers and choreographers to support the visualization of a movement

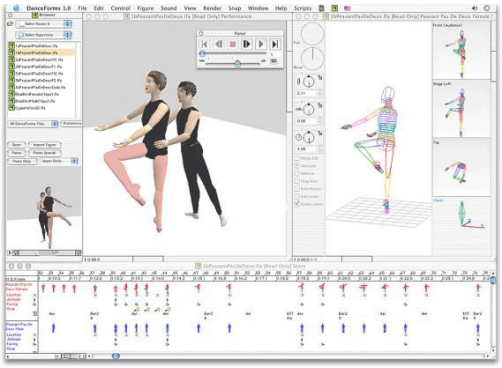

Figure 5. Process of Using 3D DanceForm2 Software for Dance Visualization.
Source: Art Management & Technology Laboratory, https://amt-lab.org/reviews/2020/3/lets-get-digital-visualizing-movement-in-dance, accessed September 22, 2024

This visualization software uses the latest 3D motion that allows for intuitive visual interaction and analysis. Users can rotate, change perspectives, and analyse dancer movements interactively.

6. Integration with IoT and other technologies, Ji & Tian (2024) explain that IoT-based dancemovement recognition is a system that uses Internet of Things technology to recognize dance movements when someone dances. This system uses sensors to detect movement and sends data to an analysis engine that can recognize various movements and produce records. This system can be used to educate dancers, assess the performance of professional dancers, and even for games. This system can also provide real-time feedbackto dancers, helping them improve their technique. One of the IoT systems that works using Residual Connection is creating images that help bridge the gap between the generator andthe discriminator by allowing the generator to utilize information from the discriminator to produce better images.

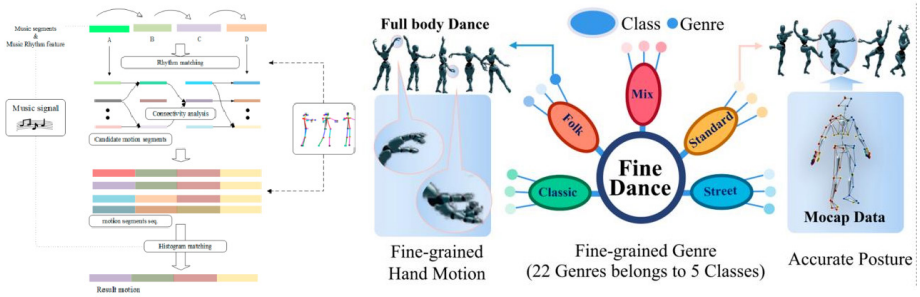

Figure 6. Scheme of IoT Usage in Dance Arts.
Source: https://www.mdpi.com/2076-3417/14/19/9084, accessed September 20, 2024

Current dance movement analysis systems can be integrated with Internet of Things (IoT)technology, Cloud Computing, and other smart devices. This allows for centralized and scalable collection, processing, and analysis of movement data.

Digital technology has brought about major changes in the way dance artists create and present their work. Rheingold (2000) stated that technologies such as Augmented Reality (AR),Virtual Reality (VR), and Motion Capture allow dance artists to explore movement in new dimensions, creating a more immersive experience for the audience. In some modern dance productions, digital technology allows the audience to interact with the performance, changing visuals or sounds in real time based on the dancer's movements.

The Use of Artificial Intelligence in the Creative Process of Dance

Based on findings from interviews with choreographers and dancers involved in the useof AI in dance, AI is used in various stages of the creative process, from creation to performance. One of the main ways AI is used is through movement data analysis, where AI can identify common or rare movement patterns then produce new and unique movement variations. AI is trained using thousands of existing dance movement recordings, both from dance performance videos and Motion Capture data. This allows choreographers to use AI as a movement experimentation tool, opening up possibilities for more innovative and varied choreography (McCormack et al., 2020).

In addition, AI has also been used to create choreography independently with minimalhuman intervention. For example, AI can generate choreography based on specific instructions such as music or a particular dance theme, which is then modified by the choreographer or dancer. A real-world example of this use case is where an AI algorithm generates choreographyfor a contemporary dance performance based on the analysis of human body movement data matched to specific musical elements (Cook & Colton, 2018).

However, AI is not just a tool that generates mechanical movements. Some choreographers emphasize that AI can be a creative experimental tool that allows artists to pushthe boundaries of what is possible with the human body. By harnessing AI's ability to think outside of traditional movement patterns, choreographers can create movements that may be considered unconventional or experimental, but still have strong aesthetic appeal (Sykes, 2024).

The Role of Artificial Intelligence as a Collaborator in Dance Artworks

AI is not only a tool used to help choreographers create new movements but also has the potential to be a creative collaborator in dance. Cook & Colton (2018) noted that AI can provide feedback to dancers in real-time, interact with them on stage, and even generate new movements based on direct analysis of the dancers' movements. This creates opportunities fordance artists to explore the interaction between humans and machines in an artistic context.

The collaboration between AI and dance artists opens up a new dimension in the creative process. AI not only produces movements based on human instructions but also makes an independent contribution to creating unique and innovative works of art. McCormack et al.,(2020), emphasize that AI as a creative collaborator can present new perspectives in dance, allowing dancers and choreographers to push the boundaries of human movement.

One successful project between traditional dance experts and technology experts in analysing dance is the Cirebon mask dance digitalization project led by Harry Nuriman, a lecturer at the Faculty of Fine Arts (FSRD) of the Bandung Institute of Technology (ITB). In this project, he explained that Motion Capture technology was used to document the movements of the Cirebon Mask Dance. This project aims to preserve traditional Indonesian dances so that they do not become extinct along with the loss of the successors of the culture (Nuriman, 2018). Motion Capture allows dance movements to be recorded digitally and savedas 3D files, which can be analysed from various angles, unlike ordinary video recordings.

Figure 7. Digitalization of Cirebon Mask Dance Movements.
Source: Digitalizing the Motion of Traditional Dance, Harry Nuriman Uses Motion Capture Technology - Institut Teknologi Bandung (itb.ac.id), accessed September 24, 2024

This collaboration involves not only technology experts, but also dance maestros suchas Irawati Durban to ensure the authenticity of the documented movements. This project beganin 2016 and was successfully patented in 2017. With digital documentation, the younger generation and the global community can now study the Cirebon Mask Dance in a more accessible and affordable way (Koran Jakarta, 2018).

Another project worked on by Nuriman (2018) is the use of motion capture technology for preservation, education, and performances by documenting the movements of the Indonesian martial art Silat Tuo (Tiger Silat) from Minangkabau, West Sumatra, and exploring the possibility of its use for performances. With a database of these movements, these movements can be studied without time and place constraints and can minimize costs for performance production.

Figure 8. Digitalization of Silat Tuo Dance Movements.
Source: https://journal.unesa.ac.id/index.php/jsm/index accessed September 24, 2024

Using the recording of dancers' movements with markers attached to them to create a 3D digital body model. The use of a digital body greatly helps overcome the limitations of an artist's expression; the resulting digital files will later be used to run and move various charactermodels that have been previously created in 3D applications. However, how do the body and technology—in this case digital technology—work together? When a moving body, or a dancing body, is codified into a 3D image, there will be a shift or change. This shift includes what is most important in the process of integrating technology and the body.

Figure 9. Use of the Maengket Dance Application.
Source: https://ejournal.unsrat.ac.id/v3/index.php/informatika/article/view/16976/16509, accessed September 23, 2024

Another example as in Figure 9 is the use of Augmented Reality (AR) and Virtual Reality (VR) in the introduction and preservation of traditional dance carried out by Rambing (2017) at Sam Ratulangi University using 360-degree video with a focus on immersive culturalpreservation by creating an application of Minahasa traditional dance known as Tari Maengket. The method used is the Interactive

Multimedia System of Design and Development (IMSDD) and Google Cardboard as a device in video visualization. The aim is to make my interest in studying dance in Minahasa culture more interesting.

Another activity is a project by Fajri et al. (2020) entitled The Design of Interactive Media for the Patih Mask Dance in Malangan Mask Wayang using the Kinect Sensor using the R&D method, the final result of which is a dance simulator application. Malangan Mask Wayang is a form of traditional East Javanese art that is thick with cultural and spiritual values. The patih figure in the mask puppet is presented with strong and dynamic movement characters, and technology such as Kinect allows for visualization and analysis of these movements innovatively.

Figure 10. Interactive Media Description of the Patih Mask Dance in the Malangan Mask Puppet. Source: https://www.researchgate.net/journal/INVOTEK-Jurnal-Inovasi-Vokasional-dan-Teknologi-2549-9815, accessed September 23, 2024.

Another work is the work of Ismiati et al. (2021) on the use of Augmented Reality technology in identifying basic Sundanese dance movements through the application of basic Sundanese dance movement cards which aims to design and test the feasibility of applicationsthat can be used as learning innovations. This application is a combination of ordinary cards with Augmented Reality technology. Markers are a complement to ordinary cards with the Quick Response code (QRC) type so that the combination of these technologies can lift an object that was previously flat as if it were real. This study uses the ADDIE model, namely analysis, design, development, implementation, and evaluation. The results of the application were tested to be very suitable for use.

Another activity is the creation of a 3D animation of the Riau Malay Offering Dance using Motion Capture technology that also uses special markers (Marker-Based Motion Capture). In this project, the movements of the Riau

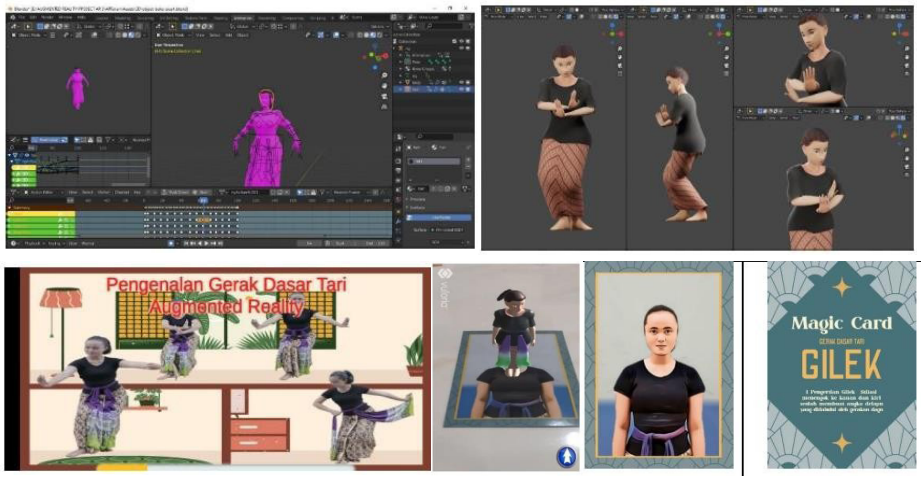

Figure 11. Use of the Sundanese Dance Basic Movement Card Application. Source: https://jurnal.untirta.ac.id/index.php/JPKS/article/view/12909, accessed September 20, 2024.

Malay Offering Dance were recorded andtranslated into a 3D animation model using software such as OptiTrack and Blender. This project aims to introduce the Riau Malay Offering Dance to the wider community, especially the younger generation, with a more modern approach through animation.

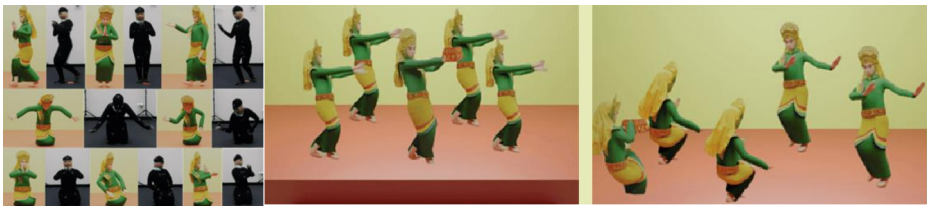

Figure 12. Overview of Making 3D Animation of Malay Offering Dance Using Motion Capture. Source: https://opac.lib.pcr.ac.id/index.php?p=show_detail&id=14113&keywords=, accessed September 15, 2024.

There are still several examples of similar successful collaborative projects between traditional experts and technology experts in analysing dance such as the Javanese Dance project between Professor Waridi (a Javanese Dance expert) and a team from the UGM Faculty of Engineering by utilizing a depth camera / or Depth Camera to analyse movement patterns. There is also a 3D Animation work of the Cokek Dance using the optical-based Motion Capture method from Gunadarma University. According to CNN in Ratmono (2023), there is an activityaimed at preserving the Lengger Lanang Dance originating from Central Java using Motion Capture carried out by Australia through the Victorian College of the Arts (VCA) in collaboration with Indonesian dancers and choreographers Rianto and his friends. They aim toensure that the dance, which is hundreds of centuries old, does not become extinct. This dancehas

a spiritual meaning for Central Javanese people in the past. Even the dancers are worshiped for their ability to embody femininity and masculinity during performances.

Key Challenges in Integrating AI into the Creative Process of Dance in Indonesia

Although AI offers many benefits in dance, several significant challenges dance artists face in integrating this technology into their creative process, especially in Indonesia. First, limited technology and infrastructure are the main obstacles. Many art studios in Indonesia do not have adequate access to advanced AI technology. Even the cost of adopting AI technology, including the cost of implementing this technology, both hardware and software, is very expensive, making many people reluctant or unable to use it (Yi et al., 2024)

Second, there are challenges related to the technical skills needed to use and operate AIin dance. Many dance artists in Indonesia do not have a technology background or experiencein working with AI software or algorithms. This creates a skills gap that needs to be addressedthrough training and education. Several choreographers have expressed that the process of learning to understand how AI works is quite complex and requires collaboration with technologists and programmers (Choi, 2023).

Third, there are also cultural challenges that hinder the adoption of AI in dance. Some artists have expressed concerns that AI could remove the humanistic element from dance, which should be an expression of human emotion, feeling, and individuality. These concerns mainly arise from artists who adhere to highly personal dance traditions. According to Herdiani(2020), dance is seen as a representation of human subjectivity and inner experience, which often cannot be translated by AI technology. Artists feel that AI only copies movement patterns without understanding the deep emotions or philosophy involved in dance, especially Bedhaya dance or other dances that have spiritual meaning in every movement.

In addition, an opinion article from literasiaktual.com written by Darmayanti (2024) entitled The Transformation of Dance in the AI Era: innovation, preservation, and Ethical Challenges highlights that artists are concerned that AI can reduce the role of individuality in dance, especially improvisation-based dance, which relies heavily on the dancer's expression, and AI technology, which works based on pattern data, risks creating uniform works and doesnot provide space for individual creativity. Fitriani's research (2023) also revealed that AI presents ethical and philosophical challenges related to the authenticity

of art. Some artists argue that this technology can lead to homogenization, reducing the space for improvisation and the emotional connection between the dancer and the audience.

Dance Community Responses to the Use of AI in Artworks

The dance community's response to the use of artificial intelligence in Indonesia is varied. On the one hand, there is enthusiasm for the potential of this technology to expand creative boundaries and bring innovations to the world of dance. Many young choreographers are interested in experimenting with AI, seeing it as an opportunity to create more complex and interactive works. They see AI as a tool that allows them to explore dimensions of movement that they have never thought of before (Sykes, 2024).

However, on the other hand, there is scepticism and resistance to the use of AI, especially among more traditional dance artists. Some artists' feel that AI can damage the essence of dance, which relies heavily on human expression, they feel that technology, although useful, should not take over the central role of humans in the creative process. This raises a broader discussion about authenticity and emotionality in dance in the digital age.

Conclusion

This study shows that artificial intelligence has great potential to enrich the creative process of dance in the digital era. AI not only functions as an aid but also as a creative collaborator that can produce new, innovative movements. However, challenges such as limited technological infrastructure, technical skills, and cultural resistance to technology still need to be overcome so that AI can be more widely adopted in dance in Indonesia. The findings of this study open up opportunities for further development of artificial intelligence in dance. The adoption of AI in dance is still in its early stages, but the potential to create innovative and interactive works is enormous. Further research is needed to explore how AI can be used more effectively in dance, as well as how artists can overcome the challenges involved.

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