JTS

The Journal of Transdisciplinary Studies, 7(3): 349-359, 2023
https://doi.org/10.22685/JTS.2023.7.3.349

A Study on the Approaches for Applying Digital Human in Safety Education*

Younghee Noh[1], Jong-Hwa Jang[2], Myunghee Jung[3], Bo-Ram Hyun[4], Sang Hyeon Ju[5]

[1]Professor, Department of Library and Information Science, Konkuk University, Republic of Korea (irs4u@kku.ac.kr), First Author
[2]Professor, Department of Dental Hygiene, College of Health Science, Dankook University, Republic of Korea (jhj@dankook.ac.kr), Co-Author
[3]Professor, Department of Software Engineering, Anyang University, Republic of Korea (mhjung@anyang.ac.kr), Co-Author
[4]Research Professor, Department of Performing Arts, College of Health and Human Development, Korean National Sport University, Republic of Korea (boram0770@hanmail.net), Co-Author
[5]Professor, Department of Public Administration, Jeonbuk National University, Republic of Korea (ju1414@jbnu.ac.kr), Corresponding Author

ARTICLE INFO

Article history:
Received 18 December 2023
Revised 25 December 2023
Accepted 27 December 2023

Keywords:
Digital Human,
Disaster Situations,
Safety Education,
Safety Education Content,
Scenarios and Stories

ABSTRACT

In this study, we aim to propose approaches for applying digital human technology to safety education. Towards this end, we conducted research on the theoretical background of digital human, the current state of digital human technology, cases of its application, and instances where digital human technology has been used in industrial safety. The research findings suggest the following approaches for the application of digital human in safety education: Firstly, it is essential to identify and categorize high-risk work environments. Secondly, safety education content should be developed diversely to suit different work environments. Towards this end, it is crucial to conduct surveys to understand the demands of the users and create scenarios and stories based on this information. Thirdly, it is necessary to build a database of disaster scenario compositions to enhance workers' crisis management skills and provide them with the ability to acquire disaster response strategies through various situational experiences. Fourthly, an analysis of the effectiveness of safety education content based on digital human technology should be conducted. Lastly, once the digital human is created, consideration should be given to maintaining security by storing the original data of the digital human in an external repository using blockchain technology.

* This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2023S1A5A2A21083786).

1. Introduction

Digital humans are a technology which uses digital technology to create the virtual humans who look and act similar to the humans. Towards this end, they photograph real people or utilize various technologies such as three dimensional modeling, animation, and voice synthesis to embody their appearance, facial expressions, and body movements as in reality. Based on which, one can interact with real people in virtual reality and perform various tasks or achieve necessary goals. Currently, it is used across various fields such as broadcasting, education, and guidance, such as AI anchor, AI banker, and AI librarian.

If such digital human technologies are applied to safety education for workers at construction sites, which are the most industrially hazardous, it would be expected to contribute to reducing accidents at industrial sites.

According to the statistics, the accidents involving foreign workers at construction sites continue to increase. According to a survey by the Construction & Economy Research Institute of Korea, 1.75 million workers would be needed in the construction industry annually in 2023, of which foreign construction workers are expected to account for approximately 11% of the total workforce. However, according to the Ministry of Employment and Labor's survey results1, the number of deaths among foreign workers increased by 1.6% from 94 (10.7%) in 2020 to 102 (12.3%) in 2021, or 12.3% of the total, and in the construction industry among all industries, the number of fatal accidents involving foreigners turned out to be the highest at 42, accounting for 41.2% of the total industry.

This is due to the risk of the sage itself, but it is also known to be because foreign workers cannot properly complete safety education due to language problems. Hence, in this study, we would like to propose a way to apply digital human technology to safety education. Towards this end, we sought to understand the theoretical background on digital humans, the current status of digital human technology, the cases where digital human technology has been applied, and the cases where digital human technology has been applied to the industrial safety field. This study was conducted by using a literature survey analytical method.

2. Digital Human Theory and Its Status

2.1 Previous research on digital humans

First, it may be seen that the direction and technology of utilizing digital humans is introduced to the metaverse content market under the theme of the present and future of digital humans. As the digital technologies have developed fast and the content market has become more active than ever, metaverse has become a major trend in the market. Furthermore, technological developments related to the production of high-quality 3D digital humans are fast accelerating. The development of the latest technology has made it easier to produce such digital human content, making it possible to utilize it across various fields. However, despite the high demand and diversity of applications,

the scope of development and use of digital humans is still limited due to limitations in the realistic production process (Oh et al., 2021).

The virtual humans that first appeared were unable to overcome limitations in many aspects and had limited areas of activity, but the most recently applied digital humans have a human appearance and behavior so similar to the real thing that it is difficult to distinguish them, and are used in a variety of fields. Researchers Moon-seok Oh, Gyu-hoon Han, and Yong-ho Suh pointed out that while there is a demand for digital humans across various fields, the scope of development and use of digital humans is bound to be limited because there are significant limitations in the production process. Furthermore, by overcoming the technical limitations of research on the use of current digital human images, a digital character called "Meta Human" was proposed (Oh et al., 2021).

Studies have been conducted to examine and understand the impact of virtual reality on humans in the era of the 4th Industrial Revolution, and it has been said that the perspective in the virtual environment affects the perspective on other objects in real life. Hence, virtual reality will change the way people interact with others, and the development of technology beyond the constraints of time and space will make it possible to share experiences in the virtual space (Lee, 2022).

Subsequently, as an example of using digital humans, a survey of marketing over the past 10 years illustrates that digital marketing, especially influencer marketing using digital humans, accounts for the majority. Influencers have also claimed that they are receiving social recognition within online communities. Researchers analyzed that the effect of social media influencers on brands was positive and suggested ways to utilize virtual influencers (Bendoni & Danielian, 2019).

A study was conducted to analyze the impact of celebrities, that is, digital human Instagram celebrities and traditional celebrities, on envy, brand attitude, trust, and social presence. As a result of the study, consumers did not recognize the difference between the information provided by humans and AI, which was interpreted as the consumer's inability to understand the difference between digital humans and real people. However, it was claimed that digital human influencers can have a greater impact on the consumers with a high desire for originality. Meanwhile, studies have also been conducted to understand the communication methods of digital human influencers in the era of digital marketing.

Meanwhile, in a study on how to promote one's business as a marketing strategy, there was a positive relationship between social presence and trustworthiness when the content came from a fashion influencer account, and in the conditions of product posts with real people and product-only posts. It was also analyzed that there was no difference between the two. Such results suggest that Instagram posts promoted by fashion influencers can produce similar effects of social presence or PSI even if they are not displayed in brand content (Jin et al., 2019). Digital human influence was measured among the 254 SNS users, and it was a study that investigated consumer reactions under the premise that speakers have different characteristics from actual humans (Nah et al., 2022).

Meanwhile, as marketing actively utilizes forms of technology, including AI and the Internet of Things, research has been conducted to investigate industries where digital humans are utilized. In one example of digital marketing, it was claimed that a digital expert's use of the services of a digital human influencer illustrates trust in the digital human. It was also claimed that digital humans can give new color and dimension to the world of global marketing and are widely used

in various industrial and social fields such as games, movies, fashion, music, education, politics, and marketing (Wibawa et al., 2022).

2.2 Principles of digital humans

2.2.1 The concept of digital human

Digital human refers to a character which is created with computer graphics that has the appearance of a person and the voice of the artificial intelligence (AI) technology. As computer technology has developed, models of real people have been created through technology that makes them difficult to distinguish from real people. The digital humans make independent decisions similar to real humans, and interaction is possible even among digital humans (Hong, 2018). The digital humans use computer graphics (CG) to express appearance and movement, and artificial intelligence (AI) to express mental functions, and they essentially are an integration of modern technology that combines AI and the metaverse, an activity space.

In the virtual world, they grab our attention because they do not age and have an attractive appearance. The digital humans are sociable and free-spirited, and communicate actively through social media activities. While they exist in the virtual world, their activities and communication traverse virtual and reality, securing tens of millions of followers and demonstrating their charm through fashion brand marketing, music releases, and advertising models (Kwon, 2022).

Table 1 illustrates the definitions of digital humans given by various scholars. While conducting research on the persona of digital humans, Sae-young Kim and Jeong-yoon Huh defined the digital humans as the three dimensional virtual humans that generate realistic results in a form developed from the existing concept of avatar (Kim et al., 2021), and in a study on the analysis of production techniques of meta dormancy, it was defined as a three dimensional model which was modeled after the appearance of a real person, created for the purpose of replacing the role of a person (Oh et al., 2022).

Table 1. Definition of digital human

Source	Details
UniQ	An existence that can reproduce human-like conversations through real language and body language with AI
Deloitte	An avatar that can generate any human body language
Soo-ho Kang, Mi-ae Son (2012)	An object that can mimic the physical characteristics or motions of representative people performing a specific task
Bo-eun Kwak, Jeong-yoon Huh (2021)	A 3D virtual human that looks and speaks like a real person
Sae-young Kim, Jeong-yoon Huh (2021)	A 3D virtual human that produces realistic results in terms of form and movement, evolving from the concept of a traditional avatar.
Moon-seok Oh, Gyu-hoon Han, Young-ho Suh (2021)	A 3D model modeled after the appearance of a real person with the purpose of taking the place of a person.

2.2.2 Classification of digital humans

Digital humans are classified in a varietyt of ways depending on the perspectives such as scholars and technological development, and Cavazza's classification according to the extent of technological development is illustrated in Table 2 below.

Table 2. Classification of digital humans according to technological advancements

Action	Pure avatars	Guided digital human	Autonomous digital human	Interactive-perceptive digital human
Walking on flat ground	Only possible through sensors	A walking program or function that calculates stride length and speed is needed.	Walking program required	
Walking on curved ground			Need a free walking program/need a generalized algorithm	
Grasping	Gloves can be used, but feedback is difficult to achieve	Use inverse kinematics	More than adequately possible with the provided functions.	
Avoiding obstacles	Impossible	Can be implemented using algorithms based on graph theory	Processing (navigation) based on future prospects	
Recognizing gestures	Not provided			Provided
Facial animation	Use a video camera	Use fewer parameters	Model-based animation	
Communication with digital humans	Not computer generated		Limited communication	Perception-based communication
Communication with the users	Consistent with real-life communication		Not provided	Communicate through avatars

2.3 Implementation of digital human and the cases of their utilization

Currently, digital humans are used across the areas where two-way communication is possible, such as brand ambassadors, digital influencers, customer support representatives, and medical advisors.

First, they are the case used for marketing purposes. From unique appearance to personality, the image of a digital human is designed to have the most lasting and positive impact on users as an image that can provide credibility in each field. Among the digital humans, virtual influencers are elaborate digital creative images created based on artificial intelligence using 3D software and visual effects (Han, 2021), Rozy (Korea), Imma (Japan), and Shudu (UK), Lil Miquela (USA), Ailynn (Thailand), and Hua Zhibing (China) are known to be the representative virtual influencers.

Second, it is the case of digital human which is grabbing the attention on SNS. 'Lil Michela', developed by Broad, debuted on Instagram and grew into a mega influencer by working as a model for famous brands such as Chanel, Prada, Calvin Klein, and Dior. Michela, who currently has 2.41 million followers, is a 19-year-old girl from LA and appeared on Instagram in April 2016. Since her Instagram appearance, she has lived the life of a typical influencer, while modeling for

brands, releasing music, and attending fashion illustrates. Michele works as a human rights activist and also supports sexual minorities. Second, Bermuda is a white woman living in LA who illustrates her closeness to Miquela by frequently uploading photos of her with Miquela on her own Instagram. They argue and reconcile over different political views. They act with realistic human appearances and personalities, making it difficult for people to determine whether they are fictional characters or real people. Third, Nuri, takes on the appearance of an unrealistic cartoon character created by Joerg Zuber, a graphic designer from Munich, Germany. On her Instagram profile, she describes herself as an activist, Vegan, 9-year-old from Munich, Germany.

2.3.1 Deep brain AI

An artificial intelligence (AI) specialized company, Deep Brain AI joined hands with Incheon National University and implemented Korean language education professor Pyeong-won Kim, who serves as the director of the Education Innovation Institute, as an AI human. By applying TTS (AI voice synthesis technology), it can speak over 50 languages, including English, Spanish, Chinese, French, and Russian. Furthermore, 15 gestures, including ▲ 4 voice tones (normal/soft/natural/news), ▲ two outfits (formal and casual), and ▲ speech using both hands may be customized to suit the class content.

The AI human created may be easily and conveniently used through AI Studios, a SaaS-type video synthesis platform. When you enter the desired sentence as text, a natural video of the AI human speaking the sentence exactly is immediately produced. Deep Brain AI has the AI human solutions based on voice and video synthesis, natural language processing, and voice recognition technology. With excellent video synthesis technology based on GAN algorithm and deep learning, it produces the AI dormancy which is similar to the actual model, including lip sync, movement, and facial expressions.

To date, Deep Brain AI has collaborated with prominent figures at home and abroad, such as announcer Joo-ha Kim and Howie Mendel, to implement the AI humans that can work in various industries such as media, education, finance, commerce, public, entertainment, transportation, and mutual aid. Meanwhile, Deep Brain AI provides a variety of generative AI technologies and services with the goal of implementing conversational artificial intelligence that helps business convenience, and was recently selected as one of the ‘Global Top 250 Generative’ by the global market research firm of CB Insights. It has also been mentioned in the list of promising companies in the enterprise AI avatar field among the AI (Generative AI) startups.

2.3.2 UNEEQ

UneeQ, an American digital human development company, announced ‘UneeQ Creator,’ a platform that allows you to easily create virtual humans using 9 self-created virtual humans. Recently, there has been an increasing amount of content about digital humans, mainly focusing on the development of visual elements. This is to overcome the phenomenon commonly referred to as the uneasy valley, i.e., the more roughly similar, the more detestable it is.

In terms of visuals, it takes on a quality that far exceeds that of many existing 3D avatars, and head animation and synchronization between voice and lips are also natural. Not only can it be integrated with conversation engine platforms from Google, Microsoft, and Amazon, but a certain level of customization is also possible, such as choosing one of several pre-made characters and utilizing user data.

UneeQ, an American digital human development company, announced 'UneeQ Creator', a platform that allows you to easily create virtual humans using 9 self-created virtual humans. Furthermore, Ipsoft, an American artificial intelligence company, launched a platform for creating interactive virtual humans. Lastly, Soul Machines launched 'Digital DNA Studio' to enable the creation of virtual humans.

2.3.3 Brud

Brud is an American startup company which is among the representative companies that create the digital humans. They are creating digital influencers based on technological capabilities such as robotics and artificial intelligence (AI). The digital dormant they produced named Michela is a celebrity with over 3.1 million followers on social media, and signed a contract with CAA (Creative Artistic Agency), one of Hollywood's top three agencies. Digital humans act like celebrities in the real world and communicate with people through social media activities. Makela is currently expanding her influence by collaborating with luxury brands Chanel, Prada, Kenzo, and Givenchy.

Furthermore, Ipsoft, an American artificial intelligence company, launched a platform for creating interactive virtual humans, and Soul Machines launched 'Digital DNA Studio' to create the virtual humans.

3. Application Plan for the Digital Humans' Safety Education

The cases of application for the digital humans to safety education were investigated, including previous studies. However, the actual cases were found to be very inadequate. That is, digital human technology is used in a variety of fields that require two-way communication, such as brand ambassadors, education, medical advisors, customer support staff, and digital influencers, but there have not been many cases of it being applied to safety education. Furthermore, there are quite a few cases where AR and VR technologies have been applied to safety education (Lee, 2020), but there appears to be no cases of applying true digital human technology to safety education. Accordingly, in this chapter, we would like to propose a way to apply digital human technology to safety education.

3.1 Selection and typing of the sites with the highest risk

There are various industrial fields, and it has also been investigated that the accident rate in the construction field is high among industrial fields. Examining the construction industry, there

are building construction, civil engineering construction, airport and aircraft-related construction, energy-related construction, water and wastewater treatment facility construction, transportation and railroad construction, renewable energy, and environment-related construction. Among such, it is necessary to select sites with the highest risk and apply them in order of priority. Furthermore, educational content must be divided into the above types and digital human-based educational contents suitable for each type must be developed. That is, safety education is prioritized for the workers who perform work with many risk factors, such as welding in closed places, electric welding work in wet places, work in manholes or confined spaces, work using cranes weighing more than 1 ton, construction lifts or gondolas, and work on installing, raising, or dismantling tower cranes.

3.2 Safety education content development and story production

The safety education content must be developed in a variety of ways to suit the type of field, and consumer needs must also be investigated and scenarios and stories based on this must be produced. To determine demand, it is necessary to conduct qualitative and survey surveys (learners, institutions) to identify education needs to foster safety education and utilize the IPA (Important Performance Analysis) analytical technique proposed by Martilla and James (1977).

In particular, the storyboard production needs to take into account the following situations for each accident, disaster, and industry Table 3.

Table 3. Production of specific storyboards for each accident, disaster, and industry

• Since more than 90% of accidents occur due to worker negligence, focus on improving workers' accident response ability by emphasizing what happens after an accident (e.g. bleeding and cut fingers).
• Consider all factors that affect disasters, not just visual factors
• First select and utilize the hypothetical scenarios that are expected to have a significant effect when applying digital human-based technology
• Actively utilize the scenario construction techniques used in human-computer interaction or human reliability analysis, etc.

3.3 Development of the safety education guidelines

It is necessary to build a disaster situations scenario composition database to strengthen workers' ability to respond to crisis situations and acquire disaster tips through experiencing various situations. It is also necessary to establish a database for accident site review and technical inspection through periodic safety education.

Furthermore, an expert consultative body needs to be formed to revise and supplement the content through evaluation of the content validity and interface validity of the educational content by each expert, and then reflect the verified content to complete the final safety education content. Based on which, the education site guidelines must be developed, and a final prototype must

be presented that includes implementation methods, explanations of protective equipment, accident implications through accident cause explanations, accident experiences, safety measures explanations, and safety quizzes.

3.4 Verification of the effectiveness of digital human safety education content

An analysis of the effectiveness of safety education content based on the developed digital human technology must be conducted. A comprehensive analysis of literature analysis, interviews with safety managers, and the author's related experiences from various perspectives such as lecture-centered education methods, field experience-centered education, and VR-based education, and practical comparison and digital human technology-based education methods must be carried out, while the studies that go through an empirical process on the practical effects of is required. Specifically, it would be necessary to analyze the changes in the learners' safety related knowledge, attitudes, practices, learning and social presence, satisfaction, interaction capabilities, safety anxiety, and fidelity before and after education.

Based on which, usability evaluation must also be conducted, and based on the results derived from learners, educators, system development, and effectiveness verification, it is necessary to derive ways to utilize it in academic, social, economic, industrial, human resource education, and educational fields.

3.5 Maintenance of the security of digital humans

Once a digital human is created, the need to maintain security of the digital human's original data must be considered by storing it in a storage external to the blockchain. After signing an NFT transaction containing digital human data, the transaction must be propagated to the blockchain network and the miner who creates the block creates the block. Ultimately, the digital human NFT confirmation and ownership verification must be carried out.

4. Conclusion and Recommendations

Hence, in this study, we intended to propose a way to apply digital human technology to safety education. Towards this end, we discussed the theoretical background on digital human technology, the current status of digital human technology, cases of application of digital human technology, and industrial safety information on digital human technology, and the case studies applied to the field were identified.

As a result of the study, the cases of application of digital humans to safety education were investigated, but the actual cases were analyzed to be very inadequate. However, it turned out that there are quite a few cases where AR and VR technologies have been applied to safety education. Accordingly, in this study, as a method of applying digital human safety education, first, it would be necessary to select and type the sites with the highest risk. Second, safety education content

must be developed in a variety of ways to suit the type of field, and consumer demands must be surveyed and scenarios and stories based on this must be produced. Third, it is necessary to build a disaster situations scenario composition database to strengthen the workers' ability to respond to crisis situations and acquire disaster tips through experiencing various situations. Fourth, the effect of safety education content based on developed digital human technology must be analyzed. Fifth, once a digital human is created, the need to maintain security of the digital human's original data by storing it in a storage external to the blockchain should be considered.

Towards this end, the future studies must urgently conduct the literature research related to the digital human-based education programs and safety education. In particular, it is necessary to analyze cases of industrial accidents involving foreign workers in industries such as architecture and civil engineering and analyze the current status of safety education. Furthermore, there is a need to further analyze the industrial safety education programs that combine the existing technologies such as VR and AR, including interviews with foreign workers, safety education experts, and field supervisors.

Conflicts of Interest

No author has any other conflict of interest to declare.

References

Bendoni, W., & Danielian, F. (2019). The future of influencer marketing in the digital age of virtual influencers. *Global Fashion Management Conference*, 604-660.

Han, K. H. (2021). The reactions of korean virtual influencers to the instagram users. *Digital Convergence Research, 19*(11), 471-483.

Hong, S. W. (2018). Artificial intelligence and virtual humans. *Korean Architects, 585*, 154-163.

Jin, S. V., Muqaddam, A., & Ryu, E. (2019). Instafamous and social media influencer marketing. *Marketing Intelligence & Planning, 37*(5), 567-579.

Kim, S. Y., & Huh, J. Y. (2021). An analysis of fashion style as a factor affecting the persona of digital humans: With a focus on its use for advertising. *Proceedings of the Korean Society of Design Conference*, 108-109.

Kwon, S. H. (2022). A study on the use of digital human images. Korean Human Image Design, *Korea Human Design, 4*(2), 16-34.

Lee, H. J. (2022). The development of digital human empathy index for the era of AI and human coexistence. *Journal of the Korea Contents Association, 22*(3), 1-16.

Lee, Y. W. (2020). The status and prospects of the VR based safety education content. *Journal of the Korea Information and Communication Society, 24*(10), 1294-1299.

Martilla, J. A., & James, J. C. (1977). Importance-performance analysis. *Journal of Marketing, 41*(1), 77-79.

Nah, K., Oh, S., Han, B., Kim, H., & Lee, A. (2022). A study on the user experience to improve immersion as a digital human in lifestyle content. *Applied Sciences, 12*(23), 12467.

Oh, M. S., Han, G. H., & Seo, Y. H. (2021). An analytical study on the production techniques for digital humans and meta humans for the metaverse. *Korea Design Research, 6*(3), 133-142.

Oh, M. S., Han, G. H., & Suh, Y. H. (2022). The dynamic face production based on the 3D volumetric capture for hyper-realistic metahumans. *Journal of the Korea Broadcasting Engineering Society, 27*(5), 751-761.

Wibawa, R. C., Pratiwi, C. P., Wahyono, E., Hidayat, D., & Adiasari, W. (2022). Virtual influencers: Is the persona trustworthy?. *Jurnal Manajemen Informatika (JAMIKA), 12*(1), 51-62.