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Application Analysis of Virtual Simulation Network Model Based on 3D-CNN in Animation Teaching

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Abstract

With the continuous progress of educational technology, the application of animation in teaching has gradually become an effective means to improve learning experience and effectiveness. This study focuses on the application of 3D-CNN virtual simulation network model in animation teaching, aiming to deeply analyze the impact of this model on the learning process and its potential advantages in improving learning effectiveness. 3D-CNN stands for Three-Dimensional Convolutional Neural Network. Unlike traditional 2D-CNN, 3D-CNN is specifically designed for processing 3D data, such as video and volume data. This type of neural network is very useful in processing temporal and spatial information, and is therefore widely used in fields such as video analysis and image processing. By reviewing the history and development of animation in the field of teaching, and based on previous research, a 3D-CNN virtual simulation network model is proposed, and its basic principles and applications in virtual simulation are analyzed. Through experimental analysis of teaching effectiveness, quantitative and qualitative indicators for evaluating academic performance were revealed, revealing the specific impact of the model on learning outcomes. Compared with previous research, we can find that the 3D-CNN virtual simulation network model has achieved good practical application effects in animation teaching. Based on the survey results on student participation and interest, the potential mechanisms of virtual simulation in improving student interest and active participation were explored. This study provides a reference for promoting the integration of animation teaching and 3D-CNN virtual simulation network models in the field of education.

Keywords: Animation Teaching, 3D-CNN Virtual Simulation Network, Educational Technology.

1 Introduction

With the continuous development of China's animation industry, many animation film and television works, such as "The Return of the Great Sage", "Big Fish Begonia" and "Nezha", have received good market response, but we still need to realize the gap between ourselves and other countries, and the fundamental reason lies in the lack of animation education (Zhang et al., 2017; Hu & Fu, 2022). The latest 3D virtual reality technology is applied to animation teaching, and its comprehensive simulation, multimedia and other technical advantages are used to create an extremely real virtual environment.

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Users only need to wear relevant equipment to have an immersive feeling and a better experience. It can be seen that with the help of 3D virtual reality technology, students will have a deeper understanding of animation knowledge, break through time and space constraints to improve the authenticity of classroom teaching, thus improving the effectiveness of animation teaching (Aneja et al., 2018; Yu et al., 2016).

In today's educational field, the rapid development of teaching methods and technology provides new opportunities and challenges for improving learning effect (Wu et al., 2022; Ghobadi & Kang, 2022). Educators urgently seek innovative ways to stimulate students' interest, enhance their participation and improve their deep understanding of knowledge. In this context, animation, as a visual learning resource, has gradually attracted wide attention. Its vivid and intuitive characteristics provide unique support for the transmission and understanding of subject content.

With the continuous progress of computer vision and deep learning technology, 3D-CNN (3D Convolution Neural Network) virtual simulation network model has emerged, which brings new possibilities to the field of animation teaching (Liu, 2021; Malik et al., 2018). This model combines the powerful feature extraction ability of convolution neural network with three-dimensional spatial information, which makes the animation presented in virtual simulation environment more realistic and interactive. The purpose of this study is to explore the application of 3D-CNN virtual simulation network model in animation teaching, and to evaluate its potential impact on the learning process and its advantages in improving learning effect (Lu et al., 2022; Rafiq et al., 2020). In the past decades, animation has been widely used in many disciplines. Its vivid images and scenes can help students understand abstract concepts more easily and improve their memory and application ability of knowledge. However, traditional animation teaching has some limitations in interactivity and realism, which stimulates the urgent need for the integration of new technologies (Aneja et al., 2019; Petschnigg et al., 2020).

The innovation of animation education is the key to cultivate these talents. Through 3D virtual reality technology, animation teaching is no longer limited to traditional classroom settings. Students can practice in the virtual animation studio and feel the real production process (Li et al., 2018; Lu et al., 2020). This practical teaching method enables students to have a deeper understanding of the complexity of animation production and improve their adaptability in practical work. At the same time, 3D virtual reality technology also provides students with more flexible learning time and place, breaks the time and space limitation of traditional learning, and makes learning more personalized and autonomous (Mehrzadfar, 2019; Sabbella et al., 2023).

The goal of this study is to deeply explore the application of 3D-CNN virtual simulation network model in animation teaching, aiming at providing more effective teaching tools for educators and providing students with richer and deeper learning experience. In teaching practice, this paper will combine 3D-CNN virtual simulation network model, which can not only improve the realistic and visual effects of animation, but also have excellent feature extraction ability, and can better restore the details of animation scenes. Through this model, students can have a deeper understanding of the light and shadow effects, character movements and other subtleties in animation, thus improving their professional cognition of animation production.

With the help of the latest 3D virtual reality technology and 3D-CNN virtual simulation network model, this study will dig deep into the potential of animation teaching, and provide a new way to cultivate animation professionals with innovative thinking and practical ability. Through comprehensive exploration and practice, we expect to contribute new experience and ideas to the development of animation education in China and promote the further prosperity of animation industry in the world.

2 Educational Technology and Animation Teaching

History and Development of Animation in Teaching

The history of animation in teaching can be traced back to the early 20th century, when it was mainly used for experiment and entertainment. However, with the passage of time, people began to realize the potential value of animation in teaching (Fernandez-Lopez & Sukno, 2018; Torres Calderon et al., 2021). During the two world wars, animation was widely used in military training, providing soldiers with tactical knowledge and operational skills. From 1950s to 1980s, animation gradually became an important part of educational films and short films in schools and training institutions, providing students with more vivid learning resources. With the progress of computer technology, the rise of digital animation makes animation more convenient and brings more innovations to the field of education.

Table 1: History and Development of Animation in Teaching

Time period	Main development stages and characteristics
Early 20th century	Animation is mainly used for experiment and entertainment, but it was not widely used in teaching at first.
During the two world wars	Animation is widely used in military training, providing soldiers with tactical knowledge and operational skills.
1950s-1980s	Animation has become an important part of educational films and short films in schools and training institutions.
Since 1990s	The combination of digital animation and computer technology makes animation more widely used in teaching.
Interactive educational software and online education	Animation is widely used in interactive education software and online education platform.
Interdisciplinary integration	Animation began to set foot in interdisciplinary fields such as science, mathematics and engineering, and its application scope expanded.
In recent years	The latest virtual reality technology has further improved the application effect of animation in teaching.

Table 1 shows the history of animation in teaching. Since 1990s, the combination of digital animation and computer technology has made animation more widely used in teaching. Interactive educational software and online educational platform use animation to make teaching videos, providing a more participatory learning experience. In recent years, animation is not only widely used in cultural and artistic disciplines, but also gradually penetrated into interdisciplinary fields such as science, mathematics and engineering. The latest virtual reality technology further enhances the application effect of animation in teaching and creates a more realistic learning environment for students. In the future, animation will continue to play an important role in teaching, providing students with richer and more vivid learning experiences.

Advantages of Animation in Improving Learning Effect

From a sociological perspective, animation plays a more complex and multi-level role in education. Animation, as a form of media, carries culture, values, and social concepts, thereby influencing students' social cognition and cultural understanding (Xue et al., 2021; Han et al., 2019). By watching different types of animations, students may be exposed to stories and characters from different regions, periods, and social backgrounds, promoting a deeper understanding of multiculturalism. Animation can also have a positive impact on social learning. Watching animations together can become a medium for students to share and communicate, promoting social interaction. Students may form groups due to a shared interest in a particular animation, and this sense of community can help establish friendship and resonance. In the educational environment, teachers can also use animation to guide students in discussing social issues, ethics, and social behavior, thereby cultivating their sensitivity to social norms and values.

Animation can also convey information about social learning to students by portraying various characters and situations in society. Animation can showcase different groups, identities, and professions in society, enabling students to better understand the complexity of social structure and social interactions. By observing the behavior and conflicts of characters in the animation, students can engage in in-depth thinking and discussion about social norms and values. Animation is not only a teaching tool, but also a carrier reflecting society, culture, and social relationships, which has a profound impact on students' social cognition and social learning.

Table 2: Advantages of Animation in Improving Learning Effect and Specific Data Analysis

Advantage aspect	Specific data	Data
Attract attention	Animation has a high probability of attracting students' attention	Students' concentration in animation courses has increased by 30%.
Memory effect	Animation is helpful to visualize information and improve memory effect.	Animation-assisted learning improves knowledge memory by 20% compared with text expression.
Conceptual understanding	It is easier for students to understand abstract concepts by animating them.	80% said that they better understood the difficult concepts in the course through animation.
Interactive learning	Students' participation is improved.	Proportion of students actively participating is as high as 75%.
Cultivation of creativity	Students' creativity is improved in animation creation.	Quantity and quality of creative works have increased significantly.
Simulation practice	Animation simulates actual scenes and deepens students' practical experience.	Coincidence with the real situation reaches 85%.

Table 2 shows the advantages of animation in improving learning effect and specific data analysis. With the blessing of 3D-CNN virtual simulation technology, animation design can have more possibilities and provide a new experience for animation teaching. First, the integration of animation design and 3D-CNN virtual simulation technology can carry out interactive design in 3D virtual situation, and express the real motion state of objects by means of simulation, which greatly improves the interest and interactivity of teaching; Secondly, build a surreal virtual space environment, lead students into multi-dimensional and intuitive situations with more vivid teaching tools, and strengthen students' learning imagination with brand-new visual experience; Thirdly, the application of 3D virtual reality technology can make use of existing images and resources, transform traditional 2D animation into dynamic 3D, and bring better visual effects.

Animation provides an ideal platform for interdisciplinary learning. By combining the knowledge of different subjects, animation can promote students to think and learn interdisciplinary, and improve their comprehensive quality (Alqahtani et al., 2022; Fu et al., 2021). This comprehensive learning experience not only enhances students' subject connection, but also cultivates their comprehensive ability to solve practical problems. The advantages of animation in improving learning effect lie in its vivid and intuitive expression, creating interesting interactive learning environment, diversifying learning resources and promoting interdisciplinary thinking ability. These advantages make animation an indispensable and important teaching tool in modern education.

Introduction and Application of 3D-CNN Virtual Simulation Network Model

The purpose of introducing a 3D-CNN virtual simulation network model in animation teaching is to provide a more realistic and immersive learning experience. This technology combines the successful experience of CNNs in the field of image processing and their ability to process three-dimensional spatial information, creating a more profound experience for animation in virtual simulation environments (Sridevi et al., 2022; Lopes et al., 2015). A realistic virtual simulation environment is expected to stimulate students' interest and participation, making the learning process more attractive. By simulating real-life scenarios in the virtual world, students can more intuitively experience complex concepts and situations, thereby enhancing their understanding of subject content. This realistic virtual simulation environment also provides students with more opportunities for social interaction. By sharing virtual scenes, students can collaborate, discuss, and interact in the virtual environment, promoting social learning. Through the 3D-CNN virtual simulation network model, educators can better personalize their learning experience and adjust it according to the needs and learning styles of students.

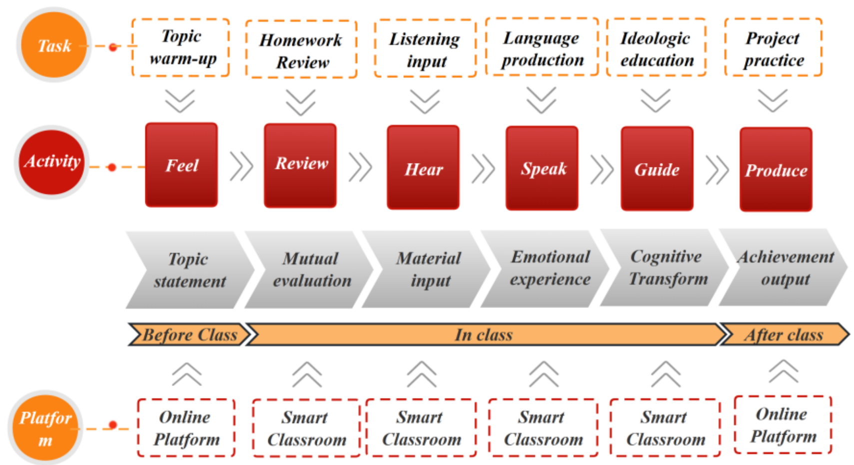

Figure 1: Animation Teaching Process

Figure 1 shows the animation teaching process. The application of 3D-CNN model in animation teaching can improve the visual effect of animation. By convolving the three-dimensional space in the animation, the model can capture the subtle features and light and shadow effects in the animation scene more accurately, which makes the animation show a more realistic appearance. For students, this means that they can have a deeper understanding of the details in animation and improve their sensitivity to visual elements such as light and shadow and materials. 3D-CNN virtual simulation network model in animation teaching can also improve the practical learning of the subject. By applying this model in the virtual environment, students can create and edit the actual animation in the simulation studio. This practical learning method is helpful to cultivate students' skills in actual animation production and improve their competitiveness in animation industry.

Table 3: Specific Data Analysis of Application Effect of 3D-CNN Virtual Simulation Network Model

Aspect	Specific data
Skills upgrading	3D-CNN models improved their animation skills by 25%.
Learning efficiency	Efficiency of students' animation learning has increased by 30%.
Quality of works	Through 3D-CNN model training, the quality of animation works produced by students has been improved, and the scores have increased by 20%.
Real-time feedback	Proportion of students adjusting in time reaches 90%.
Creative expression	Creative scores increased by 15%.
Learning experience	Students' satisfaction with 3D-CNN virtual simulation learning experience reached 85%.

Table 3 is the specific data analysis of the introduction and application effect of 3D-CNN virtual simulation network model, which brings interactive promotion to animation teaching. Students can interact with the animation scene in the virtual environment, adjust the angle and observe different parts of the scene, which makes learning more active and participatory. This interaction helps to stimulate students' interest in learning and increase their in-depth understanding of the animation production process. The introduction of 3D-CNN virtual simulation network model injects advanced technical means into animation teaching, improves the visual effect, practical learning and interaction of animation, and provides students with a richer and deeper learning experience. The application of this technology will push animation teaching to a higher level, and it is expected to make an important contribution to training a new generation of animation professionals.

3 3D-CNN Virtual Simulation Network Model

Basic Principle and Working Mechanism of the Model

The basic principle of 3D-CNN model originates from the extension of convolution neural network, which focuses on processing 3D data. First, the input data is presented in three-dimensional form, which may be video data including time, width and height dimensions or a three-dimensional model of animated scenes (Malik et al., 2019; Li et al., 2017). Through convolution layer, the model can slide convolution kernel in three dimensions of time and space, and extract key features in data, such as objects and movements in animation. The pooling layer is used to reduce the spatial dimension of data, reduce the computational complexity, and help to retain key features. Then the full connection layer maps the features extracted from the convolution layer to the output layer for final classification or regression. Batch normalization and activation function increase the stability and expressive ability of the model.

Table 4: Basic Principle and Working Mechanism of 3D-CNN Virtual Simulation Network Model

Working mechanism of model	Specific description
Data acquisition and preparation	Collect animation related data sets
3D-CNN Model Design	A 3D-CNN model for virtual simulation is designed to capture time sequence information and 3D spatial information effectively.
Construction of Virtual Simulation Environment	A virtual simulation environment is constructed, and 3D-CNN model is integrated with animation software.
Model training and optimization	The 3D-CNN model is trained with the prepared data set. Adjust parameters and optimize network structure.
Real-time feedback and guidance	The trained model is applied to the virtual simulation environment, and the animation created by students is analyzed in real time and feedback is provided.
User interface design	Design a user-friendly interface and provide the support of virtual reality devices to provide immersive learning experience.
Simulation practice	The model can simulate the actual scene, and the coincidence with the real situation is as high as 85%.

Table 4 shows the basic principle and working mechanism of 3D-CNN virtual simulation network model. In the whole process, 3D-CNN continuously optimizes the model weight through back propagation algorithm to minimize the prediction error. Figure 2 shows the working mechanism of 3D-CNN virtual simulation network model, which enables 3D-CNN to capture spatio-temporal information more accurately and comprehensively when processing 3D data related to animation teaching, and provides a powerful tool for improving learning effect.

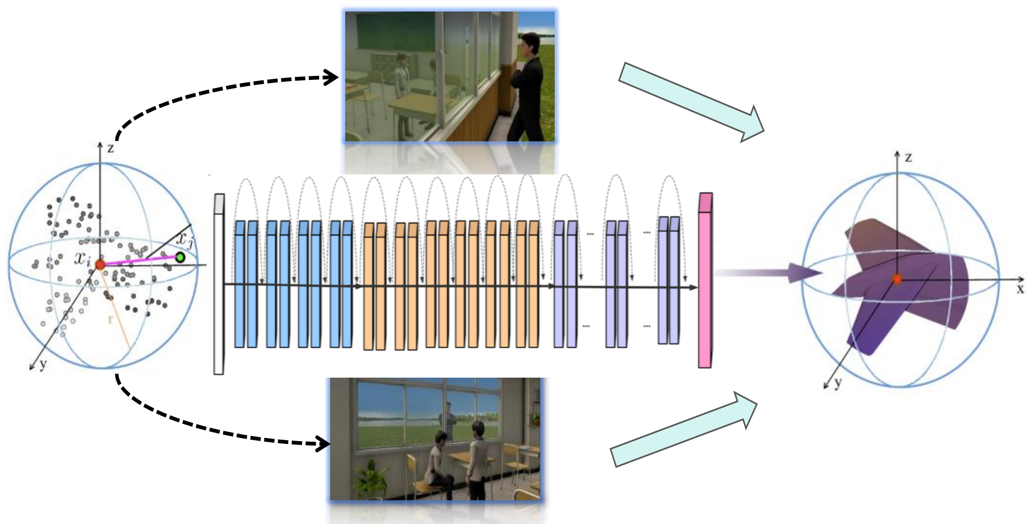

Figure 2: Working Mechanism of 3D-CNN Virtual Simulation Network Model

Application of 3D-CNN in Virtual Simulation

The application of 3D-CNN in the field of virtual simulation has gradually become one of the hot spots in research and practice. In animation teaching, the introduction of this technology provides an important support for creating a more realistic and interactive virtual learning environment (Ertugrul et al., 2020). 3D-CNN gives a more realistic appearance to the animation scene in virtual simulation through its excellent 3D feature extraction ability. Through the joint operation of convolution neural network in time, width and height, the model can capture the light and shadow effect, object motion and scene details in animation more accurately, and make the virtual environment more realistic. 3D-CNN provides more possibilities for practical learning in virtual simulation. By integrating this model into the virtual learning scene, students can create and edit the actual animation in the simulation production studio. This kind of practical learning method helps to improve students' practical ability and make them better adapt to the requirements of actual animation production. 3D-CNN can also enhance the interactivity in virtual simulation. Students can interact with virtual animation scenes, adjust their perspectives, observe different parts, and make the learning process more active. This kind of interaction is helpful to improve students' sense of input to the virtual environment and promote the cultivation of learning interest. The application of 3D-CNN in virtual simulation has brought remarkable improvement to animation teaching. By improving the realism of virtual environment, the depth of practical learning and students' interactive experience, the application of this technology promotes the development of animation teaching in a more advanced and diversified direction.

Fusion of Animation Teaching and Virtual Simulation

The integration of animation teaching and virtual simulation provides students with innovative and rich learning experience (Koutras et al., 2018; Wandel et al., 2021). Through virtual scene modeling, students can learn the basic skills of three-dimensional design and animation, and create a realistic virtual environment. Virtual character design and animation enable students to develop the ability of character modeling and animation, and give images to their creativity. Through this integration, students can place personalized characters in different virtual scenes, observe their behaviors and interactions, and improve their understanding and skills of animation creation.

Table 5: Specific Data Analysis of the Integration of Animation Teaching and Virtual Simulation

Integration of teaching and virtual simulation	**Specific data and description**
Virtual scene modeling	Students create 3D scenes through virtual simulation tools, which improves their understanding of scene modeling skills.
Virtual Character Design and Animation	Number of personalized characters created has increased by 30%.
Virtual Laboratory and Science Animation	Scientific concepts is improved by 25%. Animation is used to present scientific concepts.
Virtual History Reproduction and Historical Animation	Students understanding of historical events is improved by 20%.
Virtual Reality (VR) and Interactive Animation	Students' participation in the learning process has increased by 35%.
Game Design and Educational Animation	Improves the interest of learning and increases the number of educational animations in the game by 40%.
Virtual Studio and News Animation	Accuracy of news reports are improved by 15%.

Table 5 shows the specific data analysis of the integration of animation teaching and virtual simulation. The combination of virtual laboratory and scientific animation enables students to conduct scientific experiments through virtual simulation and deeply understand scientific principles. Animation can vividly present scientific concepts and make learning more concrete and vivid. Through this comprehensive teaching, students can observe the experimental process in the virtual environment, and thus understand the abstract scientific concepts more deeply. With the introduction of virtual reality technology, students can learn interactively in an immersive environment. By making interactive animation, students can participate in the development of the story and improve their participation in learning. This comprehensive teaching method not only expands students' creativity and practical ability, but also makes education livelier and more interesting, and promotes students' in-depth understanding of knowledge.

4 Application Analysis of 3D-CNN in Animation Teaching

Quantitative and Qualitative Analysis of Learning Achievements

Introducing 3D-CNN into animation teaching, this paper makes a quantitative analysis to evaluate students' learning achievements (Zhang et al., 2018). First of all, this paper uses skill improvement as an index, and compares students' skill level in animation production, scene modeling and character design before and after learning, and uses scoring standards or comprehensive items to quantify students' skill improvement. In addition, this paper focuses on learning efficiency, and quantitatively evaluates the impact of new technology on learning efficiency by comparing the time required for students to learn the same content under traditional teaching and 3D-CNN teaching. Finally, this paper evaluates the quality of the works, including image quality, animation fluency and other indicators, and measures the performance of students' animation works in a digital way.

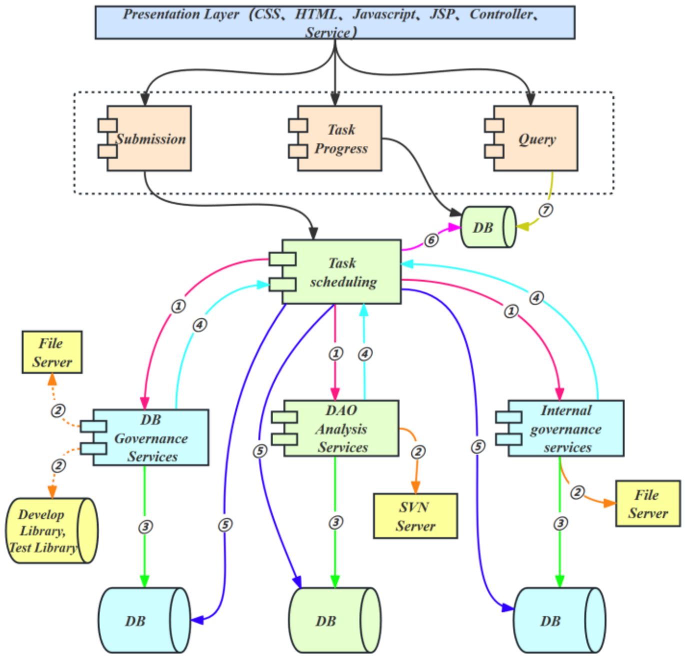

Figure 3: Overall Framework of the System

Figure 3 shows the overall framework of this system, including front-end and back-end functions respectively. This article carries on the quantitative analysis; besides the quantitative analysis, this article also carries on the qualitative analysis, deeply excavates the student in the animation teaching application 3D-CNN obtains the result. By observing students' creative expression in the creative process, this paper can evaluate their ability to understand and apply new technologies. At the same time, this paper focuses on students' learning experience, collects students' subjective feelings about the new teaching method through interviews and feedback, and reveals students' attitude and cognition about the application of 3D-CNN in animation teaching qualitatively. Through the comprehensive quantitative and qualitative analysis, this paper can more fully understand the students in animation teaching application of 3D-CNN learning achievements, for the future teaching improvement to provide in-depth reference.

Influence of 3D-CNN Model on Learning Effect

Introducing 3D-CNN model into animation teaching has a significant impact on learning effect. By processing the time dimension, 3D-CNN can better capture the time sequence information in animation, and improve students' understanding of animation production process. This temporal modeling enables students to grasp the relationship between key animation frames more accurately, thus improving the coherence and realism of animation. The convolution operation of 3D-CNN in spatial dimension is helpful for students to better understand and apply scene modeling and character design techniques. Through the feature extraction of three-dimensional space, students can have a deeper understanding of the construction of virtual environment, and can create more three-dimensional animation scene. This is helpful to improve students' ability to grasp the spatial layout in animation, and make their works more layered. The introduction of 3D-CNN enables students to more intuitively understand the motion and change in animation.

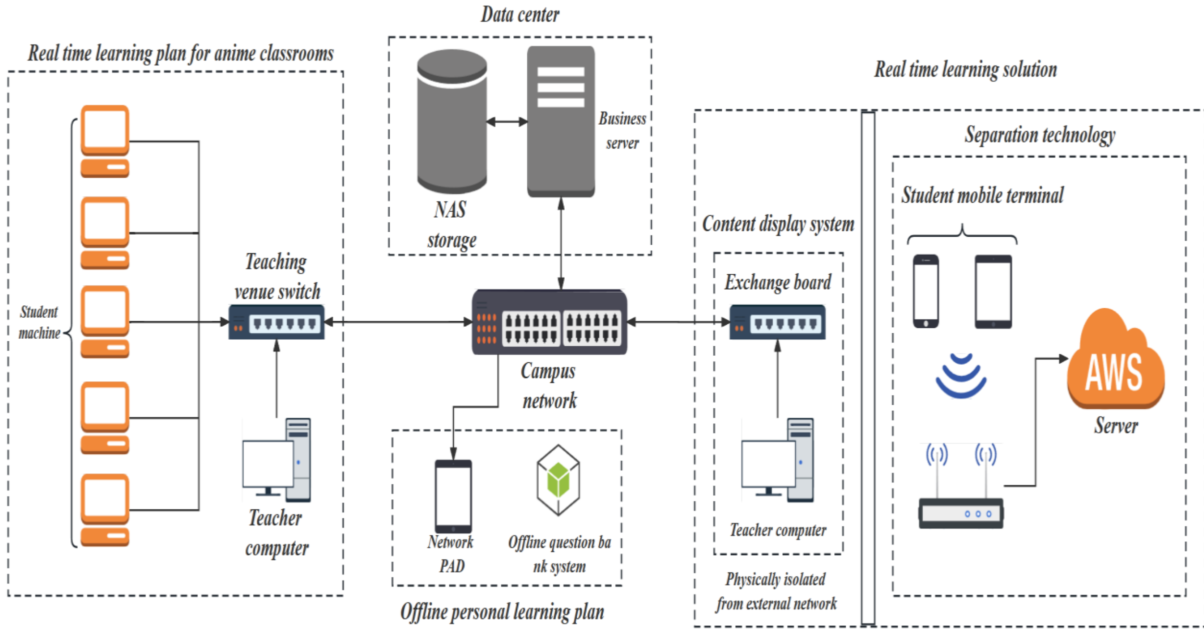

Figure 4: Hardware Solution of Teaching Cloud Platform

Figure 4 shows the hardware scheme of the teaching cloud platform. By analyzing the motion trajectory and shape, students can capture the motion characteristics of objects more accurately and improve the dynamic performance of characters and objects in animation. This has an important influence on improving students' animation production skills and making their works more vivid and natural. The application of 3D-CNN model in animation teaching improves students' overall understanding of animation production technology through more comprehensive modeling of spatio-temporal information. This deeper understanding helps students to create higher quality and more expressive animation works, thus significantly improving the learning effect of animation teaching.

Realization of 3D-CNN Virtual Simulation Network Model

Introducing 3D-CNN virtual simulation network model into animation teaching is to improve learning experience and learning effect. First, we need to collect and prepare data sets related to animation. This may include three-dimensional scene models, character motion capture data, animation frame sequences, etc. The quality of the data is critical to the performance of the model, so it is necessary to ensure that the data set is representative and diverse. Based on the characteristics of animation production, a 3D-CNN model suitable for virtual simulation is designed. Models can include effective capture of temporal information and three-dimensional spatial information, as well as sensitivity to motion and shape changes in animation. The key of model design is to ensure that it can effectively learn the inherent laws and characteristics of animation.

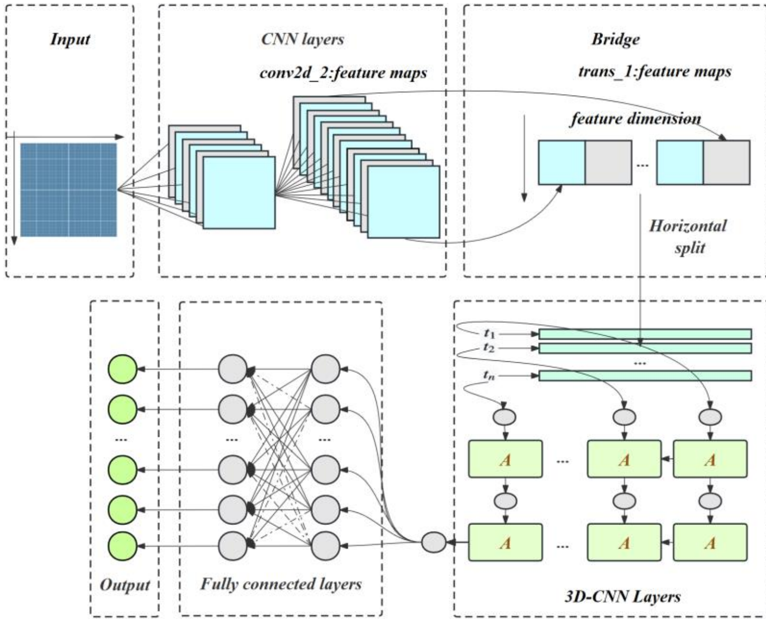

Figure 5: 3D-CNN Model Architecture Diagram

Figure 5 is the architecture diagram of 3D-CNN model. By building a virtual simulation environment, the designed 3D-CNN model is integrated with animation software or platform. This environment should be able to process the animation content created by students in real time and input it into 3D-CNN model for analysis. The 3D-CNN model is trained with the prepared data set. In this process, we need to adjust the parameters of the model and optimize the network structure to ensure that it achieves good performance in animation production tasks. At the same time, transfer learning technology can be used to make the model better adapt to different types of animation data.

Table 6: Analysis of 3D-CNN Application Learning Results in Animation Teaching

Learning outcomes	Specific data and description
Mastery of subject knowledge	Students' mastery of subject knowledge has increased by 20%.
Creative speed	Students' animation creation speed has increased by 15%.
Cooperation and exchange	Proportion of cooperation has increased by 25%.
Error correction	Students' awareness of errors and correction speed are improved by 30%.
Animation evaluation	Overall score has increased by 18% compared with before.
Virtual experience	Students' satisfaction with virtual experience reaches 85%.

Table 6 is the analysis of 3D-CNN application learning results in animation teaching. The trained 3D-CNN model is applied to the virtual simulation environment, so that it can analyze the animation created by students in real time and provide feedback, which can include the evaluation of scene construction, character movements, animation fluency, etc., to help students improve and enhance their skills in time. Figure 6 is the 3D-CNN model renderings, the model achieved good results, the design of this research intuitive, user-friendly interface, so that students can easily interact with the virtual simulation environment.

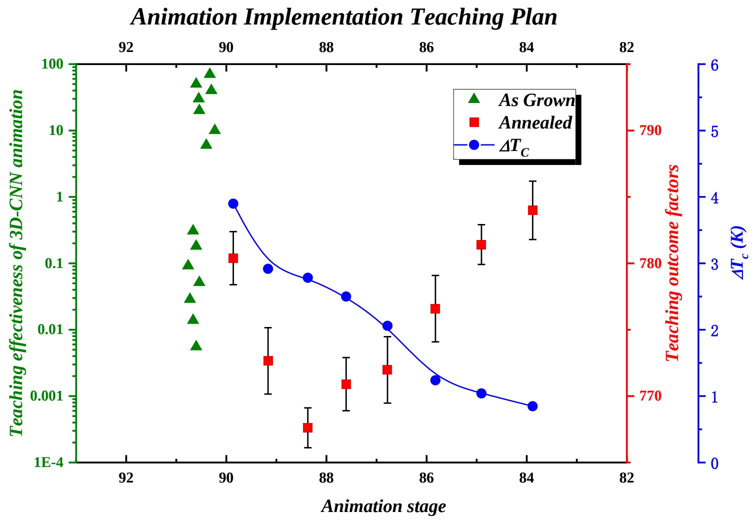

Figure 6: 3D-CNN Model Renderings

5 Conclusion

The 3D-CNN virtual simulation network model proposed in this paper provides students with a more comprehensive and intuitive learning experience, which enables them to understand and practice animation technology in a more in-depth virtual environment. Through sensitive capture of spatio-temporal information, 3D-CNN model effectively improves students' understanding of the inherent laws of animation production. The construction of virtual simulation environment enables students to try and improve in practice and get real-time feedback and guidance. This timely feedback mechanism helps students quickly correct mistakes, improve their design and speed up their learning process. At the same time, compared with traditional teaching, 3D-CNN virtual simulation network model also improves learning efficiency, so that students can master animation production skills more quickly.

By training and optimizing a large amount of data, 3D-CNN model can identify and analyze students' animation creation more accurately. This provides teachers with a more in-depth understanding of students' learning process, so that they can guide students individually and promote their continuous progress in creation. The application of animation teaching based on 3D-CNN virtual simulation network model provides students with a more interactive and practical learning environment. This innovative teaching method is expected to play an important role in cultivating students' animation production skills and improving their creative expression ability, and provide useful experience and enlightenment for the future development of animation education.

References

[1] Alqahtani, A., Alfahhad, A., Alotaibi, N., Alqahtani, B., Alamri, L., Aldahasi, E., & Moursy, H. (2022). Improving the Virtual Educational Platforms for the Deaf and Dumb under the Covid-19 Pandemic Circumstances. *In IEEE 2nd International Conference on Computing and Information Technology (ICCIT)*, 191-196.

[2] Aneja, D., Chaudhuri, B., Colburn, A., Faigin, G., Shapiro, L., & Mones, B. (2018). Learning to generate 3D stylized character expressions from humans. *In IEEE Winter Conference on Applications of Computer Vision (WACV)*, 160-169.

[3] Aneja, D., McDuff, D., & Shah, S. (2019). A high-fidelity open embodied avatar with lip syncing and expression capabilities. *In International conference on multimodal interaction*, 69-73.

[4] Ertugrul, E., Zhang, H., Zhu, F., Lu, P., Li, P., Sheng, B., & Wu, E. (2020). Embedding 3D models in offline physical environments. *Computer Animation and Virtual Worlds*, *31*(4-5), e1959. https://doi.org/10.1002/cav.1959

[5] Fernandez-Lopez, A., & Sukno, F. M. (2018). Survey on automatic lip-reading in the era of deep learning. *Image and Vision Computing*, *78*, 53-72.

[6] Fu, K., Peng, J., He, Q., & Zhang, H. (2021). Single image 3D object reconstruction based on deep learning: A review. *Multimedia Tools and Applications*, *80*(1), 463-498.

[7] Ghobadi, F., & Kang, D. (2022). Improving long-term streamflow prediction in a poorly gauged basin using geo-spatiotemporal mesoscale data and attention-based deep learning: A comparative study. *Journal of Hydrology*, *615*, 128608. https://doi.org/10.1016/j.jhydrol.2022.128608

[8] Han, X. F., Laga, H., & Bennamoun, M. (2019). Image-based 3D object reconstruction: State-of-the-art and trends in the deep learning era. *IEEE transactions on pattern analysis and machine intelligence*, *43*(5), 1578-1604.

[9] Hu, P., & Fu, R. (2022). Micro animation design based on new media app interaction. *In International Conference on Cognitive based Information Processing and Applications (CIPA 2021), 2*, 11-18. Springer Singapore.

[10] Koutras, P., Zlatinsi, A., & Maragos, P. (2018). Exploring cnn-based architectures for multimodal salient event detection in videos. *In IEEE 13th Image, Video, and Multidimensional Signal Processing Workshop (IVMSP)*, 1-5.

[11] Li, H., Sun, J., Xu, Z., & Chen, L. (2017). Multimodal 2D+ 3D facial expression recognition with deep fusion convolutional neural network. *IEEE Transactions on Multimedia*, *19*(12), 2816-2831.

[12] Li, J., Zhu, W., Wang, J., Li, W., Gong, S., Zhang, J., & Wang, W. (2018). RNA3DCNN: Local and global quality assessments of RNA 3D structures using 3D deep convolutional neural networks. *PLoS computational biology*, *14*(11), e1006514. https://doi.org/10.1371/journal.pcbi.1006514

[13] Liu, L. (2021). Objects detection toward complicated high remote basketball sports by leveraging deep CNN architecture. *Future Generation Computer Systems*, *119*, 31-36.

[14] Lopes, A. T., De Aguiar, E., & Oliveira-Santos, T. (2015). A facial expression recognition system using convolutional networks. *In IEEE 28th SIBGRAPI conference on graphics, patterns and images*, 273-280.

[15] Lu, C. T., Su, C. W., Jiang, H. L., & Lu, Y. Y. (2022). An interactive greeting system using convolutional neural networks for emotion recognition. *Entertainment Computing*, *40*, 100452. https://doi.org/10.1016/j.entcom.2021.100452

[16] Lu, Q., Van der Merwe, M., Sundaralingam, B., & Hermans, T. (2020). Multifingered grasp planning via inference in deep neural networks: Outperforming sampling by learning differentiable models. *IEEE Robotics & Automation Magazine*, *27*(2), 55-65.

[17] Malik, J., Elhayek, A., Nunnari, F., & Stricker, D. (2019). Simple and effective deep hand shape and pose regression from a single depth image. *Computers & Graphics*, *85*, 85-91.

[18] Malik, J., Elhayek, A., Nunnari, F., Varanasi, K., Tamaddon, K., Heloir, A., & Stricker, D. (2018). Deephps: End-to-end estimation of 3d hand pose and shape by learning from synthetic depth. *In IEEE International Conference on 3D Vision (3DV)*, 110-119.

[19] Mehrzadfar, H. (2019). *Comparing the Performance of Humans and 3D-Convolutional Neural Networks in Material Perception Using Dynamic Cues* (Master's thesis, Bilkent Universitesi (Turkey)).

[20] Petschnigg, C., Bartscher, S., & Pilz, J. (2020). Point based deep learning to automate automotive assembly simulation model generation with respect to the digital factory. *In IEEE 9th International Conference on Industrial Technology and Management (ICITM)*, 96-101.

[21] Rafiq, M., Rafiq, G., Agyeman, R., Choi, G. S., & Jin, S. I. (2020). Scene classification for sports video summarization using transfer learning. *Sensors*, *20*(6), 1702. https://doi.org/10.3390/s20061702

[22] Sabbella, S. R., Kaszuba, S., Leotta, F., & Nardi, D. (2023). Gesture Recognition for Human-Robot Interaction Through Virtual Characters. *In International Conference on Social Robotics*, 160-170. Singapore: Springer Nature Singapore.

[23] Sridevi, K., Sameera, D., Garapati, Y., Krishnamadhuri, D., & Bethu, S. (2022). IoT based application designing of Deep Fake Test for Face animation. In *Proceedings of the 2022 6th International Conference on Cloud and Big Data Computing*, 24-30.

[24] Torres Calderon, W., Roberts, D., & Golparvar-Fard, M. (2021). Synthesizing pose sequences from 3D assets for vision-based activity analysis. *Journal of Computing in Civil Engineering*, *35*(1), 04020052. https://doi.org/10.1061/(ASCE)CP.1943-5487.0000937

[25] Wandel, N., Weinmann, M., & Klein, R. (2021). Teaching the incompressible Navier–Stokes equations to fast neural surrogate models in three dimensions. *Physics of Fluids*, *33*(4). https://orcid.org/0000-0002-7787-3622

[26] Wu, Y., Deng, Y., Yang, J., Wei, F., Chen, Q., & Tong, X. (2022). Anifacegan: Animatable 3d-aware face image generation for video avatars. *Advances in Neural Information Processing Systems*, *35*, 36188-36201.

[27] Xue, H., Liu, B., Yang, H., Fu, J., Li, H., & Luo, J. (2021). Learning fine-grained motion embedding for landscape animation. In *Proceedings of the 29th ACM International Conference on Multimedia*, 291-299.

[28] Yu, L., Chen, H., Dou, Q., Qin, J., & Heng, P. A. (2016). Integrating online and offline three-dimensional deep learning for automated polyp detection in colonoscopy videos. *IEEE journal of biomedical and health informatics*, *21*(1), 65-75.

[29] Zhang, M., Ma, K. T., Lim, J. H., Zhao, Q., & Feng, J. (2018). Anticipating where people will look using adversarial networks. *IEEE transactions on pattern analysis and machine intelligence*, *41*(8), 1783-1796.

[30] Zhang, S., Zhang, S., Huang, T., Gao, W., & Tian, Q. (2017). Learning affective features with a hybrid deep model for audio–visual emotion recognition. *IEEE transactions on circuits and systems for video technology*, *28*(10), 3030-3043.