Scalable Computing: Practice and Experience, ISSN 1895-1767, http://www.scpe.org
© 2024 SCPE. Volume 25, Issues 6, pp. 5460–5468, DOI 10.12694/scpe.v25i6.3328

VISUAL COMMUNICATION METHOD OF MULTI FRAME FILM AND TELEVISION SPECIAL EFFECTS IMAGES BASED ON DEEP LEARNING

JINGLEI ZHANG *

Abstract. For the dynamic film and television special effects industry, creating visually stunning and valuable graphics requires the integration of excellent deep-learning algorithms. This paper presents an enhanced version of the 3-D Convolutional Neural Network (3-D CNN), specifically tailored to meet the demanding needs of multi-frame television and film special effects. The version's key feature is its efficient data handling through coupled precision training, significantly increasing computational efficiency while reducing memory needs. This method, which combines floating-issue operations of 16 and 32 bits, is ideal for efficiently processing large amounts of high-resolution video data. The proposed 3-D CNN structure excels in extracting and analysing complex spatiotemporal capabilities from video sequences, capturing the spatial and temporal nuances crucial in film imagery. This capability is important for accomplishing excessive fidelity in visual results, ensuring seamless integration with live motion pics. Incorporating a cutting-edge attention mechanism inspired by the aid of transformer-based architectures, the model specialises inside the maximum pertinent components of video frames to enhance the quality and realism of outcomes. Furthermore, the model boasts an excessive-resolution processing characteristic, permitting simultaneous capture of first-rate records and broader scene context. This guarantees consistency and realism in outcomes, from complicated textures to the overarching visual narrative. Advanced regularisation strategies are hired to prevent overfitting, permitting the model to generalise efficiently through numerous film manufacturing conditions. The state-of-the-art 3-D information augmentation techniques make the model robust and prepare it to deal with an intensive variety of challenging situations involving computer special effects. Real-time processing competencies make the model a game-changer for on-set visible outcomes and adjustments. Designed for seamless integration with the famous CGI software program software utility, it allows a harmonious aggregate of AI and ingenious creativity. Acknowledging the environmental impact of high-powered computing, the model consists of power-efficient computational techniques that align with sustainable computing practices, lower operational costs, and are related to processing complex video statistics. model boasts an excessive-resolution processing characteristic, permitting simultaneous capture of first-rate records and broader scene context. This guarantees consistency and realism in outcomes, from complicated textures to the overarching visual narrative. Advanced regularisation strategies are hired to prevent overfitting, permitting the model to generalize efficiently through numerous film manufacturing conditions. The state-of-the-art 3-D information augmentation techniques, in addition, make the model robust, and prepare it to deal with an intensive variety of computer special effects challenging situations.

Key words: Visual communication methods, mixed precision training, spatiotemporal feature extraction, real time processing, 3D CNN, data augmentation, sustainable computing practices

1. Introduction. In the dynamic world of film and TV product, the combination of advanced technologies similar as deep learning has come a foundation for producing instigative and inspiring content [15, 2]. The development of special effects, due to the arrival of advanced computer methods, changed visual narrative of language. This study presents a 3D convolutional neural network(3D CNN) model designed to meet the complex requirements of multi-frame film and TV special effects [13, 19]. The proposed model uses optimal training, a model that balances computational effectiveness and model delicacy, which is suitable for recycling large quantities of high- resolution video data, this is the substance of ultramodern special effects processing.

The armature of this model has been precisely designed to reuse and dissect complex spatial features in video sequences [12, 3]. This capability allows you to understand the complexity of the scene and the dynamics of the scene in the picture images, which is important to achieve high dedication in visual situations [23]. By guaranteeing the integration of effects into live action footage, this model will change the way visual narratives are crafted and presented [4]. The model layers are adept at feature extraction, but the preface of advanced styles similar as mixed integration training improves the model effectiveness, which is veritably important for the dynamic conditions of the film and TV products [10, 17].

An important part of this model is its focus on operational efficiencies. Using a combination of 16- bit and

*Jilin animation college Changchun China 130013 (jingleizhang21@outlook.com)

32- bit afloat- point operations during training, this model optimizes recycling speed and training effectiveness [11, 6]. This approach is important to manage the quantum of data involved in recycling high quality special effects. In addition, the stiffness of this model is shown in different operations across age groups and professional surroundings, showing its scalability and versatility in content creation [22, 18]. Processing time and resource operation criteria increase the model's utility, making it a precious tool for content generators and workrooms to efficiently produce content without compromising quality [24, 20].

Eventually, the effect of models on the quality of vision cannot be overstated [5]. In an application where the participation of the followership is important, the visual appearance and trustability of the special effects are important [7]. The model can give dependable, high-quality products that appeal to different audiences and demonstrate its effectiveness. The study concludes that the proposed 3D CNN model represents a significant advance in film and TV products with its innovative armature and processing capabilities. Its benefactions not only enhance the visual quality of content but also define the scalability and reliability of special effects products in a decreasingly digital and fast-paced media terrain.

A revolutionary change in the rapidly expanding sector of special effects for cinema and television is imminent, thanks to the use of cutting-edge deep learning algorithms. The goal of this proposed research is to use enhanced 3-D Convolutional Neural Networks (3-D CNNs) to create extremely realistic and visually appealing special effects, thereby addressing a major obstacle. The need for realistic, high-quality graphics that mix in with live-action footage is greater than ever in the fast-paced and highly technical world of film and television production. This work presents a novel 3-D CNN model with coupled precision training that establishes a new industry standard.

The contribution of the paper are as follows:

1. Proposed a novel approach of 3D CNN with mixed precision training integration for movie and television special effects.
2. The proposed model is trained with the different set up of simulations and demonstrates its efficacy in respective manner.
3. The experiments of the proposed are depicted with valid proofs.

2. Related Work. The paper [9] explores the synergy among virtual era and new media art, emphasizing the evolving function of digital tools in ingenious expression. The observe introduces practical visible art work creation, an idea that aligns with the improvements of the smart era, blending artwork with deep learning. The studies technique, encompassing case research and experimental analysis, creates an interdisciplinary framework, highlighting the functionality and worrying conditions of this novel artwork. It posits a future wherein virtual technology profoundly affects and figures the scene of virtual media art. The paper [21] addresses the increasing recognition of spiritually themed films and tv suggests, emphasizing the need for efficient techniques to find audience desired animations in large databases. It employs artificial intelligence and machine learning to know to discover new visible expressions in animation movies, using a Convolution neural network to investigate "Kung Fu Panda news." With an accuracy of 57% in the test set, the observe underscores the importance of revolutionary visible illustration inside the movie industry's development and creative development. The paper [16, 14] examines the impact of AI and machine learning knowledge of to recognize in enhancing the visible outcomes of active movies, specializing in computer imaginative and prescient packages. by using analyzing the Hollywood anime film "Coco" with convolutional neural algorithms, the examine finds an everyday check set accuracy of around 59%. This study emphasizes the feature of digital technology in elevating the audiovisual great and creativity of movie productions, contributing to sustainable increase in the animation location. The paper [1] explores the aggregate of artificial intelligence and digital truth (VR) era in film and tv animation (FTA) training. It combines dynamic environment modeling, actual-time 3-D images, and VR for training layout, considerably improving students' engagement and comprehension in FTA. The utility of VR in FTA training is established to beautify lecture room delight and expert skill acquisition, highlighting VR's potential to revolutionize instructional strategies in animation and format

From the above review analysis, visual communication in the television applications has more effects when technologies upgrade to 3D models. These 3D models needs to be communicated using AI technologies for efficient feature transactions.

3. Methodology. The system of the proposed study on advanced 3D CNNs for film and TV special effects relies on a sequence of methodical and connected way which is illustrated under Figure 3.1. Initially, the study starts with the collecting a comprehensive dataset comprising multi-frame sequences from different film and television content material. This dataset is strictly curated to include a wide range of visible issues, ensuring diversity in the data. Following data collection, the coming step consists of preprocessing the data, which incorporates normalization, resolution adaptation, and the operation of primary pollutants to enhance the quality of the input frames for more effective training of the neural network. The center of the system revolves across the layout and perpetration of the 3- D CNN interpretation. This includes configuring multiple layers of the network, together with convolutional layers, pooling layers, and fully connected layers, each serving as a distinct function in feature extraction and pattern recognition. A big aspect of the model's configuration is the combination of combined precision training, the operation of both 16- bit and 32- bit afloat-element operations to balance computational effectiveness and model delicacy. Once the model is configured, it undergoes a rigorous training manner using the organized dataset. This training is done with the operation of back propagation and gradient descent algorithms, with the amalgamated perfection approach ensuring faster computations and efficient memory usage. Throughout the training section, continuous monitoring and changes are made to optimize the models average performance, together with tuning hyperparameters and applying advanced regularization ways to prevent overfitting. After the training phase, the model is estimated by separate set of data not included within the training process. This assessment specializes within the model's delicacy, overall performance, and capacity to address several special effects challenges. The models real-time processing capabilities are also precisely tested to insure its connection in live surroundings. The final step of the methodology is the integration of the trained 3D CNN model with being CGI software program software operation systems. This integration is important for realistic software, allowing special goods artists to seamlessly use the model with in their separate workflows. The system concludes with an expansive evaluation of the models overall performance, together with its effect on enhancing the quality and literalism of special effects in film and TV production.

3.1. Proposed 3D CNN with mixed training precision Integration. This section implies the clear illustration of proposed 3- D CNN structure which is adapted from the study [13]. Traditional machine learning method depends upon manual feature extraction from datasets, feeding these extracted low- stage features into a machine learning algorithm. In comparison, deep learning ways, like CNNs, automatically extract features from raw datasets, processing low, middle, and high- level features for tasks like detection and classification. This eventuality to apply nonlinear features to raw statistics and produce abstracted outputs is an index of deep learning, significantly benefit from huge datasets and effective GPUs, which minimizing training time and enhance classification accuracy. In the realm of computer visionary, audio classification, and natural language processing, CNNs, along other infrastructures like DBNs, RNNs, LSTMs, and DSNs, were vital in dealing with huge datasets. CNNs, inspired through connected biological neurons, encompass neurons with weights and biases. At the same time as both CNNs and traditional ANNs include layers, CNNs vary appreciably of their structure. Unlike the one-dimensional 1D CNN layer structure in ANNs, CNNs have 3 D dimensional neurons in a layer, encompassing width, height, and depth. Each neuron in a CNN layer connects a particular region of the previous layer, utilizing local connections and pooling operations to come through and combine identical features. The usual CNN armature incorporates convolutional layers, pooling layers, and fully connected layers.

For our proposed 3 D CNN model made for television special effects, we adjust those generalities with a focal point on combining precision training. This model combines 16 bit and 32- bit afloat- point operations, optimizing computational performance and delicacy for managing with the large volumes of high- decision video data typical in special effects processing. The convolutional layers in our model will include feature maps and neurons, Pooling layers will reduce parameter countand network computations, preventing over fitting for the duration of training. On this proposed 3-D CNN structure, we emphasize the combination of mixed precision training in all layers, especially inside the convolutional and fully connected layers, to enhance the training effectiveness and performance. The fully connected layers, similar to the bones in regular ANNs, will connect all neurons of a layers to all neurons of the previous layer, supplying the fineness score among all dataset classes. also, the use of the ReLU activation function will insure high performance and fast learning, critical for real-time processing in special effects packages.

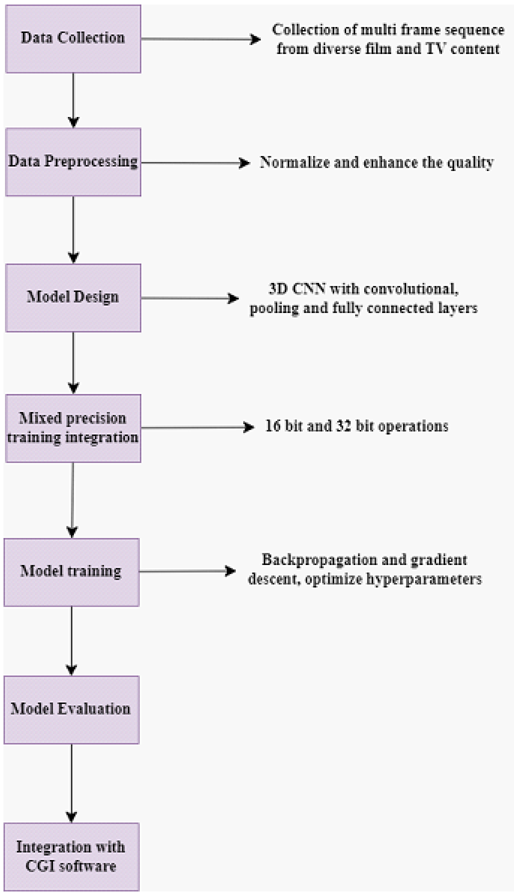

Fig. 3.1: Proposed Architecture

The algorithm for the proposed 3D CNN with combining precision training for enhancing special effects in TV begins with raw datasets of multi-layered video sequences. In the first step, these datasets are regularized and their decision is adjusted to make sure uniformity and utmost dependable optimal quality for processing. Following this preprocessing, entails applying convolutional operations to each feature maps in the statistics. This step is pivotal as it allows for the extraction and improvement of unique functions within the video frames, this is essential for detail and quality special effects. Next is to reduce the size of the affair from the convolutional layers. This system, generally related to as pooling, facilitates to drop the computational load and the complexity of the interpretation by repeating the functions extracted within the convolutional layers. Following this, all neurons in one layers are connected to all neurons within the previous layer. This completely fully connected layer integrates the features extracted in previous steps, taking into consideration more complicated and higher- level understanding of the data. The application of the ReLU function for non-linear transformation. This activation function introduces non-linearity into the model, enabling it to learn redundant complex styles in the records. Next, a combined precision training is employed, combining 16- bit and 32- bit operations. This system enhances the computational effectiveness of the interpretation, making it faster and more resource-effective, which is essential in large size of video datasets. Updating the weights of the network using Stochastic Gradient Descent(SGD) and back propagation. This is a crucial phase where the model learns from the data by using adjusting its weights to reduce minimize errors in its predictions. latterly, the trained network is applied to model and special effects in TV products. This entails making use of the learned models to new records, growing bettered and further sensible special effects primarily grounded on the

Algorithm 1 Video Sequence Processing and Enhancement

```
Input: Raw datasets of multi-frame video sequences
procedure DATA PREPROCESSING
    Normalize and adjust the resolution of input data.
end procedure
procedure CONVOLUTIONAL OPERATIONS
    Apply convolutional operations to each feature map:
    y_i^l = b_i^l + sum_{j=1}^{m_{1(l-1)}} f_{i,j}^l × w_j^{(l-1)}
end procedure
procedure REDUCE OUTPUT SIZE
    Reduce the size of the output from the convolutional layers:
    w_2 = (w_1 + f × s) + 1
    h_2 = (h_1 + f × s) + 1
end procedure
procedure CONNECT NEURONS
    Connect all neurons of a layer to all neurons of the previous layer:
    y_i^l = f(z_i^l) with z_i^l = sum_{j=1}^{m_{1(l-1)}} sum_{r=1}^{m_{2(l-1)}} sum_{s=1}^{m_{3(l-1)}} w_{i,j,r,s}^l × (y_{r,s}^{l-1})
end procedure
procedure RELU TRANSFORMATION
    Apply ReLU for non-linear transformation:
    { 1  for z > 0
    { 0  otherwise
end procedure
procedure MIX PRECISION TRAINING
    Combine 16-bit and 32-bit operations, mix precision for computational efficiency during training.
end procedure
procedure UPDATE WEIGHTS
    Update weights using SGD and back propagation:
    C = 1/n ( sum × sum_j (y_j ln a_j^l) ) + (1 + y_j) ln(1 - a_j^l)
end procedure
Output: Trained network for processing and enhancing special effects in television products.
```

delicate styles the model has discovered to apprehend and interpret.

4. Results and Experiments.

4.1. Simulation Setup. The proposed study uses the simulation setup based on the study [8]. The dataset within study at is characterized through its awareness on a numerous range of target groups, which affords depth and connection to the evaluation of computer graphics in tv and animation. these groups encompass Preschoolers, lower Grades of elementary schools, higher Grades of elementary schools, Baomoms and dads and Animation developers, each imparting particular insight into their separate choices and perceptions. The addition of such varied demographics gives a comprehensive view of the target group spectrum, starting from very young children to grown- ups and professional content creators. Preschoolers and elementary school students represent the younger audience, whose engagement with animation is fundamentally distinctive because of their development ranges and cognitive capacities. Junior high school students, being slightly older, have further sophisticated tastes and understanding, it's really meditated in their responses to special effects. Bao mom and dad probably the parents of the children in the earlier corporations, provide a parental angle this is critical in knowledge circle of relatives orientated content. Ultimately, Animation creators provide a professional point of view, that specialize in technical and imaginative components of computer graphics, that is important for gauging the enterprise morals and tendencies. The dataset's shape permits for an in-intensity assessment of the way exceptional age agencies and stakeholders reply to and perceive the exceptional, effectiveness, and attraction of special effects. The form of multifaceted model is useful for accommodating content to specific audiences, ensuring age-appropriate and engaging visual stories. It additionally presents valuable perceptivity

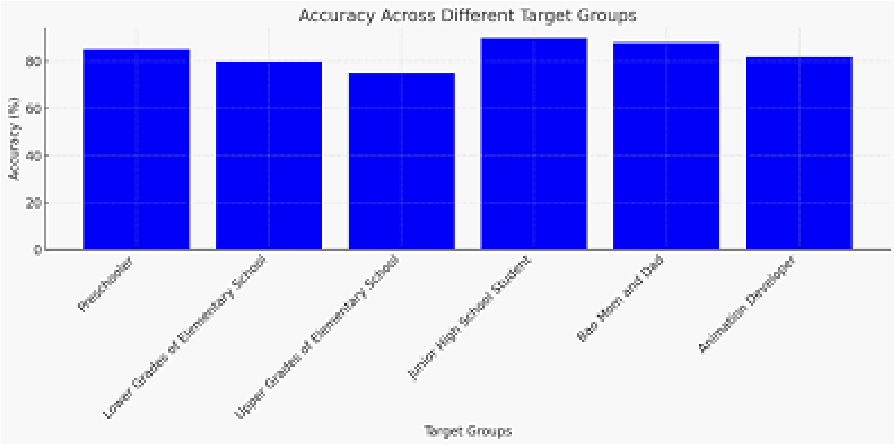

Fig. 4.1: In Terms of Accuracy

for animation creators and producers in growing content that resonates with their supposed target audience, making the dataset an important tool for enhancing the excellent and connection of tv and animation content.

4.2. Evaluation Criteria. The proposed model's effectiveness in demonstrated in terms of accuracy is illustrated throughout different target groups, ranging from Preschoolers to Animation creators. Figure 4.1 shows a nuanced sample of efficacy degrees, with Junior high school students experiencing the highest score at 90.12%. This shows that the model's special effects are specifically resonant and effective for this age association, possibly aligning nicely with their cognitive and perceptual development ranges. Preschoolers and Bao moms and dads with(85.68% and 88.32%), indicating that the effects are well- received and accurately perceived by means of these groups. still, the low grades of elementary schools show slightly reduced efficacy, inferring at a capacity mismatch between the results produced and the preferences or understanding of these younger audience. This variation in accuracy underscores the models capability to cater to different age groups and highlights areas wherein further customization or refinement may want to enhance target request engagement and satisfaction.

The processing time figure 4.2 for the proposed model showcases its performance across different target groups. A clean downward trend in processing time is observed, beginning from 30 hours for Preschoolers to 20 hours for Animation developers. This lowering sample indicates that the model is specifically effective for expert users like Animation creators, in all liability due to their lower requirements or the models optimization for professional content material. The extensively advanced processing times for younger age groups, like Preschoolers and lower grades of elementary school, might reflect the complexity or the additional effort required to create engaging and age-appropriate content for these viewers. The gradual reduction in processing time as we move toward older age groups and professionals may also be attributed to the model's capability to adapt to the varying complexity of the tasks. This efficacy highlights the model's scalability and severity in processing times, feeding to a large spectrum of users from chidren to professionals in the animation industry.

The proposed model demonstrates its efficacy in terms of resource utilization across different target groups. Figure 4.3 suggests a shifting pattern, with Junior high school students and Bao moms and dads experiencing lower resource utilization (68.89% and 66.74%respectively), which could represent the models effectiveness in developing results for these groups without overreaching computational sources. In comparison, Preschoolers and the lower grades of elementary school exhibit slightly higher resource usage, potentially due to the complexity of making content this is engaging but suitable for younger viewers. The variation in resource operation displays the model's strictness and its capability to balance useful resource demands with the conditions of different age groups. This thing is vital for making sure that the interpretation can be effectively used in numerous product settings, catering to a wide range of audience preferences while maintaining computational efficiency.

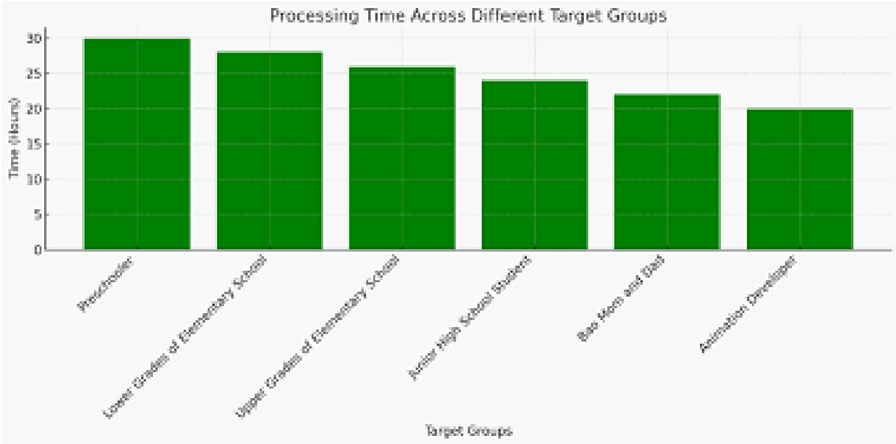

Fig. 4.2: Processing Time

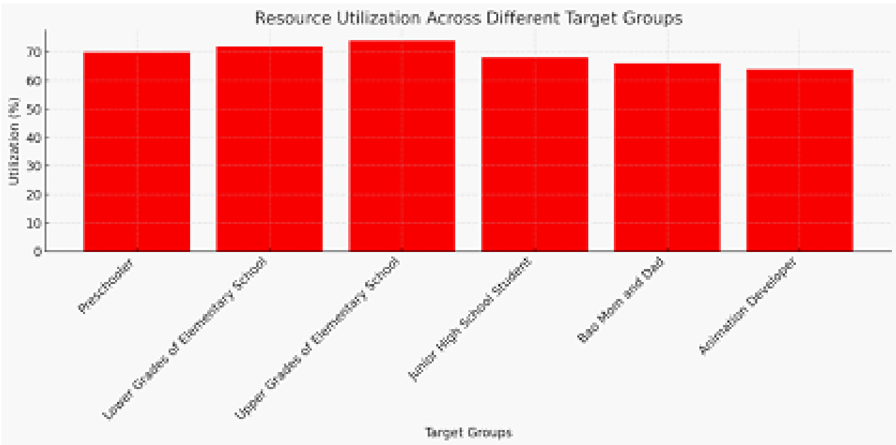

Fig. 4.3: Resource Utilization

The visible quality Figure 4.4 reveals the proposed model's capability to supply outstanding special effects, as perceived by means of special target groups. An ascending trend in visual quality ratings is observed, with the highest score of 90.38% for animation developers, indicating their high pleasure with the visible appeal and class of the effects. This trend would possibly image the growing complication and discerning tastes of aged viewers and professionals, who in all liability have advanced prospects for visual satisfactory. The models eventuality to deliver visual quality rankings across all associations, mainly excelling with animation developers, underscores its effectiveness in creating visually appealing and impactful content. This is important in the realm of television and animation, where the visible attraction and inventive high- quality of special effects play an important position in audience engagement and the overall success of the content.

5. Conclusion. The study underscores the effectiveness of the proposed 3D combined with mixing precision integration in enhancing special effects for television throughout various demographics. The model demonstrates a high degree of accuracy in special effects, especially resonating with Junior high school students, at the same time as also attractive efficaciously to younger audience and experts like Animation developers. Its performance is clear within the reducing processing cases, indicating the model's eventuality to address complex tasks suddenly, an essential feature in fast paced production environment. The shifting pattern in resource operation

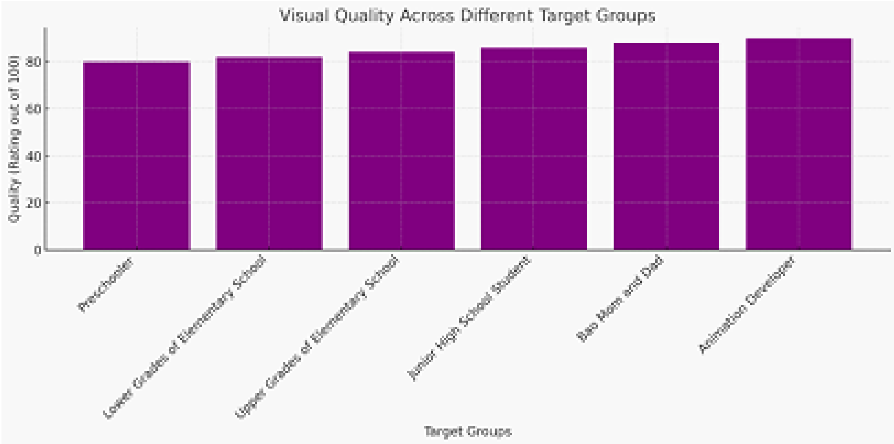

Fig. 4.4: Visual Quality

throughout distinct age groups highlights the model's severity in managing computational means, making it applicable for numerous product settings. likewise, the continuously high scores in visible quality throughout all demographics attest to the model's capability to produce visually fascinating and impactful special effects. This is particularly noteworthy with professional users, who regularly have better contemplations in expressions of visible complication. Overall, the study concludes that the proposed interpretation is a strong tool within the realm of television and animation, offering scalable, efficient, and visually striking results that feed to a wide range of audience, from children to industry experts. This makes it a treasured asset in enhancing the high- quality and enchantment of TV content in an increasingly more competitive and various media outlook.

Acknowledgements. Jilin Provincial High tech Fair Project, ""Case Study on Brand Design and Opening in Nong'an County from the Perspective of Rural Revitalization"" JGJX2023D659"

REFERENCES

[1] Y. Bao, *Application of virtual reality technology in film and television animation based on artificial intelligence background*, Scientific Programming, 2022 (2022), pp. 1–8.
[2] L. Cui, Z. Zhang, J. Wang, Z. Meng, et al., *Film effect optimization by deep learning and virtual reality technology in new media environment*, Computational Intelligence and Neuroscience, 2022 (2022).
[3] C. Du, C. Yu, T. Wang, and F. Zhang, *Impact of virtual imaging technology on film and television production education of college students based on deep learning and internet of things*, Frontiers in Psychology, 12 (2022), p. 766634.
[4] J. Fang and X. Gong, *Application of visual communication in digital animation advertising design using convolutional neural networks and big data*, PeerJ Computer Science, 9 (2023), p. e1383.
[5] H. Gong, *Text mining of movie animation user comments and video artwork recommendation based on machine learning*, Security and Communication Networks, 2022 (2022).
[6] X. Guan, K. Wang, et al., *Visual communication design using machine vision and digital media communication technology*, Wireless Communications and Mobile Computing, 2022 (2022).
[7] D. Liu, Y. Li, J. Lin, H. Li, and F. Wu, *Deep learning-based video coding: A review and a case study*, ACM Computing Surveys (CSUR), 53 (2020), pp. 1–35.
[8] X. Liu et al., *Animation special effects production method and art color research based on visual communication design*, Scientific Programming, 2022 (2022).
[9] Z. Lu et al., *Digital image art style transfer algorithm and simulation based on deep learning model*, Scientific Programming, 2022 (2022).
[10] K. Makanyadevi et al., *Efficient healthcare assisting cloud storage strategy using fog prioritization logic based on edge devices*, Turkish Journal of Computer and Mathematics Education (TURCOMAT), 12 (2021), pp. 1059–1066.
[11] S. Nandakumar, M. Le Gallo, C. Piveteau, V. Joshi, G. Mariani, I. Boybat, G. Karunaratne, R. Khaddam-Aljameh, U. Egger, A. Petropoulos, et al., *Mixed-precision deep learning based on computational memory*, Frontiers in neuroscience, 14 (2020), p. 406.
[12] L. Ni, *Application of motion tracking technology in movies, television production and photography using big data*, Soft Computing, 27 (2023), pp. 12787–12806.

[13] H. Polat and H. Danaei Mehr, *Classification of pulmonary ct images by using hybrid 3d-deep convolutional neural network architecture*, Applied Sciences, 9 (2019), p. 940.
[14] V. S. Reddy, M. Kathiravan, and V. L. Reddy, *Revolutionizing animation: unleashing the power of artificial intelligence for cutting-edge visual effects in films*, Soft Computing, 28 (2024), pp. 749–763.
[15] F. Shan and Y. Wang, *Animation design based on 3d visual communication technology*, Scientific Programming, 2022 (2022), pp. 1–11.
[16] V. SivaKrishna Reddy, M. Kathiravan, and V. Lokeswara Reddy, *Novel visual effects in computer vision of animation film based on artificial intelligence*, in International Conference on Information, Communication and Computing Technology, Springer, 2023, pp. 993–1007.
[17] M. Subramanian, N. P. Lv, and S. VE, *Hyperparameter optimization for transfer learning of vgg16 for disease identification in corn leaves using bayesian optimization*, Big Data, 10 (2022), pp. 215–229.
[18] J. Tan and Y. Tian, *Fuzzy retrieval algorithm for film and television animation resource database based on deep neural network*, Journal of Radiation Research and Applied Sciences, 16 (2023), p. 100675.
[19] Y. Tong, W. Cao, Q. Sun, and D. Chen, *The use of deep learning and vr technology in film and television production from the perspective of audience psychology*, Frontiers in Psychology, 12 (2021), p. 634993.
[20] S. VE, C. Shin, and Y. Cho, *Efficient energy consumption prediction model for a data analytic-enabled industry building in a smart city*, Building Research & Information, 49 (2021), pp. 127–143.
[21] R. Wang, *Computer-aided interaction of visual communication technology and art in new media scenes*, Computer-Aided Design and Applications, 19 (2021), pp. 75–84.
[22] Y. Wei et al., *Deep-learning-based motion capture technology in film and television animation production*, Security and Communication Networks, 2022 (2022).
[23] X. Xing, *Application of slow-motion images based on visual saliency algorithm in film and television advertising*, in 2022 International Conference on Edge Computing and Applications (ICECAA), IEEE, 2022, pp. 970–973.
[24] M. Zhang, X. Wang, V. Sathishkumar, and V. Sivakumar, *Machine learning techniques based on security management in smart cities using robots*, Work, 68 (2021), pp. 891–902.

Edited by: Sathishkumar V E
Special issue on: Deep Adaptive Robotic Vision and Machine Intelligence for Next-Generation Automation
Received: Feb 5, 2024
Accepted: Apr 4, 2024