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Three-Dimension Animation Character Design Based on Probability Genetic Algorithm

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***Abstract*—The Three-Dimension (3D) animation design typically rely on front and back information is critical component in many downstream image processing task such as activity recognition and motion tracking. However, there is currently a lack of automated approaches for generating anime character in the 2D design and 3D design is performed efficiently but computational high and many similarity characters. This paper, proposed Probability Genetic Algorithm (PGA) method is performed efficiently by using 3D animation is detecting the similarly of another animation character design. The PGA is automating a time-consuming process allowing rapid generation of diverse character designs and helps to explore a wider design specific parameter and constraints to be incorporated into the algorithm. Initial data acquire from the danbooru dataset and pre-processing using data augmentation for rotation, slipping to find the various direction of the animation character design. The proposed PGA method is evaluated using the danbooru data achieving a higher accuracy of 91.25% respectively. The existing techniques, Mask Region Convolutional Neural Network (RCNN) and Deep Neural Network (DNN) are evaluated the proposed method.**

Keywords—deep neural network, data augmentation, three-dimensional character design, mask region convolutional neural network and probability genetic algorithm.

I. Introduction

Three-Dimensional (3D) animation scene design plays a crucial role in digital entertainment, advertising and cartoon games, capturing widespread attention from audiences. [1]. These type of design interfaces present the user with the broadest selection graphics or animation to produce by varying a given input parameter values [2]. Automatically generating 3D faces design from real time input enhance the capabilities of digital content creation by extending the reach and impact of engaging digital experiences. Although the 2D to 3D animation character generation by using optimization approach to frame the professional 3D modelling software [3-4]. However, achieving high quality results remains challenging as recent implicit reconstruction methods, like optimization technique often rely solely on 2D image due to the lack of publicly available high quality 3D data [5]. Character design is crucial in graphics, focusing on constructing 3D animation scenes and scanning character using advanced tools. These manual processes are time-consuming and require the scanned character to maintain a fixed posture for an extended period [6-7].

The main contribution of the research is considered in below;

- pre-processing using data augmentation for rotation, slipping to find the various direction of the animation character design.
- The proposed Probability Genetic Algorithm (PGA) method is performed efficiently by using 3D animation is detect the similarly of another animation character design.
- The PGA is automating generated various character designs of animation and helps to explore a wider design specific parameter and constraints to be incorporated into the algorithm.

The paper is organized as follows: Section 2 evaluates literature review, summarizing 3D animation character design. Section 3 introduces proposed method utilized by PGA method, Section 4 discusses results and comparative analysis, while conclusion of this research is given in Section 5.

II. Literature Survey

Kangyeol Kim *et al.* [8] presented an Animation Celebheads was address to animation character action to capture in 3D animation model as the controllable image samplers was consider the large data. These was involved the 3D computer graphics software with implemented the annotation system efficiently to consider the high level quality to every direction in the animation image. However, animation image was limited data to efficiently analysis and different animation does not have same character so difficult to apply a standardized criterion before annotating an inaccurate to performed 3D animation.

Shuhong Chen *et al.* [9] implemented a DL based technique Mask Region Convolutional Neural Network (Mask R-CNN) for image feature space to matching the other animation region, position and size. These was performed efficiently and detect object in an animation, create pixel level masks for each instance of the object and create pixel level masks for each instance of the object. However, Mask R-CNN has slower inference computational and the requiring maximum effort to implement fine tune and deploy, complexity lead to difficulties to debugging the 3D animation character.

Hanzhou Wu *et al.* [10] developed a hinging data from the 3D animation that secret information into a cover object such as digital image for covert communication and information embedding tool and a data extraction as a Deep Neural Network (DNN). These was handle complex animation object that achieve high accuracy because ability to learn and represent intricate patterns and adapt to new patterns or change in underlying data distribution. However, DNN require large amount of labelled data then complexity of the parameter and overfitting occur due to training small data.

Ziwen Lan *et al.* [11] introduced a hierarchical multi-model attribute classification model for anime by using Graph Convolutional Network (GCNs) that use semantic feature of

3D animation character. These was capturing complex pattern and dependencies between nodes in a graph it learning process was efficiently and allows them to model data with irregular structures effectively. However, GCN has over smoothing where analysis the repeated animation character to design leads to degraded the performance and adjacency matrix was minimum spares because lead to high computation.

Shuqing Tan [12] presented a design style of 3D dimensional animation character integrates with traditional art and dynamic model of the character to established in the design of the joint motion trajectory simulated. These was virtual in 3D animation which improve the fineness of character image enriches colour to makes the character method produce better quality and use less energy. However, 3D virtual structure does not easy generated by one or more graphics and high level of popularity in animation image design was complex, high computational range of simulated 3D animation.

III. Proposed Method

In this section, PGA is performed efficiently in the 3D animation character design to detect similarities with other animation character design. Initial data is acquired from the danbooru dataset and pre-processing is performed using data augmentation. This significantly expands the dataset effective size by creating multiple variations of the original data through transformation like rotation, scaling and flipping.

A. Data Collection

The Danbooru dataset contain the 12,000, 2000 and 5000 image randomly involved from the data for training, test and validation by using optimization model. The select the labels from the danbooru dataset to use for the 3D animation character design and constructed the high-level feature.

B. Pre-processing

Data augmentation is vital in enhancing 3D animation particularly in the character des a crucial role to enhance the 3D animation particularly in the character designed where the availability of labelled data is limited or when the model capacity to generalize is critical. The data augmentation exponentially increases the effective size of the data by generating multiple variation of the original data through transformation such as rotation, scaling and flipping.

C. Genetic Algorithm for 3D Animation

In the process of generating animated character achieving a high-level character design involves determining the role of the GA in the phase, design an appropriate optimization strategy and gradually approaching the optimal solution through iterative refinement. The GA is widely popular search and optimization method for resolving learning approaches and various strategy like population, fitness function of initial population, Crossover, Mutation, evaluated fitness of recent generation and selection. Figure 1. Flowchart of the GA technique.

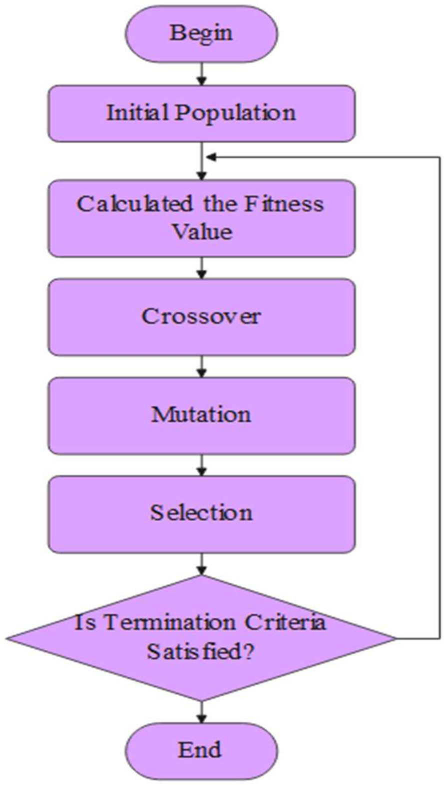

Fig. 1. Flowchart of the GA

1) Population: Each chromosome indicated the fixed number of the genes it seems like animation character design are similarity. The feature and behaviour are similarity of the other animation character that mention the population count of the other character design.

2) Fitness function of initial population: The chromosome function is represented by a non-negative integer indicating competence and individual ability of each chromosome. To evaluated fitness of every chromosome in animation design determine matrix of coordinate of same design that expressed in equation (1) below;

$$f(x) = \left(\sum_{i=2}^{n} \sqrt{(x_i - x_{i-1})^2 + (y_i - y_{i-1})^2}\right) + \sqrt{(x_1 - x_n)^2 + (y_1 - y_n)^2} \quad (1)$$

Where, there are consider the fitness values in the distance of the genetic to similarity of the animation character.

3) Crossover: The operator is responsible for mating process because it has been help to exchange data between couple chromosomes and cover convergence rate of GA. The probability it acts as 0.6 to 0.9 respectively. These values are called by crossover rate and represented the p_n. The parent and arbitrarily position between parent genes are consider in right side of the velocity and chromosome moved in the new chromosomes.

4) Mutation: The another operator is responsible for gathering recent data from other genetic. This operator affects one of resulted genes and overall probability of mutation on a chromosome is known as mutation rate indicated by p_m and pair of chromosome are arbitrarily displaced.

5) Calculation fitness of new generation: The fitness function is evaluated size of population for crossover and mutation operator, constant values is involved in the best and worst case in the optimization approach.

6) Selection: The selection involves choosing the best chromosomes to transfer next generation. Pairs of chromosomes are arbitrarily choose from population and assigned value of [0,1] respectively. Finally, choose genes are designated as next stage are proceeding to subsequent round of process.

7) Proposed probability genetic algorithm: The GA use a crossover probability, P_a and mutation probability, P_b, P_a and P_b both of which significantly impact the algorithm convergence rate. In traditional GA, P_a and P_a are fixed and does not change with iteration. However in improved the P_a and P_a vary according to dispersion of population fitness. This adjustment enhances population distribution and enhance convergence as expressed by equation (2) to (4) shown below,

$$g_{av} = \frac{1}{n}\sum_{i=1}^{n} g_i \quad (2)$$

$$\sigma = \sqrt{\frac{1}{n}}\left(\sum_{i=1}^{n}(g_i - g_{av})^2\right) \quad (3)$$

$$g_{lim} = \frac{1}{2}(g_{max} - g_{av}) \quad (4)$$

Where, g_{av} denoted the average fitness value of population and g_i denoted the fitness of ith individual in the population with n being the total number of individuals. The dispersion level of the population fitness is quantified by the standard deviation denoted as σ repsectivley. Additionally g_{lim} and g_{max} denoted the minimum and maximum fitness values in the population respectively. The enhance the crossover probability P_a and variation probability P_b are evaluated using equation (5) and (6) as shown below.

$$P_a = k_1 \frac{\sigma}{g_{lim}} \quad (5)$$

$$P_b = k_2 \frac{g_{lim}}{\sigma} \quad (6)$$

Where, k_1 and k_2 denoted the fitness factor consider the various value as needed to concentrated the population fitness. It values of population size is scattered and only crossover is generating individually. Therefore, crossover probability P_a should be reduce correspondingly values of fitness. The improvement significantly reduces algorithm running time accelerates convergence and help prevent algorithm from falling into local optimal solution.

IV. EXPERIMENTAL ANALYSIS

In the section, 3D animation design is proposed PGA techniques is performed efficiently to achieve high accuracy. The simulation environment used Python 3.2 on an Intel Core i7 system with 8GB RAM and Windows -10 is evaluate the PGA algorithm. The English teaching is evaluating proposed approach using different metric like accuracy, Structural Similarity (SSIM) f1 score, recall and precision for 3D character. The mathematically expression by equation (7) to (10) shown below;

$$Accuracy = \frac{(TP+TN)}{(TP+TN+FP+FN)} \quad (7)$$

$$Precision = \frac{TP}{(TP+FP)} \quad (8)$$

$$Recall = \frac{TP}{TP+FN} \quad (9)$$

$$F1-score = 2 * \frac{(Precision*Recall)}{Precision+Recall} \quad (10)$$

Where, $TP, TN, FP,$ and FN illustrate True Positive, False Positive, True Negative and False Negatives respectively.

A. Performance Analysis

In this section, the proposed PGA for 3D character design processes is evaluated using several performance metrics such as Accuracy, F1-score, Precision and Recall, which are presented in Tables 1. The 3D character design detecting process using the Danbooru dataset is represented in Tables 1, which describe the detection of 3D character.

TABLE I. PERFORMANCE ANALYSIS OF 3D CHARACTER DESIGN WITH DIFFERENT OPTIMIZATION

Method	Accuracy (%)	Precision (%)	Recall (%)	F1-Score (%)
PSO	87.19	86.03	85.72	87.13
BOA	88.75	87.96	86.29	88.42
GWO	89.19	88.09	87.19	89.39
FO	90.52	89.73	88.42	90.42
PGA	91.25	90.45	89.12	91.45

The performance of 3D character detection is evaluated based on accuracy, precision, F1-score, and recall on Danbooru dataset, as described in Table 2. The existing methods using feature selection techniques such as PSO, Bat Optimization Algorithm (BOA), Grey Wolf Optimizer (GWO) and TDO are evaluated. The PGA method achieves high accuracy of 91.25%, precision of 90.45%, recall of 89.12%, and F1-score of 91.45%. The detection technique Danbooru dataset achieves high accuracy, reaching 91.25%, respectively.

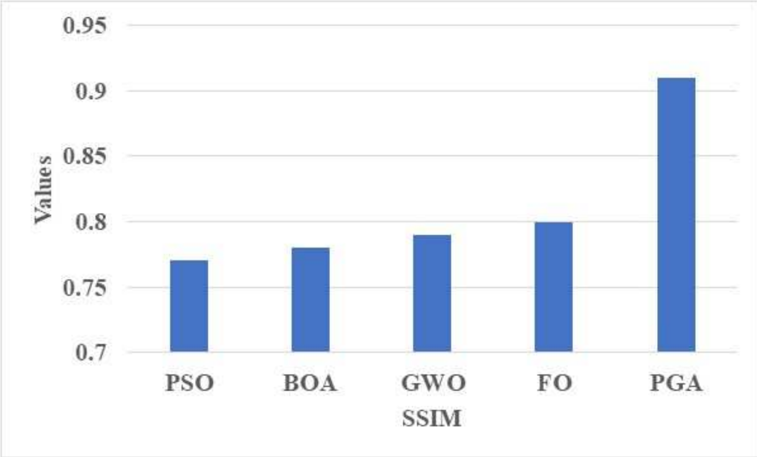

Fig. 2. performance analysis of SSIM for PGA

Figure 2. graphically represented the 3D character detection is evaluated based on accuracy, precision, F1-score, and recall on Danbooru dataset, as described in Table 2. The existing methods using feature selection techniques such as PSO, BOA, GWO and TDO are evaluated. The PGA method achieves high SSIM of 0.91 on danbooru dataset. The detection technique Danbooru dataset achieves high SSIM of 0.91 respectively.

B. Discussion

In this section, advantage of PGA method and limitation of state-art-of-method are discussed such as animation image [8] was limited data to efficiently analysis and different animation does not have same character so difficult to apply a standardized criterion before annotating an inaccurate to performed 3D animation. Mask R-CNN [9] has slower inference computational and the requiring maximum effort to implement fine tune and deploy, complexity lead to difficulties to debugging the 3D animation character. DNN [10] require large amount of labelled data then complexity of the parameter and overfitting occur due to training small data. GCN [11] has over smoothing where analysis the repeated animation character to design leads to degraded the performance and adjacency matrix was minimum spares because lead to high computation. The 3D virtual [12] structure does not easy generated by one or more graphics and high level of popularity in animation image design was complex, high computational range of simulated 3D animation.

V. CONCLUSION

This paper, proposed PGA method is performed efficiently by using 3D animation is detecting the similarly of another animation character design. The PGA is automating a time-consuming process allowing rapid generation of diverse character designs and helps to explore a wider design specific parameter and constraints to be incorporated into the algorithm. Initial data acquire from the danbooru dataset and pre-processing using data augmentation for rotation, slipping to find the various direction of the animation character design. The proposed PGA method is evaluated using the danbooru data achieving a higher accuracy of 91.25% respectively. The existing techniques such as RCNN and DNN are evaluated the proposed method. Future work will consider the hybrid method by using various application to enhance the accuracy.

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REFERENCES

[1] Marks, J., Andalman, B., Beardsley, P.A., Freeman, W., Gibson, S., Hodgins, J., Kang, T., Mirtich, B., Pfister, H., Ruml, W. and Ryall, K., 2023. Design galleries: A general approach to setting parameters for computer graphics and animation. In Seminal Graphics Papers: Pushing the Boundaries, Volume 2 (pp. 73-84).

[2] Tang, J., 2023. Graphic design of 3D animation scenes based on deep learning and information security technology. Journal of ICT Standardization, 11(3), pp.307-328.

[3] Guo, M., Xu, F., Wang, S., Wang, Z., Lu, M., Cui, X. and Ling, X., 2023. Synthesis, Style Editing, and Animation of 3D Cartoon Face. Tsinghua Science and Technology, 29(2), pp.506-516.

[4] Chen, S., Zhang, K., Shi, Y., Wang, H., Zhu, Y., Song, G., An, S., Kristjansson, J., Yang, X. and Zwicker, M., 2023. Panic-3d: Stylized single-view 3d reconstruction from portraits of anime characters. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 21068-21077).

[5] Giuliano, R., Mazzenga, F. and Vizzarri, A., 2020. Integration of broadcaster and telco access networks for real time/live events. IEEE Transactions on Broadcasting, 66(3), pp.667-675.

[6] Bonorden, M. and Papenbrock, J., 2022. Evidence-based optimization of classroom teaching units using 3D printers for designing models—from the 2D Picture to the 3D flower model. Education Sciences, 12(11), p.831.

[7] Singh, D. and Mohan, C.K., 2017. Graph formulation of video activities for abnormal activity recognition. Pattern Recognition, 65, pp.265-272.

[8] Bonorden, M. and Papenbrock, J., 2022. Evidence-based optimization of classroom teaching units using 3D printers for designing models—from the 2D Picture to the 3D flower model. Education Sciences, 12(11), p.831.

[9] Chen, S. and Zwicker, M., 2022. Transfer learning for pose estimation of illustrated characters. In Proceedings of the IEEE/CVF winter conference on applications of computer vision (pp. 793-802).

[10] Ramesh, G.P., 2020, September. Probabilistic Analysis of Dynamic Power and Area in Network on Chip. In IOP Conference Series: Materials Science and Engineering (Vol. 925, No. 1, p. 012066). IOP Publishing.

[11] Lan, Z., Maeda, K., Ogawa, T. and Haseyama, M., 2023. Hierarchical Multi-Label Attribute Classification With Graph Convolutional Networks on Anime Illustration. IEEE Access, 11, pp.35447-35456.

[12] Tan, S., 2022. Animation Image Art Design Mode Using 3D Modeling Technology. Wireless Communications and Mobile Computing, 2022(1), p.6577461.