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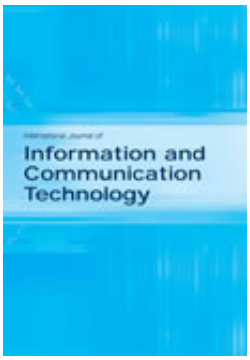

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Optimisation of digital media technology for film and television animation post-production considering motion capture technology

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Abstract: With the rapid development of computer technology, the post-production of film and animation (FATA) has undergone profound changes driven by digital media technology (DGMT). The introduction of 3D animation significantly enhances the three-dimensional sense and realism of FATA, making it increasingly close to reality. However, motions capture technology (MCT), as a difficult point in 3D animation, directly affects the final effect of film and television works. MCT improves the image quality of FATA by capturing real movements, including those of people, animals, etc., and is widely used in the field of virtual reality. Virtual animation has become an important application in FATA post-production, driving the development of MCT. This article first explores the specific application of DGMT in FATA post-production, then analyses the classification of MCT, and finally elaborates on the animation production process based on MCT, demonstrating its revolutionary potential in 3D animation technology.

Keywords: motions capture technology; MCT; FATA; post-production; digital media technology; DGMT.

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1 Introduction

Motion capture technology has many advantages in film and television animation production First, act naturally. Early 3D film and television animation production mainly depended on the frame by frame adjustment of animators, which would take a lot of time. Therefore, the traditional three-dimensional film and television animation is inefficient,

and the motion effect is not real (Wu, 2021). Through motion capture technology, engineers have changed the existing situation, which will create a variety of vivid animation characters based on motion capture technology, such as vivid animal images in 3D films avatar, Lord of the rings and King Kong (Niu, 2020). Through motion capture technology, 3D film and television animation will show the character's lifelike body movements and plump facial expressions, which is realised by capturing the movements and expressions in the real world. Second, shorten the production cycle of three-dimensional film and television animation (Pang et al., 2020). The traditional frame by frame adjustment method will consume a lot of time, which is an inevitable problem of traditional film and television 3D animation. Through motion capture technology, the adjustment time of traditional animation can be shortened to 1/6 of the original, which saves a lot of time and money. At the same time, a lot of time and energy saved can be put on artistic creation such as script and creativity of animation, which will further improve the content effectiveness of film and television animation creation (Sun, 2020). Therefore, for 3D film and television animation production team, motion capture technology has become an indispensable basic technology in contemporary film and television 3D film and television animation. Third, accumulate a large amount of motion data (Duan, 2020). Through motion capture data recording, the film and television animation production team can apply the data to any virtual character, which is not only used in a film and television creation (Su and Meng, 2019). By recording a large amount of motion data, the post-production team will have a huge motion database, which can search a variety of motion actions. By recombining and editing the data, the animator will create more motion data, which will meet the different needs of the director. Therefore, the 40 minute data obtained from ordinary motion capture can basically be used to make 8 MTV clips (Wang, 2019).

In the process of 3D FATA production, the motion design and adjustment of characters are actually equivalent to the performance of actors, which has become one of the bottlenecks restricting the development of 3D FATA. At present, motion capture technology has become one of the practical tools, which plays a wide role in motion analysis, motion optimisation and auxiliary referee in film and television sports. As a type of animation with strong visual impact and realistic effect, motion capture technology has attracted more and more attention, which has become an indispensable technology in 3D FATA (Cao and Shi, 2019). In post-production, dynamic effect technology can imitate the real scene, which will restore the objective elements in the scene. Therefore, dynamic effect addition technology can effectively increase the performance tension of the whole plot. Dynamic effect adding technology can create a free and romantic imagination space. These professional software help to stimulate the author's imagination and creativity, and help to constantly present excellent art film and television works in front of the audience. Therefore, dynamic effect production technology is one of the most common digital media technologies in film and television post-production (Zhu, 2019; Li and Liu, 2018; Tan and Yan, 2018).

By adding multiple light, shadow and scene effects, film works can add many scenes that cannot appear. Therefore, dialogue optimisation technology is a situational rendering technology integrating information technology and artistic concept, which can further improve the appeal of film and television plot (Li, 2018a, 2018b; Liu et al., 2018). Through nonlinear editing technology, we can reduce the error probability of traditional linear editing operation, which can further reduce the production cost. The lens still needs to re record the material, which will not only increase the relevant workload, but also

greatly increase the cost of film and television production. Motion capture technology is mainly used in animation and special effects, which can use dynamic capture to draw the habits of ancient creatures (Qin and Wang, 2020). By simulating the expressions and actions existing in life, people can more conveniently watch the actions and expressions of characters in film and television animation works, which are more real and vivid. Therefore, the research on FATA post-production considering motion capture technology is of great significance (Wang, 2020a).

2 Application of digital media technology

In addition to music and narration, dynamic effect addition technology runs through a variety of areas of film and television post-production, such as character action dubbing, simulating natural sound, manufacturing mechanical sound, etc. which makes the overall film and television works have a more vivid plot and viewing experience. Dynamic effect is a very important part of film and television post-production. All sound effects are included in the dynamic effect production, which requires the later personnel to deal with them in more detail in combination with the director's ideas. By designing different sound effects, film and television 3D film and television animation can bring an immersive experience to the audience, which will make the overall film and television lens coherent and orderly. Through the dynamic effect addition technology, the three-dimensional film and television animation can highlight the interest, which can make the film and television picture more vivid. In the dynamic effect production, the later stage personnel need to fully understand the plot and picture. Through the dynamic effect technology, the sound effects of various characters in film and television works can be effectively processed, which reflects the personality characteristics of film and television characters. Through dynamic elements, we can use integration and conception to improve the addition process of dynamic effects, which will fully integrate many elements such as viewing and hearing. Therefore, film and television works will form a film and television character image with unique sound quality. The sound effects of various sci-fi giants and the operation sounds of various machines common in film and television pictures can be perfectly displayed by using dynamic effect production technology. In post-production, dynamic effect technology can imitate the real scene, which will restore the objective elements in the scene. Therefore, dynamic effect addition technology can effectively increase the performance tension of the whole plot. Dynamic effect adding technology can create a free and romantic imagination space. These professional software help to stimulate the author's imagination and creativity, and help to constantly present excellent art film and television works in front of the audience. Therefore, dynamic effect production technology is one of the most common digital media technologies in film and television post-production (Zhang, 2020).

Dialogue production is an important content and key link of post-production film and television animation, which is a key element to further improve the emotional atmosphere and infectious ability of film and television animation products. Therefore, there is a big gap between dialogue optimisation technology and traditional recording, which does not have a profound discussion on sound aesthetics. Film and television post-effect technology can not only reduce production funds, but also shorten the time of post-creation. Therefore, dialogue optimisation technology can not only express the

expression needs of creators, but also further improve the infectious ability and sense of space of film and television works. By adding multiple light, shadow and scene effects, film works can add many scenes that cannot appear. Therefore, dialogue optimisation technology can integrate it and artistic rendering, which can increase the sense of space and distance of products, and improve new production technology and artistic concepts (Liu and Lu, 2020).

Nonlinear editing technology can randomly process different video elements. The editing technology of computer multimedia technology is very flexible, which can cut the length and position of the picture reasonably according to the needs of relevant staff of the branch. Therefore, in the process of editing, nonlinear editing technology can be more flexible. Through post-sorting, film and television animation can realise film output. By reasonably adjusting its order, film and television works can be more coherent, which will perfectly present the film and television effect. Nonlinear editing technology can flexibly adjust the duration and important nodes of different elements, which can realise the integration and splicing of different elements. Through the organic combination of video editing technology and audio editing technology, we can obtain the effect of combining sound and picture, which will further improve the overall quality of film and television works. By effectively expressing the story plot, we can use orderly cutting methods to repeat, flashback, flashback and so on (Hu, 2020). Editing machine mainly involves tape recorder and video player. Staff needs to use video player to summarise materials. The advanced editing machine can complete the production of a variety of special effects skills, which will realise the effective adjustment of animation, overlapping texture and subtitle introduction. Through nonlinear editing technology, we can reduce the error probability of traditional linear editing operation, which can further reduce the production cost. The lens still needs to re record the material, which will not only increase the relevant workload, but also greatly increase the cost of film and television production. Therefore, linear editing also has many inconveniences, which makes it difficult for editors to innovate their works effectively. Through nonlinear editing technology, film and television animation can expose the plot through the memories of the protagonist, which is more interactive and infectious (Chen et al., 2020).

A large number of dynamic capture can realise the simulation of expression, action and other elements, which will promote the continuous closeness between virtual animation and real life. In the production of film and television works, digital media technology can more accurately capture the movements and micro expression changes of film and television characters, which will capture the facial expressions of film and television characters. Through motion capture technology, film and television animation can have higher viewing value (Chen, 2020). Modern image capture technology improves the creative flexibility of film and television production, which can imitate people's Micro expressions and actions in reality and capture them dynamically. Through digital media technology, directors can capture dynamic elements, which can not only improve the efficiency of capture, but also make dynamic elements more real. With the maturity of image capture technology, people can make works more flexibly, which will achieve better virtualisation. Motion capture technology is mainly used in animation and special effects, which can use dynamic capture to draw the habits of ancient creatures (Fan, 2020). By simulating the expressions and actions existing in life, people can more conveniently watch the actions and expressions of characters in film and television animation works, which are more real and vivid. For example, in Jurassic Park, dinosaur movements are dynamically captured using human models. Through the optimisation and

synthesis of later digital media technology, film and television animation has formed a vivid dinosaur form. Multimedia technology can improve its picture texture and effect (Wang, 2020b).

At present, motion capture systems are mainly divided into mechanical, electromagnetic, acoustic, optical and video. Among them, the mechanical motion capture system captures the motion through the target personnel wearing specific clothes, which will sense in the bones, joints or key positions of the human body (Zhou, 2020). Mechanical motion capture is the earliest motion capture device, which is mainly used to capture body motion or static capture, as shown in Figure 1.

Figure 1 Mechanical motion capture device (see online version for colours)

Electromagnetic motion capture system mainly arranges electromagnetic fields in fixed areas. By wearing the receiving sensor, we can receive the sensing signal at the key parts of the human body (Dong et al., 2020). Through cable and data processing, the wearer can move in the electromagnetic field. The common electromagnetic motion capture system is represented by the products of Polhemus ascension, as shown in Figure 2.

3 Related algorithms of motion capture technology

3.1 Feature extraction

Based on Kinect's depth sensing technology, we can obtain the three-dimensional coordinate information of 20 key human nodes. By extracting the angle feature of node information, testers can collect and analyse the human posture information. In this paper,

a reference system is selected to number the key parts of the human body, as shown in Table 1.

Figure 2 Shows an electromagnetic motion capture device

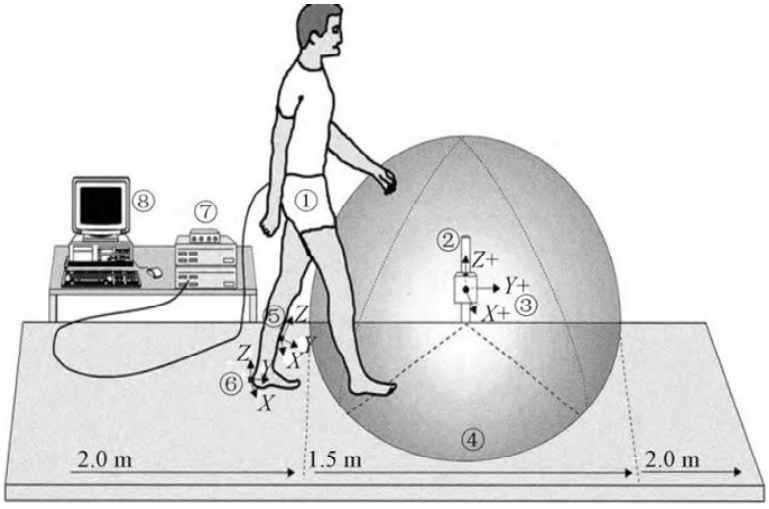


Table 1 Angular representation of major joints

Joint name	*Angle 1*	*Angle 2*	*Angle 3*
Left elbow	IJK	-	-
Right elbow	FEG	-	-
Left knee joint	QRS	-	-
Right knee joint	MNO	-	-
Left shoulder joint	IJX	JIY	IJZ
Right shoulder joint	EFX	EFY	EFZ
Left hip joint	QRX	QRY	QRZ
Right hip joint	MNX	MNY	MNZ

Through Kinect, this paper collects the movement state sequence of athletes, which will collect the movement state data at a fixed frame rate. Therefore, the motion speed of human key nodes can be calculated by using the time difference between two adjacent frames, as shown in formula (1).

$$S_{J,i} = d\left(P_{J,i}, P_{J,i-1}\right) \tag{1}$$

Among them, $P_{J,i}$ are the spatial coordinates of node j in frame i. $S_{J,i}$ is the instantaneous speed of node j in frame i. $d(P_{J,i}, P_{J,i-1})$ is the spatial geometric distance between two vectors. Therefore, this paper constructs $m \times n$ matrix network, as shown in formula (2).

$$D=\begin{bmatrix} d(U_1,V_1) & d(U_1,V_2) & \cdots & d(U_1,V_n) \\ d(U_2,V_1) & d(U_2,V_2) & \cdots & d(U_2,V_n) \\ \cdots & \cdots & \cdots & \cdots \\ d(U_m,V_1) & d(U_m,V_2) & \cdots & d(U_m,V_n) \end{bmatrix} \tag{2}$$

3.2 FATA video pre-processing

In the early stage of video collection of film and television works, there may be noise such as jitter and occlusion, which will lead to the fuzziness and incomplete data of the collected video images. Therefore, the early video of FATA will reduce the accuracy of later image processing, which will affect later image analysis and recognition. By effectively controlling video image interference, this paper can reduce the impact of noise on image data processing. At present, there are many image denoising methods in academia, such as mean filter, median filter, Gaussian and so on. The mean filtering calculation formula is shown in formula (3).

$$g(x,y)=\frac{1}{m\times m}\sum_{i=1}^{m}\sum_{j=1}^{m}f(x+i,y+j) \tag{3}$$

The calculation formula of Gaussian function is shown in formula (4).

$$f(x,y)=e^{-\frac{(x^2+y^2)}{2\sigma^2}} \tag{4}$$

The median filter is shown in formula (5).

$$g(x,y)=med\{f(x,y)\} \tag{5}$$

3.3 Moving object segmentation and detection

Moving object segmentation and extraction is an important topic in motion capture technology, which is the main way to find moving region. By extracting the area size, spatial coordinates, contour, motion speed and other information of the moving target, we can provide correct target source information, such as image analysis, image understanding, motion attitude recognition and so on. Moving object extraction has become an important branch of computer vision, which will be affected by background disturbance, illumination change, shadow occlusion, self occlusion and so on. At present, the commonly used moving target segmentation and extraction methods are optical flow method, background subtraction method, inter frame difference method, edge detection and so on (Li, 2020).

In motion capture technology, video pre-processing and moving target segmentation and extraction can be regarded as the early steps of motion capture. Among them, moving target detection is the core step of motion capture. Therefore, this paper divides human motion capture into model-based and model-free motion capture technologies. The general process of model-based motion capture is shown in Figure 3.

Figure 3 General flow of model-based motion capture

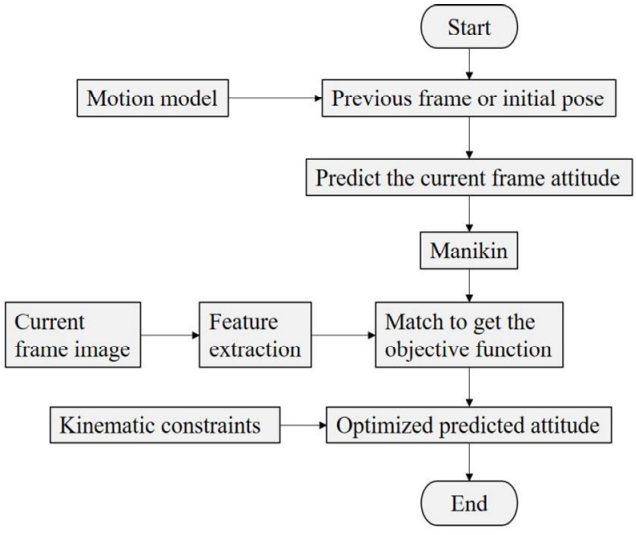
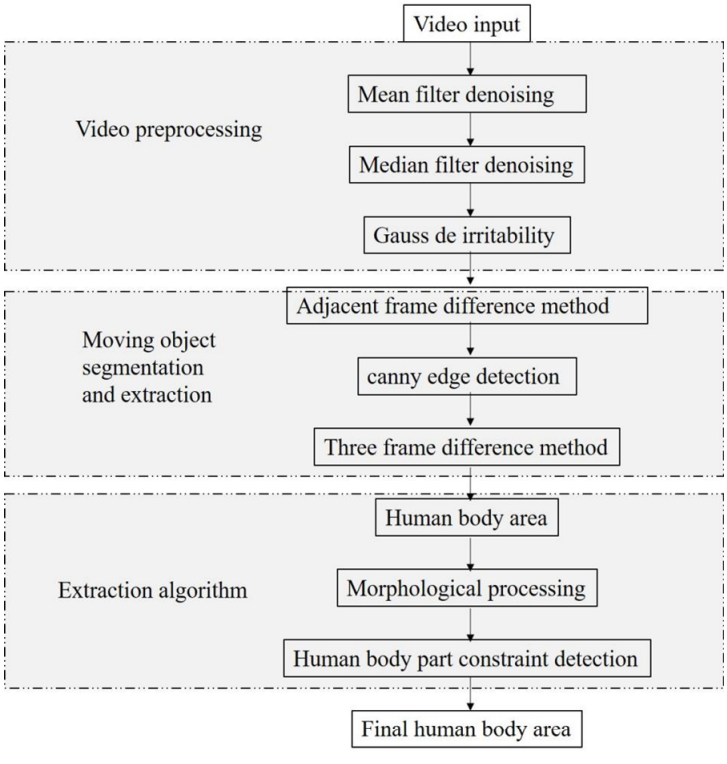


Figure 4 Moving human body extraction process



3.4 Moving human region frame extraction algorithm

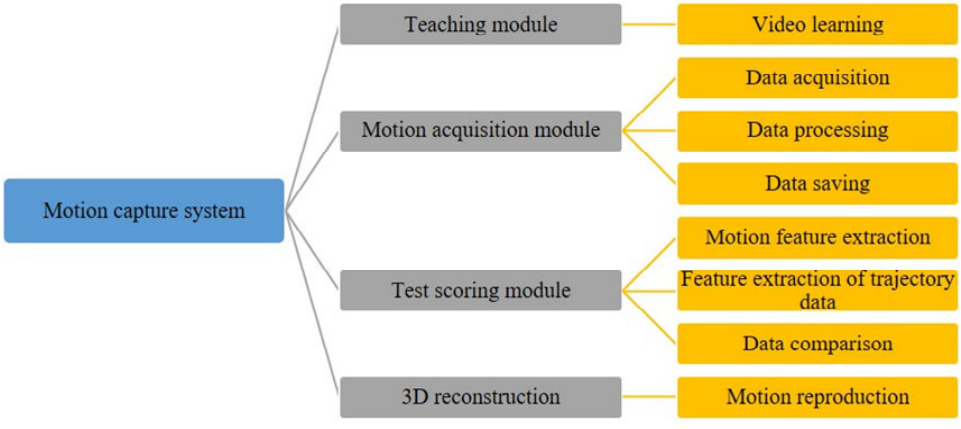
At present, the testing of human motion capture methods is based on public datasets, which requires direct analysis of dataset images as input sources. In the motion capture technology for animation production, the human body often does not occupy a large area, which needs a variety of complex image processing and model matching detection. When the number of frames is large, we can save a lot of time, which will omit redundant image blocks. By reducing the detection range of human parts, we can reduce the probability of positioning error, which will increase the accuracy of joint detection. The moving human body extraction process is shown in Figure 4.

4 Analysis and results

4.1 Design of motion capture system

According to the demand analysis of the system, this paper designs the framework of motion capture system, mainly including teaching module, motion acquisition module, test scoring module and three-dimensional reconstruction module, as shown in Figure 5.

Figure 5 Overall framework of motion capture system (see online version for colours)



At present, optical motion capture system is the most commonly used in FATA. In order to ensure the accuracy and effectiveness of the system, we will regard the human body as a simple model composed of 13 to 16 joint points, which can compare the joint point action to the actual action. Therefore, we need to fix a special reflective material on the corresponding joint point, which belongs to the marking point. When the reflective material is irradiated by an external light source, the material can reflect at multiple angles, which will reflect the RGB value of the light. Through multiple cameras, the staff can capture the sequence pictures of the cameras, which can reflect the specific motion of the marked points in each frame. Therefore, we can get the corresponding points, which will change the continuous trajectory over time. The model of motion capture system is shown in Figure 6.

Figure 6 Motion capture system model

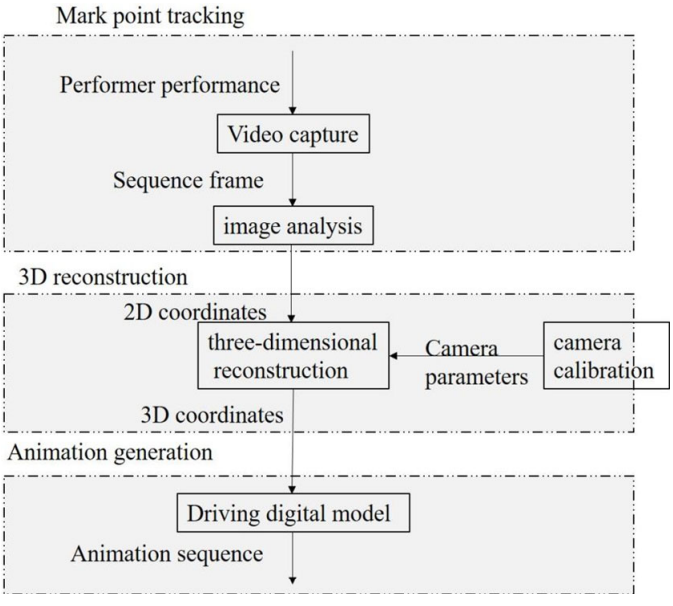
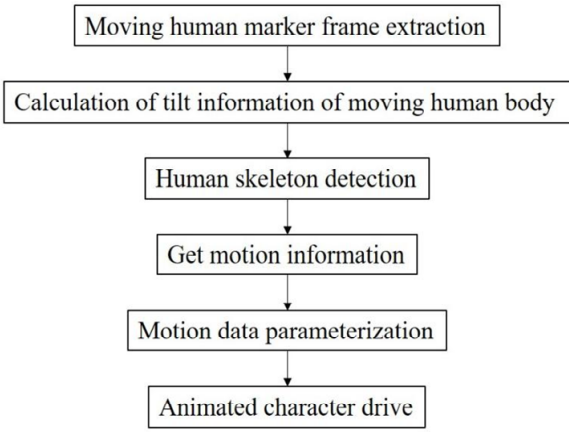


Figure 7 Algorithm flow of motion capture 3D FATA production



4.2 Video animation motion capture production solution

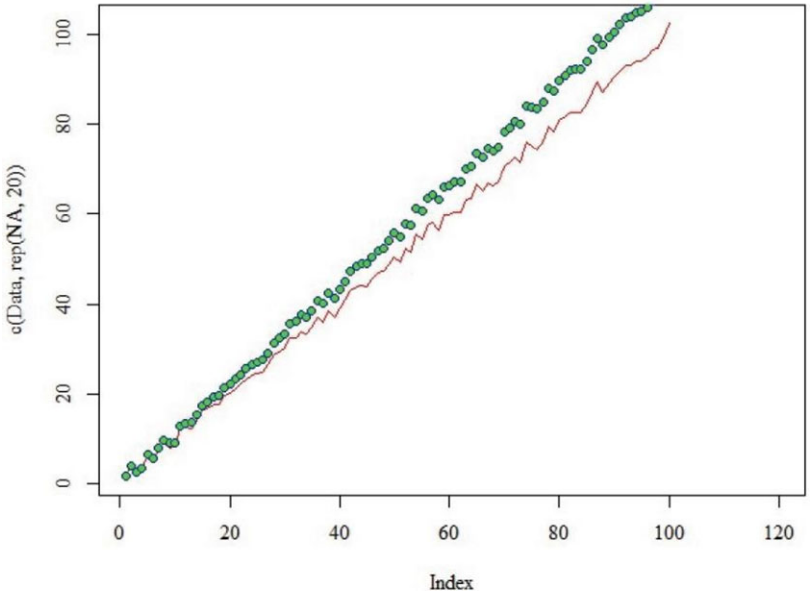
When motion capture technology is applied to 3D video animation generation software, there will be three main problems: the accuracy of motion capture technology, the problems of generation software, and the interface between motion capture data and generation software. There are also many problems in using motion capture to make 3D FATA. First, there are often errors in the extraction of moving human body. Second, although human posture is diverse, it is not universal. Third, most human motion capture methods have high estimation accuracy for trunk and head. Fourth, the detection accuracy

of limb parts is low. The algorithm flow of motion capture 3D FATA is shown in Figure 7.

5 Discussion

The results of the motion capture system demonstrate its ability to vividly describe real human motion. The skeleton model, combined with captured motion data, drives the three-dimensional human model, transforming real-world movements into virtual animations. The accuracy of the system, especially in capturing trunk and head movements, is commendable. However, limb detection accuracy remains a challenge that requires further improvement. The integration of motion capture technology into 3D FATA production software presents opportunities for rapid and efficient animation creation. The collaboration between animators, performers, and digital modelling software enables the production of recognised FATA works in a short time frame. The proposed models and algorithms, as shown in Figure 8, demonstrate the potential for simulating complex human actions.

Figure 8 Data simulation (see online version for colours)



Future research should focus on enhancing the accuracy of limb detection and improving the robustness of the motion capture system under various conditions. Additionally, exploring the integration of motion capture technology with other advanced digital media technologies, such as virtual reality and augmented reality, could further revolutionise the field of film and television animation.

6 Conclusions

Looking ahead, future research on motion capture technology in film and television animation post-production should indeed focus on enhancing the accuracy of limb detection. This is a crucial aspect that currently poses challenges, as mentioned in the reference material. Improving limb detection accuracy will significantly enhance the realism and immersion of 3D animations, making them even more convincing and engaging for audiences.

To achieve this, several strategies can be explored:

- Advanced algorithms: Develop and refine algorithms that can more accurately capture and track limb movements. This may involve incorporating machine learning and deep learning techniques to improve the recognition and analysis of limb postures and gestures.
- Improved hardware: Invest in the development of advanced motion capture hardware, such as higher-resolution cameras and more sensitive sensors, that can capture fine-grained movements of limbs with greater precision.
- Markerless motion capture: Explore markerless motion capture systems that do not rely on markers attached to the body. This can eliminate the need for calibration and setup time, as well as potential occlusion issues caused by markers, while potentially improving the overall accuracy of limb detection.
- Hybrid approaches: Combine marker-based and markerless systems to leverage the strengths of both approaches. Marker-based systems can provide initial tracking, while markerless systems can refine the results, particularly for limb movements that are difficult to capture accurately with markers alone.
- Data fusion: Integrate data from multiple sources, such as cameras, sensors, and other tracking devices, to obtain a more comprehensive and accurate understanding of limb movements. This can help compensate for errors and inaccuracies in individual data streams.
- Real-time feedback and adjustment: Implement real-time feedback mechanisms that allow for adjustments to be made during the motion capture process. This can help correct errors in limb detection as they occur, ensuring that the captured data is as accurate as possible.

By focusing on these key areas, future research can help to further advance the capabilities of motion capture technology in film and television animation post-production, ultimately leading to even more realistic and engaging 3D animations.

References

Cao, X. and Shi, J. (2019) 'Research on motion capture technology in FATA creation', *Research on Communication Power*, Vol. 3, No. 18, p.72.

Chen, Q. (2020) 'Research on the construction and implementation of practical teaching system of digital media specialty', *Theoretical Research and Practice of Innovation*, Vol. 3, No. 1, pp.107–108.

Chen, W., Wei, C., Huai, Y. and Chen, C. (2020) 'Integration and innovation of new media art and traditional culture', *Art Education*, Vol. 11, No. 4, pp.125–128.

Dong, M., Wang, M. and Li, J. (2020) 'Research on problems and countermeasures of regional higher film and television education', *Art Education*, Vol. 32, No. 9, pp.135–142.

Duan, J. (2020) 'On the application and influence of motion capture technology in films', *Journal of Puyang Vocational and Technical College*, Vol. 33, No. 6, pp.96–100.

Fan, J. (2020) 'Application of DGMT in animation design and production', *Satellite TV and Broadband Multimedia*, Vol. 7, No. 5, pp.204–205.

Hu, L. (2020) 'Reconstruction and coordination of FATA production process by DGMT', *Popular Literature and Art*, Vol. 9, No. 6, pp.159–160.

Li, S. (2018a) '3D data acquisition method based on dynamixyz face capture system', *Computer Knowledge and Technology*, Vol. 14, No. 23, pp.217–218.

Li, S. (2018b) 'Research on the application of performance based motion capture technology in film and television performance animation', *Television Technology*, Vol. 42, No. 10, pp.43–45 + 49.

Li, S. and Liu, X. (2018) '3D data processing based on Cara face capture system', *Science and Technology Innovation*, Vol. 24, No. 15, pp.71–72.

Li, X. (2020) 'Research on the application of DGMT in post production of FATA', *Media Forum*, Vol. 3, No. 21, pp.39–41.

Liu, B. (2018) 'Application of motion capture technology in FATA', *Television Technology*, Vol. 42, No. 10, pp.46–49.

Liu, Y. and Lu, Y. (2020) 'Research on the orientation of digital media art design specialty in higher vocational colleges', *Art Education Research*, Vol. 3, No. 3, pp.108–109.

Niu, J. (2020) 'Application analysis of motion capture technology in FATA production', *Theoretical Research and Practice of Innovation and Entrepreneurship*, Vol. 3, No. 5, pp.141–142.

Pang, X., Guo, J., Liu, D. and Gao, W. (2020) 'Application of motion capture system in interdisciplinary teaching', *Software Guide*, Vol. 19, No. 4, pp.263–267.

Qin, L. and Wang, P. (2020) 'Analysis on the relationship and application between FATA and digital media art', *Drama House*, Vol. 5, No. 5, pp.89–90.

Su, C. and Meng, X. (2019) 'Application of performance motion capture technology in film and television performance animation', *Nanfang Agricultural Machinery*, Vol. 50, No. 4, p.181.

Sun, J. (2020) 'Application analysis of multimedia technology in post effect editing', *Information and Computer (Theoretical Edition)*, Vol. 32, No. 16, pp.153–154.

Tan, J. and Yan, Y. (2018) 'Application of optical 3D motion capture in motion system related research', *Hainan Medicine*, Vol. 29, No. 14, pp.2029–2032.

Wang, B. (2020a) 'Application of DGMT in animation design', *International Public Relations*, Vol. 18, No. 1, p.234.

Wang, F. (2020b) 'Research on the impact of DGMT on animation design', *Digital Technology and Application*, Vol. 38, No. 6, pp.101–102.

Wang, Y. (2019) 'Research on motion capture technology in FATA creation', *Chinese and Foreign Entrepreneurs*, Vol. 6, No. 3, p.72.

Wu, C. (2021) 'Application of motion capture technology in model interactive control', *Electronic Technology and Software Engineering*, Vol. 27, No. 3, pp.144–145.

Zhang, X. (2020) 'Digital media art in FATA – a review of digital film and television short film creation (second edition)', *Chinese Journal of Education*, Vol. 55, No. 3, p.125.

Zhou, Z. (2020) 'Art and technology share the same origin and root, drive each other and constantly transform – Zhou Zongkai on digital media art', *Design*, Vol. 33, No. 12, pp.86–90.

Zhu, Y.Q. (2019) 'Development of motion capture technology in film and television creation', *China National Expo*, Vol. 10, No. 14, pp.233–235.