

**The factors that influence the visual quality by using image matting technology
in films and TV series and how these factors work in Chinese TV series**

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in partial fulfilment of the requirements for the degree of
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Abstract

This paper is intended to explore the use of image matting technology in film, focusing particularly on the Chinese film and TV industry. This paper concludes some factors that influence the visual quality of compositing scenes, which are the unification of the perspective and lens, the choice of green screen or blue screen, the unification of colour, the appearance of edges in the foreground subject and the unification of movement. Also, this paper points out the circumstance of Chinese film and television work and explains why image matting technology needs to be developed in China. Furthermore, two case studies are taken in this paper: “General and I” and “Nirvana in Fire”, to give people a bright idea about how to produce synthetic scenes that look like being shot together with only one lens during the process of making a film or television series based on those concluded factors. In addition, This paper seeks to provide readers of the importance of these factors in the visual quality of synthetic scenes and know how to use these factors properly. Finally, the paper will provide a discussion of possible future directions that image matting technology might take.

Keywords: Image matting technology, green or blue screen, colour correction, Shadow, Bayesian approach, High-speed photography, motion control system

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Chapter 1. Introduction

Nowadays, with the higher and higher living standards of people, they start to pay attention to spiritual food, such as watching films and TV series through various video sites online, which is one of the favourite ways for the public for leisure and entertainment. Due to the demand for films and TV play, directors are continually seeking advanced computer technologies to give viewers different visual sensations within a short time. As a technology that is often used in post-production of film and television works, image matting technology might bring directors much convenience by matting exciting parts from a whole image into a stunning background that does not exist in real life (Rhemann et al., 2009). In China, the use of image matting technology now is broader and broader; there have been a lot of TV series and films that have used this technology, especially those old costume TV series, such as “Ancient Love Song”, “The Journey of Flower” and so on. However, the application of image matting technology in some TV series and films are always unsatisfactory, especially “General and I”, which triggered many discussions online in China. People think that “General and I” was a terrible television series with a lot of fake scenes and they gave a low rating for this play. Because of this bad phenomenon, some inexperienced directors are finally aware of the importance of image matting technology that it can influence the visual quality of films and TV series.

Although there is a lot of literature on image matting, most of them are very scientifically focused and tend to analyse a single algorithm in many details, instead of providing a broad analysis of the entire technological area. In order to give these directors and even ordinary people who have interest in this technology a general idea about image matting technology, this paper will focus on extracting the essence to introduce what is image matting technology and conclude some factors that influence the use of this technology. After knowing these factors, some directors still do not know how these factors affect the quality of the compositing scenes and how to produce

realistic scenes instead of fake scenes by this technology, and what real scenes should be. Therefore, this paper will also take two case studies to analyse those synthetic scenes of them and make a comparison between them to make directors have a clear understanding.

The purpose of this paper is to give the reader an understanding of what is image matting technology and the factors that affect this technology, such as the unification of the perspective and lens, the choice of green screen or blue screen, the unification of colour, the appearance of edge in the foreground subject and the unification of movement. Meanwhile, it will also use case studies to make audiences realise why some synthetic scenes are fake and others are realistic and make people aware of how to avoid the lousy quality of compositing scenes with the use of image matting technology. This paper also aims, in general, to provide evidence about the importance of paying attention to these factors while using image matting technology to composite a scene in the production of TV series and films. Furthermore, it may give filmmakers some practical information about how to use image matting technology properly and contribute to the development of image matting technology in the production of films and television in China.

The following is what is going to be covered in this paper. This paper consists of four sections. The first part is the introduction of this subject, including the reason of why writing this paper and the purpose of this paper. The second part focus on image matting technology itself, containing the concept of image matting technology, the fields that this technology used in, and the factors that influence the visual quality of synthetic scenes. The third part sets out the case study part which takes two cases for comparison, and use the factors that concluded in Chapter 2 to analyse some typical synthetic scenes. Also, it will make people aware of how to avoid producing bad scenes by image matting technology and what real scenes should be. The fourth part is the conclusion part, which concludes what has been covered in this paper and identifies the possible limitations in

this paper, and gives some indication as to where future research regarding image matting technology that applied in films and TV series need to be addressed.

Chapter 2. Literature review

2.1 Introduction

This chapter will introduce image matting technology, as well as the concepts and fields of this technology. Also, this section will explain why this technology needs to be developed in China and conclude some factors that affect the visual quality of image matting technology.

2.2 Image matting technology

Image matting is one of the image processing technologies that used on digital images, which plays an important role in the production of films, TV series and advertisements. With image matting technology, filmmakers can add some visual effects to film and TV series, which brings much convenience to the post-production industry. Therefore, matting is widely used in film and TV industry, and more and more people are trying to understand it. The principle of this technology is to separate certain parts which are also called interesting foreground parts, from the background part of an image, and display the colour of each pixel from foreground objects exactly in the compositing image (Rhemann et al., 2009). In fact, Image matting technology can be represented by a mathematical formula (Porter and Duff, 1984):

$$I_i = \alpha_i F_i + (1-\alpha_i) B_i,$$

This is also called the synthesis equation which has more unknown values than known values. On the left side of this formula is I_i , which is the colour of the known pixel in the position of i within an input image. On the right are some unknown quantities, F_i is the colour of the foreground part while B_i is the colour of the background part of the pixel at position i (Levin and Weiss, 2008). For α_i , it represents the opacity of foreground part of the pixel with the position of i and usually takes the value between

0 and 1 as a mixed pixel (Yao, 2017). If α_i equals to 1, I_i represents a pixel with only foreground information (F_i). While if α_i equals to 0, it is the value of a pure pixel (B_i) that only has background information. When taking a colourful image as an example, which has Red, Green and Blue three channels, the number of the formula will be extended into three, and these three formulas will have seven unknown quantities in total, $\alpha_i, F(R)_i, F(G)_i, F(B)_i, B(R)_i, B(G)_i, B(B)_i$. It has many difficulties to sort unknown quantities out because they can have infinitely many results. Therefore, some use of image matting technology in film and TV series cannot reach great effects due to those difficulties.

2.3 The fields of image matting technology

With the development and progress of human society, people are surrounded by various kinds of information, like digital images. Also, due to the rapid development of computer technology and mathematics, image processing technology has got unprecedented progress. With these technologies, people can create a variety of colourful visual effects for promotion, entertainment and art. Image matting technology, a vital part of technologies that used in the processing of the digital image, is widely applied in many areas, like commercial television, advertisement design, medical treatment, game design and film production (Chen et al., 2004). Especially in film and TV industry, image matting technology plays an important role, and almost every film and TV series use this technology during the process of post-production. Post-production is the technical process for audio and visual effects of the production of a film and television, which is the final part of the whole production and has a significant status (Bourriaud and Herman, 2002). In post-production, image matting technology is usually used to mat exciting parts in a scene. With this technology, the director can shoot actors and actresses in the front of a green screen or blue screen and then mat them to insert into other scenes, which brings a lot convenience for film and TV production and can reduce production costs. Moreover, it can improve visual effect by adding new elements to the original scene, such as those prevalent films "Star Wars",

"Jurassic Park" and "The Adventures of Harry Potter" that all used image matting technology to have special visual effects.

2.4 Motivations for development of image matting in China

Currently, with the requirement of visual effects in film and television production, there have been some well-known visual effects companies and studios in the world, such as Weta Digital and Blue Sky Studios, which master the most advanced technology for special effects in the world ("9 Animation," 2016). In the system of Hollywood, the team of special effects join in the production of the film before finishing shooting the film, instead of after finishing all the shooting. Also, there is always a special effects coordinator in the team to take control of the whole production and communicates with the director about the visual effects he wants, however, this mature and active mode of operation is missing in China (Yien, 2016). The production for visual effects usually happens in the post-production, so there is little communication between director and visual coordinator about details of the production, which results in difficulties in quality assurance of synthetic scenes. Meanwhile, the scales of those Chinese visual effects companies are still small and medium, and those core scenes are generally produced by foreign companies. So, there is still a particular gap between Hollywood and Chinese special effects companies because the technologies for visual effects in most Chinese companies are still in growth stages and need more learning and progress, although there have been some tremendous visual companies and studios in China, such as Base FX and Industrial Light Magic (Zeng, 2015). Furthermore, sufficient time and funds are also required to achieve a certain degree of height in the area of visual effects. In fact, not all directors want to leave a lot of money and time for visual effects, especially in TV series. That is because a television play usually needs a long time to shoot and much money have been used to pay actors' salaries, which leads to insufficient time and money for post-production. So that, not each product can be done by excellent visual effects companies, and most of them need to be done by small post-production teams which might have immature technologies, such as image matting technology.

According to two bar charts below of the survey from entgroup.cn¹ in the November of 2016 about the factors that influence young audiences who are under 40 years old selecting and discarding a TV series, it is clear that having a favourite star is the primary consideration for young users to choose to a TV series to watch. While a television series has a mediocre plot is the core reason for why they give up carrying on watching this play. In this survey, the total number is 3000, and each respondent can choose multiple options. The chart on the left side is about the factors that influence young audiences to choose a TV series, where having favourite stars occupies 50%, having a good reputation and well-made occupy 46% and 44% respectively. While the chart on the right side is regarding the reasons for young audiences giving up to continue chasing this TV series, in which having the lousy plot accounts for 33%.

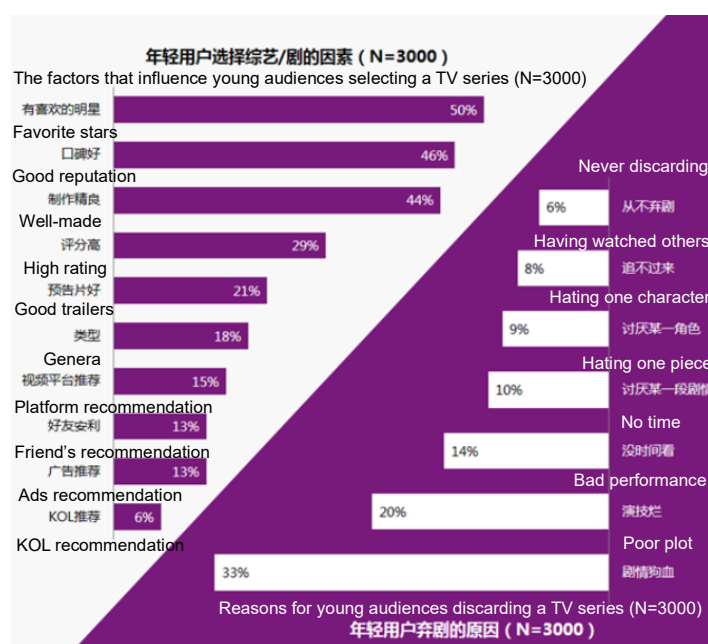


Figure1: The factors that influence young audiences selecting and discarding a TV series (Image from entgroup.cn¹)

Another bar graph is also from a survey of entgroup.cn on the 24 November of 2016, regarding the preference genera of TV series of young users. The most preferred type is ancient costume court, and more than half people want to see this kind of television

¹ <http://www.entgroup.cn/views/37955.shtml>

play. The following are urban, romantic, martial art and funny types, and each of them nearly occupies 40%. The remaining are suspense, fantasy, alert, history, military, rural and children types, where children style accounts for the least percentage.

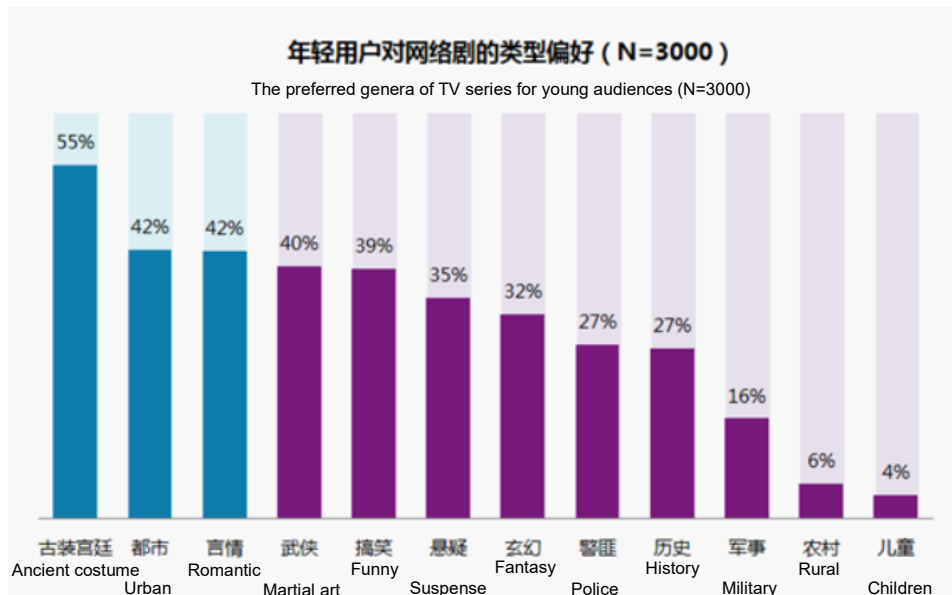


Figure2: The preferred genera of TV series for young audiences (Image from entgroup.cn¹)

From these data, it is clear to see that young person like watching old court drama most and having favourite stars are the critical factor for them to choose a TV series. So some directors prefer using some stars that have many fans to make sure that his television play will have enough people to see. However, some famous actors and actresses have a lot of commercial activities to attend, and they only have the limited time for the television crew, which leads them to be shot individually in front of the green or blue screen indoors instead of wasting time changing places. In the post-production, image matting technology will be used to mat main characters and then insert them into other scenes to stay together with other characters. Also, with old costume TV series, many buildings cannot be used as a scene for shooting a television efficiently or even do not exist in the real world. Therefore image matting technology is always used in this type of TV series to change the background of some scenes and add additional buildings to them. Due to the situation that most money has been used to pay for those actors and

actresses, there is not enough money left to ask those leading visual effects teams to do the part of matting images. Moreover, some directors do not show emphasis on post-production, and they consider that having audiences' favourite stars, as well as the excellent plot these two key points can make their television works succeed. However, they do not realise that some fake matting scenes cannot make audiences concentrate on the plot, which can influence the effect of the whole play. So it is necessary to make directors aware of image matting technology and know how to use this technology better in the production of TV series.

2.5 The factors that influence the quality of this technology

2.5.1 The unification of the perspective and lens

For a combined scene, there may be several material components, such as actors and buildings, so it is necessary to make sure that these matted elements can be put together in one scene without conflicts. To correctly match the final scene, the most critical part is to make perspective angles for different parts to be consistent (Liu, 2011). Perspective is a technique for displaying an accurate three-dimensional scenery of what people see with depth and space on a two-dimensional plane, which can create some effects due to different distances and angles, such as zoom out, colour change and blur (Boddy-Evans, 2018). For the order of shooting different parts, it is essential to separate the primary material which is the most important and characteristic part in the synthetic scene, and the secondary material in advance. The general sequence is to shoot the main part first and then the auxiliary part to make the central part as a reference for the secondary composition part so that all technical requirements can have a corresponding standard (Hao, 2002b).

After separating the primary and secondary parts, using the same perspective for them is quite vital to make them combine well in one scene and have a stronger sense of reality. In theory, making the same position and angle of cameras for shooting different materials can realise the same perspective. However, sometimes the same position

cannot be found, so it is compulsory to get similar results in other positions by calculating the matching distance and angle (Liu, 2011). When the camera for the main scene is in the position of camera1, the following method can be utilised to capture the high-definition matted scene to match the main scene.

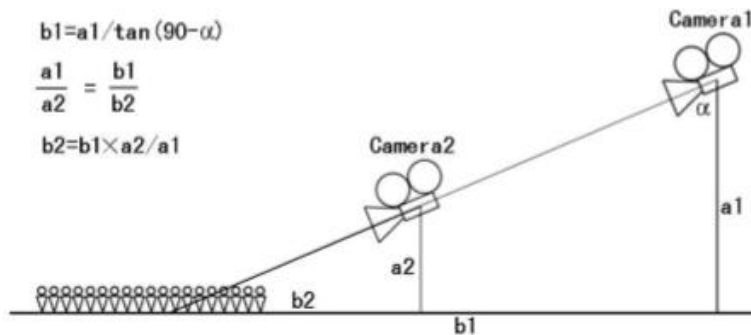


Figure3: The position for camera1 and camera2 (Image from Liu's article²)

According to Figure3, the tilt angle (α) for camera1 and the heights for camera1 ($a1$) and new camera2 ($a2$) are known, so the distance from actors to camera1 ($b1$) can be calculated by the formula: $b1 = a1 / \tan(90 - \alpha)$. So it is easy to sort out the distance to camera2 through this formula: $b2 = b1 \times a2 / a1$ (Liu, 2011). In this way, the position of camera2 for other scenes can be optional instead of finding the same position of camera1 for the main scene, which brings much convenience for shooting and can make the quality of compositing scene better.

After using the same perspective for shooting different parts, the coordination for clarity and blur also needs to be consistent, which will also affect the unification of the synthetic scene (Hao, 2002a). Using different lenses of cameras for shooting different compositing parts, such as long-focus lenses and wide-angle lenses, will make the depth of field and the viewers' feelings different, which might cause the final compositing scene to be unreal when combining them. Therefore, the director should choose the proper depth of field for cameras and adjust the degree of blur and clarity for each

² <http://www.airitilibrary.com/Publication/alDetailedMesh?docid=P20091014017-201102-201105300044-201105300044-26-32>

compositing object according to their positions in the synthetic scene, to achieve the natural depth of field in real life (Wang, 2015). The depth of field refers to the area that makes objects display openly in front of and behind the focal point, while scenery will be blur out of this area. The choice of aperture, focal length and focus distance of a camera all may influence the depth of field that broader aperture, longer focal length and closer distance will make the depth of field shallower (Hawkins, 2018). For example, when the director wants to shoot different compositing parts, one is for the actor, and the other is for the actress, and then image matting technology will need to be used to make them appear in the same scene to talk with each other face to face. At this time, if the camera lenses for these two parts are different, that is not the same the depth of field, a possible situation might happen that in the synthetic scene the actor is bright while the actress is vague. According to the audience's common sense, it is very fake because they should both be evident in this situation to look like being shot together. So it plays an essential role in the unification of the synthetic scene that making sure that the perspective and lens for different compositing parts are consistent.

2.5.2 The choice of green screen or blue screen

The shooting foreground was shot in front of a solid-coloured curtain to replace this into other backgrounds better. However, if the screen background has different shades of parts or stains, it will affect the quality of the final composite scene, so directors need to check this in advance and make sure that the green or blue screen has the same shade and is clean. For the single-coloured screen, the colour of this type of background is limited and approximately known, ordinarily blue or green, which is much more comfortable than the natural background screen to mat foreground subject to composite it in the aiming background (Yao, 2013). The process of matting foreground objects from the screen background involves three parts: the foreground part, the blue or green screen background, and the target background part (Foster, 2014). In the shooting process of films and TV series, the green or blue screen is usually used as the screen to distinguish the foreground and background instead of other colours because these two

colours belong to the three primary colours of RGB, which may bring some convenience to the process of matting. In general, the reason for why seldom using red screen which also belongs to RGB is that blue and green these two colours account for the least in the colour of humans' skin, especially for Asian people whose skin is warm tone. In this way, if the director uses the red screen for shooting, there will be some problems in the process of matting characters (Ma, 2015).

In general, choosing green or blue screen based on the colour of foreground project (Weigert, 2010). It is necessary to analyse the foreground object that needs to be shot before shooting, such as the colour of actors' custom. If the object has a large area of the same or similar colour as the green screen, the director can choose the blue screen to avoid matting the same colour inside the object in the latter stage, which will cause troubles in the process of matting in post-production.

Nowadays, green screen is prevalent in the shooting for films and TV series because of the sensitivity and processing of the green channel are higher than other two channels within RGB in digital cameras, where sensitivity influences the noise level while processing affects the resolution (Weigert, 2010). In most digital cameras, green channel has the highest luminance compared to other two digital channels: red channel and blue channel, so there is the least noise in the green channel that delivered by the sensor (Weigert, 2010). Also, with the sampling rate of the sensor as 4: 2: 2 in digital video cameras, there will be twice as much information as a red channel or blue channel, which makes the information in green channel is double the information in the red and blue channel (Foster, 2014). With the high definition of a green screen, it is widely used for video compositing use.

However, there are still some situations that need to use blue screen background instead of green screen. It is more challenging to do colour correction on green screen than blue screen because of the higher luminance of green screen, which results in the higher

reflection and bounce of light (Weigert, 2010). For example, if the foreground part is an actress with blond hair and then this character is matted by removing the green background, which will also remove the green spill of the hair, so the hair will turn to reddish (Foster, 2014). In this way, the filmmaker needs to do plenty of work to correct the foreground colour to match the target background. Therefore, in this situation, shooting with the blue screen background can make things easier and better. In order to mat subjects with blond hair, blue screen is more suitable than the green screen, and in the compositing for foreground and target background part, a blue screen can have more advantages when the scene is in the night with cool-coloured light (Foster, 2014).

2.5.3 The unification of colour

During the process of post-production in a film or TV series, some scenes need to change backgrounds and insert other elements by using image matting technology, so lighting is crucial to be appropriately used to combine different parts (Peers et al. 2007). So it is necessary to ensure that the conditions for lighting, such as the type of lighting: natural or artificial light, the angle and brightness of light, are the same in different parts of the compositing scene (Wang, 2015). Otherwise, the synthetic scene will be unrealistic. For instance, parts of the scene might appear to be lit by sunlight appearing to come from two or even more directions together, which is not in line with real life. Shooting with the solid-coloured screen is very common for matting interesting parts in the pre-production of films or TV series. Usually, giving suitable light to the foreground subject to match the light of the target background part is the first step and then using light in the blue or green screen. While giving light to the solid-coloured screen, it is significant to make the colour and lighting of the screen background be well-proportioned and make sure that the background has sufficient brightness and saturation. Meanwhile, there needs to be a contrast between the colour and brightness of the foreground and the background to make the process of matting easier. Otherwise, the difference of the brightness between these two parts cannot be too significant to avoid matting a too hard edge of the foreground (Hao, 2002).

When shooting in front of the solid-coloured screen indoors, it is also necessary to make the solid-coloured screen and the coverage area of lighting wide, especially for shooting moving objects (Hao, 2002). For example, when an actor needs to fly by using a hanging wire from the ground to the air, the lighting needs to cover this whole area to make sure that the actor flies in the same place not entering from the light area to the dark area. The difference of light conditions will be visible when combining the foreground part which is shot indoors with the target background in the natural sunlight together. Due to the high price of solid-coloured screen and lighting, the director can use the natural sunlight outside the door to save money, which has many advantages for shooting but need to be adequately used for placing the setup (Foster, 2014). Also, to reduce the influence of the reflection of green or blue screen background on the foreground subject which may make the colour of the foreground part strange, the director can make the foreground part a little bit farther from the background. If still having reflected light on the foreground part, the colour correction process can be used in the post-production.

After reaching the requirements of these two aspects, the compositing scene may still have some little problems on the unification of colour because the colour temperature of the foreground subject that filmed in front of the solid-coloured screen cannot always correctly match it of the target background (Foster, 2014). Therefore, the colour of these affected parts that are unbalanced or have problems with the exposure during the process of pre-production need to be corrected by using some colour adjustment software, to restore the original colour and achieve the unification of the colour in the post-production (Gao, 2011). In this way, the colour of the compositing scene will look comfortable. Otherwise, audiences will think that the scene is very fake in vision because these problematic parts destroy the spatial relationship of colour and would not reach foreground objects.

Also, as compositing the foreground subject to the target background, there needs to add some shadow to the foreground part to make the subject three dimensional not like a flat paper in the synthetic scene, which can make the whole scene more realistic (Williams, 1978). A shadow is the natural product of light, which occurs when there is a light source illuminates an object partially or entirely, and the depth of it is affected by the intensity of a light source (Al-Najdawi et al., 2012). For adding the shadow to the compositing scene, it should be based on those factors, such as the intensity and quality of the light source (Wang 30). Due to the importance of shadows which can provide significant visual cues for the corresponding position of the objects in a scene, a lot of work in computer graphics has appeared about how to create shadows in those interactive applications (Heidrich, 2000). The shadow algorithms have several categories, including shadow maps which is a method based on sampling the area light (Williams, 1978). In Heidrich's paper, he proposed an algorithm for shadow algorithm that based on shadow maps, which can be applied in post-production by making an assumption that the light sources are linear and just a limit number of samples is needed to create a soft shadow (Heidrich, 2000). In some areas lights can be considered as linear light, this method can be used to make a soft shadow, while in other cases that use area lights, this method cannot make shadow well because the dark and bright area cannot be made the approximation that they are linear under the area light. A new soft shadow algorithm has been proposed by Heidrich that making area approximation for area light to get rid of the shortcomings of this algorithm (Ying and Dong, 2002). The soft shadow area can be achieved after the following steps (Ying and Dong, 2002):

Firstly, performing the two pre-processing steps: one is making an approximation of the samples that sequenced from P_0 to P_n on the same plane according to the edge of the area light. The other is considering these samples as point lights and storing this depth map one by one by looking from each point light. Secondly, a depth map algorithm that is mentioned in Heidrich's paper (Heidrich, 2000) can be used to obtain whether each pixel can be seen from light P_i , which is stored in a Boolean variable $V_p(P_i)$. Then,

using S_e to represent the area that is visible from each pixel while S_a is the variable for the bright area that under the whole area light. In this way, S_e/S_a can be considered as the intensity of shadow that if S_e/S_a equals to 0, it represents the total dark area, while 1 represents the bright area. Also, it uses $V_s(P_i)$ to represent the apparent value of each division. After calculating the hatched area by these steps, it can be understood clearly in the following hexagonal polygon example.

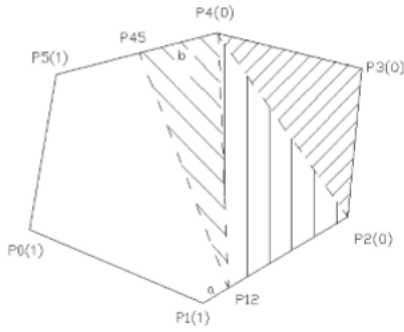


Figure4: The samples for area light³

In this example, there are eight samples in this polygon: $P_0(1)$, $P_1(1)$, P_{12} , $P_2(0)$, $P_3(0)$, $P_4(0)$, P_{45} and $P_5(1)$, where the digit inside the bracket is the value of $V_p(P_i)$. In this circumstance, 1 indicates light area while 0 represents shadow area respectively. Meanwhile, $V_s(P_1)$ equals to a while $V_s(P_4)$ equals to b which are both visible value in the segment. The following equation can be used to sort out the hatched area in the hexagonal polygon.

$$S_k = S(P_2P_3P_4) + S(P_{12}P_2P_4) + S(P_4P_{45}P_{12})$$

In this formula, the value of $S(P_{12}P_2P_4)$ can use $S(P_1P_2P_4) * (1 - a)$ to sort out while $S(P_4P_{45}P_{12})$ can be calculated by $b * (S(P_1P_4P_5) + (S(P_2P_4P_5) - S(P_1P_4P_5)) * a)$. Through this algorithm, the shadow of the foreground subject can be added in the synthetic scene correctly, which can make the scene look like shooting with one lens and realistic.

³ [https://domino.mpi-inf.mpg.de/intranet/ag4/ag4publ.nsf/0/DFE7C64654A5388AC12569DE0060A5C7/\\$file/RW.00_1.pdf](https://domino.mpi-inf.mpg.de/intranet/ag4/ag4publ.nsf/0/DFE7C64654A5388AC12569DE0060A5C7/$file/RW.00_1.pdf)

2.5.4 The appearance of edges in the foreground subject

In order to mat the entire foreground subject without missing image information from the green or blue screen background, it is necessary to pay attention to the quality of the edge part of the foreground section. Otherwise, the matted part will look patchy and lose the authenticity due to the hard edges. According to the equation that proposed by Porter and Duff in 1984, each pixel of an input image called I_i can be represented by the foreground F_i and background information B_i , and the opacity component called α_i :

$$I_i = \alpha_i F_i + (1 - \alpha_i) B_i,$$

It is clear that the number of unknown variables is greater than the number of equations, so it is necessary to find some additional constraints or use other information on the image to complete the estimation of the uncertain value. In general, most of the input image are known that belong to certain foreground part and background part, and the only small part that belongs to mixed edge section, like the contour of hair and fur, is unknown where the value of α_i should be only between 0 and 1 (Yao, 2017). It is a challenge to separate the part that contains foreground information from the background, like in the production of film and TV series, matting the foreground subject from the screen background to insert into a different background (Smith and Blinn, 1996). When the effect of matting matches the desired requirement, the resulting foreground can be synthesised with the target background according to the equation. In recent years, most of the matting technologies use an interactive mask which is also called Trimap to divide the input image into three areas: pure foreground area A_f , bright background area A_b , and unknown area A_u (Wang and Cohen, 2008). Using Trimap to determine the most know area is usually used as a pre-processing process before start matting the foreground part from the screen background, which might reduce the unknown area A_u and save the total time for matting objects. The ideal Trimap make the unknown area A_u contain mixed information because there are some remaining known pixels (pure foreground and background) still in A_u area (Yao, 2017). Therefore, if the Trimap can

be used to make the uncertain area smaller, this Trimap will be more accurate, and the effect of matting subjects will be better.

For all the methods that use Trimap as the pre-processing process before pure matting, the Bayesian approach that proposed by Chuang et al. is undoubtedly the most representative method among them and has reached a right balance between speed and effect of matting the foreground subject (Chen et al., 2004). Compared with previous methods that each pixel is processed one by one by using optically-differenced scanning sequence, this method takes the lead to use the result of the fixed points to estimate the current point that needs to be processed. Also, the process of it is to process the points that near the contour of the unknown area first, and then process other points of the unknown area that inside the contour, which is similar to the process of peeling onions layer by layer (Chuang et al., 2001).

This original Bayesian approach makes the estimation of α_i unstable and generates some impulse noise in the opacity channel, and although the noise can be filtered out by some simple filtering tools such as the median filter, at the same time the matte will lose some details (Sindeyev and Vezhnevets, 2007).

To solve this problem, Sindeyev and Vezhnevets proposed that smooth constraints can be added into the original Bayesian method. The smoothness is defined as one-dimensional Gaussian distribution model that called $L(\alpha)$, which takes α_0 as the centre that is the weighted average among processed pixels (α) and σ_α as the standard deviation (Sindeyev and Vezhnevets, 2007). The equation proposed by Sindeyev and Vezhnevets is as follows:

$$L(\alpha) = -\|\alpha - \alpha_0\|^2 / \sigma_\alpha^2$$

For the entire smoothing constraint, choosing a functional expression is crucial. This formula also defines σ_α , but just based on the influence of the distance in the colour space of the foreground and background cluster points on the estimated accuracy of α , which is indicated as (Lv and Zhan, 2010):

$$\sigma_{\alpha} = \sigma_{\alpha}^0 + \lambda \|\overline{F} - \overline{B}\|$$

It does not take the influence of the proportion of the cluster points in the total pixels on the estimated accuracy of α , which is not reasonable. In general, the higher the percentage of the number of the sample clusters in the number of total points in the foreground and the background area, the higher the credibility of the sampled cluster points. Meanwhile, the colour components and the value of α that are estimated through the cluster points will be more reliable (Lv and Zhan, 2010). Therefore, the proportion of the cluster points in the total pixels of the foreground and background part need to be taken into consideration when using the sampling cluster points to estimate the value of α . The equation is as follows (Lv and Zhan, 2010):

$$\sigma_{\alpha} = \sigma_{\alpha}^0 + \lambda \cdot \rho_F \cdot \rho_B \|\overline{F} - \overline{B}\|$$

Among them, ρ_F and ρ_B represent the proportion of the numbers of the sampling cluster points of the foreground and background part in the numbers of the total foreground and background points respectively. In this way, the details of the edge will be more visible, and the entire image will appear smoother, whose effect is significantly better than the original Bayesian algorithm. Here are the result pictures for the process of hair of the original Bayesian approach and the improved Bayesian approach:



Figure 5: The original image (Image from Lv and Zhan's journal article⁴)

⁴ <http://www.cqvip.com/qk/95200x/201003/32808852.html>

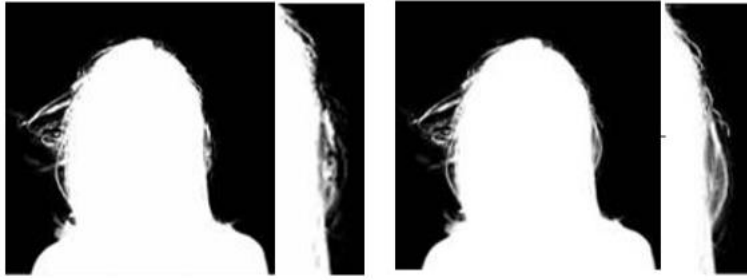


Figure 6: The results of the original and improved Bayesian approaches (Image from Lv and Zhan's journal article⁴)

It can be seen that there is some impulse noise in the Trimap of the original Bayesian algorithm, which is on the left side. The Trimap of the improved Bayesian approach on the right side shows the details of hair very detailed and the whole Trimap is smoother compared to the original result. Therefore, this improved Bayesian approach can be applied in matting the foreground subject from the background during the post-production of films and TV series.

2.5.5 The unification of movement

Movement is the life of a film and TV series, and it should appear in most shots which can better attract the attention of the audience and enhance the sense of rhythm (Li, 2005). The sense of movement and depth of the cinematic picture is the basis for distinguishing the film from visual arts, such as photography and painting. It is because that in the process of movement, the continuous spatial presentation brings a sense of depth to the three-dimensional space and gets rid of the fixed and rigid internal structure of two-dimensional picture (Gao, 2012). So movement should also be used in a synthetic scene to make this the whole film or TV series more dynamic, although it will increase the difficulty of matting the moving foreground subject from the original background. To composite the target background and the moving foreground part successfully, the director needs to be especially cautious on shooting this kind of moving subject because the fast movement will result in motion blur of the foreground, which will add many difficulties to mat it from the green or blue screen. Motion blur is

a moving effect of an object, which will make the object blurry and lose some information (Cho and Lee, 2009). The cause of why motion blur is created is that there is a relative motion that the speed of a moving subject is higher than the shutter speed between a scene and a camera or there is a camera shake during the moment of exposure (Cho and Lee, 2007). If the foreground object moves slowly, it can be photographed clearly without motion blur. However, reducing the speed of the object often has a conflict with the requirement of the director or the plot. For example, the director wants to shoot the foreground part that the two actors fight with each other in front of the solid-coloured screen background to insert this foreground into the target background where two armies fight each other fiercely. Then he asks the two actors to fight slowly to match efficiently; the synthetic scene will be in a mess because the slow movement of these two actors cannot match this intense fighting scene and will destroy the plot. Therefore, it is essential to find a way to solve the motion blur due to the fast movement.

High-speed photography can be used to match the fast foreground subject from the solid-coloured background screen by getting rid of the motion blur. It is defined as a method of shooting at a very high speed (frame rate) and during a short exposure time, which has a high superiority of getting detailed information about the fast moving process (Field, 1983). From this definition, it can be known that there are two elements included in high-speed photography: The first element refers to shooting at a very high frame rate and the second one refers to getting a clear picture by avoiding motion blur of the fast moving object. Therefore, to shoot the foreground subject with high speed without motion blur, the director can use the high-speed photography with a higher frame rate instead of the traditional photography.

Apart from that, the movement of the foreground object should be used appropriately, and it needs to match the movement of the target background when this background is moving or contains other moving elements to avoid the inconsistent synthetic scene (Foster, 2014). It is tough to composite multiple moving materials together to make

audiences think they are shot with the same lens, even if the director pay attention to them carefully, there will still have some defect. However, if the advanced equipment called motion control system is applied in this shooting process, these moving objects can be controlled well and combined naturally in the synthetic scene. In general, motion control system is an interactive system that can control the objects to move in the way that the director wants precisely by inputting the shooting path that recorded from other objects by this system, which also can help systematically master the entire performance (Sabanovic and Ohnishi, 2011). It is composed of a controller and an automatic system which can get the signals created by the controller and then convert the signal information to the motion information of an object (Brown and Clark, 1999). For this reason, using control system in shooting the moving foreground objects in front of the solid-colour screen background is very helpful not only because it can ensure the movement of compositing materials be consistent, but also it can indicate when they do not match together (Sabanovic and Ohnishi, 2011). After using high-speed photography and motion control system in matting the moving foreground subject and compositing this with the moving target background, the synthetic scene will follow the entire plot and give audiences a natural and real feeling.

2.6 Conclusion

This chapter mainly introduces image matting technology and concludes five factors that influence the visual quality of a compositing scene. The first factor is the unification of the perspective and lens, which will result in inconsistent sizes and different degrees of the clarity for those parts in a compositing scene if this factor is not taken into consideration. The second factor is the choice of green or blue screen, which means choosing proper solid-coloured screen background in advance and then avoiding the similar colour appearing in the foreground subject. The third factor is the unification of colour, which contains several parts that need attention, including the unification of lighting, colour correction and the generation of shadows that may make the matted foreground part three dimensional. The fourth one is about the processing of edges of

the foreground object, which needs to use an advanced Bayesian algorithm to get a sharp edge. The unification of movement is the last factor that usually needs to be considered during the process of shooting instead of post-production. In general, these five factors all play significant roles in the production of a realistic scene that meets audiences' visual experience.

Chapter 3. Case studies

3.1 Introduction

According to the survey of entgroup.cn on the 24 November of 2016, ancient costume court is the most popular type among all the types of TV series, and the audiences of this genre of TV play show a trend of younger and younger in China (Yien 2016). Directors always take the preference of young people into consideration first to have plenty of people to watch their film and television works. The costume drama is an effective way to spread and inherit the Chinese classical culture and can make people perceive Chinese traditional culture to a certain degree by watching this kind of TV series, such as historical figures and events, traditional costumes and rituals, social systems and historical inheritance (Song and Zhang, 2015). Compared to boring and difficult-to-understand ancient books, the TV series makes people have more interest and a sense of closeness. However, due to the first factor for young audiences to decide whether watching this play or not is having their favourite stars, directors usually prefer using those stars who have many fans to make sure their TV series are in high demand. In this era of mass media, stars have unique appeal and influence and the joining of the stars means pushing the TV series to the climax of ratings (Gao and Guang, 2016). It is understandable to produce TV series that caters to the need of most people, but directors need to avoid using plenty of money as salaries for those famous stars and have not limited money for the post-production, in the end, to produce excellent TV series to transmit Chinese culture better. For the production of the costume dramas, there are a lot of nonexistent and imaginable sceneries and buildings, so directors need to use image matting technology to mat characters from a green or blue screen background to insert them into those target computer-generated backgrounds with some buildings and sceneries to composite new scenes. Therefore, it is essential to make directors aware of image matting technology and better know how to use it, and realise that a popular TV series and film not just depends on stars but also visual quality, which will affect audiences' final evaluation of it.

As the post-production is not yet mature in China, some filmmakers do not realise the importance of image matting technology and do not know which factors influence the result of using image matting technology. As is concluded in Chapter 2, there are five factors that influence the quality of the synthetic scene that used the image matting technology. They are the unification of blur and clarity, the choice of green screen or blue screen, the unification of colour, the process of the edge of the foreground subject and the unification of movement. It is necessary to show emphasis on these factors while matting the exciting foreground subject into the target background part in order to achieve a realistic compositing scene, not a fake scene. The following two cases both have the application of the image matting technology during the process of post-production to make some shots that cannot use one lens to shoot all required materials. Also, these two cases are used for comparison to let people be aware of why some compositing scenes are fake, and others are realistic, and what realistic scenes should be.

3.2 Works

3.2.1 General and I

“General and I” is a Chinese ancient costume television series that adapted from a novel called “A lonesome fragrance waiting to be appreciated”. It tells a love-ridden story between Chu Beijie, the invincible Kingdom of Jin dynasty, and Bai PingTing, the wise maid of Yan dynasty. There are many shots in this play are synthetic due to some reasons, such as the general reason that some background sceneries do not exist in real life and the unique reason that some actors and actresses just want to shoot all the shots that need them together in front of the solid-colored screen background instead of wasting time to change shooting places. To a certain degree, using image matting technology can add special effect to some scenes which cannot use the actual shooting to realise. However, if this technology is not used in a proper way that some factors are not taken into consideration while using this technology, those composite shots that are

synthesised from the background and foreground part will be very fake, which ultimately affects the visual experience that the entire play brings to audiences.

“General and I” is a typical example that uses image matting technology not in a good way because these five factors that mentioned before are not well valued in this play. The following part will do some analysis about which shots are done by using image matting technology, and why these shots do not use this technology properly in “General and I”. Actually, “General and I” has caused a lot of discussions on the Internet as well as in real life, many people have ridiculed that the quality of this TV series is poor and some scenes are very fake. The rating for this TV series is just 3.0 on Douban which is one of the most influential websites in China where people registered users can share opinions about film, books and TV series. Also, on IMDb which is known as Internet Movie Database in the world, is also not high. The reason for why taking this play as a case to do research is to make directors realise the importance of image matting technology in synthetic scenes and understand how to avoid making the same mistake like this one.

孤芳不自赏 (2017)



导演: 鞠觉亮
编剧: 张永琛 / 冀安
主演: 钟汉良 / 杨颖 / 甘婷婷 / 孙艺洲 / 元航 / 更多...
类型: 剧情 / 古装
制片国家/地区: 中国大陆
语言: 汉语普通话
首播: 2017-01-02(中国大陆)
集数: 62
单集片长: 45分钟
又名: 孤芳不自赏电视剧版 / General and I
IMDb链接: [tt6424812](https://www.imdb.com/title/tt6424812)



Figure 7: The rating for “General and I” in Douban⁵

⁵ <https://movie.douban.com/subject/26608228/>



Figure 8: The rating for “General and I” in IMDb⁶

The following will analyse the reasons for why those shots that used image matting technology are fake in this play based on five factors that have concluded in Chapter 2.

3.2.1.1 The unification of the perspective and lens

In order to composite the foreground part with the target background part without conflict, it is necessary to make sure that the perspectives of these materials are the same (Liu, 2011). While in Figure 9 and Figure 10 which are screenshots of “General and I”, the perspectives of them are not consistent. In Figure 9, Chu Beijie holds Bai Pingting in his arms, which should be a romantic and beautiful picture, but this two starring seems like standing on the grounds of different heights with those group performers in the back, and they are magnified compared to other group performers. Also, in Figure 10, Chu Beijie raises his hands to pick up the bowl in Bai Pingting’s hands, where they should look at each other, but in this shot, Chu Beijie’ eyes look in the other direction not the direction to Bai Pingting’s eyes. These two shots both not use perspective correctly and make the synthesised scenes not coordinated. To use perspective to combine compositing materials well, directors can shoot the primary part first, and then use this part as a reference to the second part (Hao, 2002b). To make

⁶ <https://www.imdb.com/title/tt6424812/>

finding the same perspective easier, directors can use the way in Figure 3 to calculate the matching distances for cameras instead of wasting much time finding the same position for those materials.



Figure 9: Scene from Episode 9 of “General and I” showing the inconsistent of the perspective⁷

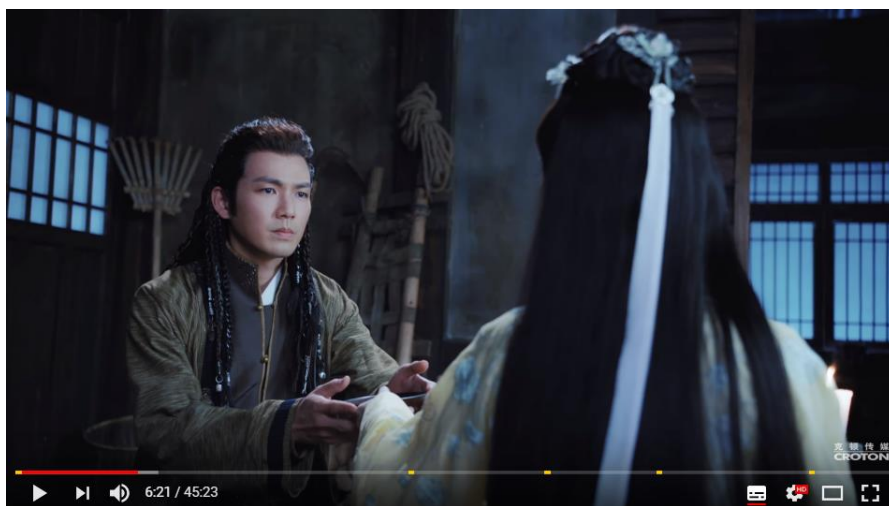


Figure 10: Scene from Episode 54 of “General and I” showing the inconsistent of the perspective⁸

⁷ <https://www.youtube.com/watch?v=d4zbaYaD4-4&t=2341s>

⁸ <https://www.youtube.com/watch?v=EFJ4KIOPayU&t=1121s>

In addition, it is also essential to choose the proper depth of field appropriately according to their positions in the compositing scene to make sure the synthetic scene looks natural and real. It is clear that Figure 11 and Figure 12 do not use the depth of field correctly and is different from what people think should be in real life. In Figure 11, Bai pingting is in the front and says something to Chu Beijie, where they should all be clear to make people observe the expression of both of them. However, Bai Pingting is sharp while Chu beijie is very blur, which make audiences guess whether their eyesight is very poor. The same problem happens in Figure 12, where Chu Beijie is sharp while Bai Pingting is blur. Because of the unreasonable use of depth of field, these shots are all very fake. To use the depth of field appropriately, directors need to assume where these materials need be in the synthetic scene to determine the degree of clarity and blur, and then choose the suitable depth of field for shooting them to have the required sharpness.

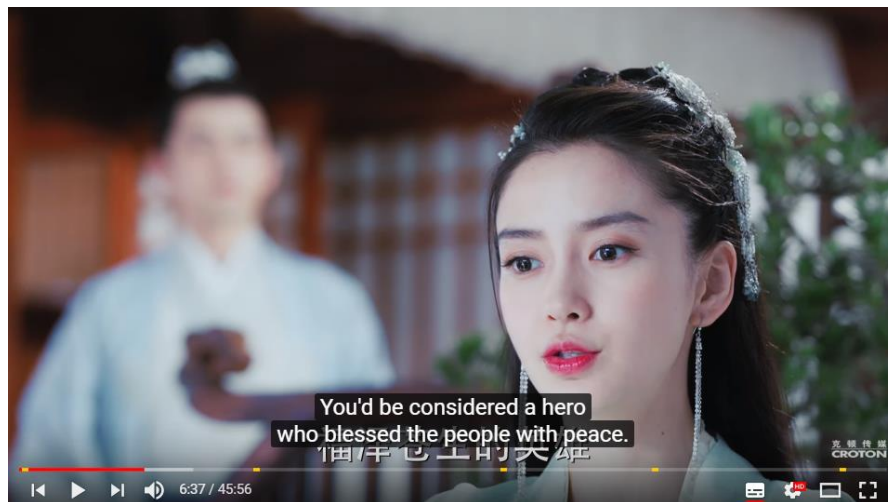


Figure 11: Scene from Episode 3 of “General and I” showing lack of unification of lens⁹

⁹ <https://www.youtube.com/watch?v=U5aqHxnfOBk&t=697s>



Figure 12: Scene from Episode 54 of “General and I” showing lack of unification of lens⁸

3.2.1.2 The choice of green or blue screen

In order to mat the foreground part smoothly and precisely, the colour for screen background needs to be chosen reasonably, mainly green or blue. In general, the choice needs to be based on the colour of the objects and clothing in the synthetic scene (Weigert, 2010). In the following three figures which are screenshots of the same scene, Bai Pingting stabs Chu Beijie with a knife and then accidentally falls to the ground. In this scene, Bai Pingting should wear the same clothing because these actions happen together within one minute. However, the colour of her clothing changes from lake blue to macaron blue, and then to white. The reason why the colour of Bai Pingting’s colour changes quickly is that this clothing has coincident colour with the screen background. To make sure the colour of the foreground is not affected by the background during the process of matting, it is essential to take what are unusable colours into consideration in advance, so that directors can reduce the appearance of this colour at the time of setting. As in this case, the colour of Bai Pingting’s clothing is blue, so directors need to use green screen background instead of blue one to avoid the distortion of the colour in the synthetic scene.

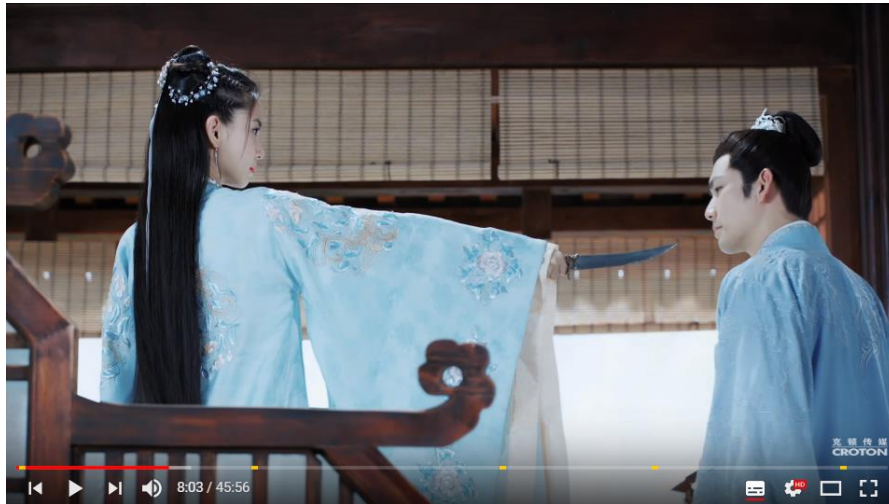


Figure 13: Scene from Episode 3 of “General and I” showing not according to the requirements of the solid-coloured screen⁹

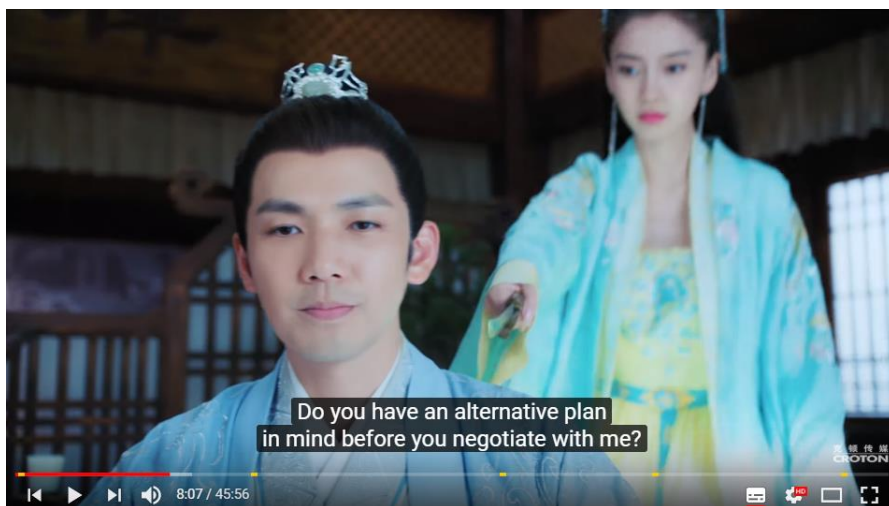


Figure 14: Scene from Episode 3 of “General and I” showing not according to the requirements of the solid-coloured screen⁹



Figure 15: Scene from Episode 3 of “General and I” showing not according to the requirements of the solid-coloured screen⁹

3.2.1.3 The unification of colour

For the purpose of achieving the unification of lighting, compositing materials should be in the same lighting conditions, such as natural or artificial light, the angle and brightness of light (Wang, 2015). In Figure 16, Bai Pingting and her brother stand by the river, and they look at each other, where their screen brightness should be the same, but the lights for them are different apparently. The light for Bai Pingting is very dark, which cannot suit the light for her brother, and the whole synthetic scene looks very inconsistent. The reason why they do not have the same brightness might be that Bai Pingting is photographed in the studio while her brother is taken a shoot under the sun outdoors. To avoid making the same mistake, directors need to make sure that the lights for all materials of the compositing scene should be in the same condition, in other words, if the primary material uses natural light, other elements should also use natural light or artificial light which has the same brightness and saturation.



Figure 16: Scene from Episode 5 of “General and I” showing lack of the unification of lighting¹⁰

Due to the difficulties in making the colour temperature of the foreground part exactly match that of the target background all the time, a colour correction needs to be used during the process of post-production to solve some unbalanced problems in the pre-production and restore the original colour of them (Gao, 2011). In Figure 17 and 18, Bai Pingting and her brother speak to each other face to face, where the backgrounds are entirely different. It can be seen that the background for Figure 17 is natural while it for Figure 18 seems like the green plastic. To fix this problem, directors need to do colour correction in the post-production by using some colour adjustment software. In this way, those parts that destroy the spatial relationship of colour can restore the original colours and look more real.

¹⁰ <https://www.youtube.com/watch?v=iO2y9UEvIOE&t=1812s>



Figure 17: Scene from Episode 6 of “General and I” showing the inconsistent of the colour¹¹



Figure 18: Scene from Episode 6 of “General and I” showing the inconsistent of the colour¹¹

In addition, the shadow is also an important part that needs to pay attention to, which will make matting materials look more three dimensional not like flat papers (Williams, 1978). In Figure 19, Chu Beijie and Bai Pingting stand on the roof at a particularly beautiful night, but they are lack of contrast with the background because there is no shadow with them, the whole scene loses a sense of reality. Also, in Figure 20, Bai

¹¹ <https://www.youtube.com/watch?v=J62sSij2VH0&t=2268s>

Pingting has a shackle on her head and will be beheaded soon, where she looks very flat and a little bit like a ghost due to missing shadows, which adds a sense of terror to the whole scene. From these two figures, it is clear that the shadow is very vital because the three-dimensional effect of the compositing scene will be destroyed by the loss of shadow and unshaded subjects will also seem like floating on the target background. The first thing needs to do is to consider the light source as a polygon and then calculate the shadow area based on the equation that mentioned before to create a shadow in the synthetic scene (Ying and Dong, 2002). In this way, the shadow can be added to the compositing scene and will make the scene looks more realistic and seems like shooting with one lens.



Figure 19: Scene from Episode 3 of “General and I” showing lack of shadow⁹



Figure 20: Scene from Episode 5 of “General and I” showing lack of shadow¹⁰

3.2.1.4 The appearance of edges in the foreground subject

In the post-production, the edge of the materials should take into consideration. Otherwise, the objects that are matted from the foreground will have a sense of patchwork and loses its authenticity. In Figure 22 and 23, the left edges of Bai Pingting's long hair both look like being cut off directly by a knife, with no trace of flashes and the line for her hair are not smooth. In Figure 21, the use of image matting technology for hair is more apparent that the edge of Bai Pingting's hair is jagged and there is no flying hair in the air. Not only the edge of the hair is not processed well, but also the edge of other parts, such as in Figure 24, the process for the edge of a hand is very roughly, which makes audiences shocked. It can be seen clearly from Figure 25 that the hand of the man with red clothing should be round and plump, while in Figure 24, the hand of the same man is sharp and thin, which looks like a chicken claw. The cause of this lousy matting is that these edges, such as hair and fur, belong to the known area so that these parts cannot be identified efficiently and correctly. To make the edge of the foreground part be matted correctly, directors can use the improved Bayesian algorithm that proposed by Lv and Zhan to address it. The critical point of this algorithm is that it adds smooth constraints that proposed by Sindeyec and Vezhnevets to the original Bayesian method, which reduces some impulse noise in the opacity channel without loss some details of the edge. So this advanced Bayesian approach should be taken into consideration while matting the foreground subject from the solid-coloured screen background, to show the details of each edge correctly and add more reality to the synthetic scenes finally.



Figure 21: Scene from Episode 5 of “General and I” showing lack of the sharp edge¹⁰

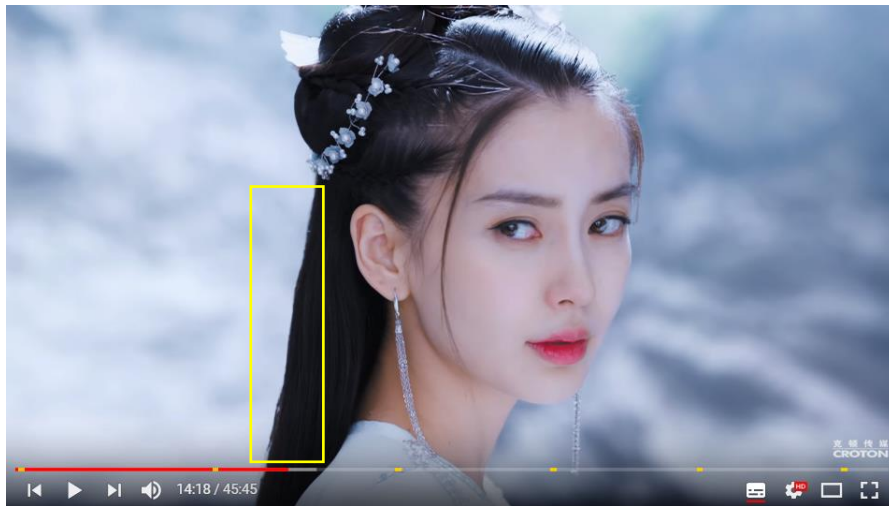


Figure 22: Scene from Episode 8 of “General and I” showing lack of the sharp edge¹²

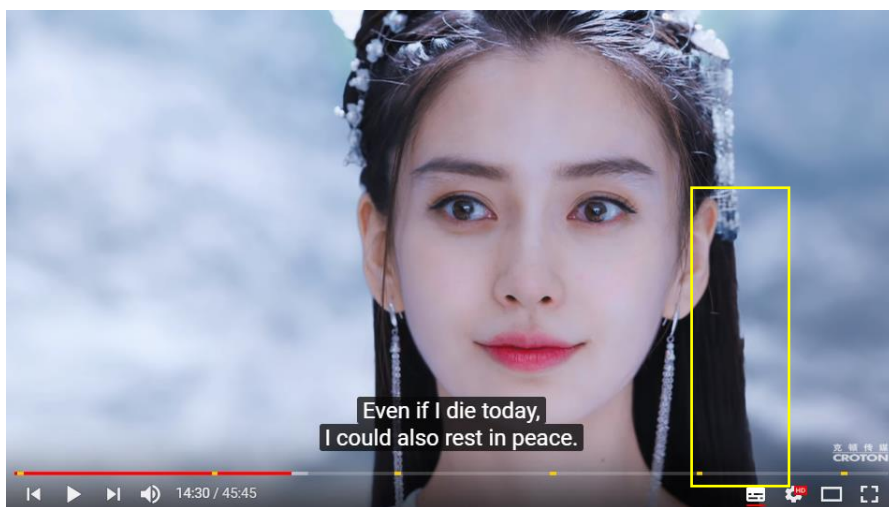


Figure 23: Scene from Episode 8 of “General and I” showing lack of the sharp edge¹²

¹² <https://www.youtube.com/watch?v=6naUdbVz04I&t=940s>

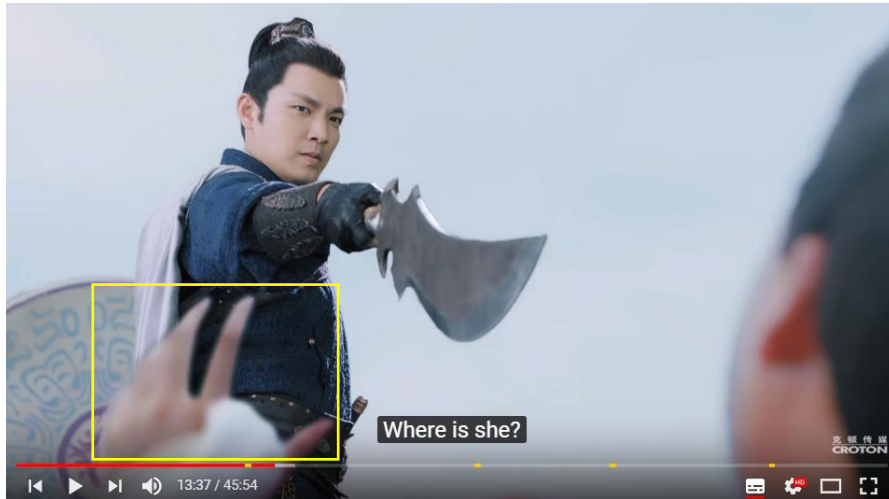


Figure 24: Scene from Episode 5 of “General and I” showing lack of the sharp edge¹⁰



Figure 25: Scene from Episode 5 of “General and I” showing lack of the sharp edge¹⁰

3.2.1.5 The unification of movement

The last but not least is the unification of movement, which means matching the movements of the foreground and the target background parts coordinately. In Figure 26 and 27, Bai Pingting and Chu Beijie should have fierce fighting with other enemies. However, the movement of them is slow, and they seem like dancing in front of the background, which is contrary to the plot that has set before. The reason for asking these two stars to move slowly by the director is that if in the real speed, the difficulty of matting foreground objects will increase exponentially, so the director can only use dance instead of fighting. However, there are some ways that have been concluded

before can solve this issue. Due to the motion blur that will appear in the foreground subject because of fast speed, it is necessary to get rid of motion blur by using some ways. Using high-speed photography is an excellent way to avoid motion blur because this photography can shoot moving objects at a very high frame rate and needs a short exposure time. After solving the problem caused by motion blur, there is still another issue that how to make all the compositing materials move consistently, which can be addressed by motion control system. With motion control system, directors can record the track of the foreground's motion and then use the same track for other materials. So directors can shoot the object at high speed to match the rhythm that the plot should have by using the high-speed photography and motion control system.



Figure 26: Scene from Episode 5 of “General and I” showing inconsistent movement¹⁰



Figure 27: Scene from Episode 5 of “General and I” showing inconsistent movement¹⁰

3.2.2 Nirvana in Fire


“Nirvana in Fire” is also a Chinese historical drama that adapted from a novel with the same name that is written by Hai Yan. It is directed by Kong Sheng and Li Xue, which tells a story about the protagonist called Mei Changsu, a frail and talented genius, made a series of struggles to crack the criminal cases and support the new monarch of Liang dynasty. There some shots in this play use image matting technology due to some hard-to-realise scenarios, which makes the entire play more complete and outstanding. In fact, “Nirvana in Fire” is a very successful work, and it is highly sought after by domestic and even overseas audiences. The rating for “Nirvana in Fire” is 9.1 in both Douban and IMDb, which is a very high score and many viewers gave high praise to it. “Nirvana in Fire” is an excellent example that uses image matting technology quite well, which contributes to the success of this work. While people watched this play, they did not realise that some scenes were achieved by matting the foreground part to insert into the target background. They all shocked with the visual effect of this work and wholly immersed in the plot. After the post-production department of this “Nirvana in Fire” released a video about the special effects that used in this play, people realised that some scenes were synthetic and they were amazed at the matting technology used in this TV series which makes those compositing scenes look like shot with one lens and very realistic. The cause of taking this case to do research is to compare with “General and I” to make people realise how to make synthetic scenes have sound quality that gives audiences a more intense visual experience, and what realistic scenes should be.

琅琊榜 (2015)



导演: 孔笙 / 李雪
编剧: 海宴
主演: 胡歌 / 刘涛 / 王凯 / 陈龙 / 黄维德 / 更多...
类型: 剧情 / 古装
制片国家/地区: 中国大陆
语言: 汉语普通话
首播: 2015-09-19(中国大陆)
集数: 54
单集片长: 45分钟
又名: Nirvana in Fire / List of Langya

豆瓣评分

9.1  226531人评价






5星		71.2%
4星		20.4%
3星		4.8%
2星		0.9%
1星		2.6%

Figure 28: The rating for “Nirvana in Fire” in Douban¹³

¹³ <https://movie.douban.com/subject/25754848/>



Figure 29: The rating for “Nirvana in Fire” in IMDb¹⁴

Compared to “General and I”, “Nirvana in Fire” is produced by a mature and experienced production team that led by Hou HongLiang and Li Xue, which has produced many successful films and TV series in China. This team always participates in the production process of the entire movie which ensures them know which scene needs to use visual effects exactly and knows how to use image matting technology appropriately. The following will combine five factors to make people understand why these synthetic scenes can be realistic. It can be seen that these synthetic scenes all used green screen background, which has the most brightness information and the least noise, and the green screen is broad enough to make the foreground objects always be in front of it (Weigert, 2010). Meanwhile, any green colour was not used in all foreground parts, which avoided the influence of green screen background and make the colour keep original in the synthetic scene.

In Figure 30, a student walked down the stairs by holding a box of scrolls was as the foreground part. Moreover, then this part was inserted into a target background which was generated by computer and the compositing scene is shown in Figure 31. It is clear that both the foreground and background are bright because the director paid attention

¹⁴ <https://www.imdb.com/title/tt5141800/>

to the unification of clarity and blur by using the proper depth of field based on the position of each material that should be in the synthetic scene. Also, the light for each part is in the same condition, like the same brightness, colour temperature and saturation, which achieves the unification of colour. The most important reason why this scene looks realistic is that the shadow was added during the process of post-production, which can be seen not only on the stairs but also on the background wall. Because of the shadow of this little boy, he looks three dimensional and seems like being photographed with the target background together.



Figure 30: Screenshot1(Screen background) from “Special effects in Nirvana in Fire.”¹⁵



Figure 31: Screenshot1(Compositing) from “Special effects in Nirvana in Fire.”¹⁵

¹⁵ <https://www.youtube.com/watch?v=hLTLEJgl4mM>

In Figure 32, Mei Changsu stood on the boat and played the flute, which was considered as the foreground part and combined with the background part, where has mountain and river. In Figure 33, all materials were under the fog and had the same tone, which was achieved by using some colour adjustment software to add a foggy effect to the compositing scene. Also, there was some light shadow of the foreground part of the river, which made Mei Changsu and the boat have a sense of three-dimensional. The process of the colour correction and adding shadow made the synthetic scene achieve the unification of colour. In the video, when Mei Changsu and the boat moved forward, the river and background would seem moving backwards with the same speed, which met the relative movements that occur in real life. Therefore, it achieved the unification of movement because the movements of the foreground part and the target background part were consistent and matched very well. This scene was full of atmosphere and has met people's visual experience, so viewers all thought this is a real scene that shot through one lens.



Figure 32: Screenshot2 (Screen background) from “Special effects in Nirvana in Fire.”¹⁵



Figure 33: Screenshot2 (Compositing) from “Special effects in Nirvana in Fire.”¹⁵

To create a chaotic scene that the military of Liang and Wei dynasties fought each other with swords and spears, the director photographed some fighting scenes with close-up lenses in front of the green screen. Moreover, he inserted the foreground into the background part that was made by the computer to create some fires and other fighting warriors in the distance. To create a sense of tension in the army fighting, these warriors need to move quickly, which usually will add some motion blur during the process. However, this problem was handled very well in this scene, and audiences can see an obvious fighting scene without motion blur. Also, the edge of the foreground part was processed very well, all details of the foreground were displayed in the synthetic scene, even the flowing flame.



Figure 34: Screenshot3 (Screen background) from “Special effects in Nirvana in Fire.”¹⁵



Figure 35: Screenshot3 (Compositing) from “Special effects in Nirvana in Fire.”¹⁵

3.3 Conclusion

This chapter focus on Chinese ancient costume television series which always need to use image matting technology due to some scenes nonexistent in real life. This section takes “General and I” and “Nirvana in Fire” as two cases that all belong to ancient court television series to make Chinese directors realise the importance of image matting technology in synthetic scenes. In these two cases, the use of image matting technology in both of them is analysed based on five factors that concluded in Chapter 2. It can be

seen that the use of this technology in “General and I” is not good, while in “Nirvana in Fire” is quite well. The main reason for the big difference between them is that “General and I” did not use an experienced production team which has no sophisticated production system and is lack of the understanding of new technologies, such as image matting technology.

Also, the investment for the post-production in “General and I” is limited, while in “Nirvana in Fire” is sufficient enough to hire a professional technical team which knows how to use image matting technology very well. By comparing the synthetic scenes in these two cases, directors will know how these five factors affect the quality of the compositing scenes and what realistic scenes should be. Due to the limit number and high price of professional visual effects companies, not every film or television work can be made by experienced teams. So this paper concludes these five factors that influence the visual quality of compositing scenes to make unmatured producers aware of image matting technology. In the future, more and more directors will know how to use image matting technology correctly, which will help directors produce more excellent television works and contribute to the development of image matting technology in TV series and film industry.

Chapter 4. Conclusion

This paper introduces image matting technology which is used to mat individual parts from an image, and those related areas of it, especially films and TV series industry, to give people a general idea of this technology. It also points out the circumstance of Chinese film and television work by analysing the results of a survey conducted by entgroup.cn¹ and explains why image matting technology needs to be developed in China. The most important thing of this paper is that it concludes five factors that influence the visual quality of synthetic scenes which are composed of a matted foreground part and a target background. These factors are the unification of the perspective and lens, the choice of green or blue screen, the unification of colour, the appearance of edges in the foreground subject, and the unification of movement, which are concluded in Chapter 2. Furthermore, this paper takes “General and I” and Nirvana in Fire” which both belong to Chinese TV series as two cases for comparison to give people a bright idea about how to produce real compositing scenes by image matting technology, and what real scenes should be. After finishing reading this paper, those directors who are not familiar with this technology may understand it and show emphasis on these five factors during the process of production, which will push them to produce more excellent film and television works.

In the future, image matting technology will be used to create a lot of films and videos that are full of apparent unfamiliarity and show a totally different feeling from familiar video images on TV platforms. With this technology, directors can show their creativity and imagination easily in their films or TV series. Also, it will be developed in a more smart and convenient direction and break down the limitations of a real-life shooting. For example, a real-time video matting technology will be reached by the public, by which people do not need to mat interesting foreground objects from a captured video frame by frame. This system can mat certain parts automatically from a video, which simplifies tedious steps of the original method (Wang et al., 2012). In this way, the

process of matting objects will be faster, and it may reduce the post-production time so that directors do not need to be worried about the long production cycle. Moreover, more and more people can know how to use matting technology and can mat the foreground part correctly because the system runs automatically after the user imports some videos and it does not need artificial control. So that those inexperienced directors can create some visual effects that meet the requirements without having to spend much money on professional post-production teams, which will bring a lot of convenience for the production of film and TV series.

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