Director Oriented Virtual Cinematography

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Abstract

Traditionally film making costs a huge amount of money and a great deal of time and labor. Converting traditional techniques of film making into virtual techniques could save money, time and labor. In this research, we have established a director friendly virtual camera work, which gives a film director the freedom to look through the shots before shooting. This way, a director is able to make a judgment on shot composition, rhythm of any kind of camera movement, actors' placements and their movements. The image size of frame is the key to develop the virtual camera operation, which is the similar concept of camera operation in the real film making. Considering the image sizes of actors in frame determines the sizes of shots and that helps to place the actors at appropriate positions. Controlling different kinds of camera movements and the speed of movements also depends on the image sizes of actors. A director as a user has the creative control in assessing and evaluating the artistic concern of shot composition in entering the input. This kind of camera operation and imaging is the foundation of director oriented Virtual Creative Cinematography. The system is also regarded as more than an alternate of storyboarding concept at pre-production stage of film making and an advanced approach of monitoring the continuity of every shot which is done by video-assist system at the time of live action shooting.

Key Words: *shot size, actor's image size, camera movement, primary frame, compared value*

1 Introduction

Although the graphical advancement has disclosed our vision in developing 3D activities, creative filmmaking by using this technology has already explored a new horizon for the filmmakers as well as related artists and visionaries. If the success of controlling camera helps a director to work creatively in 3D environment that will provide a new thought in virtual film directing.

In realizing this concept, we develop a system where a filmmaker is able to create a certain kind of mood or emotion in the image frame like a cinematographer. Traditionally, the use of set, light, acting, sound and music, the creation of proper compositions with the appropriate kind of camera movements and the rhythm of editing do create the desire mood. But in our research, we concentrate to the development of appropriate shots through the placements and movements of actors as well as the movements and placements of camera.

Instead of performing the automatic camera control in real time following the strict grammar of film language or continuity rule of movie making, we have to focus on ensuring the flexibility of the system by the creation of virtual camera. As creativity overrules the grammar, a director is able to create any kind of shot of his choice with this virtual camera following not only the grammar and continuity rule but also breaking the rule as well to extend the director's creativity. Moreover, in automatic cinematography, thousands of idioms require to develop in taking shots in different compositions and variations. There are still lots of unknown situations in every movie shooting which demand completely new types of compositions, variations and subject or object placements while staying within grammar and continuity rule of film making. Overcoming these problems is a great challenge for automatic cinematography in real time.

Considering these realities, in designing our system we just follow the same way as a cinematographer does in shooting a scene. For this purpose, we merely want to develop a virtual camera which has the same kinds of characteristics as a camera of live action movie shooting. With proper film sense, a user can shoot the desired shots in computer in following the way a cinematographer does in real movie making. The uniqueness of this system is the camera and its movements are controlled by the desired image size and the desired image position of an actor (or object), which is directed by a user. This way the system does not limit itself with previously prepared automatic shot compositions. In contrast, this paper addresses the immense opportunity of virtual creative cinematography through assessing and evaluating shots in real time.

2 Related Works

We have analyzed the work of He *et al.* [1]. In this work, the authors emphasize more to the grammar of common standard of film language than to a director's creative talent. The authors have implemented a system of Virtual Cinematographer (VC - a real time camera controller for automatic cinematography) and demonstrated its application in a virtual 'party' setting. But the process of implementation is confined to the system's rigidity because of its very conditional approach in composition of shots. As Pudovkin (one of the silent cinema's most noted directors) came to the conclusion that the process of editing – the selection, timing and arrangement of given shots into a film continuity – was the crucial creative act in the production of a film [2], developing certain camera modules and idioms just limits a director's creative concern. In their paper, a realization of strict continuity style has been followed in developing camera modules and idioms. But directors like Ozu, Bresson and Dreyer developed narrative techniques that frequently violate the conventions of continuity filmmaking to achieve their aims [3]. Other methods, such as kinetic or analytical editing, may be in conflict with strict continuity and yet provide better solutions to creative problems [3]. In the same paper, the organization of camera modules and idiom for 2 person conversations and the use of exceptions for lengthy conversation in 3Talk idiom may not be used by a director who wants to create an unconventional dramatic situation from a film script. Although the authors say that as each of the authors of this paper worked on the VC, a slightly different style emerged for each one - still the styles are within the conventions of continuity filmmaking with just few variations. Actually always a style developed on a sequence of shots when a director wants to create a certain mood and to convey the same mood to the moviegoers for the sake of art. If anything is true of the arts, it is that there are no rules [3]. We have cited the creative camera work and explained it in the appendix.

As we are presenting a system which is shot assessing and evaluating, we have also considered computer aided storyboard like StoryBoard Quick and StoryBoard Artist of Power Production Software [4]. The purpose of this kind of software is same as the traditional storyboarding of live action movie productions or feature animations that designs the structuring, staging, compositing of shots in sequences with the shot-flow, which is still far from creating individual shots including the moving effect of a camera or actor in virtual 3-D environments by a film director in real-time.

The video assist system of live action filming offers a director to have a close look of shot taking. With any kind of dissatisfaction, a director is still able to explain it to the proper person for the expected look. In our system, a director is the only person who brings any change required for a scene as many times as it requires.

We receive some valuable information from Jim Blinn's Corner [5]. But our research differs to his paper that proposes the unique placement of camera for an interesting picture by placing the spacecraft in the foreground and a planet or moon somewhere in the background. We work to develop a reliable virtual camera which has the same kind of ability as a movie camera.

3 Concept of Designing

In live action shooting, a cinematographer (or director of photography) is the main expert who visualizes a scene under the guideline of a director. In this research, a director's inputs, the placement of actors, the size of a focused actor in origin together with the aspect ratio and the view angle, are the determining factors to initiate a shot. The vertical focus height is at the vertical half size of the actor and the camera follows the same height. Because the system works as the

same way as a movie camera does, instead of looking through a view finder, the focused actor's desired image size defines a shot size whether it is a full shot or a long shot. Then the elevation of camera up determines the other kinds of framings of human figure with the use of zoom-in or front tracking as it requires.

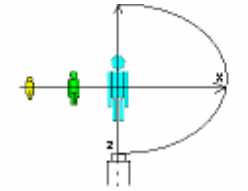

Figure 1: To maintain the continuity camera can be placed at any where within the half circle

To make the system user friendly, we develop a menu of preferences of virtual cinematography. The preferences are serially organized by choosing the intended view angle first as well as the lens to create an initial frame automatically with the given horizontal positions of desired actors. This frame calls the *primary frame*, which is used to form an expected shot size and to place the other actors according to the director's input. The primary frame is also used later on to get reference of its focal length and the actors' full image sizes at the time of camera movements and the time of changing actors' positions as well. Comparing the image sizes of the actors of the desired shot size to the image sizes of the same actors of the primary frame, which is called the *compared value*, renders the idea of camera movements of other degrees of freedom. In opposition to moving camera while looking through the view finder in live action filming, a director requires to input the final size or position of the focused actor into the system. Thus the system translates this information to the required camera move and gets the information of moving speed of camera from director's input. The system also saves a file after each type of camera work and reads a file for any further change of a shot.

As filmmaking is a creative concern, a user must be a film language literate. Through the film sense as well as cinematography, a user is able to construct the appropriate shot after comparing the possible images for a desired shot. That's why image position of actor on the frame is another point to concentrate in this research. While we create the different kinds of camera movements, our prime interest always lies on actors' image positions which is the key of moving a camera required for intended imaging. In view of this, we design our system on OpenGL which is portable for any computer.

Figure 2: A primary frame where actors are in full sizes

Figure 3: Actors are in three different sizes

3.1 Placing Camera Initially

Visualizing a shot generally follows the *line of action* as an imaginary partition running through the space in front of the camera towards the motion or in the direction that an actor is facing. Although OpenGL has a unique feature to move the camera around the 360-degree circle, the default camera position of OpenGL places the camera at the origin of world coordinate and looks at negative z axis. In this research we primarily place the camera on the line of action where characters face the camera towards positive z-axis. We also place the camera at the negative z-axis when it requires taking the camera at the back of the actor while actors are facing each other assuming that the background related to the shots remain same. Moreover, we have also experimented in keeping the camera and the actors all are at the same side of the coordinate system when it requires. In Figure 1, camera is on the line of action and facing the Cyan actor straightly. Choosing the vertical height of the focused actor at the center of origin gives us the proper width of a frame with a given aspect ratio in any given view angle. Then the focal length is determined with all of this information available [7]. Thus the focal length considered the distance of camera on positive z-axis from the actor of origin and the camera is placed at the center of x-axis. The elevation of camera to the half height of the focused actor on origin creates the full view of same actor which becomes the primary frame that controls the framings of subsequent shots of the same view angle.

3.2 Organizing a Shot

The system has the opportunity to equip itself with as many models as a director requires. At the time of creation of the primary frame, a user downloads the required actors. As the visual

extents in the image space are usually standardized into the minus one to plus one range in x and y axes [8], positioning the other actors up to the width of half frame at the both sides of x-axis confirms their positions inside the frame with almost full sizes. Finding the z-

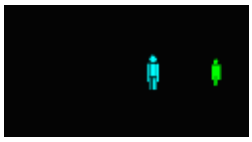

Figure 4: Not good for initial position of shot 1

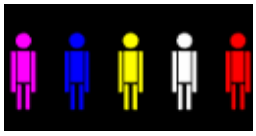

Figure 5: Tracking before tilting to shot 2

Actors' Pos.: C (10.0, 0.0, - 296.4), G (44.8, 0.0, -395.2)
Image Sizes: (1.9, 1.5)
View Angle: 8°
Camera Elevation: 6.9
Focus Point: (0.0, 6.9, -296.4)
Focal Length: 98.8

Actors' Pos.: Y (0.0, 0.0, 469.5), R (-18.2, 0.0, 471.1) M (18.2, 0.0, 471.1), W (-9.1, 0.0, 469.90), B (9.1, 0.0, 469.9)
Camera Elevation: 6.9
Focal Length: -98.8
View Angle: 2.58 °
Image Sizes: (3.9, 3.9, 3.9, - 3.9, 3.9)
Focus Point: (0.0, 6.9, 469.5)

positions of the actors just follows the *Pythagoras' Theorem* where z position is the subtraction of hypotenuse from the focal length, x position and the focal length are the two sides of the right angle. In Figure 2, actors' actual heights are same but their image heights are different because of their different placements on x and z axis.

A *full shot* of a focused actor is the full size of the actor on an image plane, which hinders the background of the same shot; placing the actor in a long shot exposes the background more than the full shot. At this stage, a director initiates into developing the shot size and decides the image sizes of the other actors. The image sizes of the actors determine the new x and z positions of the actors where x are the values multiplied by the compared value. The distance of Green and Yellow actors of Figure 2 is changed to long distances in the Figure 3.

The elevation of camera at the full shot with the use of zoom-in or front tracking as it requires establishes the other kinds of shot sizes like *medium full shot*, *medium shot*, *medium close shot*, *close shot*, *full close-up*, and *extreme close-up*.

There may be more than one character in a shot. After the placement of actors, a director's still has the opportunity to change the positions of the actors.

3.3 Changing Actor's Position

Changing positions of actors horizontally is the kind of work always essential at the time of

Figure 6: Focus Shifted to Cyan from Yellow

Figure 7: Not good for Shot 4

Actors' Pos.: Y (0.0, 0.0, -469.5), R (-18.2, 0.0, 471.1) M (18.2, 0.0, 471.1), W (-9.1, 0.0, 469.90), B (9.1, 0.0, 469.9), C (-2.5, 0.0, 60.0)
Focal Length: 10.37.8
View Angle: 0.736°
Image Sizes: (14.1, 14.1, 14.1, 14.1, 14.1, 8.21)
Focus Point: (-8.8, 13.4, 60.0)
Camera Elevation: 14..9

Actors' Pos.: Y (0.0, 0.0, -469.5), R (-18.2, 0.0, 471.1) M (18.2, 0.0, 471.1), W (-9.1, 0.0, 469.90), B (9.1, 0.0, 469.9), C (-2.5, 0.0, 75.0)
Focal Length: -98.8
View Angle: 2.58°
Image Sizes: (3.9, 3.9, 3.9**,** 3.9, 3.9, 24.4)
FocusPoint:(0.0,14.4, 469.5)
Camera Elevations: 12.4

filming. A user usually changes the positions of actors after organizing a shot. Changing needs to be calculated from the reference of actor's position in primary frame from where a user gets the idea of actor's desired position. After having decision of required change in viewing the primary frame, desired position is multiplied by the compared value to find out the appropriate position of the actor of particular image size.

While filmmaking is the creation of sequences of shots, a cinematographer organizes different kinds of camera movements for creating a scene according to the direction of a director.

3.4 Establishing a Camera

Establishing a Virtual Camera with all the features of traditional camera movements like elevation, tilting, tracking, panning, zooming and the satisfactory imaging from the given positions of the actors gives us the solution for a director's freedom to create a scene. The concept of 3-D transformation, projection and viewing constructs the necessary camera works by C programming language. Besides, a user has choice to fix the proper speed for the camera movements.

3.5 Combination of Movements

Individual camera movements are not the all for live action filming. Generally a cinematographer develops shots when camera follows the actor's actions and movements. Film shooting has always been an interactive movement between the actor and camera. So the concept of shot creating is a perfect blend of these two factors. Moreover, establishing a scene also requires the combination of more than one kind of camera movements. In this research, we are assuming that the actor can move in 360 degree circle on their own axes. While we combine the movements of actor(s) and the camera, first we find out the displacement of the main actor in each step and count down the steps required to reach to the certain distance. Then the counted number is used to calculate the proper speed of the camera to synchronize the actors' movement with the camera speed for the creation of appropriate shot.

4 Experimental Results

Because we are unable to use the motion data for the character, video shooting of live actors is required to get the impression of our virtual shoot. Figure 8 to Figure 17 give us the impression how the live action shooting looks if we develop a sequence of shots after assessing and evaluating.

4.1 Assessing, Evaluating and Developing Shots

In this research we develop a sequence of shots in which the actors walk and stand and the camera visualizes the shots. We have created six shots in a sequence where in every shot we have looked for the best combination of the actors' positions and camera movements for the required images.

We keep a story in our mind while developing the sequence shot by shot. At the first shot, two young men are coming forward. The Cyan (C) actor in Figure 18 has been away from his friends (not in the frame) for a certain period of time because of the problem in their relationship out of misunderstanding. We have taken a front view of the actors coming forward. There is another Green (G) actor, who is following the Cyan as if G is carefully keeping an eye on C while he is moving ahead to his other friends. To visualize this situation, we try to find out the most possible actor's placement and the camera movements. First of all, we have had to find out the appropriate actors' sizes and then place them at the desired positions of the frame. Here we decide that keeping the actors in a long shot at the beginning in frame helps to create C's mental distance from his other friends, which eventually gets evidence. That's why in the Figure 18, the focus point of z is same as the distance of Cyan actor from the camera. Before identifying the actual shot, few kinds of actors' sizes had been considered and the camera elevated up as well to verify the placement that needed. We have also changed the position of the actor finally on x-axis in Figure 18. We try to keep camera close to eye level because friends have mentioned the equality. We have also evaluated few other shots like Figure 4, which we don't think our preferable shot.

For the final position of shot 1, a target move forward of the actors or the certain distance of actors' displacement has been calculated. Cyan actor walks forward toward the middle of the frame, which means he is given importance and Green actor follows Cyan behind to make it sure that Cyan is moving to the proper direction. The composition we exactly desire finally in this shot is shown in Figure 19. We keep the camera static for this shot from the beginning to end. As we don't use actor's movement (walking) data, we only consider the actors' displacement.

In shot 2, a combined full shot of the other friends has been seen. Now it's clear to whom and where the Cyan actor is moving forward in shot 1. That is the reason we visualize the shot in the Figure 20. Here the camera has been placed at the other side of the line of action. We have to track the camera to a suitable position in Figure 4 to get the medium full shot in Figure 20 by tilting up.

We use the shot 3 to bring a variation in the sequence of shots and to show the exact position of the Cyan actor compare to other friends of the previous shot. Not only his physical distance is evident here, but also the mental distance of him from others is evident in this panning over the shoulder shot in Figure 22. From Figure 6, we have realized what is going to be the exact elevation of camera for the over the shoulder shot.

In this shot 4, we feel the distance between the protagonist and his friends clearly. The back shot from Cyan meaningfully establishes this

reality. This shot also makes us curious to understand the feeling of his other friends. While we are not satisfied with the position of Cyan actor in Figure 7, we adjust it in Figure 23.

We use pan in Shot 5 to see the reactions of each of the other friends. A close up panning also creates a moderate tense feeling.
Finally we take a close shot of the Cyan actor to get close to his emoting or reaction. With the enlarged size of the actor's figure puts more emphasis on the solo character against the group of five that creates balance in this sequence. Actually we move camera in both the positives and negative z-axis as it is essential in the virtual environment.

The way we composed these shots follows an editing pattern. Although we are not able to show the movements of actors, placing the images serially gives us the impression of a perfect editing to build up a sequence.

4.2 Actual Shooting

As location or set design is one of the important elements like lighting in cinematography, through actual shooting we could get the idea how our virtual shooting turns out.
Because of the subtlety in capturing the image of the virtual camera, we have faced some discrepancy while working with the Mini DV Handy Camera. So, we have tried to be loyal to the process of live action filming for the simplicity of our video shoot. Moreover we have a different aspect ratio which is 1.6: 1 for video framing whereas it is 1.85:1 in virtual shoot. There is also limitation with the automatic feature of this video camera specially, in setting the focus point manually. The longest focal length of this video camera is 5.16 cm. Besides the sizes and shapes of the models force us to make some adjustments in shot compositions and camera placing which are noticeable in video shoot results in section 4.

5 Conclusions and Future Work

We have developed a virtual camera with its basic movements. We have also demonstrated how we create shots for the purpose of preview from a director's point of view. Besides, by creating a sequence of shots, the system verifies its authenticity. We want to be faithful in following the way a cinematographer usually does in visualizing a scene in a live action filming. But the system gives us more advantage in placing and moving the camera or actor accurately than in a live action filming. The ultimate success of virtual cinematography depends on harmonizing the camera works with the actor's movements and acting following the guideline of film language and grammar, as well as the creativity of the concerned filmmaker. There are still more complicated camera works needed to be done which are, tracking cameras around a subject of 360 degree circle, simultaneous vertical and horizontal movement through craning, and special kinds of swift camera moves. We would also like to apply actors' movement and action data in creating a sequence of shots in virtual environment to verify the system genuineness accurately.

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Appendix

A Director's Approach

A director is always aware of the aesthetical requirement to apply to the creation of art. As a filmmaker of unconventional category, Andrei Tarkovsky has the tendency to go beyond the convention in his works. In his last movie, *The Sacrifice*, Tarkovsky created a sequence where the character Alexander (Erland Josephson, the actor) takes his son for a walk in a wood [6]. While Alexander is resting on the field, his son goes out of the shot. After a few moments Alexander starts looking his son and calling him with a fear. A little while, the son gets into the frame and about to jump to his father's back from the left side of the frame as Mr. Joshepson is kneeing down on the ground placing his back angularly to the screen. At the very next shot, the camera crosses the line of action and placed at the opposite side to its previous placement as the shot have an affect of *jump cut*. In this shot the son still on the jumping rhythm at the back of his father but Mr. Joshepson is now facing the camera angularly towards the direction opposite to the previous shot. The kind of mood and fear, the way the director renders to the viewer is very unconventional where the camera just crosses the line of action and breaks the rule for the sake of creativity that does not follow the conventional rule of continuity. Although it is true that over the years, filmmakers have developed a set of rules and conventions that allow actions to be communicated comprehensibly and effectively [1], filmmakers also break the conventions when it is essential. This kind of example makes us to think about the freedom of a director in compositing a shot.

*OTS – Over the Shoulder

Figure 8: Shot 1 - Initial Position

Figure 9: Shot 1 - Final Position

Figure 10: Shot 2 - Actors Face Camera

Figure 11: Shot 3 - Start of *OTS Pan

Figure 12: Shot 3 - End of *OTS Pan

Figure 13: Shot 4 - Back of Main actor

Figure 14: Shot 5 - Start of Close up Pan

Figure 15: Shot 5 - Pan Continues

Figure 16: Shot 5 - Pan Ends

Figure 17: Shot 6 – Close Shot of Main

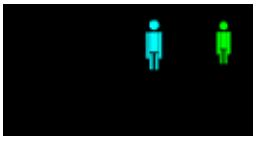

Figure 18: Shot 1 -

Initial Position
Actors' Pos.: C (6.9, 0.0, -174.8), G (30.7, 0.0, -222.4)
Image Sizes: (2.7, 2.3)
View Angle: 8°
Camera Elevation: 10.9
Focus Point: (0.0,- 0.1, -174.8)
Focal Length: 98.8
Image Sizes: (2.7, 2.3)

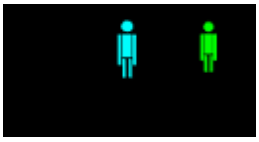

Figure 19: Shot 1 -

Final Position
Actors' Pos.: C (-0.6, 0.0, -135.9), G (21.5, 0.0, -170.5)
Image Sizes: (3.1, 2.7)
View Angle: 8°
Camera Elevation: 10.9
Focus Point: (0.0, -0.1, -174.8)
Focal Length: 98.8
Image Sizes: (3.1, 2.7)

Figure 20: Shot 2 -

Actors Face Camera
Actors' Pos.: Y (0.0, 0.0, 469.5), R (-18.9, 0.0, 471.1) M (18.9, 0.0, 471.1), W (-9.5, 0.0, 469.90), B (9.5, 0.0, 469.9),
Focal Length: -98.8
View Angle: 2.58°
Image Sizes: (3.9, 3..9, 3.9, 3.9, 3.9)
Focus Point: (0.0, 14.4, 469.5)
Camera Elevation: 9.9

Figure 21: Shot 3 -

Start of *OTS Pan
Actors' Pos.: Y (0.0, 0.0, 469.5), R (-18.9, 0.0, 471.1) M (18.9, 0.0, 471.1), W (-9.5, 0.0, 469.90), B (9.5, 0.0, 469.9), C (-2.5, 0.0, 60.0)
Focal Length: 1037.8
View Angle: 0.736°
Image Sizes: (14.1, 14.1, 14.1, 14.1, 14.1, 8.21)
Focus Point: (-13.7, 13.9, 60.0)
Camera Elevation: 12..9

Figure 22: Shot 3 -

End of *OTS Pan

Actors' Pos.: Y (0.0, 0.0, 469.5), R (-18.2, 0.0, 471.1) M (18.2, 0.0, 471.1), W (-91, 0.0, 469.90), B (9.1, 0.0, 469.9), C (-2.5, 0.0, 60.0)
Focal Length: 1037.8
View Angle: 0.736°
Image Sizes: (14.1, 14.1, 14.1, 14.1, 14.1, 8.21)
Focus Point: (-8.8, 13.9, 60.0)
Camera Elevation: 12.9

Figure 23: Shot 4 -

Back of Main actor

Actors' Pos.: Y (0.0, 0.0, 469.5), R (-18.2, 0.0, 471.1) M (18.2, 0.0, 471.1), W (-9.1, 0.0, 469.90), B (9.1, 0.0, 469.9), C (-2.5, 0.0, 60.0)
Focal Length: -98.8
View Angle: 2.58°
Image Sizes: (3.9, 3.9, 3.9, 3.9, 3.9, 24.4)
Focus Point: (0.0, 14.4, 469.5)
Camera Elevation: 12.4

Figure 24: Shot 5 -

Start of Close up Pan

Actors' Pos.: Y (0.0, 0.0, 469.5), R (-18.2, 0.0, 471.1) M (18.2, 0.0, 471.1), W (-9.1, 0.0, 469.90), B (9.1, 0.0, 469.9)
Focal Length: -98.8
View Angle: 0.736°
Image Sizes: (10.2, 10.2, 10.2, 10.2, 10.2)
Focus Point: (18.9, 13.4, 469.5)
Camera Elevation: 14.9

Figure 25: Shot 5 -

Pan Continues

Actors' Pos.: Y (0.0, 0.0, 469.5), R (-18.2, 0.0, 471.1) M (18.2, 0.0, 471.1), W (-9.1, 0.0, 469.90), B (9.1, 0.0, 469.9)
Focal Length: -98.8
View Angle: 0.736°
Image Sizes: (10.2, 10.2, 10.2, 10.2, 10.2)
Focus Point: (4.6, 13.4, 469.5)
Camera Elevation: 14.9

Figure 26: Shot 5 -

Pan Ends

Actors' Pos.: Y (0.0, 0.0, 469.5), R (-18.2, 0.0, 471.1) M (18.2, 0.0, 471.1), W (-9.1, 0.0, 469.90), B (9.1, 0.0, 469.9), C (-2.5, 0.0, 60.0)
Focal Length: -98.8
View Angle: 0.736°
Image Sizes: (10.2, 10.2, 10.2, 10.2, 10.2)
Focus Point: (-13.6, -13.4, 469.5)
Camera Elevation: 14.9

Figure 27: Shot 6 -

Close Shot of Main

Actors' Pos.: C (0.0, 0.0, 0.0), G (41.0, 0.0, -98.8)
Image Sizes: (14.6, 7.3)
View Angle: 3.8°
Camera Elevation: 12.5
Focus Point: (0.0, -0.1, -174.8)
Focal Length: 98.8 °