Diorama Engine - A 3D Directing Tool for 3D Computer Animation Production

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Abstract

Recent advances in 3D computer graphics technologies have enabled 3D computer animation to become a popular method of storytelling. However, the tools which provide access to the technology are targeted mainly at trained professionals, and are seldom easy enough for a director to use.

In this paper, we present Diorama Engine, a 3D directing tool for 3D computer animation. Diorama Engine is a limited but specialized tool which focuses on ease of scene construction, camera control, and shot editing. This allows for quicker and easier creation of full length video storyboards. Furthermore, the produced 3D data can be directly passed to later production processes, enabling the work of a director to form a data foundation for the production process.

A prototype version of our tool is tested, and the experimental results suggest that the directing tool can be integrated into an actual production process.

1. Introduction

Recent advances in 3D computer graphics technologies have created new possibilities for digital motion picture production. Such a development greatly enhances the means of expression available to creators of storytelling environments. On the other hand, directing environments have yet to change drastically. Particularly in 3D animation production, the lack of specialized directing tools which leverage the means of expression to the heights of 3D, often leave the director with no other choice than to use inefficient conventional approaches.

Diorama Engine (Diorama) is a specialized 3D directing tool which aims to solve this problem. It is currently being developed in a joint effort between Tokyo University of Technology and Keio University, Japan. With support from OLM Digital, a Japanese animation studio famous for creating the "Pokemon" series, we are planning to use Diorama in actual production environments in the near future. Currently, we have implemented a prototype version, and are working towards the first major release.

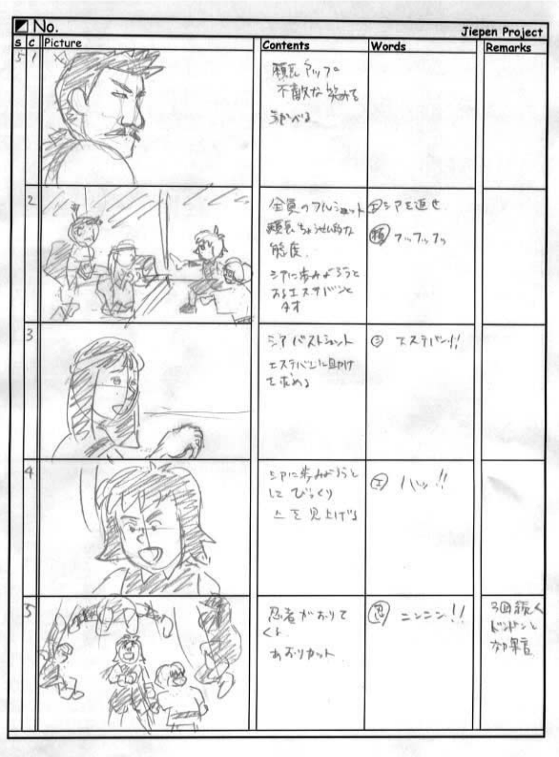
2. Conventional Approaches and Drawbacks

2.1. Directing with Traditional Storyboards

The storyboard is an important document where the shot sequence and timing is designed. The importance can be stressed not only in traditional animation, but also in 3D computer animation. Storyboards contain all of the text-based directing information intended by the director.

However, one of its major drawbacks is the lack of temporal description, and the following can be said.

- Grasp of timing is non-intuitive
- Understanding of motion is difficult
- Complex camera motion is hard to reproduce



No. Jiepen Project

s	c	Picture	Contents	Words	Remarks
5	1		頼長アップ 不敵な笑みを 浮かべる		
	2		全員のフルショット 頼長ちょうせん的な 態度 シアに歩みよろうと するエステバンと 今才	㊀シアを返せ (頼) フッフッフッ	
	3		シアバストショット エステバンに助けを 求める	㋛ エステバーン!!	
	4		シアに歩みよろうと してびっくり 上を見上げる	㊀ ハッ!!	
	5		忍者がおりて くる あおりカット	(忍) ニンニン!!	3回続く ドンドンと 効果音

Figure 1. Storyboard Example

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2.2. Directing with Electronic Storyboard Tools

Electronic storyboard tools (ESB) help solve the drawbacks of hand drawn storyboards listed in 2-1.

In ESB tools, a "digital canvas" is provided for the user to spatially layout material in 2D. This material can be of various types, such as bitmaps, icons, vector graphics, scanned in images, and so forth. Each material element may be animated using a timeline user interface.

In the context of 3D animation production, since these tools are 2D based, it is necessary for the 3D staff to reproduce in 3D, directions that were issued in 2D. This often requires an inefficient "loose translation" in part of the 3D staff, which frequently leads to misunderstanding. Also, there are shot compositions that are possible in 3D, but difficult to reproduce in 2D. This has the effect of narrowing the means of expression for the director.

2.3. Directing with 3D Applications

3D applications may be used as a directing tool, where the director creates animated storyboards. Since directions can be given directly in 3D, problems which arise in 2D based approaches are automatically solved. Furthermore, 3D data may be reused in later production processes.

However, 3D applications are typically designed for trained 3D staff and not directors. It is demonstrated that working with 3D software is very difficult [1] where high skills and hours of training is required. Furthermore, 3D software in the current market tends to require high performance hardware.

3. Ideas for a Directing Tool

Reflecting on the drawbacks with conventional approaches given in 2, we suggest the main ideas for a directing tool that utilizes 3D graphics. The following is a list of main ideas.

- Intuitive user interface

The director is not a 3D application operator, nor has time for extensive training to become one. The directing tool should be useable with minimum training, via an intuitive graphical user interface.

- Real-time preview

Real-time in this context means two things. One is to guarantee playback at the specified frame rate. The other is to guarantee smooth frame updates while working in the 3D scene.

- Shot sequencing

Shot sequencing is a powerful means of storytelling. The director should not only be able to create individual shots in 3D, but be able to connect shots together to view and confirm the full sequence.

- Direct pass of data to 3D applications

In conventional approaches, the storyboard is viewed for purposes of visual and dramatic communication. However, the staff has to interpret the written directions in order to construct the work on the production tool. Efficiency would be greatly increased if data could flow directly from the directing tool into the production tool.

4. Workflow of Diorama

The workflow in Diorama is given in Figure 2. There are two modes in Diorama, Scene Mode and Editing Mode. The director starts in Scene Mode, where 3D scene construction tasks are executed to create an animated scene. These include model import and layout, simple object animation, and camera shooting tasks. The director then moves on to editing mode, where the main task is to create shots from footage taken from cameras in Scene Mode. The completed video storyboard is then exported to one of three formats: an AVI file for later viewing, a 3D scene file format, which can be directly imported into 3D applications, and a storyboard printout for convenience.

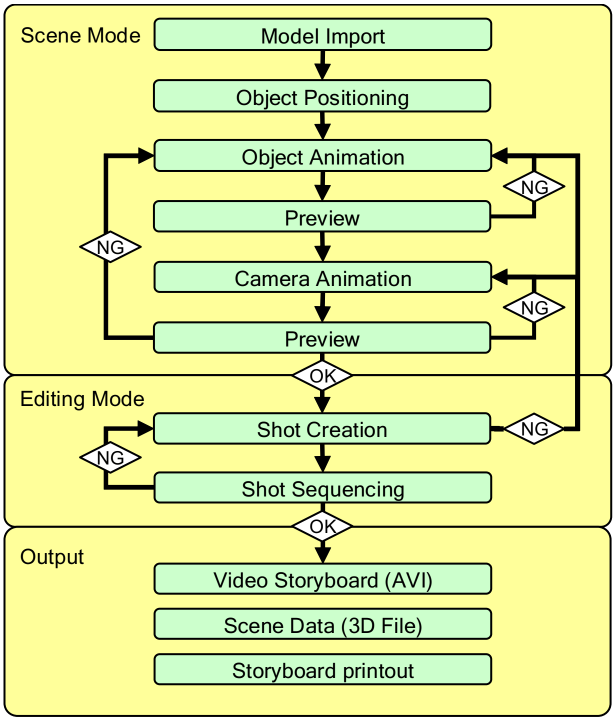

Figure 2. Workflow of Diorama

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4.1. Scene Construction

Typical 3D animation production using conventional 3D applications require geometric modeling and animation tasks at the least. To consume skills to perform either one of these tasks requires training. In Diorama, the focus is to provide an intuitive 3D scene construction interface. The idea is to allow a director to construct a 3D scene using simple and primitive methods, which take little time to learn.

The workflow is to first import pre-built models from a model database, and then add simple animation to those models. Finally, the animated scene will be shot using the camera. These are the tasks which the director executes in Scene Mode.

4.1.1. Layout

The first task in Scene Mode is object layout. The goal is to spatially position visual objects. This is accomplished by first importing pre-built models from the model database. Then the models are spatially positioned in 3D space by using a manipulator widget[1][2]. The result is a static scene with objects spatially positioned at their initial positions

The model database can be browsed directly inside the Diorama interface. As shown in the left pane of Figure 4, a list of models is shown. When selecting a model of interest, a popup window is displayed, allowing the director to view the model in 3D from multiple viewpoints. The currently supported model file formats are 3D Studio Max(.max), Lightwave3D(.lwo), and Directx(.x).

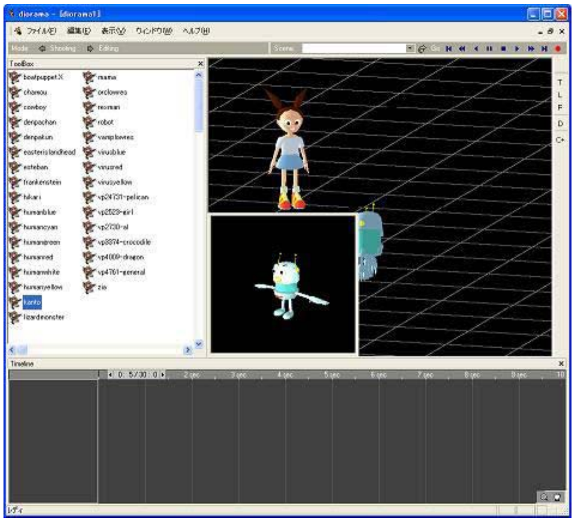


Figure 3. Layout in Diorama

4.1.2. Animation

The next task in Scene Mode is to add animation to the models which were spatially positioned in 5-1. Keyframe animation is used for this task.

The process of keyframe animation is well known and is intuitive. The user repeats the procedure of positioning an object at a specified time frame, and the intermediate positions are automatically calculated by the computer. This results in a smooth interpolating animation when played back.

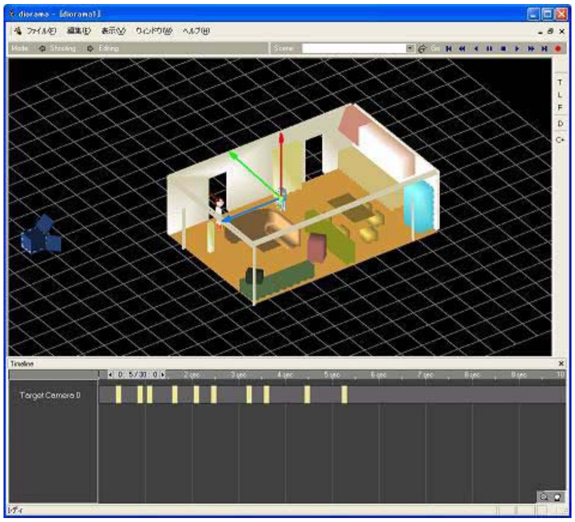


Figure 4. Keyframe Animation in Diorama

In computer animation, keyframes can be used to animate any property of the scene. Furthermore, multiple interpolation schemes exist between keyframes. Thus, it is possible to create highly detailed motions. However, at the video storyboard level, this amount of detail is not necessary. Therefore, the number of keyframe and interpolation types in Diorama is intentionally limited. For models, the keyframe types are positional, rotational, and scale. Interpolation types between keyframes can be chosen from one of spline or linear.

A timeline interface supports the procedure of editing keyframes

4.1.3. Camera Shooting

Camera shooting is the final task in Scene Mode. The goal is to animate the camera to shoot camera footage. Camera properties that can be animated are spatial position/rotation, and camera zoom. The animation is specified using the same keyframing procedure explained in 5-2.

Cameras are shown as thumbnails in the interface (Figure 6). Each thumbnail displays an updated view for each camera at the current time. Therefore, when the scene is previewed, all thumbnails are updated in real-time. This multiple view interface was designed to resemble an on-set shooting scenario in real life, where the director is presented with multiple screens, each displaying a view from each active camera. We think this interface helps the director visualize the shot flow more easily.

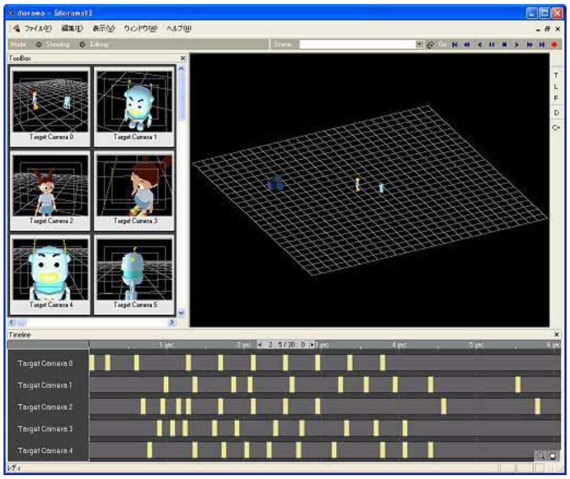


Figure 5. Camera shooting in Diorama

4.2. Shot Editing

In 3, we pointed out that conventional 3D applications seldom support shot editing. Even if it were supported, the user interface would be unsuitable for a director. The idea of Editing Mode in Diorama is to provide simple shot editing services, so that the full video storyboard sequence can be viewed and confirmed.

At this point in the workflow, an animated 3D scene and one or more cameras that capture the scene action have been made. The task of Editing Mode is to create shots from the scene cameras, and align the shots in order to create the final sequence. This will be accomplished using the Editing Mode interface.

The director will first decide on a camera that will be used in the final sequence. By dragging the camera thumbnail from the thumbnail view into the timeline interface, a span will be added which represents a single shot inside the sequence. This procedure will be repeated until all cameras of interest are added to the sequence. Next, the length of each shot can be adjusted graphically by dragging the end grippers. The ordering of shots may also be changed by a simple drag into the new position. The full sequence can be previewed at any time to confirm the results.

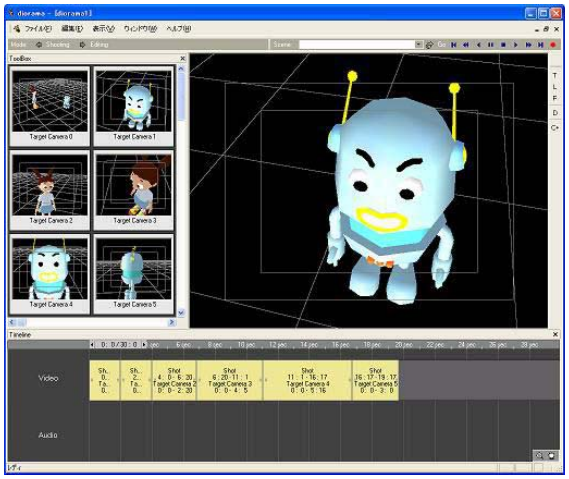


Figure 6. Shot editing in Diorama

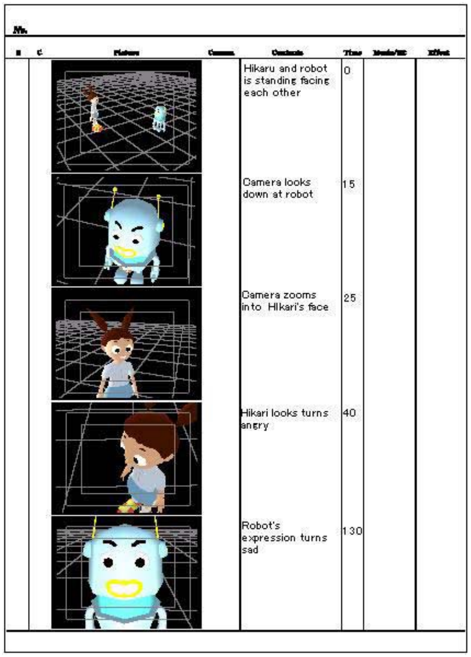
4.3. Output

The final stage in the Diorama workflow is output of the video storyboard to various formats. Currently, three formats are supported: AVI movie file, storyboard printout, and 3D file format.

The former two are convenient for handing out documents to production staff. In cases where an installation of Diorama cannot be accessed, an AVI file will come in handy since AVIs can be played back in most computer environments. A storyboard printout is convenient in that they can be written into to take notes and sketches.

In 3, we mentioned the direct pass of data to 3D applications as one of the requirements for a directing tool. The capability of Diorama to output the finished video storyboard to 3D file formats is what makes this possible. The 3D data will be passed on to 3D staff, who will use the data as a base for scene construction in 3D applications. Currently, output to 3D Studio Max (.max) is supported.

Figure 7. AVI output example



No.

S	C	Picture	Camera	Contents	Time	Music/SE	Effect
				Hikaru and robot is standing facing each other	0		
				Camera looks down at robot	15		
				Camera zooms into HIkari's face	25		
				Hikari looks turns angry	40		
				Robot's expression turns sad	130		

Figure 8. Storyboard printout example

5. Architecture of Diorama

The software architecture of Diorama has been designed with extensibility in mind, to allow further expansion of the tool in the future by both internal and external organizations. It is implemented in C++, and currently uses Microsoft Direct3D for hardware rendering and Microsoft MFC for the GUI. Since the core components of Diorama are implemented independent of external libraries, library composition may change to support various platforms.

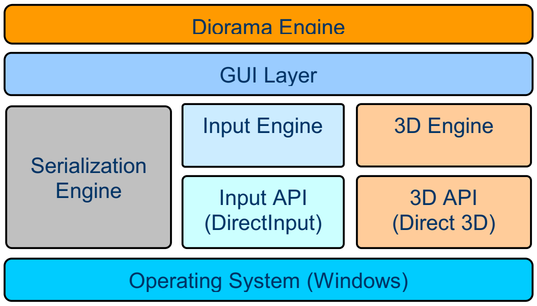


Figure 9. Diorama Engine Architecture

5.1. 3D Rendering

3D rendering in Diorama is achieved by the high level 3D engine and low level 3D API. The 3D engine manages 3D content such as geometry, cameras, lights, and textures in a scene graph node hierarchy. When a render is necessary, the engine passes 3D content and render commands in the correct order to the 3D API, and the API does the rest using hardware rendering.

One important requirement for our 3D engine is real-time preview. To guarantee scene playback at a specified frame rate, the 3D engine supports level of detail (LOD) rendering techniques. When elapsed time between frames reaches a certain threshold, the level of detail for all geometry inside the view frustum is decreased by an amount according to the geometry type. If the geometry in question is provided as progressive data, the detail level is decreased by a predefined amount. Otherwise, the geometry is rendered as a simple bounding box.

5.2. GUI

The GUI layer sits on top of the 3D engine, input engine, and serialization engine. Its role is to provide an intuitive user interface for video storyboard creation to the user, while interfacing and using the lower architecture layers. The current GUI implementation relies on the Microsoft Foundation Class (MFC) library.

At the core of the GUI layer is a document-view architecture. Views which include the 3D view, timeline interface, and thumbnail window are linked to a central document object, which contain internal video storyboard data. When a user interacts with a certain view, messages are sent to the view, where they are processed and handled. A view update usually occurs at this time. If the message triggers a change on document data, all views connected to the document get updated.

6. Evaluation

6.1. User Test

To evaluate the functionality of the tool, the prototype was user-tested by 100 students studying motion picture production at School of Media Science, Tokyo University of Technology. The exercise was executed as follows.

1. A 90 minute exercise with an assignment to create a video storyboard based on a particular theme
2. Installation of the tool on students' notebook PCs (15 minutes)
3. A simple lecture on operating instructions, and exercise explanation (20 minutes)
4. Exercise (45 minutes)

In spite of their first experience, most students were able to operate the tool without problems, and there were submissions which exceeded our expectations. Ample results were gathered as a first step towards practical use.

6.2. Practical Use in Animation Production

In addition to the user test in 8-1, the prototype was used in actual animation production led by students at Keio University, Shonan Fujisawa Campus. The director of two teams created a full length video storyboard for an animation short called "*Chack Panic*" (Figure 10) in Diorama to communicate visual ideas to the production team. Both directors had experience with hand drawn storyboards as well as creating video storyboards using 3D applications.

Concluding from the production report, a single animated shot which averaged 5 seconds in length took an average of 5 minutes to create. According to the director, the simplicity of the tool allowed for a short learning span and quick video storyboard creation compared to conventional 3D applications.

While there leaves much room for improvement until Diorama can be used in professional studios, this was a big leap towards our goal.

Figure 10. Example "*Chack Panic*"

7. Conclusion and Future Work

In this paper, we have presented Diorama, a 3D directing tool for 3D computer animation production. In our future work, we intend to add on top of the current architecture, the following services.

1. Simpler camera positioning interface
2. Collision Detection between objects and ground
3. Insertion of text captions and remarks
4. Addition of sound, music, and dialogue in Editing Mode

The stability of the tool will also be improved to withstand actual use in real production environments.

Furthermore, we are researching a semi-automatic construction method for the 3D scene using XML scenarios. Currently, in the case where video storyboards are created based on a given scenario, the user has to "reenter" the directions into the video storyboard by hand. This process would be more efficient if scenario data could be directly mapped to objects inside the model database, and animation could be automatically added.

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