

Development of *Cyber Theater* titled "PINOCCHIO" and Cyber Theater Scenario Language: CTSL

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Abstract

In Japan, most of children haven't read the Fairy Tales or tales of old Japan because the high technology video games are more exciting than most of picture books. But they must be effective to bring up the children's cultivation of aesthetic sensitivity. And we have heard from teachers of elementary schools that most of themes of computer education in school are the operation of Painting Tool or Game Software.^[17] To improve these problems and to aid the courses of computer-based education in elementary school, we developed new educational support tool named *Cyber Theater*. *Cyber Theater* provides the capability of easy making the 3D-CG animation of children's story by using Script language named *CTSL* (Cyber Theater Scenario Language). We hope schoolteachers will be able to use Cyber Tales as teaching materials in elementary schools. We also hope that upper-aged students (including junior high school students) are able to make their original CG-animation stories as the Creative Lesson.

1. Introduction

From the 2002 academic year, the new guidelines for teaching are in effect in elementary and junior high schools. Pupils are required to familiarize themselves with computers and the Internet through the new classes named "General learning". On the other hand, Some WEB site on the Internet are not useful for them. Some web sites may give incorrect information and some others are harmful in nature while pupils lack in the ability to distinguish virtue and evil. This might explain to some extent why the main exercises at elementary schools do not go beyond learning how to use software of painting, typing or game software. (Figure 1) Teaching materials must include the senses of justice, fairness, morality, and love.

To improve the situation at schools, we developed an education tool named *Cyber Theater*, which can make a 3D-CG animation story easily.

2. Preceding research

Most popular method to produce a CG cartoon movie is to use some CG animation tools^{[20][21]} and non-linear video editing system^[22]. But it takes great time to rendering CG animation and to integrate the animation, sound, music, and speaking.

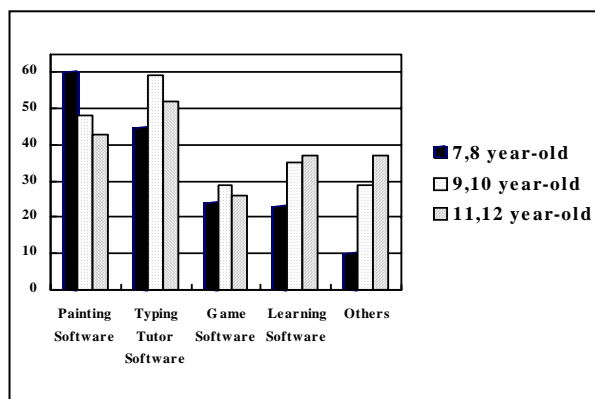


Figure 1. Main software that elementary schools use in Japan

Another way is to make a real time CG animation by using programming language and some libraries. (For examples, OpenGL, Speech SDK and MCI library). But this production cost also may be too much.

From this point of view, the SDK(System Design Kit) libraries for human shaped 3D-CG models were reported. Most famous one would be "Jack"^{[1][2][3]} developed by Pennsylvania University. It was developed as the LISP language SDK for military application.

Although Jack has a lot of excellent functions, it cannot integrate the Voice synthesizer, sound effects, music and facial expressions.

MPML^[4] is a hypertext for the WEB site presenter. Presenter is installed by using the Microsoft Agent. MPML has a lot of excellent functions. Utterance, movement and simple body performance of Presenter are managed by tag commands and it has a powerful affinity for HTML language. Moreover, It has the speech recognition function. But it dose not satisfy the specification we requested because,

- (1) The Presenter is NOT a 3D-CG model.
- (2) It has NOT virtual 3D stages and stage parts.
- (3) It hasn't 3D spatial management structure like a camera working.

TVML^{[5][6]} is the script language that can create a real time CG-animation of News Show automatically. It has a lot of excellent functions. TVML exactly reenacts the TV studio equipments and able to describe the utterance, subtitles and simple face expressions of Virtual News Caster. But it also dose not satisfy the specification we requested.

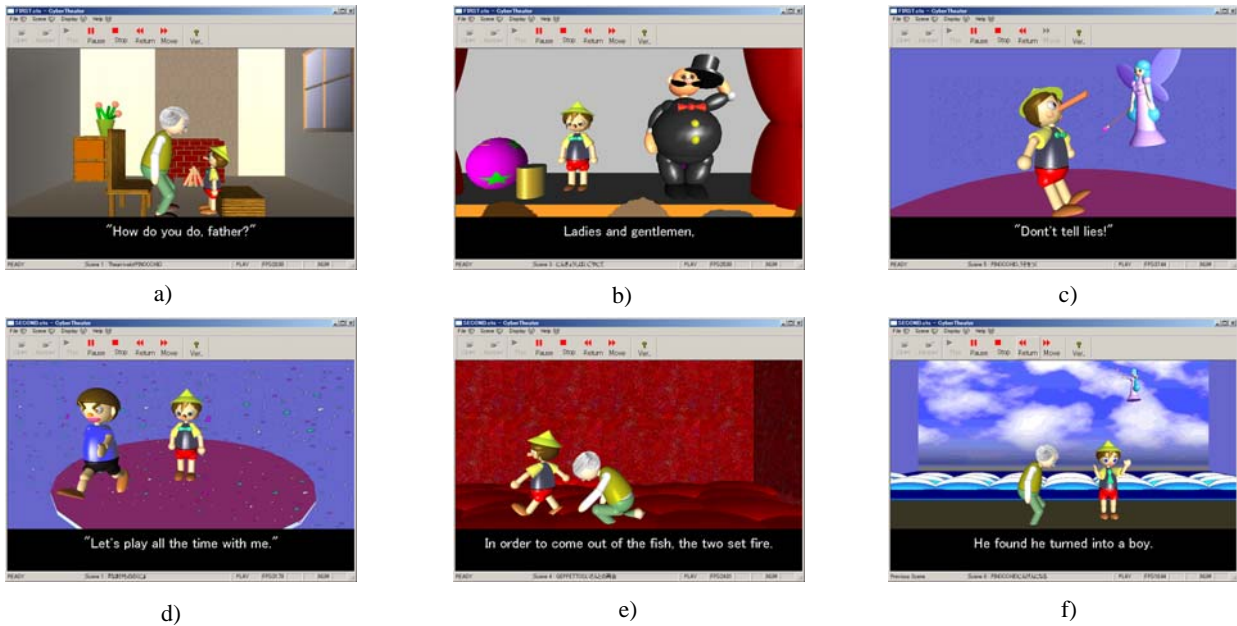


Figure 2. The screen of Cyber Theater “PINOCCHIO”

Because,

- (1) It is too complex to set up the environment.
- (2) Body actions are restricted because these are customized for a News Caster.
- (3) Stage parts (properties) cannot be moved!
- (4) TVML listings look like a programming language.

In our laboratory, similar research has been going on to apply *Cyber Teaching Assistant*.^{[14][15][16]} *Cyber Teaching Assistant* system is a real time 3D-CG animation player, which can assist a teacher in the computer seminar room during the computer exercise. Script Language named *CPSL* (Cyber Person Scenario Language) can write the scenario of 3D-CG animation. But it can support only the Human style *Virtual Actors* and cannot create various kinds of animals or monsters.

Against those situations, we developed a *Cyber Theater*.^{[7][8][9][10][11]} (Figure 2) It is a new media player attractive enough to arouse interest of low-aged children. The system of *Cyber Theater* consists of the integration of the multi-media high technology such as OpenGL, SpeechAPI and MP3. Script Language named *CTSL*, just like a HTML language, can write the scenario of CG animation. On the stage of *Cyber Theater*, *Virtual Actors* can move around on the 3D cyber stage and many parts on the stage can move simultaneously.

3. Structure of Cyber Theater

Figure 3 shows the System Structure of *Cyber Theater*. It is based on the results of research in our laboratory. *PiasGL4*^{[18][19]} is the extended library of OpenGL. Even if you do not know the details of OpenGL, it is possible to make various kinds of 3D-primitives easily. Texture mappings and billboard mappings can be available. Moreover, any Joint of a *Virtual Actor* can be moved easily. Table 1 shows the technical elements of *Cyber Theater*.

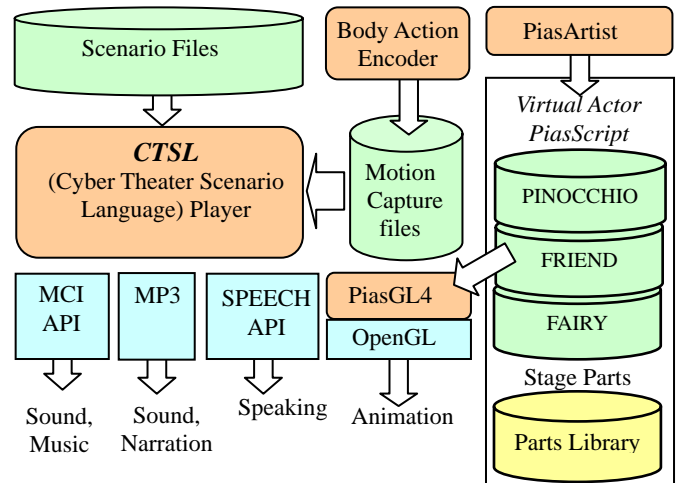


Figure 3. Structure of *Cyber Theater*

Table 1. Technical Elements of *Cyber Theater*

Items	Technical Elements
Camera	OpenGL View Volume Control
Stage	Create a background 3D stage.
Parts	3D geometric model or Billboard Primitive.
Virtual Actor	3D geometric model which may be Human, Animal or Monster. It acts by using scene graph or motion capture database.
Caption	Display the title board.(Hiragana, Katakana or English.)
Reading	Record and Play by using MP3.
Speech	Speak by Microsoft Speech API.
Sound Effects	Play the Digital Sound PCM files.
Music	Play MIDI files.

PiasScript^{[18][19]} is a Script Language to describe the 3D-geometric model as a text strings. It specifies the various kinds of geometric models, those are the surface

quality, calculation of matrix of objects, and pasting of texture mapping among and so on.

PiasArtist^{[18][19]} is a 3D modeling tool used when story maker produces a **Virtual Actors** and Stage parts. It can create and edit the 3D geometric models freely and save them as *PiasScript* file. **Body Action Encoder (BPN Encoder)** can be used when story maker encodes the Body Action to the **Virtual Actors**. (Figure3)

Moreover, in order to attract children's interest, many interactive functions were given. (Table 2)

Table 2. Functional Elements of *Cyber Theater*

Items	Contents
Angle	Change Camera to any position.
Eye-point	Select any Actor's Eye-point.
Zoom	Change the size of pictures
Procession	Choose title or narration
Contact to an Actor	Touch any Actor by mouse.
Branch of a Tale	Insert the side stories.
Get photography	Capture any scene by mouse.

4. Details of PINOCCHIO

"PINOCCHIO" is a CG animation of the Fairy Tale for low-aged children. The reasons, which story was chosen, are as follows.

- (1) Beautiful Actors and Animals appear.
- (2) The story of Tales can attract children's interest.
- (3) Friendship and love are incorporated.
- (4) Morals are naturally accepted through episodes.

Table 3 shows the title of every scene, playing period (second), and the number of lines of *CTSL* scripting. And from "a" to "f" of the alphabet marks corresponds with Figure2.

Table 3. Detail of each scene of "PINOCCHIO"

Scene	Scene name	time	lines	Fig
1	Opening	16:00	28	a
2	The arrival of Pinocchio	17:00	43	
3	Pinocchio went to school.	31:00	32	b
4	In the puppet playhouse	46:00	54	
5	He met a fox and a cat.	01:25	107	c
6	Pinocchio told a lie.	01:05	65	
7	Geppetto went to sea.....	00:25	41	d
8	"Lazy country"	00:46	61	
9	Pinocchio became a donkey.	00:24	30	
10	Injury in the circus	01:16	73	e
11	Reunion with Geppetto	00:30	40	
12	Escape from a crisis	00:19	40	
13	Pinocchio turned into a boy.	00:29	39	f
14	After that...	00:57	59	
total		09:24	712	

5. Teaching materials developed by *CTSL*

"PINOCCHIO" is our 3rd product following "THUMBELINA" and "THE BATTLE OF A MONKEY AND A CRAB"(Japanese old story).^{[12][13]}

Both "THUMBELINA" and "THE BATTLE OF A MONKEY AND A CRAB" were developed by C++ language and various kinds of libraries (OpenGL,

Microsoft Speech API and MCI libraries).^{[18][19]} But it took great time to develop these. And producers had to be the experts of Computer Graphics and Voice synthesis.

In order to extend the possibility of this media for schoolteachers (To make good uses of *Cyber Theater* as a teaching materials, or to make a student's work in comprehensive study mainly for the upper grades children), we developed a Script Language to write a 3D-CG animation scenario easily. This language is named *Cyber Theater Scenario Language (CTSL)* which is a Tag based language just like a HTML.

We produced a scenario of "PINOCCHIO" by using it. In order to write easily, various kinds of function are developed. *CTSL* has 19 kinds of Tag Commands.

Table 4 shows TAG commands we developed. <TAG>command and </TAG> terminator define one block named Tag-Block. To make a CG animation scenario, each scene would be defined by placing Tag-Blocks in suitable positions. By inserting a Tag-Block into another Tag-Block, two or more Virtual Actors or any stage parts can be moved simultaneously.

Table 4. Commands of *CTSL*

<COM>	Specify the comment text.
<SCENE>	Specify the scene.
<CAMERA>	Set up the camera work.
<LENS>	Set up the field of view.
<STAGE>	Create the 3D virtual stage.
<ACTOR>	Create a 3D Virtual Actor.
<SCRIPT>	Display the subtitles.
<ACTION>	Playback motion capture data.
<MOVE>	Move the Virtual Actor.
<WAIT>	Stop between specified periods.
<MUSIC>	Play MIDI music file.
<SOUND>	Play the sound effect file.
<SPEECH>	Speak by the Voice Synthesizer.
<NARRATION>	Play MP3 narration file.
<ROTX>	Specify the Rotation of X-axis.
<ROTY>	Specify the Rotation of Y-axis.
<ROTZ>	Specify the Rotation of Z-axis.
<DEL_STAGE>	Delete the background stage.
<DEL_ACTOR>	Delete the Virtual Actor.



a) PiasArtist



b) BPN Encoder

Figure 3. Modeling tool and Action Encoding tool.

6. Details of CTSL Tag Command

(1) Voice Speaking by Synthesizer.

Virtual Actor can speak any text string by the Voice Synthesizer. <SPEECH> specifies the speech text for selected **Virtual Actor** by "ACTOR" parameter and <SCRIPT> displays any text strings on the Title Board.

```
<SCRIPT>Take care of yourself
<SPEECH ACTOR="FAIRY">Take care of yourself.
</SPEECH>
</SCRIPT>
```

The Title Board displays the specified text strings until the end of the speaking because </SPEECH> waits until the end of speaking.

(2) Narration

<NARRATION> plays MP3 wave file recorded by natural voice for narration.

```
<SCRIPT>Hello. My name is PINOCCHIO
<NARRATION>Hello.mp3</NARRATION>
</SCRIPT>
```

The Title Board displays the specified text strings until the end of the narration because </NARRATION> waits until the end of it.

(3) Camera Work

<CAMERA> specifies the Camera Work. It moves the Camera position step by step to new position (and new direction) within the Working time (See Table 5). If TIME = "0", Camera moves to new position instantly. But if TIME is integer number, it moves to new position smoothly. <LENS> defines the shape of view volume.

Table5 Switches of <CAMERA>

Switch	Value	Function
POSITION	PX, PY, PZ	New Camera Coordinate
ANGLE	DX, DY, DZ	New Aiming Position
TIME	Integer	Working Frames

(4) Body Action

<ACTION> specifies the body action by using the Action word written in the block text. Action word is extracted and converted to the filename of Motion Capture file name to play the sophisticated body action performance. Motion Capture file includes the sequences of transformation matrix assigned to the body joints. These can be designed and registered by Body Action Encoder. (See Figure 4)

```
<ACTION ACTOR = "Fairy">Angry
<SPEECH>I'm angry.</SPEECH>
</ACTION>
```

Virtual Actor "Fairy" plays the body action of "Angry" and speaks "I'm angry" simultaneously.

(5) Movement of the **Virtual Actor**

<MOVE> moves the **Virtual Actor** to any direction (See Table 6) with the body action by using the Action word written in the block text. Body action is the same as <ACTION> command. If TIME = "0", the **Virtual Actor** moves to new position instantly. But if TIME is integer number, **Virtual Actor** moves to new position smoothly.

Table 6. Switches of <MOVE>

Switch	Value	Function
ACTOR	Name	Select the Virtual Actor
POSITION	PX, PY, PZ	New Destination Coordinate
ANGLE	DX, DY, DZ	Body Direction
TIME	Integer	Working Frames

<ROTX>, <ROTY> and <ROTZ> commands specify the rotation of the **Virtual Actor** by the same way as <MOVE> command.

(6) The other Tag Commands

<SCENE> defines the global block which specifies one of scenes of story. Any scene can be selected by pressing the toolbar button by mouse click interactively.

<MUSIC> plays the background music by using MIDI file and <SOUND> makes the sound effect by using WAVE file. <WAIT> waits the specified time to hold the scene and <COM> defines the comment text for debugging the scenario.

Figure 4 shows an example of scenario using **CTSL**. As a result of this scripts, the scene of Figure 2 a) is animated.

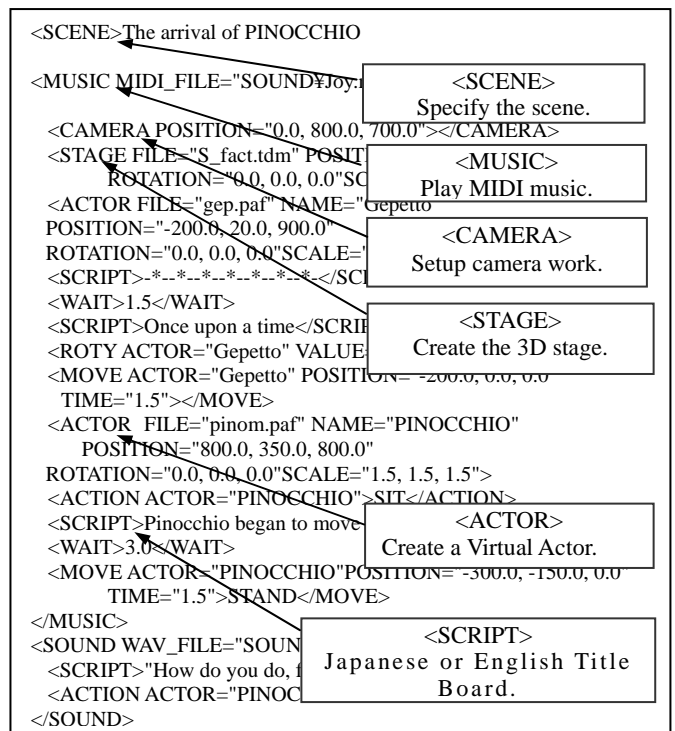


Figure 4. Example of the scenario by **CTSL**



a) Wizard of OZ



b) Peach Boy



c) Red Hood Girl

Figure 5. Screen Samples of fairy tales by using *CTSL*.

7. Teaching materials developed by *CTSL*

Cyber Theater has two utilization way. One is for low-aged children in the elementary school. It can be used as teaching materials instead of the picture books or the illustrated picture cards. During 1 year we have already developed more three stories: “Wizard of OZ”, “Peach Boy” and “Red Hood Girl”. (Figure 5) These scenarios of story are written by *CTSL*.

8. Creative Lesson by using *CTSL*

The other is for upper-aged children in the elementary school or pupils in the junior high school and high school. We would like to make use of it for the *Creative Lesson* like as follows.

- (1) Teacher supplies the sample *CTSL* scenario, and then students study how to use it.
- (2) Students try to edit or extend the sample *CTSL* scenario according to the teacher’s instruction.
- (3) Finally, students try to make their original CG animation story. Teacher may show some themes and they select one of them they want.

We made the sample *CTSL* scenario. Theme was “Traffic Safety of Cycling” developed for the experiment of *Creative Lesson*. Figure 6 shows the part of the sample scenario. Figure 7 shows the animation scene of it.



Figure7. Sample Scenario



Figure8. Creative Lesson

It took about one hour to make this scenario by Non-Expert collaborator. Figure 8 shows the scene of junior high school student’s *Creative Lesson* by using this sample *CTSL* scenario. Table 7 shows the contents of it. Each student made 2 or 3 modified CG animations in a short time.

Table 7. The quantity value of sample scenario

Scene	Scene name	Period	Lines
1	Opening	00:21	29
2	Meet friend	00:24	31
3	Violation of traffic rule	00:43	61
4	Reform	00:25	23
Total		01:53	144

Finally we supplied 35 *Virtual actors* those were developed for 4 Fairy tales: “PINOCCHIO”, “Wizard of OZ”, “Peach Boy” and “Red Hood Girl”. (Table 8) And we also supplied many stage parts. (Architectures, Plants and some tools)

Table 8. *Virtual Actors* for *Creative Lesson*

	Human Style	Animal, Monster or Robot
PINOCCHIO	5	2
Wizard of OZ	5	6
Peach Boy	8	3
Red Hood Girl	4	2
Total	22	13

As a final work of this lesson, students made their original CG animation. They used *Virtual Actors* and some stage parts they selected freely. It took only 1 hour to make their original stories. It is because the *CTSL* scenario can be re-usable. Different stories can be easily made. If some of stage parts are newly made, most of the *Virtual Actors* and stage parts may be usable without any change. Figure 9 shows the scenes of their original CG

```

<SCENE> Pinocchio's nose has grown
<SCRIPT>I'm sorry...
<SPEAK ACTOR = "FAIRY" >I'm sorry.</SPEAK>
<WAIT>1.5</WAIT>
</SCRIPT>
<CAMERA POSITION="1500.0,500,-2000"></CAMERA>
<ACTION ACTOR = "FAIRY">Magic</ACTION>
<SOUND WAV_FILE = "nose.wav"> </SOUND>
</SCENE>

```

- Title of scene is “Pinocchio’s nose has grown”.
- Subtitle “I’m sorry...” is displayed until the end of speaking plus 1.5 second.
- *Virtual Actor* named “FAIRY” speaks “I’m sorry”.
- Change the camera to the specified position.
- “FAIRY” acts the body performance named “Magic”.
- “Magic” is the entry name of Motion Capture Database.
- The sound effect file “nose.wav” is played.

Figure 6. Sample scenario of *Creative Lesson*



Figure 9. Student's original works

As a result, we are convinced that *CTSL* is appropriate for the *Creative Lesson* of pupils in the junior high school.

9. Conclusion

We have described the summary of *Cyber Theater* and *CTSL* we developed. We also reported the Fairy Tales developed by *Cyber Theater*. It took only 1 year to produce 4 long stories: "PINOCCHIO", "Wizard of OZ", "Peach Boy" and "Red Hood Girl".

And to investigate the validity of *CSTL*, we made the sample scenario for the *Creative Lesson* and did the experimental lesson with junior high school students. As a result, we are convinced that *CTSL* is appropriate for the *Creative Lesson* of pupils in the junior high school.

As a future research task, we are planning to investigate the effect of Fairy tales of *Cyber Theater* for low-aged children in the elementary school.

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