

NeGAS: Authoring System for 3DCG using extended turtle metaphor

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Abstract

A new type of Authoring System NeGAS for 3DCG animation is developed in which a user can easily manipulate three dimensional objects in 3DCG space on the computer.

This system is described using an object oriented three dimensional Logo language called o3logo developed by us. The user can manipulate objects comfortably with the help of the turtle metaphor by using o3logo programming, programming palette and hardware interface called "Kame (Turtle Controller)" developed by us. Objects, cameras, lights and turtle in 3DCG space can be manipulated by using turtle commands in our system, so DMI (Direct Manipulation Interface) for 3DCG animation is realized in our NeGAS (Fig. 1).

We have developed a visual action palette on o3logo, in which an user can manipulate them by cricking buttons on the palette instead of programming, to manipulate objects, cameras, lights and turtle in 3DCG space. We extend this visual palette to "o3Art" system by the adding several functions to form three dimensional body in 3DCG space to generate and form artful three dimensional object (Fig.3). About 600 users are using o3logo, o3Art and Negas in several Japanese universities, so we can refine the usability of our system.

This research has been supported by the Japanese national research project called Intelligent Cluster Creation Project.

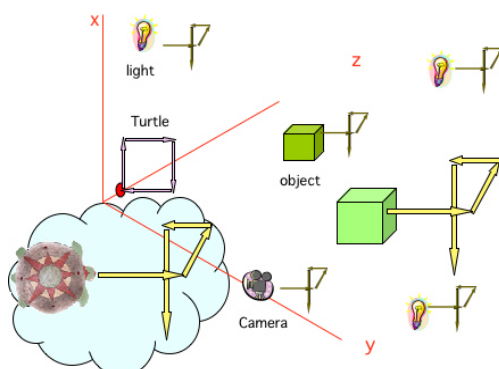


Figure 1. The Turtle Metaphor

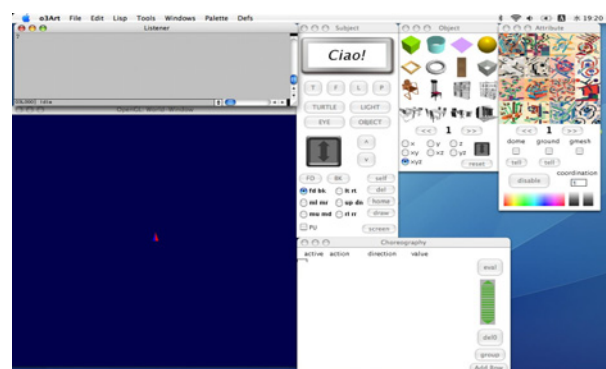


Figure 3. The whole aspect of o3Art system

Keywords

3DCG Authoring System, Object oriented 3D LOGO Language, The Extended Turtle Metaphor

1. Introduction

We propose a new type computer language and authoring system for 3DCG in this paper. There are many software packages for 3DCG creation, but they are different from each other. So, a user cannot obtain a unified concept and skill in their manipulation of these 3DCG software packages. That is one of the reasons why a confusion arise in game and amusement education concerning 3DCG software packages. (Tsushima, 2005) We deeply consider the origin of the defect of the ordinary 3DCG authoring system in Chap.4 and propose an object oriented Logo language o³logo as the base of a 3DCG authoring system called the Next Generation Authoring System (NeGAS) developed by us. (Tsushima et al., 2006)

We want to manipulate objects, cameras, lights by using the unified approach in 3DCG space (Fig.1). The Extended Turtle Metaphor proposed by us in this research may be promising to give a learner a unified approach for 3DCG.

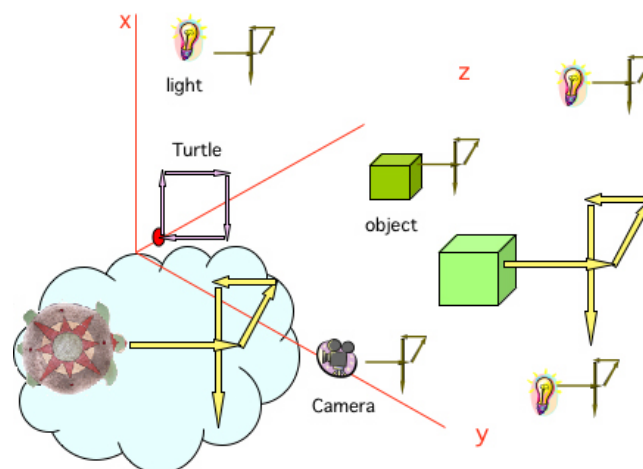


Figure 1. The Turtle Metaphor

At first, we developed an object oriented three dimensional LOGO language called o³logo on Macintosh common Lisp.

In order to create more sophisticated content, script is used frequently. But, in the ordinary 3DCG system the scriptive language does not have a kinematical nature but logical nature, so it is indirect for a learner who wants to move and manipulate objects in 3DCG space. We chose a Graphic Package Open GL for o³logo.

We can manipulate objects, cameras, lights and turtles by using turtle commands in our system, so the unified approach to manipulate them is possible in our o³logo.

As a result, the use of the Direct Manipulation Interface (DMI) for 3DCG creation was realized in our NeGAS. A user can use programming, programming palette to manipulate objects comfortably in 3DCG space with extended turtle metaphor in our o³logo. (Bowman et al., 2004), (Harvey 1997), (Lindsay and Norman, 1977)

This research project has been in progress five years as a national project called Intelligent Cluster Creation Project in Japan. (Tsushima et al., 2007)

2. Development of an object oriented Three dimensional LOGO language: o³logo

Two dimensional LOGO is frequently used in primary and secondary education in the world. It is known as an easy computer language to learn because of intuitive and interactive interface based on turtle movement. (Papert, 1980) Further, we can draw two dimensional figures and

three dimensional bodies on the computer by moving a turtle in 3DCG space using an ordinary three dimensional LOGO language such as 3D-LOGO. (Uni-Bynus 1989)

But we cannot move or manipulate a drawn figure in 3DCG space simulated on the computer. We developed an object oriented three dimensional LOGO language called o3logo (object oriented OECU logo) in which drawn figures and three dimensional bodies can be moved and manipulated like a turtle using turtle commands.

o3logo language was developed by us on LISP language at first. Parser of o3logo developed by us was implemented on CLOS of Macintosh Common LISP. (Tsushima et al., 2005)

The graphic function is very important to raise the capability of drawing and description of a visual event in o3logo. We chose Graphic Package OpenGL for o3logo after our deliberate discussion.

FD, RT, DN, MR, MU and **RR** are essential for turtle movement in three dimensional space in three dimensional LOGO language.(Fig.2)

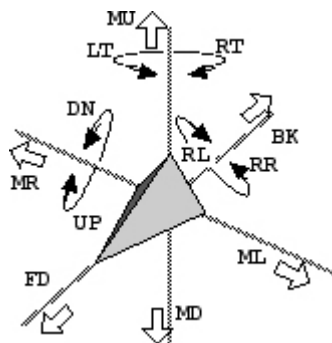


Figure 2. Turtle Commands of o³logo

2.1 creation of object

Any locus drawn by a turtle movement can be defined as an object by using **hold** <object name> command in o3logo. If we want to manipulate the defined object, we use **tell** <object name> command. Then this object can be manipulated by using turtle command.

2.2 grouping of objects

Many objects can be defined as a group by using **make-group** command. Any number of objects can be declared as a group. When this group is switched on using the **tell** command, we can manipulate this group like a turtle by using ordinary turtle commands. Hierarchical definition of group is possible in o3logo. About 120 commands are prepared in o3logo. An outline of commands of o3logo is shown in App.1

We can manipulate turtle, objects, lights and cameras using turtle commands supported by turtle metaphor in our mind. Eventually DMI for three dimensional animation can be obtained.

3. Visual Action Palette

Turtle metaphor strongly helps a user to move and manipulate objects in 3DCG space. On the other hand, we must create the form of a three dimensional body in 3DCG system. This creation is tried using the section prepared by a user or by the system in almost all the 3DCG system.

We want to develop a 3DCG authoring system helped by single metaphor; the extended turtle metaphor, to give our user DMI for 3DCG authoring. A user can produce three dimensional form using not only a section diagram but movement of object.

We realized this easily by using duplicate commands in o3logo programming.

As is well known, programming takes time and some creators do not like programming. So, we developed a palette system called the Visual Action Palette on o3logo. A user can quickly and easily make figures and three dimensional forms without programming but using our Visual Action Palette.

We developed a new palette system called Visual Action Palette on o3logo to form three dimensional bodies in 3DCG space. (Uni-Bynus 1989), (Tsushima et al., 2005) A user can make forms using successive applications of actions instead of programming in this palette system.

The Visual Action Palette has the following four palettes; Object, Choreography, Attributes and Subject (Fig.3)

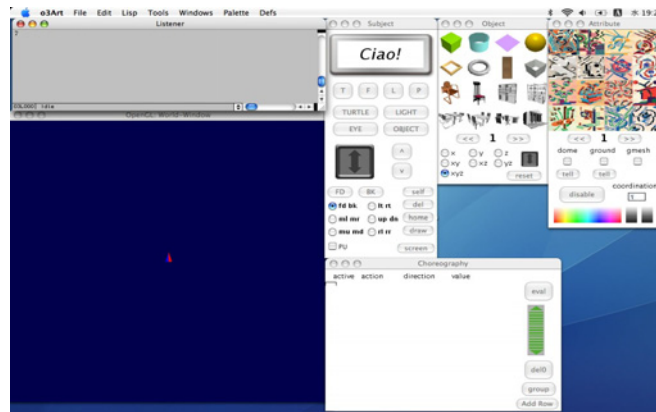


Figure 3. The whole aspect of o3Art system

3.1 Object Palette

There are about 40 objects in the Object Palette which can be used as an object in 3DCG space. (Fig.4) When an object is clicked on Object palette, it is generated on the World-Window as an object. The size and form of each generated object can be changed continuously by using a control arrow with a mouse. The rate of scaling for each direction can be changed continuously with a mouse by selecting appropriate radio buttons. Several 3D characters are prepared to create the content for daily life.

3.2 Attribute Palette

By selecting an appropriate registered pattern in the Attribute Palette, a user can paste it on the surface of the selected object. (Fig.5) As there are several hundred patterns and photos in the Attribute Palette, we can decorate an object and a background in 3DCG space very easily by using the above patterns and photos. And there is a color sub-palette to give selected colors to an object. Pattern and color can be overlapped, so we can change a color of patterns easily by using the color sub-palette.

3.3 Control Palette

We can move objects, lights, cameras and turtles in 3DCG space by manipulating the buttons on the Subject Palette. (Fig.6) When there are many objects in 3DCG space, we can select them by clicking the corresponding upward or downward buttons.

When we click an object button, the present objects are selected in cyclic sequence. We can confirm the present object by clicking a self button, because the figure of the corresponding object blinks in the window.

There are twelve turtle commands to manipulate objects in 3DCG space. We can manipulate an object by clicking the corresponding command button on Control Palette, then the object moves

with a fixed step defined beforehand. We can manipulate an object continuously with an arrow button by moving a mouse.

As quick response is obtained by using these buttons on the Control Palette to manipulate an object, a user can try several ideas on the computer very quickly. As a result, more effective and satisfactory results can be obtained.

We can change the views quickly by clicking T, F, L, P buttons. Therefore we can see the generated results from different view points in 3DCG system. Such a confirmation is frequently used in three dimensional space.

And the present scene from World-Window can be saved in disk by cricking a save button. This figure can be loaded by clicking a load button.



Figure 4. The Object Palette



Figure 5. The Attribute Palette



Figure 6. The Control Palette

3.4 Choreography Palette

We can manipulate an object in 3DCG space by using o3logo language. We developed the Control Palette to give a comfortable and quick manipulation method for a user. This palette is comfortable and convenient to move single object in 3DCG space. But, it can not be used in the following manipulation process.

- 1) Parallel complex movements of an object
- 2) Movement accompanied with modification of form, change of object parameter such as color and transparency
- 3) Parallel movement of object, light and camera

At first, we struggled with these problems using only o3logo language.

It takes a long time to create content by trial and error using programming. In these cases, step-by-step confirmation of scene using programming is troublesome. We wanted to prepare a quick and comfortable method for our user.

So, we developed the Choreography palette to improve this situation.

Even an expert of o3logo programming feels this palette is comfortable in his visual creation and strengthen his creation power.

We can manipulate an object according to parallel sequence of manipulation action by varying parameters in the Choreography Palette. In this case, the introduced decorated sphere moves forward and turns right leaving its copy behind. As a result, a bent cylinder is generated in this space. (Fig.7)

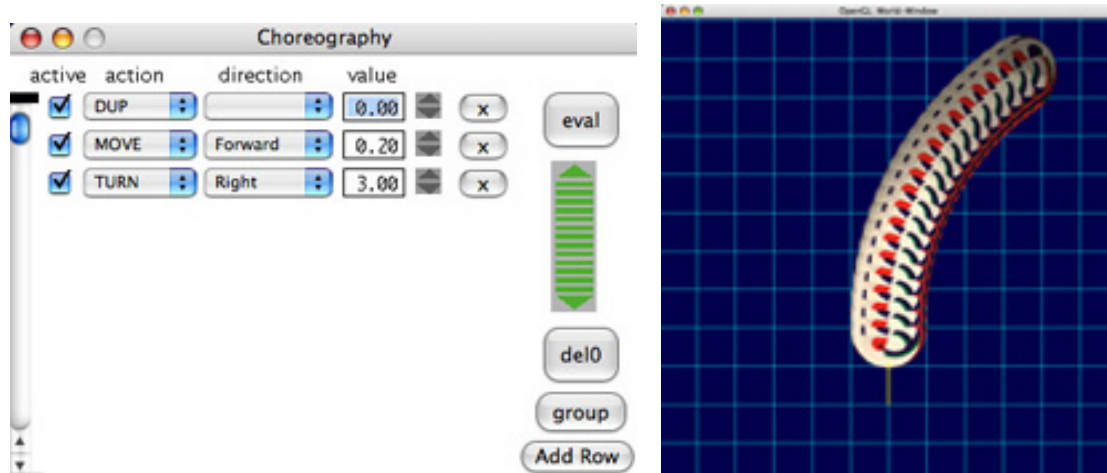


Figure 7. The example of Chereography Pallete

7 actions are prepared and several sub categories can be selected with appropriate value of parameters in the Choreography Palette. (Tab.2) Successive modification is possible by selecting appropriate ratio parameters. The generated body can be treated as a new object when a group button is clicked. Then we manipulate it as another meta-object in this Choreography Palette. So we can produce intuitively a complicated three dimensional body using this hierarchical function. (Fig.8)

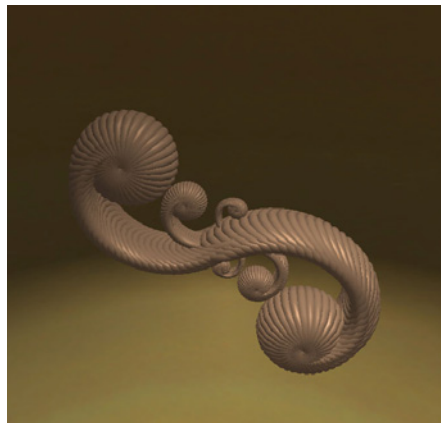


Figure 8. Content

We are aware that this Choreography Palette is really applicable to various visual creations.

At first, we can use a series of commands to move objects. So we added the following several functions to this palette.

- 1) Parallel description capability
- 2) Continuous changing parameter mechanism
- 3) To support movement , modification of the form, color, transparency

4) Simple assignment without commands

We can produce the three dimensional body of an object using this Choreography palette to move and duplicate original objects very easily and quickly. And we can assign systematic movement of objects to a check box without using the commands of o3logo language.

4. Educational Plan for 3DCG Creation using NeGAS

There is appropriate example of DMI for making figure with help of visual metaphor on the computer. It is LOGO interpreter developed by Papert.

The difference between the ordinary LOGO language and o3logo language developed by us is discussed in detail in the following.

Make (draw), see, recognize are important factors in manipulating the turtle to solve the problem in the ordinary 2D LOGO. They may be operators in human mind to solve problems concerning making content. (Tab. 1)

Ordinary 2D LOGO	3D LOGO	objective 3D LOGO
make	make	make
see	see peep	see peep lighten ditriute move leave
recognize	recognize	recognize

Table 1. Problem Solving Operator in Humanmind

In 2D space, all the produced figures can be easily seen by a user without thinking of the position of camera (eye), because the camera is fixed in the indefinite point. So, a user can easily recognize what is produced by himself by seeing the figure made on the CRT manipulating command. It is the origin of comfortability of the ordinary 2D LOGO language.

In a 3D LOGO language like 3D-LOGO, the figure produced by a user varies according to the position of the camera. So, a user must give care to the position of the camera in his manipulation. Therefore, harmony between make, see, recognize is destroyed, so peeping at the object is necessary to see the produced figure in the 3D space.

Therefore, a new strategy, such as move and peep the figure in order to recognize the meaning of produced figure.

In LOGO language and 3D-LOGO language, the drawn figure is fixed on the plane and space, and we cannot move it. If a user can move the drawn figure in 3DCG space, he can get an exciting experience in his creation. So, we developed the object oriented three dimensional language called o3logo in which the drawn figure can be moved.

We can manipulate objects, lights and cameras in o3logo language. And we can manipulate 3D turtle to draw figures in it.

A user must consider the effect of light and the position of camera to see the produced object in 3DCG space. And further, a user can move object in 3DCG space. And further, he can distribute

objects using turtle commands and duplicate command in 3DCG space systematically shown in Fig.7 and Fig.8.

So, users have many strategies to make objects and scenes using o3logo. In ordinary 3DCG software package, a user uses various strategies in a haphazard way.

To decrease mental load of a user in his manipulation, we must give a user a mental metaphor which allow him manipulate light, camera, object and drawing turtle in the 3DCG space in a unified approach. So, we extend the applicability of turtle commands to light, camera, object.

We call this concept "extended turtle metaphor". Because this control method drastically reduces the mental load of a user in 3DCG space, we give our user DMI for 3DCG with help of extended turtle metaphor as a result.

5. Conclusion and View

An authoring system for 3DCG called NeGAS is developed. It gives us comfortable manipulation and programming environment based on the movement of a turtle in 3DCG space. The form of three dimensional object can be generated using the movement of basic simple objects with help of turtle commands. So a unified approach is obtained for movement and making the forms of three dimensional objects with help of the extended turtle metaphor.

We developed other manipulation methods using a visual palette and hardware such as controller and electric pen for object in this research. The details are shown in reference 1, 2, 6 and 9. This is a special feature of our NeGAS in comparison with other advanced LOGO system such as such as FMSLogo.

But, It is not so easy to generate the motion of a object which has many internal freedom of motion even if o3logo programming is used. We developed a physical engine on o3logo and implemented it in NeGAS using coupled differential equations. Refinement of this engine is our future problem.

The extension of the Choreography Palette for many objects will give us the ultimate art tool for 3DCG and animation.

We have tested o3logo and Visual Action Palette in the actual education in our university for several hundreds of students. The student who does not have the knowledge of o3logo language can easily make many 3DCG contents using the Visual Action Palette.

We are encouraged by this fact to propose a national educational plan for 3DCG for students from elementary school to university student.

This research is supported financially by Japanese National Project called Intelligent Cluster Creation project.

Appendix 1. Commands of o³logo

o³logo has many command. The gross structures of command are shown in Table below. command about control of object is important to understand the feature of o³logo, typical example of object control command are shown in Figure 2.

Control	3
Turtle Command	18
Paint	8
Turtle Control	8
Pen Control	8
Object	6
Object Turtle	15
Parallel Execution	2
Grouping of Object	2
GLU Object	9
GL Object	7
Texture	5
Background	9
Material	5
Light Control	2
Animation	3
Time	9
Keyboard	26
etc.	45

Table 2. Commands of o³logo

Appendix 2. Action and subcommand in Choreography Pallete

The subcommands of each Action are automatically appeared cyclically by cricking each Action button.

Action	subcommand
dup	
move	forward backword rightturn leftturn upword downword
turn	up down right left
roll	right left
grow	x y z xy yx zx xyz
color	Hue Saturation Brightness

Table 3. Commands in Choreography Pallete

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