Modulobe: A New 3D-Model Creation Platform for Complex Motion Design

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Abstract. We propose *Modulobe*, a new 3D-model creation platform for complex motion design for supporting social creativity. Modulobe has two components: a 3D modeling application and a model sharing web site. The former is intended to achieve complex motion simulation of a 3D model and provide a user-friendly interface. The latter has a feature to show relationships between re-used models by embedding a global model-ID to all modules of a model.

1 Introduction

We propose a new 3D-model creation platform for complex motion design with high reality. As a 3D model creation tool, *SecondLife* [3] is gaining attention. Using SecondLife, a user can not only create a 3D model but also can buy and sell it. Complex textures can be put onto the surface of the model and program motion pattern of it. *Sodaplay*[2] and *Springs World 3D*[3] by Soda company enable users to create a model and share it via the internet. Waddoups has developed *Juice*[6], with which users produce a model and move it under the physical law constraints. In 1999, SCEI Corp. began selling Panekit [5]. Using it, a person can produce vehicles of various kinds such as cars, ships, airplanes and so on by combining square panels.

Those systems enable non-professional users to produce 3D animations. Nevertheless, we attempt to eliminate all realistic or graphical aspects and emphasize only the 'motion' of the model. We obtained suggestions related to the fact that one can recognize the object and its structure by the motion image of bright points on a black background [4]. Such an image sequence can be obtained using motion capture systems, which capture only specific small cubes on the subjects' body. In other words, we chose simple and non-graphical modules to create a model and enable users to design flexible and complex motions for each module. In brief, we try to develop a 3D modeling tool whose models move vividly and expressively.

Some problems are encountered when we design a model with such complex motion using existing tools. It is difficult for [2][3] to present rigid bodies because

[3] http://secondlife.com/

it uses a penalty method for calculation of physical simulation. Panekit [5] limits the variety of parts: a user cannot develop new parts. Juice uses *Open Dynamics Engine (ODE)* [4] which uses analytical methods. In this case, the calculation amount increases greatly when the number of parts is increased. Consequently, a user must use a small number of parts.

In this paper, we propose *Modulobe* [5] : a new 3D-model creation platform for complex motion design. Modulobe has two components: a 3D modeling application and a model sharing web site. The former is intended to achieve complex motion simulation of a 3D model and provide a user-friendly interface. The latter has a feature to show relationships between re-used models by embedding a global model-ID to all modules of a model.

The next section explains the Modulobe design. Section 3 shows our implementation of the modeling application, Section 4 shows the model sharing Modulobe web site. We present and discuss experimental results of a test installation in section 5, and conclude this paper in Section 6.

2 Modulobe Design

In the design of Modulobe, we are influenced by the fact that many people feel an original object by looking only at its motion. For example, motion capture systems using multiple cameras only detect cubes attached to a human body. The cubes are usually put on the ankle or waist, where the angles of the body components change. People cannot estimate the structure by looking only at a static scene. However, most people can recognize the structure from the motion image comprising only the bright points moving around [4]. Therefore, we decided to develop a platform to enable general users to create an articulated model with complex motion rather than particularly addressing the texture or shape of components. On the other hand, we are also influenced by Lego bricks (Lego Group). Users of the blocks are free to build any form with basic blocks in the Lego system. Originally, the small plastic bricks had only simple forms and little variety. However, users can create various models with a combination of those blocks. S. Papert attempted to develop an educational system using Lego blocks. Empirical results showed that a paucity of various prepared parts stimulates creativity of children [7]. Results showed that users emulate each other and mutually exchange ideas while developing their creative activity.

From these perceptions, we decided to provide a simple and small variety of basic components, which herein we call 'modules'. A user can create various models by combining the modules.

2.1 Module Design

A solid block like a Lego is appropriate for presenting shapes which have volume. However, it is difficult to present a shape which can bend like a hinge. Similarly,

[4] http://ode.org/
[5] http://modulobe.com

a flat panel makes it difficult to present a motion of a hinge. A stick whose cross-section is a circle or square makes it difficult to determine the direction of modules. For those reasons, we set the shape of a module to resemble a slender board.

Modules are of two types: shafts and links. A link connects shafts with various angles. Two types of link exist: static links and powered links. A user can add four shafts to a static link. A static link has a role of making a branch in a model. A user can add two shafts to a powered link and bend it. A powered link has a role of power of a model. A user sets the motion of a link by setting patterns of an angle of the powered link. A user can build a complex model which consists of many shafts and links in Modulobe.

2.2 Design of Simulation of Physics

Modulobe realizes simulation of the physical laws of the real world. A model that consists of the above modules obeys the laws of physics: gravitation, inertia, conservation of momentum, and friction with the ground and rebounding. An interactive interface is important for the use of the system. Therefore Modulobe's simulation engine is required to do real-time processing in a typical computer.

In a model, the only movable point is a link. Therefore, a motion of a model can be simulated using the penalty method. However, some problems can occur if we use only a simple penalty method for simulation [1]. Therefore, we propose an appropriate method for Modulobe.

2.3 Design of Interface

A user can create a three-dimensional shape on Modulobe. However, it is more difficult to develop a three-dimensional model than a two-dimensional model. Therefore we design an interface which gradually raises users' levels of creation. We take the approach of leading users to create a two-dimensional model first before creating a three-dimensional model. It is important to retain the same interface for both two-dimensional modeling and three-dimensional modeling. In addition, an intuitive and interactive interface is important for handling modules and programming each link's motion.

2.4 Model Sharing and Showing relationship among models

We develop the function of sharing models through a web site to stimulate distribution of models. A user can upload created models using the modeling application. Furthermore, anyone is able to download any uploaded model. A user can not only manipulate and view the downloaded models but also edit them for re-creation. The system covers all re-creation processes: downloading a model which is a creation of others, changing it, then uploading and sharing it.

It is important for creative activity to be influenced by others and to imitate them. Especially we think users will be greatly stimulated if their models are cited by others. For that reason, we implement a function to the model sharing site to show such parent-child relationships. We designed a system to be able to track such relationships by setting a unique model ID to all modules.

3 Implementation of Modeling Application

Modulobe is implemented in Visual C++ with DirectX 9. It consists mainly of a physical simulation engine and a user interface in which a user edits and sees models. We developed an optimization method of physical simulation for widely distributed computers to tolerate the large calculation burden for this complex motion model and its user interface to navigate intuitively and gradually and develop their skills.

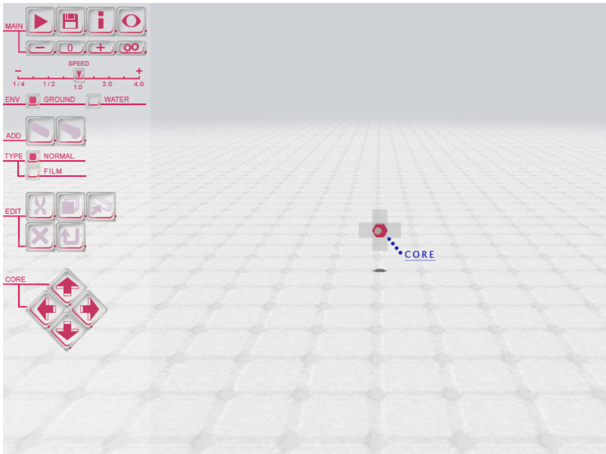

Fig. 1. Screenshot of the start-up.

Modulobe has two modes: Edit mode and Play mode. In the edit mode, the user can create a body structure by connecting modules and can set motion of the virtual creature by simply specifying a change of the angle of hinges. In the play mode, the user can test models by running.

Figure 1 is a screenshot of the start-up. At that time, Modulobe is in edit mode. Users can change the mode using the menu.

Edit Mode A model consists of many parts called "modules". Two module types exist: a "shaft" and a "link". In the edit mode, there is only one special shaft, called the "core" at the beginning. A user generates a framework of a model by connecting modules to core. A model has a tree structure whose source node is core.

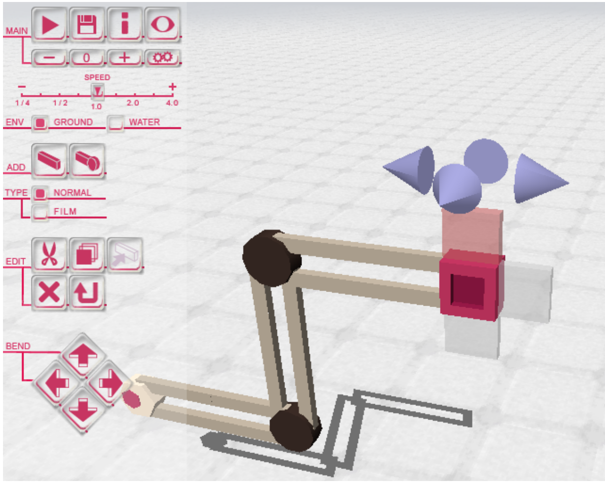

Fig. 2. Menu for a guide. A user can add new shafts. Four blue tetrahedral are controllers for changing the angle.

Each module has some guides to add a new module. When a user clicks one of them, a new module is added to the point which is indicated by the guide (Fig. 2). Thereby, a user adds a new module to the core and constructs the whole shape of a model.

A user can change the angle of connection by clicking a connector between modules (Fig. 2). A range of the angle of direction of rotation is free but an angle with a neighbor module should be less than ±45. A range of the angle of direction of folding is ±45. A step angle is ±45. A user can create three-dimensional shapes.

In addition, the viewpoint of the first time of edit mode makes a user looks the side of a model (Fig. 2). A user can create two-dimensional shape if she/he does not bent connectors to the direction of depth. It is a good training for a user to create models because to create two-dimensional shape is easier than three-dimensional shape.

The direction of rotation of the center of the link is only one direction. The axis of rotation stands vertically on the flat which the link module is in. When a user clicks a link, the system shows a graph, which shows a pattern of bending of the link (Fig. 3). The vertical axis of the graph is time. The horizontal axis of the graph shows the angle of the link. The step angle is ±15 and the maximum angle is ±90. In addition, a user can change the mode which allows a link to be rotated 360 °.

The top and bottom of the timeline are connected. The cursor repeats scrolling from the top to the bottom. The slide bar in the right side is the controller for a cycle of motion of an angle. The default is one cycle per second. The angle

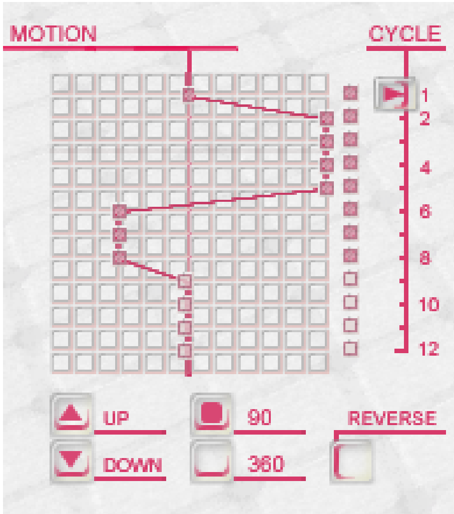

Fig. 3. Menu for a link. A graph shows a pattern of bending of the link.

that is set up in this controller is the target angle. In the play mode, force is added to modules to be the target angle. Therefore, a module cannot reach the target angle sometimes. For example, changes of target angles are too tight and the target motion is counter to the force of gravity.

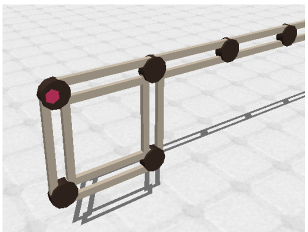

Fig. 4. Expand mode is off.

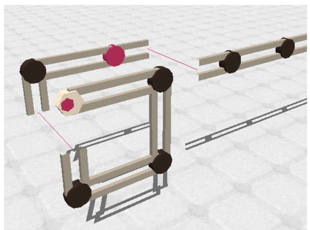

Fig. 5. Expand mode is on.

As described above, the user can create a body structure by connecting modules of two types: shaft and link. The user can set the motion of the model by simply specifying a change of the angle of hinges.

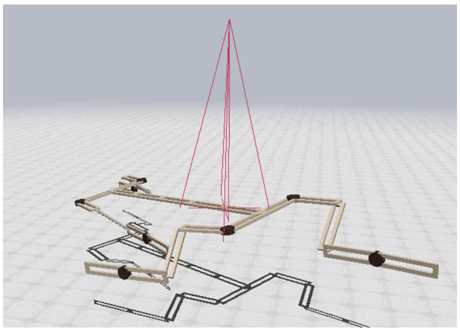

Fig. 6. Bringing up the model.

Play Mode In the play mode, a user can see animated sequences of model poses. The playground consists of a flat ground which has no wall, no obstacles, and no change. Users can apply an arbitrary force to the models using drag and drop processes. Users can bring up models by scrolling the mouse wheel (Fig. 6). Users can control the speed of operation of models using the speed control slide bar on the upper left of the screen. Users can see the relationship among the change of speed and the change of motion of models on experiment.

3.1 Model Sharing Capabilities

Users can upload a model and an introduction movie which they can produce through the system. Users can easily make an introductory movie of the model on the play mode. Anyone can freely download or upload a model from the web site. The system has functions to download several popular models at a time and generate slide shows of them. Users can modify downloaded models on the system. Users easily change from the play mode to the edit mode.

Each model has a global unique ID. Furthermore, each module in a model has a model's ID. Using this architecture, we can trace a relationship among source models and modified models on the web site.

For example, a new module in model A has model A's ID. The module continues to have model A's unique ID when a user copies and pastes the module from model A to model B. We can find a relationship among models by checking the module ID.

4 Conclusion

We proposed and developed Modulobe, which is a new 3D-model creation platform for complex motion design for supporting social creativity. A user can create a body structure by connecting modules of two types: shafts and links. Furthermore, the user can set the motion of the model simply by specifying a change of the hinge angles. The user can upload created models to the sharing web site. In addition, the user can download others' models, then modify and upload them again as their own creations. The system can trace such re-creation activities and display the parent-child relationships among models because the system assigns a global model-ID to all modules of models. For that reason, everyone can view relationships of reuse of each model on the model sharing web site.

In future studies, we would like to solve the mistakes in tracking of re-creation processes so that a user can emulate other' model without copying and pasting.

Acknowledgments

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