ZOOO: A Multi-animatronics Stage to Enhance Children's Creativity for Storytelling

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Abstract
This paper presents an animatronic stage to encourage children to be more creative in storytelling. ZOOO is a multi-animatronics stage that can control several animatronics simultaneously. It enable displacement of animatronics and make interaction among animatronics much more plentiful. Our user evaluation shows that ZOOO can enhance children's creativity and broaden the stories they can tell while making animatronic shows.

Keywords
Animatronic, Storytelling, Education

ACM Classification Keywords
H.5.2 User Interfaces: Interaction styles. I.2.9 Robotics

Introduction
More and more educational institutions begin to offter Animatronics classes. Comparing to traditional hand puppets show and marionette show, children can learn how to build mechanisms and program motions except writing stories and voice performances in animatronic shows. These courses blur traditional lines between arts and technologies. It is helpful for children to adapt modern employment, which required mix skills [1].

Figure 1. ZOOO with stage sets

However, there are many challenges for animatronics classes. Lots related works have been done to explore how to solve them. Ono [2] is a DIY friendly toolkit for making robot with facial expression. Mirror Puppeteering [3] proposes a way to author motions by simply moving an animatronic's limbs in front of a webcam. Interbots [4] aims to create interactive characters that can respond to changes automatically and provide a easier way to use the platform for interdisciplinary people. Pelo [5] provides a mixed physical and digital authoring environments to create stories which respond to the children's drawings and their touch.

But in all these researches, animatronics can barely perform displacement, which is a significant limitation compared with traditional puppets show. When writing story, children have to consider this limitation, which restricts children's imagination. As a result, the animatronic shows may lack interaction among animatronics and become more like talk shows . Although there are some animatronic shows in which animatronics can actually move on rails in amusement park like Walt Disney World, the tracks are often fixed and can only be used to play one special show. Our design provides children a multi-animatronics stage where animatronics can perform displacement. We believe that children can be more creative while making an animatronic show if animatronics can shift.

DESIGN

We aim to design an effective and user-friendly storytelling toolkit of multiple animatronics in which animatronics can perform displacement.

Compared with single-character animatronic show, multi-character animatronic show has less limitation and more possibilities on stories children can tell. When there is only one role on the stage, the story may be simple and dull. However, when multiple characters exist, relationships and interaction in the story can be much richer. Conflicts and twists of story can be created more easily in a multi-character system.

Multiple characters staying on a stage simultaneously means abundant positional relationships. For example, if there are two characters on stage, they can stand side by side, face to face, face against back and etc. And when they perform displacement, it can be one walking away from another, one turning back on another, one chasing another and etc. And each positional relationship can imply more than one type of interaction among characters depending on the scenario. For example, when one character turns back on another character, it can stand for one character getting angry with another or one character saying goodbye to another.

Furthermore, if we take the stage sets into consideration, even more positional relationships can be created. Utilizing relative ubiety among stage sets and characters, we can make it possible for characters entering and exiting the scene or even scene changing.

PROTOTYPE

We design ZOOO, a multi-animatronics stage (Figure 1). The hardware of ZOOO consists of three branches, three rotatable panels, one rotatable base (Figure 2), one Arduino Leonardo board, one servo control board, 23 servos and a power supply system. Branches are 3D-printed skeletons. Each branch has 5 degrees of

freedom: the head moves upside and downside, the mouth closes and opens, two hands move upside and downside and the body turns around. One branch is attached to one panel eccentrically. Branches can be removed from the base easily and users can replace them with their custom skeleton. All three panels are installed on the base. Each panel has one rotational degree of freedom. So does the base. Together, they enable displacement of branches. Each branch itself can rotate and can also rotate with the panel and the base, which enable the branch to move to almost everywhere of the stage. Considering there are three branches, numbers of positional relationships exist. The Arduino Leonardo board receives instructions from the computer and transmits them to the servo control board. The servo control board controls movements of servos according to those instructions.

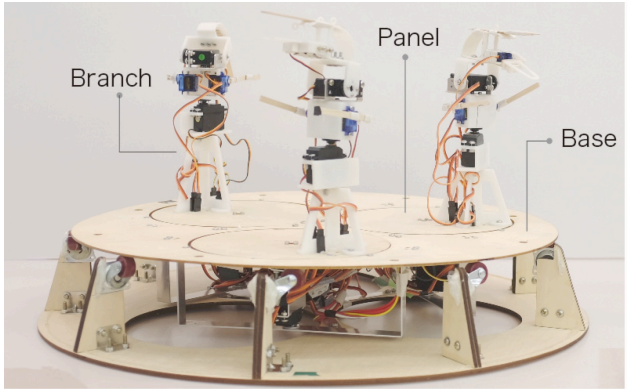

Figure 2. The branches, the panels and the base of ZOOO

We develop a timeline-based software, which integrates story creation and modification functions (Figure 3). The software mainly consists of 4 parts: Preview Windows, Control Panel, Timeline Dashboard and Editor Button Dashboard.

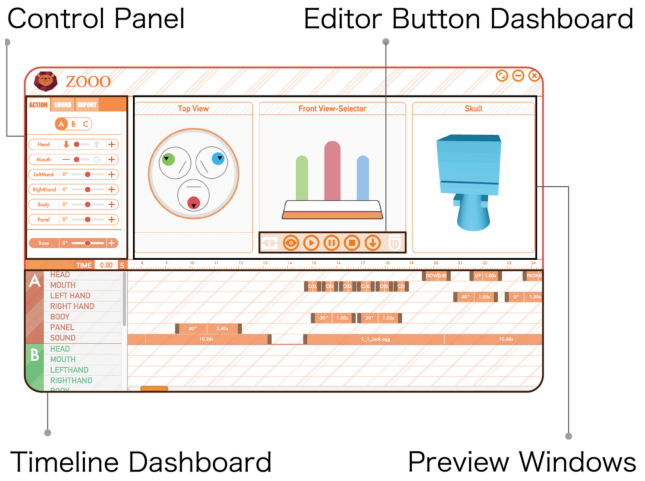

Figure 3. The supporting software of ZOOO

Preview Windows provides dynamic abstract top and front views of ZOOO and dynamic abstract 3D model of each animatronic. Users can select which animatronic to edit in front view window. Control Panel includes Action Dashboard, Sound Library and File Library. Control Panel provides functions of authoring/inserting motions, inserting sound files and importing/inserting saved motion files. Users can select and edit motion blocks in Action Dashboard, then insert them to the timeline. The appropriate motion range of each motion block is preset. User can upload pre-record sound files into Sound Library, then insert them into the timeline. File Library shows all saved files in selected document folder. Users can select one saved file and insert it to the timeline. Timeline Dashboard allows user to add,

adjust and remove the motion or sound blocks. Corresponding to degrees of freedom of ZOOO, there are 5 tracks for each branch, 1 track for each panel and 1 track for base in timeline. Besides, there is one more track for audio. Editor Button Dashboard provide 7 control buttons: connect to hardware, play (preview), play (hardware), pause (hardware or preview), stop (hardware or preview) and clean up. Users can press play (preview) to revise the show before connecting to hardware. The hardware can be connected software through serial port. We use a synchronous communicating way between software and hardware. Transmission of instructions as soon as the play (hardware) button be clicked.

PILOT STUDY

A user study was done with ZOOO. Two middle school (grade 7) students and one high school (grade 10) student are asked to create animatronics shows with ZOOO separately. We provide 3 animatronic characters to them: a lion, a tyrannosaurus, and a triceratops. We also offer them some materials such as construction paper to make stage sets if they want to.

First we told the student to keep animatronics in their original position and asked him/her to create a show. Then we told the student that animatronics can perform displacement and asked him/her to create another show. It turns out that, after being told animatronics can shift, students tend to script longer and more complex stories. They also show more interest in authoring motions of animatronics and spend more time in it than before. Thus the students scripted lots of interactions between animatronics in their shows. Such as the tyrannosaurus chasing the triceratops, the tyrannosaurus and the triceratops playing hide-and-seek and even a dance involved all of three animatronics. In addition, one student begun to make more stage sets. He made a big double-faced background and attached to the rotatable base to achieve scene changing.

There are also some limitations that need to be addressed for a future version. First, the software and hardware are not very stable right now. Then, although the high school student has no problem using the timeline based software, middle school students feel that it is not intuitive enough. We plan to develop more nature and simpler user interface for the low age. We mention that student spend more time in authoring motions. After the interview, we find out that it is not only because they become more interested in it, but also because the motions become more complicated. This is an inevitable result as more freedom are introduced. But this problem can be mitigated by offering better preview and presetting motion blocks in software.

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