Visualization and Authoring System for Robot Based Performing Art

Dongwook Lee¹, Jinsul Kim², Minsoo Hahn¹

¹ Digital Media Lab., Korea Advanced Institute of Science and Technology, Daejeon, Korea
aalie@kaist.ac.kr
²School of Electronics and Computer Engineering
Chonnam National University
Gwangju, 500-757 Republic of Korea
jsworld@jnu.ac.kr

Abstract. Recently, robots start to be used for the purpose of the dancing or performance. Because a robot can make a scene that cannot be performed by a human actor and its reusability reduced the cost and time of performance, the robot based performance are getting the spotlight in the field of performing art. This study purpose a system that visualizes the motion of the robot based on 3D virtual environment and provide robot control functionalities. The proposed system sends user created motion to the real robot in real time and provides the functionality of virtual robot assembly. The functionalities of the system were confirmed by applying the system to a performing robot.

Keywords: Performance, Authoring tool, Robot motion, Virtual environment

1 Introduction

With the advance of robotics technology, the robots are being widely used in various fields. Recently, in the field of performing arts, the robots are becoming one of important actors. Many of researchers studied and proposed systems for performance [1-6]. And several studies have focused on the robot assisted performance [7]. However, most of the studies were focused on the specific types of robots. In this paper, we propose a system that can author the motion and visualizes the motion and appearance of the robot. The proposed system controls robot object in real-time and provides assembly functionalities with module robot parts.

Detail of the proposed system and implementation will be shown in section 2. The experimental results will be shown in section 3. Finally, we draw conclusions and suggest future work in section 4.
2 System Design

The structure of the authoring tool is consisted of three main parts: robot control, robot assembly, and robot visualization. The robot control is about the control functionalities such as joint control and communication protocol. The robot assembly concerns about the relation between joint objects which is basic components of the robot object, and assembly of them. The robot visualization literally visualizes the appearance of the robot based on the 3D virtual environment. Fig. 1 shows the structure of the system with its components.

![Fig. 1. Structure of proposed system](image)

一般地，运动机器人的运动是根据关节部分的电机角度来决定的。所提出的系统将机器人看作是关节的组合，并且每个关节都有自己的ID和自由度。机器人是根据关键帧结构来动画的。当用户决定关节物体在关键帧他想要的角度时，关键帧之间的角度值是自动插值的。为了提供更精确的控制方法，运动可以控制与Bezier，Spline，Linear和Stepped线控制类型。

用户可以结合关节物体来制作一个独特的机器人结构。每个关节物体都有其可用的连接数量。虽然有些物体可以连接到其他关节，有些则只有一个或两个连接资源。下一个图显示了关节结构的抽象。

![Fig. 2. Joint object](image)

在图中，(a)显示了关节物体本身，而连接到矩形的线显示了可用的连接。线在(b)中表示了关系。
between joint objects with the angle limit of the joint object. The combination of the joint objects formed as a hierarchical structure. Therefore, if the root node moves, every connected node will also be moved.

The robot in the proposed system was rendered with 3D virtual environment. For the visualization, the 3D model data were assigned to the joint objects. Every 3D joint object contains its own 3D information which represent the position, rotation, and scaling in 3D environment.

The proposed system was implemented with C# using Visual Studio 2010. The communication between system and robot was established with serial communication and the rendering of the robot was performed with Direct3D library. In order to provide more improved visual information and reduce the render processing time, high level shading language was utilized with vertex and pixel shaders.

3 Experiments

The proposed system was examined with the small sized robot named 5720T which was manufactured by Robobuilder [8]. 5720T supported serial communication and is able to be assembled as the user wants. Firstly, we constructed a structure of 5720T with joint objects. Fig. 3 shows the abstract of the joint structures of the robot.

![Fig. 3. Joint structures of experiment robot](image)

The assembled virtual 5720T consists of 21 joint modules with the root without degree of freedom. From the root, four joints objects were spread: Chest joint 1, 2,
Pelvis joint 1, and 2. In order to examine the assembled 5720T with the real 5720T, we generated several motions, and applied them to both of 5720Ts. Fig. 4 shows the results of the motions. The motions were sent to real 5720T and virtual 5720T at the same time and the delay between motions was less than 0.001 second.

5 Conclusion

In this paper, we proposed a robot control system for the performing art. The proposed system provides functionalities including control, assembly, and visualization of the robot. The proposed system was tested with a small sized manufactured robot and it showed its usefulness for the motion control and visualization.

Our future work is to control several robots at the same time. The time delay will be an obstacle of the research, therefore we are investigating efficient time slice control.

Acknowledgments. This research is supported by Ministry of Culture, Sports and Tourism (MCST) and Korea Creative Content Agency (KOCCA) in the Culture Technology (CT) Research & Development Program.

References

1. Yvonne Jung, Sebastian Wagner, Christoph Jung, Johannes Behr, Dieter Fellner,: Storyboarding and pre-visualization with X3D, Proceedings of the 15th International Conference on Web 3D Technology, 2010, pp.73-82
2. Angelos Yannopoulos,: DirectorNotation: Artistic and technological system for professional film directing, Journal on Computing and Cultural Heritage, 2013. 03, Volume 6 Issue 1