Abstract—This paper presents a dual arm motion control method of a humanoid robot based on motion capture technique using a Microsoft’s Kinect. A method of imitating a human’s motion can be applied to various areas of tele-robotic applications due to its intuitive operation and convenience. Therefore, we propose and develop a prototype of remote motion control system which uses data captured from a depth camera and controls the joint angles of motors of dual arms of a robot by a human gesture based on motion capture method. In experiments, we successfully demonstrated dual arm control of a robot using the proposed motion capture based method.

Keywords—Motion Capture; Robot Motion Control, Humanoid Robot, Kinect;

I. INTRODUCTION

A robotic system to control a remote robot more conveniently and intuitively for various areas of application and the resulting various demands of users is thus required [1]. However, the current robot control methods are basically limited in their manipulation methods, and suffer from resultant inconveniences; e.g. users have to learn new interfaces for operating robots.

Thus, we propose a control method for existing complex robots and develop a robot remote dual arm control system employing the user’s arm gestures as an interface. As a way to improve the existing control methods, a contactless motion capture method is proposed for convenient and intuitive control by the user’s physical actions instead of a separate controller.

II. DUAL ARM MOTION CONTROL SYSTEM

A dual arm motion control system for a humanoid robot is configured as shown in Fig. 1. The system carries out joint value extraction from user skeleton data captured from a Kinect. The system then controls the motors of the dual arms of a humanoid robot in a Windows application. The processing flow consists of skeleton tracking of user, conversion to joint angles in 3D coordinate, generation of motor angles from joint angles, data communication and motion control.

We used a humanoid robot called Mokwoni, developed by the Department of Intelligent Robot Engineering in Mokwon University, as a test bed to apply and test the proposed method [2].

Fig. 1. Configuration of a dual arm control system for a humanoid robot

Fig. 2. Configuration of a dual arm control system for a humanoid robot
freedom in total including the gripper. We used a smart actuators, DYNAMIXEL EX-106+, RX-64 and AX-12A from Robotis Co. to develop the arms of our humanoid robot [3].

III. MOTION CONTROL METHOD USING KINECT FOR A FOR A HUMANOID ROBOT

To implement movement of the robot arms in real three-dimensional space, a program to find the angle value in the 3-D spatial coordinates of the user’s arm should be implemented. If the positional values of the joint point as skeleton data are obtained using Kinect, the values on the three-dimensional coordinates can be obtained, based on which the angle values should be calculated. For this calculation, the joint vector of the relevant position is projected to a plane, as shown in the left side of Fig. 3; then through the inner product of the two vectors, the angle between the two is found [4][5].

For the shoulders, 2 degrees of freedom should be extracted, 2 planes in pivot directions are respectively set, and the projected angle between the vector and the joint vector is calculated. For the elbow angle, the positions of joint points among the shoulder, elbow, and wrist are obtained as D1, D2, D3 in the right side of Fig. 3.

For smooth control of the robot motion, a unit interval should be given to send motor angles periodically. The target angle is then divided into angles between the initial angle and target angle by using interpolation technique [6].

Fig. 3. Calculating joint angles from Kinect Skelton Data

IV. EXPERIMENTAL RESULTS

We developed application software to process the depth data captured from Kinect and to control the robot’s joint motor. The software consists of a window form monitor to set each joint angle value of the robot arm and a window that displays the current angle of the motor based on a .NET Framework 4.0. It was developed using Microsoft Visual Studio 2010 and runs on a Windows PC.

The rotational angle for each joint of axes X, Y, Z of the user’s arm is set to the angle of the motor corresponding to the human joint, and in the Windows application program developed in this study, a system that controls the motor was implemented in RS-485 and RS-232 serial communication.

From the results of the test, the angle value of the user joint was calculated and displayed with the positional values of each joint point of the user read from Kinect through the Window application program developed in this study, and using cosine interpolation, each joint of the robot was controlled and the humanoid robot dual arm was successfully controlled, as seen in Fig. 4.

Fig. 4. Motion Control Experiment using Kinect with a Humanoid Robot

V. CONCLUSION

This study, we proposed a dual arm motion control method of a humanoid robot based on motion capture technique using a depth camera, Kinect. We also develop a prototype of remote control system to implement a contactless motion control system and demonstrate it with our own humanoid robot to verify the usefulness of the propose system.

The robot’s arm and the user’s arm have different length, and there is a limit to produce the same position of the motor, that is, a robot joint, in correspondence to human motion. Thus, for more precise control, studies on feedback of the robot joint angle value using kinematics and the resulting posture correction have been performed, and research on the human arm and the hardware design structure of robot arms should follow. We’re developing a method of adjusting postures by supplementing this problem as a future study.

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