Development of a 7-DOF Robotic Arm Tele operated by a Haptic Feedback Device

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Abstract

The project proposed by Dr. Ryu entailed to solve the problem of how to teleoperate a 7 degree of freedom robotic arm with a haptic feedback device. Teleoperation, or Telerobotic, still plays an important role in many robotics application. As a typical Teleoperation system comes as a master-slave pair, where the operator on the master side can operate the robot on the slave aside from a remote location.

Figure 1: Robotic Arm with multiple joint angles

Introduction / Objective

1. Construct a model of an operational master-slave robotic system.
2. Manipulator arm receives the data from haptic device.
3. Follows it to act as a virtual haptic device.

- Determine whether to obtain additional data from haptic device.
- Manipulator receives the second data to follows the haptic device.
- The manipulator generates the display of it.

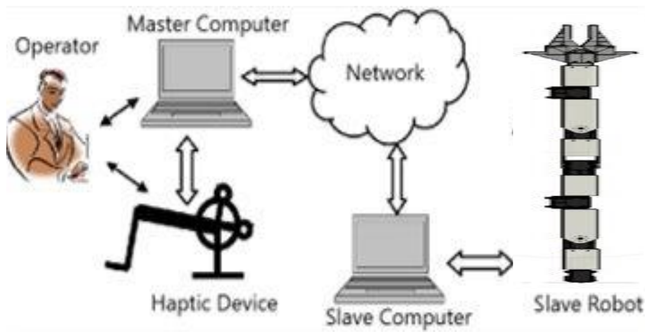


Figure 2: Communication between Slave Robotic System and Haptic Device

Methods and Materials

The Control System

The Touch™ connects directly to the computer being used. It is necessary for the system to work because the computer reads the data given from the Touch™. The microcontroller is directly connected to the robotic Arm. The microcontroller then sends the stored data to each individual motor. A program then converts the haptic device's data into data the is given to each motor to mirror the motion of the haptic device.

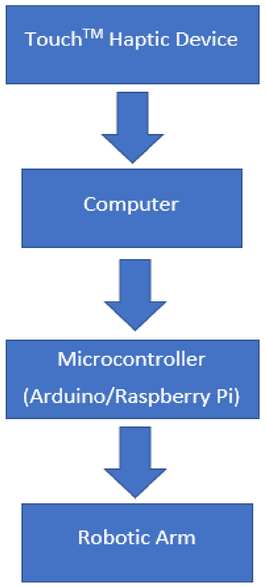
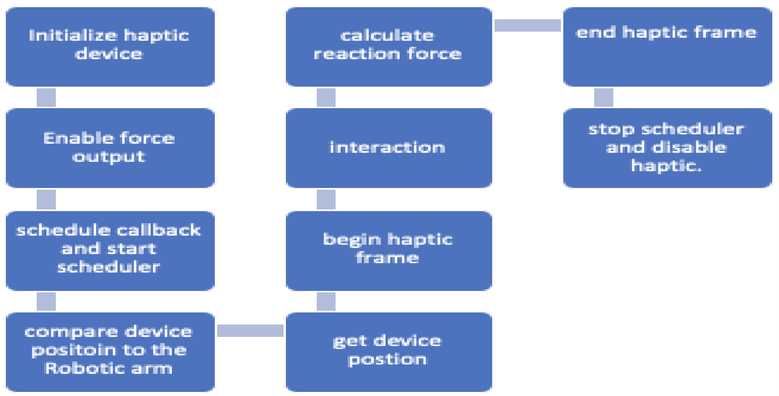
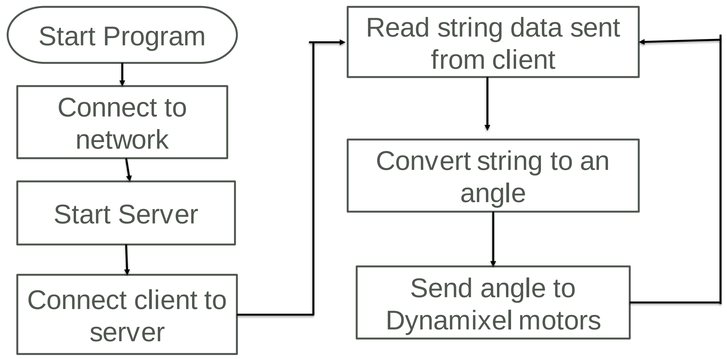


Figure 3: Control System

Haptic Device Programming



Arduino Programming



Discussion / Result

$$T_7^0 = \begin{bmatrix} 0.5245 & 0.5328 & 0.6641 & -175.0480 \\ -0.7745 & 0.6225 & 0.1123 & 79.7265 \\ -0.3536 & -0.5732 & 0.7392 & -32.7494 \end{bmatrix}$$

$$O_7^0 = \begin{bmatrix} -175.0480 \\ 79.7265 \\ -32.7494 \end{bmatrix} \qquad O_2^0 = \begin{bmatrix} -261.1103 \\ 65.1744 \\ -128.5495 \end{bmatrix}$$

$$R_7^0 = \begin{bmatrix} 0.5245 & 0.5328 & 0.6641 \\ -0.7745 & 0.6225 & 0.1123 \\ -0.3536 & -0.5732 & 0.7392 \end{bmatrix} \qquad O_2^0 = O_7^0 - R_7^0 \begin{bmatrix} 0 \\ 0 \\ d_7 \end{bmatrix}$$

The T07 is Transformation matrix of the robotic arm which was calculated by using the principle of kinematic decoupling of Inverse Kinematics. The position and Orientation of the robotic arm could be considered independently. From the Transformation matrix, it is easier to find the Rotational matrix (R07) and Orientation matrix (O07).

Conclusions

The project presented the proposal of a teleoperation technique, which is highlighted by the Touch™ haptic device to control a 7 DOF robotic arm cohesive with a vision tracking system. For the improvement, a unique sort of servo motor is used called DYNAMIXEL and haptic feedback likewise a raspberry pie 4 model B desktop kit will be utilized to an interface device for the arm. The master arm is the manipulator that generates the commands that are given to the remote manipulator, also called the slave arm.

Acknowledgments

We would like to express our thanks to Dr. Ryu, and Witenberg Santiago with the Department of Mechanical Engineering at Northern Illinois University who provided us with resources and insight to help make this project possible.