Haptic Robot Assist for Path Manipulation in V-REP Simulation

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ABSTRACT – Across the modernizing of technology, some of the common works in human daily life can be assisted by robots. Sportsmen, physicians and factory workers are groups of target people that getting the perks from this. Preceding researchers have studied numerous kind of complex techniques about robot assist. Inspired by basic haptic and vision system, we come out with a simpler method for tracking object movement in different directions. The robot will follow the position of the object according to camera images. In early findings, youBot is able to maintain the path movement of the object despite in different directions.

1. INTRODUCTION

Haptics is a type of science whereby it gives kinesthetic impact that makes the user/receiver feels with the interaction. In everyday tasks, humans touch sensory received the tactile and kinesthetics cues from the environment. Whenever the interaction or touch occur between the user and the object, it gives impact even a slight force. In industrial area, the development of haptics technology and applications are likely to be employed for cultivating the industrial works especially for line assembly and productions. Currently, robotic arms in production line has been commercially used by manufacturers as it increases the efficiency and productivity of the productions' size. Haptics also can be applied in medical works as in clinical stroke applications or rehabilitation for the patients' injury from accidents as stated in [1-4]. The training works out in bimanual exercises whereby it applies haptic rendering in path manipulation. Mansor et. al [5] found that patients are guided to reach different goals, complexity and essential movements until the completion of the clinical therapies.

However, most of the existing studies presented complex designs and ideas for tracking object movement and at the same time working on haptic part. To cut the cost and shorten the time spent for working on the project, we introduced a simple study using robotic simulation platform known as V-REP software to see whether the ideas can be applied on multifunction KUKA youBot and also for clinical exercises and rehabilitation without assistance from human trainer.

The structures of this paper are break down accordingly in different sections. Section 2 is about how the experiment conducts while results and discussion are explained in Section 3. Lastly, Section 4 concludes about this study.

2. METHODOLOGY

The experiment carried out was setting in simulation using V-REP software and Python. To develop a simple haptic working system, KUKA youBot is chosen as the haptic device. Haptic system comprises of two sub-systems which are master and slave. For this project, KUKA youBot labelled as slave system whereas the target object (green cuboid and red sphere) labelled as master. The experiment is divided into two parts which are Part A and Part B. In part A, the green cuboid will move in linear path as can be refer to Figure 1. The upper joint of the robot will track the object with the help from image camera to follow closely the direction of object moving in path as in Figure 2.

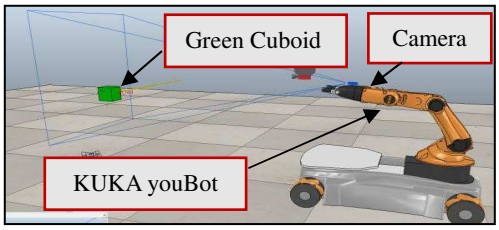

Figure 1 Part A (Linear Path)

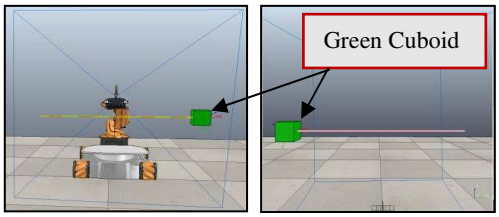

Figure 2 Path direction of the target object from (a) In front view and (b) Camera view for part A

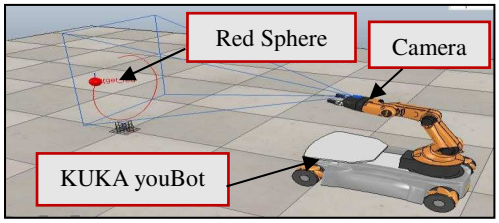

Figure 3 Part B (Circular Path)

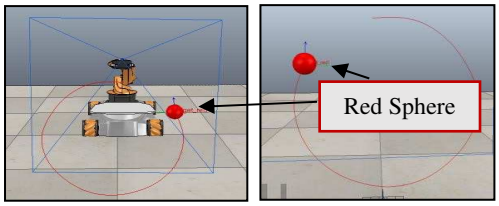

Figure 4 Path direction of the target object from (a) In front view and (b) Camera view for part B

Figure 3 illustrates the circular path for red sphere to move in Part B experiment. Subsequently, the upper joint of youBot will track the red sphere moving in circular path with the aid of image obtained from camera as shows in Figure 4. The experiment conducted was to test the performance of the youBot joint when the rate of movement of target object is fixed (dt=50ms) though outline of path and object colour is being manipulated.

3. RESULTS AND DISCUSSION

The movement pattern of joint and data from joint position for each situation are illustrated in graphs below. In Figure 5(a), it shows that movement pattern of the robot joint is in straight line which follows the path of the target object (green cuboid) which is in linear. Whereas, graph in Figure 6(a) shows that the robot joint move in circle shape which tracks the target object (red sphere) moves in rotational. Both graphs in Figure 5(a) and Figure 6(a) were gained from the camera that attached on the moving joint while following the path direction.

Next, graph in Figure 5(b) shows that it rises proportionally from -0.22 to +0.22 in x-axis, making it in linear shape. It also explains that joint position of youBot is correspond to the position of the green cuboid from the starting point -0.22(x-axis), 0(y-axis) to the end point of the path +0.22(x-axis), 0(y-axis) across the simulation time.

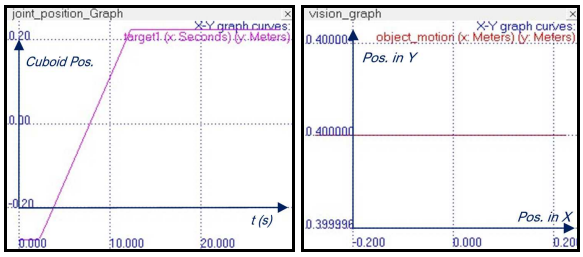

Figure 5 Graphs of (a) movement pattern for youBot joint and (b) position for youBot joint in part A

In the other hand, bell-shaped graph in Figure 6(b) shows that in the first part, position of youBot joint went up from -0.17(x-axis), 0(y-axis), +0.49(z-axis), reaching highest position +0.21(x-axis), 0(y-axis), +0.34(z-axis) and gradually decrease back to -0.17(x-axis), 0(y-axis), +0.49(z-axis). It also clarifies that across the time, youBot joint follows the red sphere position as the object moves in rotating path.

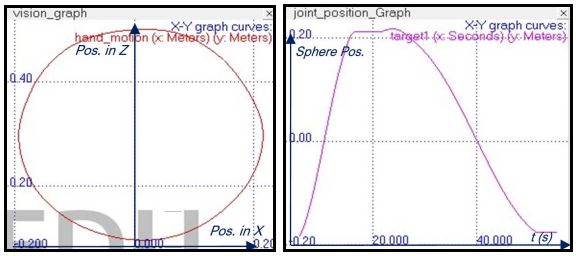

Figure 6 Graphs of (a) movement pattern for youBot joint and (b) position for youBot joint in part B

4. CONCLUSIONS

In brief, this research presents the initial progress of haptic robot assist for object manipulation with the robot simulator simulation, V-REP. V-REP is one of reliable computer software to conduct and manipulate haptics experiments using generated coding as users are able to set the parameters and specifications of the robots and applied torques desired. The result of this study might benefit to the telemanipulator works such as surgical robots and industrial robot operator.

The initial experiments show the tip of KUKA youBot successfully follows the movement of green cuboid object and also red sphere object as in two different motion which are linear and circular as depicted in Figure 2 and Figure 4 respectively. With the aid of camera attached at the top of robot gripper joint, it allows the robot to view the path movement in the scene and recorded the required joint movements in form of graph. To verify the movement of youBot arm and gather the data in terms of velocity and position of the robot upper joint, graphs are also included during the simulations to record the measured data. As a future work of this research, another KUKA youBot will be added and linked to make the system works in bilateral control system. For improving the stability and output feedback of the system, integrating with disturbance observer (DOB) is expected to ameliorate uncertainty in the system.

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