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3RD PASSIVE JOINT POSITION ANGLE VALIDATIONON 3R UNDER-ACTUATED ROBOT ARM

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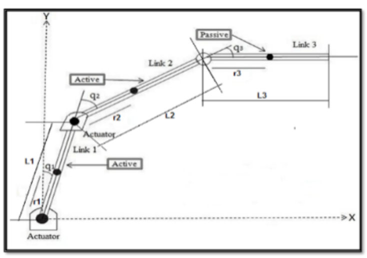
Graphical abstract



Abstract

Position angle analysis by learning algorithm on robotics is extremely important as a tool for predictive maintenance to detect faults and mechanical problems. This paper presents position angle analysis on passive joint using three rotations (3R) under-actuated robot manipulator. Experiment was conducted to predict the position angle which were applied to three joint; Active 1, Active 2 and Passive respectively. Experiment by SIMULINK software was carried out to validate the value of position angle obtained during real-time experiment. As a conclusion, the 3rd position angle of passive joint followed the position angle for Active 1 and Active 2.

Keywords: Real-time, passive joint, under-actuated robot

1.0 INTRODUCTION

Generally, the word 'robot' is usually associated with moving machine. The development of robots has grown rapidly in the last three decades from involvement in science fiction fantasy to computer-controlled industrial robots. The industrial robot may be regarded as a robotic manipulator or a robotic arm [1]. Its shape is roughly similar to a human arm. It looks like a chain of rigid links interconnected by flexible joints. The links are similar to the human anatomy such as the chest, upper arm and forearm while the joints are similar to the shoulder, elbow, and wrist. Nowadays, the robot industries' bosses are impressed and motivated as there is increasing demand of robots in the various fields.

This research is an attempt of characterizing and assessing three (3) degrees of freedom (DOF) robotic manipulator with two active links and a passive joint. It is very difficult to control and predict this 3rd joint. Tatsuo [2] has proposed a new method to control this kind of robotic manipulator where the result was not quite promising as it encountered trajectory planning problems for planar under actuated manipulators. Therefore, to apply the passive link to the system is challenging task. However, there are several advantages of using single passive joint whereby we can construct manipulator which is light-weight and with low consumption of power. These features are important in space robots and low-cost automation [3]. If these features are realized, any actuator failure due to the unexpected accident can be surmounted easily. The direct drive manipulator that experiences joints failure could be the model of cause [4]. For instance, remote or hazardous environment in robots is highly enviable inaccuracy tolerant behavior [5].

2.0 EXPERIMENTAL PROCEDURES

This project started with fabricate the three square section beam 15 cm X 15 cm is fabricated. Each joint is identified as Active 1 for joint 1, Active 2 for Joint 2 and Passive for Joint 3. The length used for each joint is the same for joint 1 and 2 is 20 cm and joint 3 is 100 cm. Figure 1 below shows the schematic diagram of robot used.

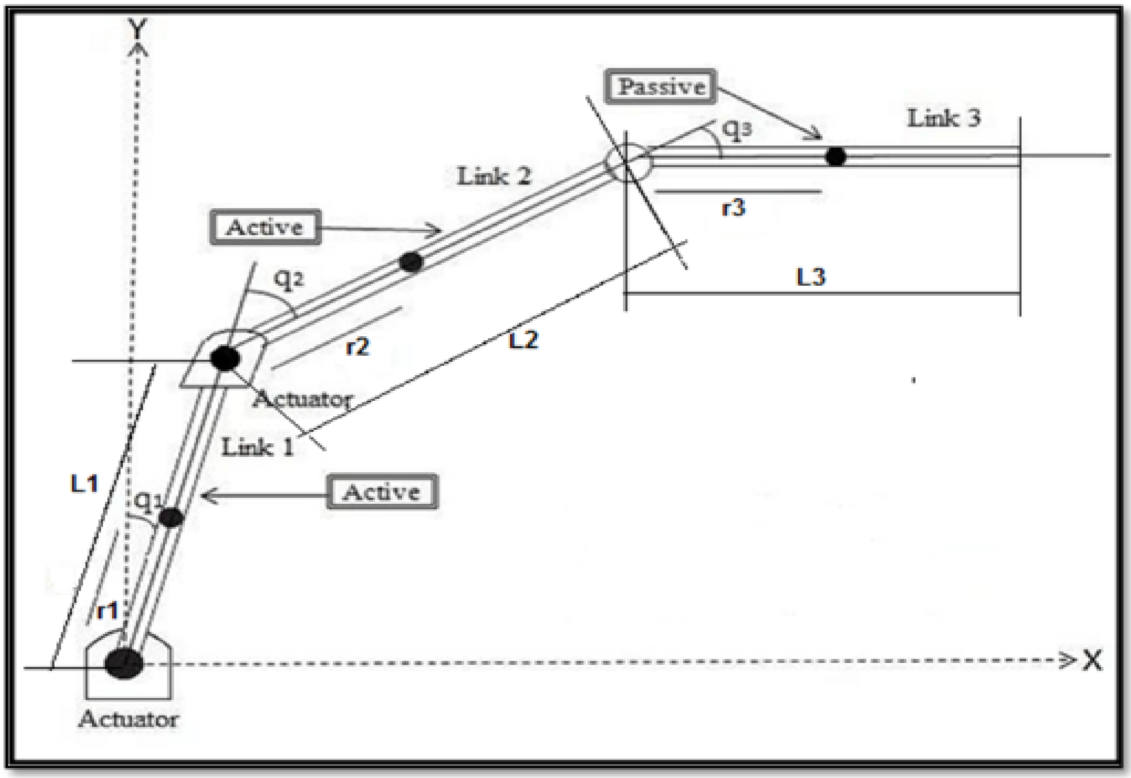


Figure 1 Schematic diagram of robot used

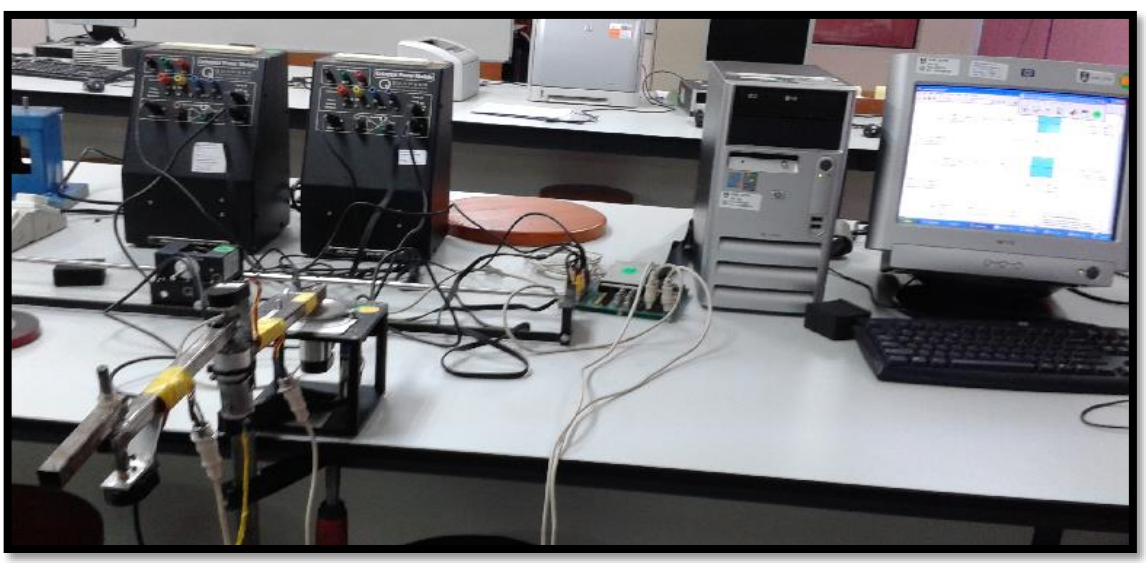


Figure 2 The robot system used

Joint 1 and 2 are active because each joint is attached with DC motor. However, joint 3 are passive because it is free to move. All the joints are attached with optical digital encoder to read and to measure how far the link should be moved and stopped; how much angle will be for passive by controlling two links movement. The DC motor for Active 1 and 2 are in the course of a gearbox using a reduction ratio of 100:1 and 70:1 respectively. Usually, this application could be found in industrial such as robotic hand which consists of three links for three motors. In this research the concept is exactly the same as three links but the total number of motors is different which is only two motors are functioning and the other motor is free from actuating. Figure 2 above shows the robot system used in the experiment.

The experiments were conducted as follows. The condition likes move at the certain value and stop; starting 0 degree to 45 degrees with 5degrees interval. However, Joint 3 just reads how far it can move. The real-time for this anexperiment as show on Figure 3 below.

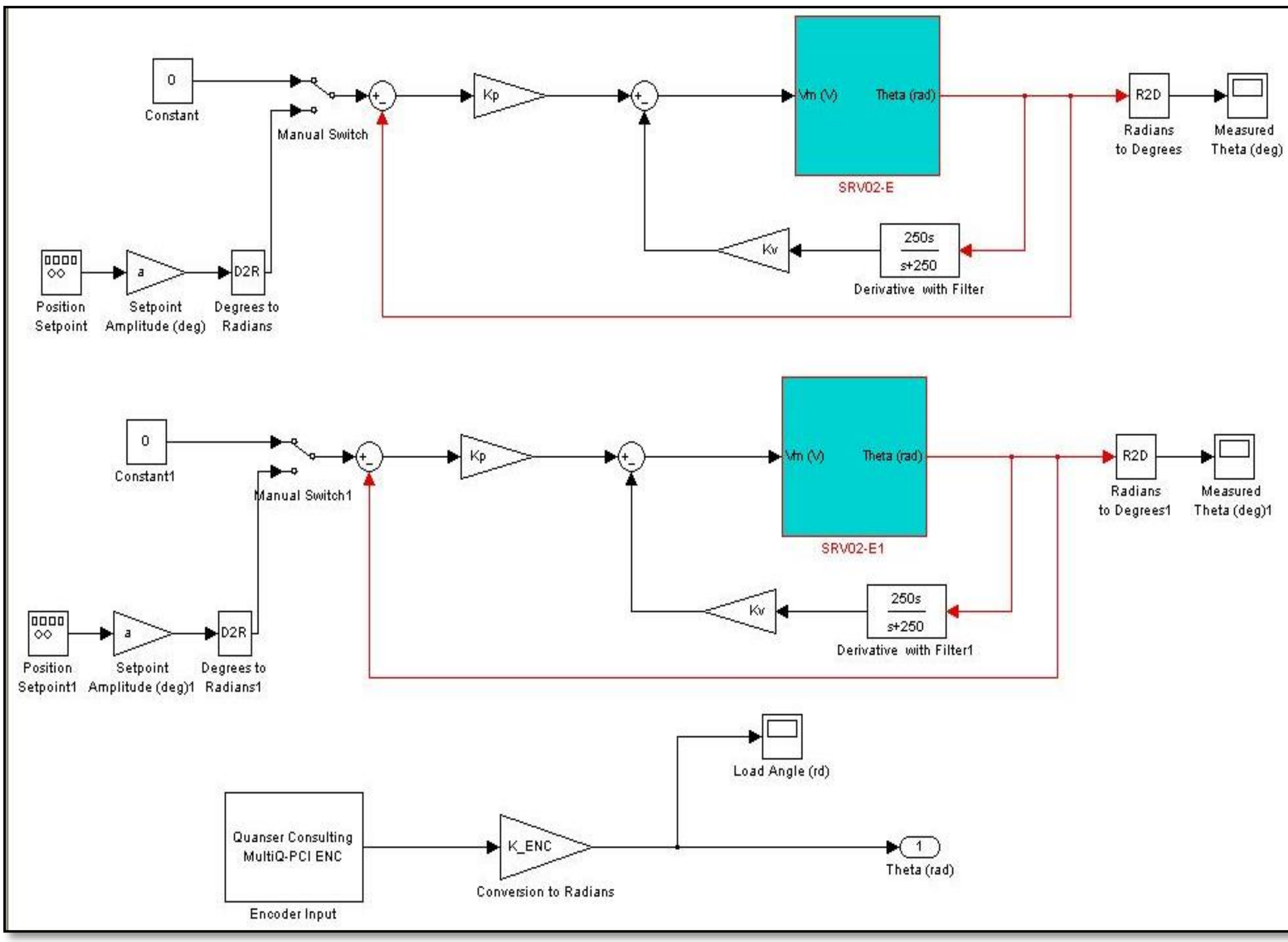


Figure 3 Real time SIMULINK

3.0 RESULTS

3.1 Position Angle of the 3R Under-Actuated Robot

Based on the previous section, the Simulink block diagram has been created for controlling the movement of the joint for Active 1 and Active 2 and it achieved the target value which is possible to move until target value starting by 0 degree to 45 degrees with 5 degrees intervals. In this section, it will show the result achieved during experiment and shown in table and plotted in graph between position angle for Active 1, Active 2 and Passive with some explanations.

The most interesting that the angle of the movement has shown starting by 0 degree till target values. Based on the experimental value here, the final angle is taken to compare between target value either Active 1 or Active 2 and Passive angle.

3.2 Position Angle for Active 1 (Positive and Negative Value)

The first link's angular position in positive direction shows the target value for each movement with 5 degrees intervals are compared to position angle for Passive. Based on Figure 4 below has plotted and showed there is no more different between position angle of Active 1 and Passive during experiment done. However, position angle for Active 2 do not have any reaction because it in "OFF" mode. It can be said that the system is controllable.

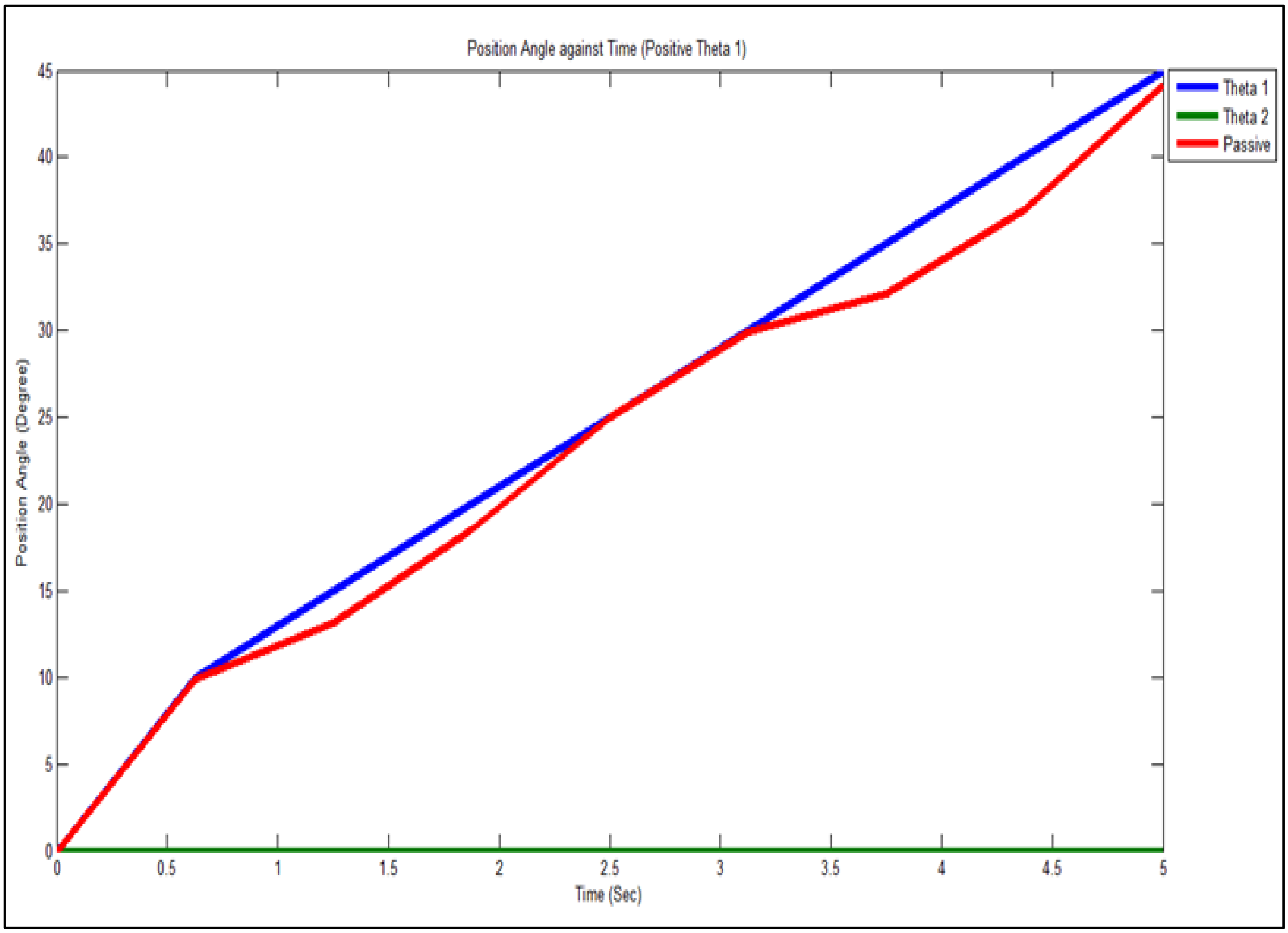


Figure 4 Position angle against time (positive Theta 1)

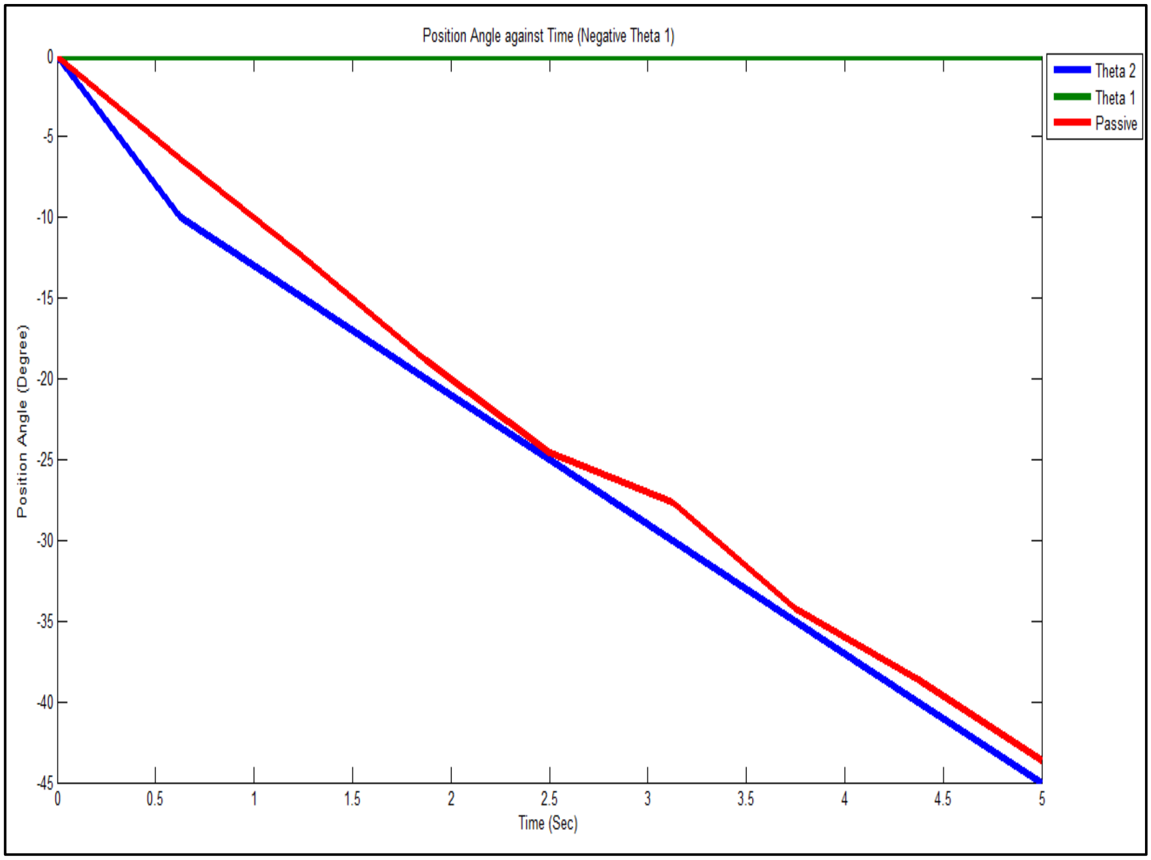


Figure 5 Position angle against time(negative Theta 1)

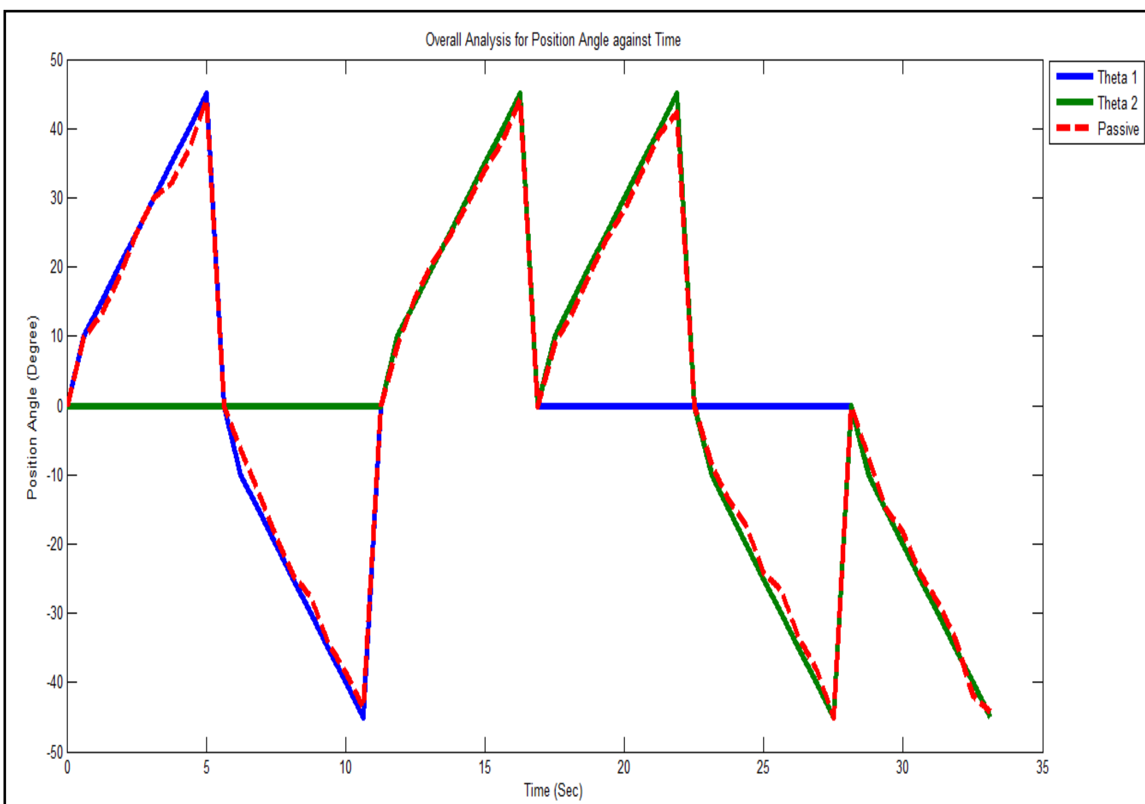


Figure 6 Overall position angle against time (Theta 1, Theta 2 and Passive)

Based on Figure 5, it showed there is small different between position angles of Active 1 and passive during experiment done. The first link's angular position in negative direction shows the target value for each movement with 5 degrees intervals are compared to position angle for Passive. However, position angle for Active 2 do not have any reaction because it is on "OFF" mode. It shows that system is controlled.

3.3 Overall Analysis for Passive Angle with respect to SIMULINK block diagram

The system is starting by identification of the operating system of the computer, then the initialization of Personal Computer (PC) control boards, followed by a safety check to guarantee that the three links run within a safe range. After doing these preliminary tasks, the main part of the real-time algorithm starts. The measurement information about the link positions is read into the rotary digital encoder.

Most of position angle of passive followed the position angle for Active 1 and Active 2 has shown in Figure 6. After choosing the best block diagram to make sure the movement is running accurately, it give more than that because all the movement for any position followed the acting of joint which has motor attach to them. Some modification for value of rotary digital encoder in SIMULINK block diagram achieved. To make clear this simulation result is under the real-time implementation achieved by proof, the result by using artificial neural network below.

4.0 CONCLUSION

The 3R under-actuated robot manipulator equipped with two active joints; Joint 1 and Joint 2, they are the main source of motion. The SIMULINK block diagram has been created for controlling the movement of the joint for Active 1 and Active 2 and it achieved the target value which is possible to move based on target value. Accordingly, whilst the signal excitation had been given, it would effects the corresponding passive joint. The rotary digital encoder is collecting the data at the angular position based on target value. After choosing the best block diagram in SIMULINK, movement of the links are running accurately because all the movement for any position followed the acting of joint which has motor attached to them; Joint 1 and Joint 2 respectively.

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