ABSTRACT

This study proposed the using of a smart structure principle with a methodology for reducing the difference (error) between the actual position (for semi-flexible robot) and the theoretically calculated position (for rigid robot) on-line. The proposed methodology depends on the interfering between the maps of the two cases; the rigid case (ideal), and the deformed case (actual). According to this methodology a class (program) was built using the visual basic.net, this class called the compensation class.

In this work, a two degrees of freedom articulated type lightweight semi-flexible robot is used. This robot is confined to move in a vertical plane. The sensors for measuring the error deformation variables are mounted on the two links of the robot to represent with Data acquisition (DAQ) system and the actuators of the joints the smart structure system. The smart structure robot systems are designed and built in this work. Also, to control the smart structure robot's systems software was built using Visual Basic.Net.

A kinematic model based on the joint angles and arm's deflections of the two degrees of freedom is presented without simplifying the deflection's variables.

The presence of error deformation variables in the kinematic model make the solving of the problem of inverse kinematic equation more difficult. So, a neural network method was proposed for finding the relation between the angles of the two actuators with the end effector position and with error deformation variables. The training showed a good fitting between the output results of the neural network and the targets data (the two angles of robot); Where the roots square error were (0.999742) and (0.999804) for the first and the second angles, respectively. The result of the neural network has been used in the compensation class.

The experimental works is divided into two parts. The first part is for checking the system and making the calibrations. And, the second part is for measuring the deflection variables which are used in the kinematic model to compute the end-effector position in x and y directions. For the measuring the end-effector position practically, the Bytescout Graph Digitizer Scout software was suggested to analyze the photos that were taken for end-effector's path that drawn on scalar board. The measured deformation variables in addition to the end-effector position are used as input data to the neural network for training.

Compensation tests have been done on the complete system to check the performance and results of the compensation system. This system showed a good improvement in the performance of robot for compensation and reduction in the error between the ideal position (rigid robot) and the practical position (measured position). The average error after the compensation reduced to 12.32 times in the x-direction and 21.76 times in the y-direction.