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Computer simulation technique for two degree of freedom agriculture robot Arm

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Abstract- In this research, a structure of pneumatic robot with consisted a pneumatic cylinder for linear movement and a pneumatic motor for rotation movement was used. Air pump pressure was fixed to 5 bar, and the time taken for pneumatic cylinder and pneumatic motor to reach from minimum to maximum position were recorded and inserted into FOR....NEXT programming loop in Visual Basic V6 for achieve real time simulation of the robot movement. The workspace of robot simulation on computer was scaled with the real workspace of robot on the real environment. Clicking the image target on graphical of user interface (GUI), the robot will move and grab the selected target according for a real time mode condition. From the result, the accuracy of real time simulation using this method was consider high if the robot actuate by electric follow by hydraulic and pneumatic. To develop real time 3-Dimensional (3-D) robot simulation is very hard, anyway 2-D simulation become easier and realistic for any real time simulation for robot that only had 2 degree of freedom.

INTRODUCTION

The kinematics model strategy almost is used to develop real time robot simulation after determine the dynamic model of robot movement parameter [1]. However side view angle was use as a parameter which taken as a data for each robot link that related. From Denavit-Hertenberg principle, the parameter such as distance and point angle on each link robot point was taken as the parameter which put in the matrix concept to determine and finally to reach the object target at certain calculation of robot angle [2]. This calculation was through with a long procedure to get the final equation of connection on each robot angle. This gap may be filled by the use of standardized simulation languages, practices, or graphic representation paradigms [3]. The actual movement of robot was determined before fabrication process for safety and cost reduction by applying simulation process [4]. Otherwise the top view robot simulation is more reliable and easier in developing 2-D simulation and calculation for 2 degree of freedom (DOF) robot movement [5]. The simulation of the robot movement in GUI was indicated an actual real movement between related parts with rotation event.

Objective

To develop control strategy on real time simulation for 2 DOF pneumatic robot.

To predict the real time accuracy of 2 DOF pneumatic robot simulation.

METHODOLOGY

The robot was designed for cutting the frond of cocoa fruit and simultaneously grabs for unloading process [5]. The robot structure was consisted 1 pneumatic cylinder for linear movement and 1 pneumatic motor for robot rotation. It's was also including the solenoid valve, air pressure pump, pneumatic wiring and personal computer with digital cameras. The computer was manipulate by developed GUI by sending 5 volts to input/output card and the solenoid valve was alternate for sending 24 volts to triggering the pneumatic valve for robot movements.

To reduce the pneumatic compression during operation, two devices were installed into pneumatic circuitry: -

Add shuttle valve for in and out of pneumatic cylinder, which control only the set pressure that supplies to cylinder.

Add air regulator at the main air supply to control the certain pressure will be feed in to actuator.

Mathematical model

The mathematical model was developed base on sine, cosine and tangent of angle of joined robot. All calculations use embedded in the developed GUI [5]. When the user clicked on the target image, the system will perform the kinematics calculation and at the same time the electrical signal will send to trigger the solenoid valve of robot.

The basic trigonometry method was used to develop the kinematical calculation base on the geometry for a top view of robot simulation. The system was read every calculated angle of robot movement and displays it as a line in a graphic during simulation at GUI. The concept of draw and erase in programming GUI make the simulation of robot movement and at the same time the electrical signal was sent to solenoid valve for actual movement. Conceptually, the first FOR…..NEXT programming code will read the

angle floating point and the second will display and erase the calculated point and show it as a moving single line graphic in GUI [6]. For the top view of simulation robot, the robot Cartesian coordinate will select at the center of robot base. The GUI from computer also was used and interfaced directly to instrumentation devices which drive and monitor the various robot actuator in real-time which is useful for development and testing [7]. Figure 1 and 2 shows the real robot workspace and body structure which was able to turn 450 left and right (-450 < □ < 450).

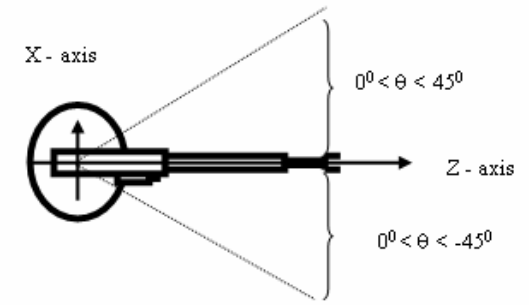

Fig. 1-Top View of Robot structure shows the angle of robot movement.

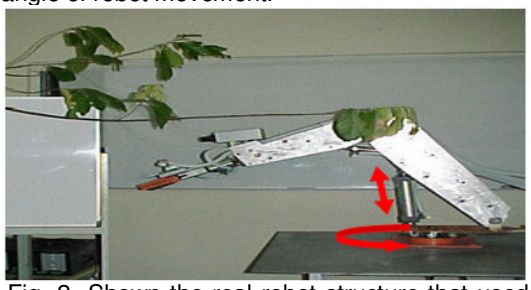

Fig. 2- Shown the real robot structure that used 1 cylinder and 1 pneumatic motor (red indicator).

RESULT AND DISCUSSION

The real time movement of cylinder and motor was taken and programmed with the simulation on user interface. By using with basic equation calculation that mention above, each individual actuator had high accuracy on real time movement and simulation. The system was not accurately performed the real time simulation during robot operation. It is due to the problem on momentum force that created by air compression inside robot cylinder and motor. The overall weight of the robot structure also was considered unsuitable compare to actuator performance due to mechanical vibration during operation. Figure 3 and 4 show the calculation method for 2 DOF robot. Figure 5 and 6 shows the GUI for simulation program of robot arm.

Calculation for turning robot simulation on top view side (x – axis)

Figure 3 show the basic calculation program for a side view of robot simulation. The red dot indicated the position movement of the robot while the angle movement was base on actual time rotation.

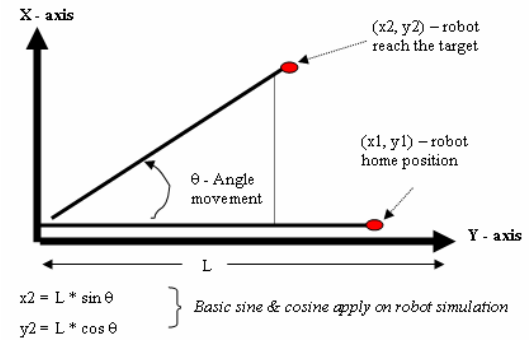

Fig. 3- show the basic calculation program for a side view of robot simulation

Calculation for up/down robot simulation on top view side. (y & z – axis)

Figure 4 show the basic calculation program for a top view of robot simulation. The black dot indicated the position movement of the robot while the linear movement was base on actual time movement.

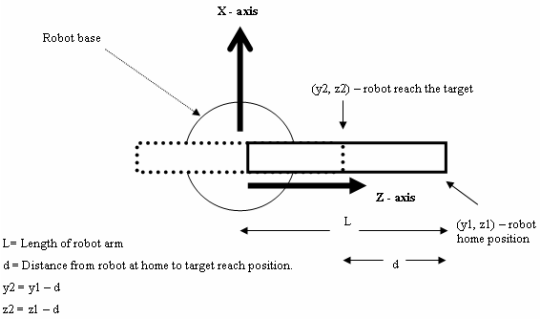

Fig. 4- show the basic calculation program for a top view of robot simulation

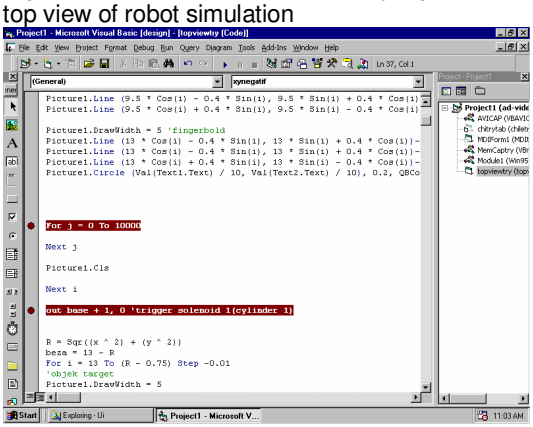

Fig. 5- The program FOR...NEXT source code program to generate the looping simulation and at same time send the electrical signal to robot solenoid.

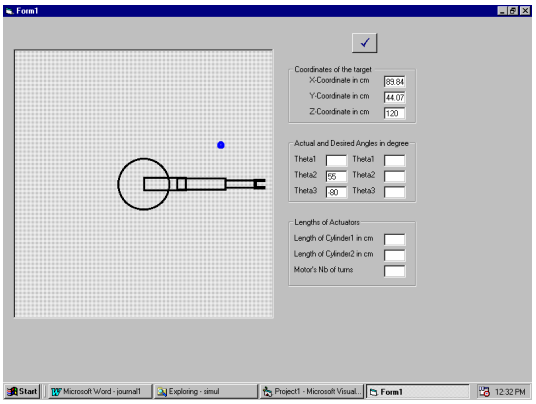

Fig. 6-The 2-Dimensional real time robot interface for a top view side

CONCLUSION

With this method, the overall accuracy of real time robot simulation was consider good if the robot actuator used electric as a medium follow by hydraulic and last is pneumatic device and was depended in it type of application with robustness and accuracy factor [8]. Otherwise the direct calculation on this method was suitable and reliable for any 2 DOF of robot movement. We can say that there is the simplest way to develop 2D real time simulation which can also created the interactive condition on close loop feedback control. The great on control subject also was mentioned in righteous book, Al. Quran. In surah of Al-Ambia verse 69 stated “We said O fire! thou cool and (a means of) safety for Ibrahim!”[9]. Allah Subhanahuwataala ordered the fire not only to become cool but the condition of cool with control the Ibrahim alaihissalam safely in the fire..

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