Professional Forum

Two Arm Robot Model Application for Automatic Barrier Gate

Thatchaset Athivongwarit, Witoon Huankhoksung and Suntisuk Srikern
Department of Automotive Technology, Siam Technology College, Bangkok, Thailand

Standpoint

The researchers designed and built a two-arm robot by having its movement activated by the servo motor and DC motor. Then, they were to measure current power, angular, angular acceleration and torque of the motor.

Overview

Robotic technology is rapidly improving nowadays as seen in basic robots controlling equipment, vacuum the floor, and distribute car fuel. Robots facilitate industrial production while saving energy. In particular, new energy from nature supports the current trend of robotic research. Robotic researchers tend to focus on controlling devices that save energy with full automation.

Auto barriers used at payment stations on expressways are a good example of robotic application widely developed by the Thai authority in transport infrastructure. The arms of auto barriers moved by weight and torque of an electric motor by acceleration angle of motor at 0° to 90°. It is the principle used by an auto arm movement in that the higher the torque, the more electric energy it consumes. Its movement is controlled before the stop point. Its swing effects can be caused by the quality of the motor and other joints. Currently, there is need for creating control arms with gentle upward and downward movements for two auto arm barriers for entry or exit of cars based on *the principle of Euler-Lagrange's Equation*. The researchers were interested in initial moment and kinetic energy, acceleration angle, angular acceleration and torque of the motor at the arm joint, to reduce arm vibration in the system.

Robot Categories

As known, robots are mainly used for industrial purposes and designed to move materials, parts, tools or special devices through variable programmed motion for the performance of a variety of tasks (Agrawal, 1998, 2001; Khodabandehloo, 2009). Robots are constantly evolving and they can work in many forms. They are mainly classified into five categories (Tonietti & Bicchi, 2002; Deguchi et al., 2008; Saneewong Na Ayuttaya, 2009).
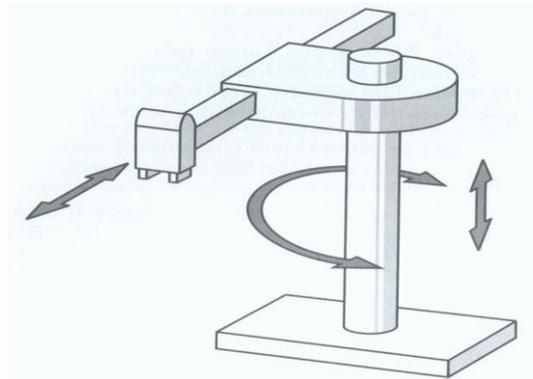
1. Cartesian manipulator: A robot with a composite structure. Three-axis perpendicular to each other, allowing them to move to the desired position.

Figure 1: Characteristics of the Cartesian Robot
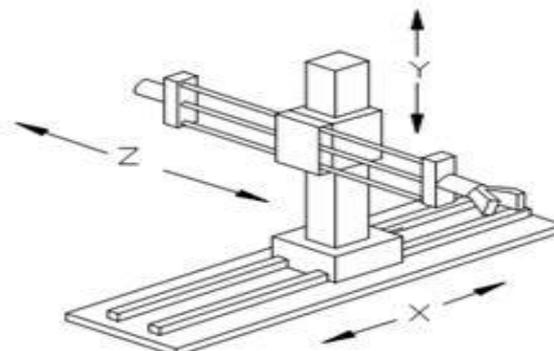
2. Cylindrical manipulator: Its arm is centered on the arm. The cylinder can move up and down, twist and twist.

**Figure 2:** Characteristics of the Cylindrical Manipulator

3. Spherical manipulator: It has a two-axis structure moving in a rotating manner. The other axis moves in a straight line.

**Figure 3:** Characteristics of the Spherical Manipulator

4. SCARA manipulator: A robot with two cores that look alike moving in a vertical rotation of the axis. One axis moves in a straight line.

Figure 4: Characteristics of the SCARA Manipulator
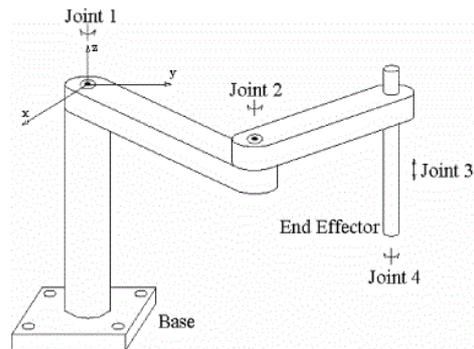
5. Articulated manipulator: A mobile robot with joints in rotation. It is designed to work similar to an arm.

Figure 5: Characteristics of the Articulated Manipulator
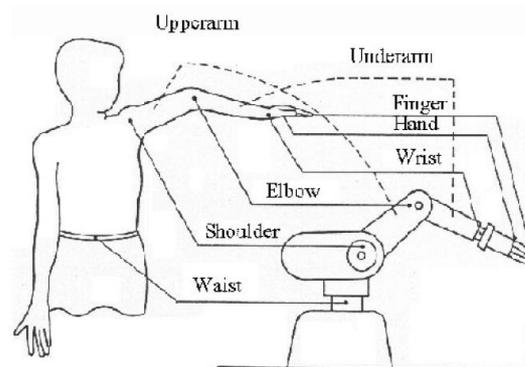
The Experiment

The researchers created five steps in the experiment:

Step 1
(1) Two objectives were (a) to design and build the auto barrier with two arms by most gentle principle control, and (b) to compare the built auto barrier with the *principle* regarding acceleration angle, angular acceleration and torque of the motor
(2) Car barrier with two arms made of aluminum--120cm and 100cm longer.
(3) Auto carrier arm height at 85 cm at position 0˚.
(4) The motor used DC motor and servo motor.
(5) Defined D-H parameters

Step 2
The D-H parameter is Denavit-Hardenberg parameters. Its created parameters are for robotic movement equation. It has four parameters:
(1) Link length (ai) is distant of xi perpendicular to zi axis to zi + 1
(2) Link twist (αi) is angle of zi − 1 and zi see from xi − 1

(3) Link offset (di) is distant of axis ai − 1 cross to axis zi with axis ai on axis zi

**Figure 6:** Details of variant locations of D-H Parameters
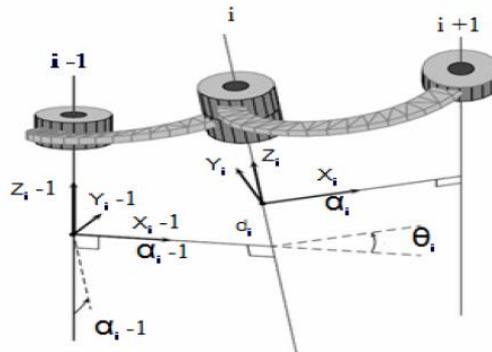
Step 3
Instruments and analysis methods
The criteria were created and used to solve the problem and control the work of the robot with three arms.The researchers used the principle of Denavit Hartenberg Parameter (DH Parameter) to determine the position and movement direction of the motor arm to assist in process for a mathematical analysis to know the angular acceleration. And the torque moved in various positions.

Figure 6: shows the model of the two-arm robot. (A) is Initial condition of the arm bar (0 °) (B). This is the state in which the arm is moving. (C) is the state of the arm moving to the final position (90°)
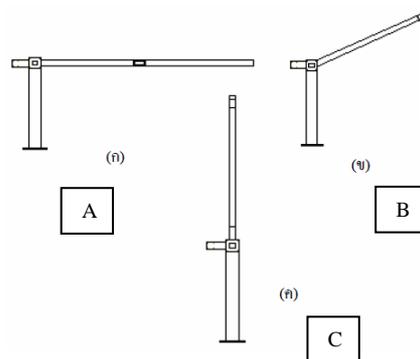
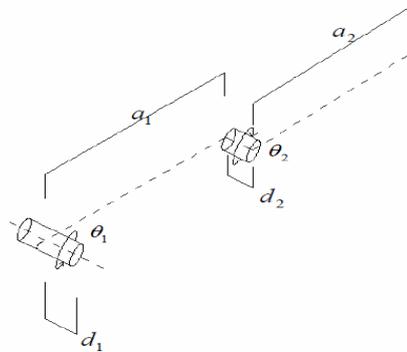**Figure 7:** Armrest set made of steel box 7.5 cm x 7.5 cm x 85 cm
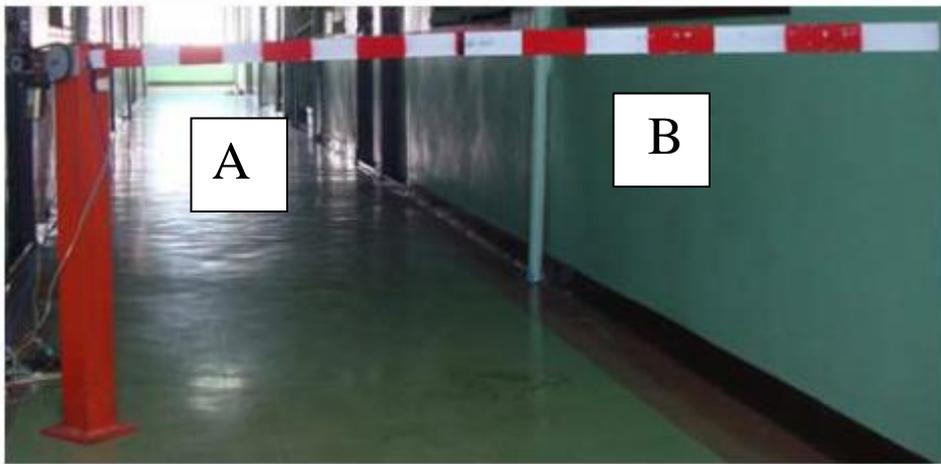
Step 4
Equation of motion
The researchers created the equation of motion of a two-arm control arm with MATLAB program.

Figure 8: Moving model

Table 1: DH-Parameter Table of Mechanical Arm

i	a_i	α_i	d_i	θ_i
1	1.2 m	0	0.08 m	$x_1(t)$
2	1 m	0	0.034 m	$x_2(t)$

Final Point

The researchers were interested in robotic movement of a mechanical arm to grasp, move something, weld objects on an assembly line. They designed and built a two-arm robot powered with motors 1 and 2. Its movement was activated by the servo motor and DC motor and the current power was measured. Also measured were angular, angular acceleration and torque motor. The results showed comparison between what was actually measured and by *the principle of Euler-Lagrange's Equation.* The results indicate that motor 1 showed 35%, 57% and 44%, higher than *the principle*. And motor 2 showed 39%, 42% and 43%, higher than *the principle*. The vibration occurred 39% of *the principle*.

References

Agrawal, S.K. (2001). Designing robot for optimal performance During Repetitive Motion. IEEE Transaction on Robotics and Automation.

Agrawal, S.K. (1998). Fabien New Computation Framework for Trajectory Optimization of Higher – Order Dynamic System. AIAA Journal of Guidance Control and Dynamic, May 1998, *24*(2): 228–236.

Deguchi,K., Sakurai, H. & Ushida, S (2008). *A Goal Oriented Just-In-Time Visual Servoing For Ball Catching Robot Arm.* Tohoku University, Japan, 2008 IEEE/RSJ   International Conference on Intelligent Robot and System, Acropolis Convention Center , Nice, France, September, 22-26, 2008, pp. 3034 – 3039.

Khodabandehloo, K. (2009). *Performance Analysis of a Two Arm Robot*. R.O. Buckingham, AMIEE, P.N.Bratt, AMIMechE, MIEE, IEEE.

Saneewong Na Ayuttaya, S. (2009). *A Study on the Comparison Between Minimum Jerk and Minimum Energy of Nonlinear Dynamic Systems*. Joint Post Graduated Program (SWU-CRMA), Department of Mechanical Engineering, Chulachomklao Royal Military Academyand Srinakharinwirot University.

Tonietti, G. & Bicchi, A**.** (2002, October). Adaptive Simultaneous Position and Stiffness Control for a Soft Robot Arm. Centro "E. Piaggio", University of Pisa, Italy.*Proceedings of the 2002 IEEE/RSJ Intl. Conference on Intelligent Robots and System EPFL*, Lausanne, Switzerland – October 2002 pp.1992-1997.