Proceedings of MUCEET2009
Malaysian Technical Universities Conference on Engineering and Technology
June 20-22, 2009, MS Garden, Kuantan, Pahang, Malaysia

MUCEET2009

1-ARMBOT: A Single DOF Robot Arm using PIC Microcontroller

Muhammad Suhaimi Sulong, Vijaya Kumar Ratana Vellu, Asmarashid Ponniran, Ariffuddin Joret

***Abstract*—**In industrial assembly applications and also in material handling, pick and place robot arms were extremely used. They usually have three to six degree of freedom (DOF) and mainly for manufacturing operations. This paper presents the development of single DOF of an arm robot that have similar function with others three to six DOF which is picking up a part and placing it at specified destination. It uses only a magnetic actuator as a gripper and the operations are controlled using Peripheral Interface Controller (PIC) microcontroller and used servo DC motor for single movement operation. The system architecture and operations including the design structure are explained in this paper. As a result, this model robot was capable of picked a maximum load of 63 gram in period of 8.37 seconds with maximum power of 12 watts and movement orientation from 0^o to 60^o. It is said to be low cost, low power consumption and be able to operate in a small workplace area. This newly developed robot might have a demandable prospect in the industrial market especially in high-end and low-end operations.

***Keywords*:** Pick and place robot arm, single DOF, magnetic actuator, PIC microcontroller

I. Introduction

WITH the pressing need for increased productivity and the delivery of end products of uniform quality, industry is turning more and more toward computer-based automation. The inflexibility and generally high cost of these machines, often called hard automation systems, have to lead to broad-based interest in the use of robots capable of performing a variety of manufacturing functions in a more flexible working environment and at lower production costs. [1]

An industrial robot arm is meant for general purpose, and the computer controlled manipulator consist of several rigid links connected in series by revolute or prismatic joints. One end of the chain is attached to supporting base while the other end is free end equipped with a tool to manipulate objects or perform assembly tasks. Whereby the scenario in industry is much more differ where three or more DOF (Degree Of Freedom) robot arm is used to pick and place object from one place to another place respectively without considering any obstacle in its working envelope. [2]

According to Masory in [2], for many cases Programmable Controllers (PC) is used to control the robot including the peripheral equipment. Currently, microcontroller is gaining popularity among robot builders compare to microprocessor because of its size, cost and the performance of the microcontroller which is way better compare to a microprocessor [3]. A microcontroller is the combination of a microprocessor, memory, input and output ports and some of the special functions like timer, analogue to digital converter, mathematics processor and PWM generator in one chip [4].

This paper highlights the development of single DOF of an arm robot (called 1-ARMBOT) that have similar function with others three to six DOF. It uses only a magnetic actuator as a gripper and the operations are controlled using Peripheral Interface Controller (PIC) microcontroller and used servo DC motor for single movement operation. Besides, the application will maintain the quality of product, reduce the operation time and minimize power consumption. The robot also emphasize on cost effectiveness, easy operation and reliable for manufacturing process.

II. The Development of 1-ARMBOT

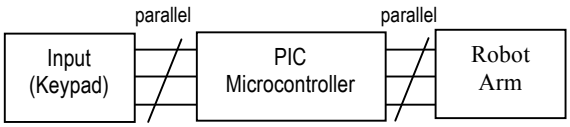


Figure 1: System Architecture of 1-ARMBOT

The system architecture of this robot arm as shown in Figure 1 was adapted from [5]. The input is a keypad and consists of 16 inputs that control movement and direction of the motors. PIC microcontroller act as brains that translates input from keypad and convert it to the signal for servo DC motor to move. Motor is rotate for some degree (depend on the setting) after receive signal from PIC microcontroller. This process is continues and follows the instruction that programmed into PIC microcontroller. [5]

The system built up through several process and development involving hardware and software to control the

Engr. Muhammad Suhaimi Sulong, MIEEE, Asmarashid Ponniran, MIEEE and Ariffuddin Joret, MIEEE is with the Faculty of Electric and Electronic Engineering, Universiti Tun Hussein Onn Malaysia (phone: 607-4537629; e-mail: msuhaimi@uthm.edu.my).

Vijaya Kumar Ratana Velly is with the Faculty of Electrical Engineerig, Universiti Teknologi Malaysia (e-mail: ajai02f@yahoo.com).

robot. Figure 2 show the block diagram for pick and place robot arm development.

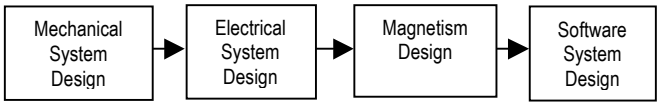


Figure 2: Block Diagram of 1-ARMBOT

The mechanical design for this single DOF robot arm that need to consider is the structure of the model. The robot has only one DOF as illustrated in Figure 3. There are two actuators in this model; first is a servo DC motor act as a supporting base which needs repeatable position control and second is a magnetic actuator act like a gripper to pick and place an object.

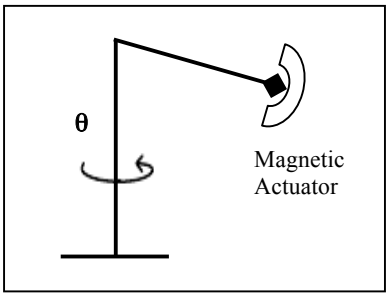


Figure 3: Single DOF Robot Arm Model

The servo motor is used to move the robot arm according to a specific angle until it detect or touch an object. As the end effectors touch the object, it will immediately pick the object from a conveyer lane and place it to the other on the opposite side. This entire process took place in a single axis only. After a few seconds fissure the end effectors return to origin and start back the entire process again.

III. RESULTS

The standard pulse widths are varies among servo motor manufacturers and brands. There are varies from 1.0 ms to 2.0 ms with duty cycle about 18 ms to 20 ms. In this prototype of arm robot, 1.0 ms is needed to turn the output shaft to 60°, 1.5ms is need to turn to centre or 90° and 2.0ms is needed to turn the output shaft to 120° as shown in Figure 4. The rotation of this robot used a single movement and placed at the base of the robot. The measurement of the pulse width has been done. As a result, the pulse width per 1° angle is 8.33μs.

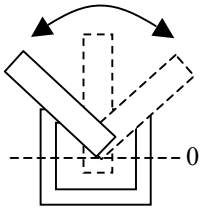


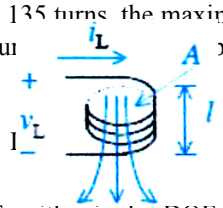
Figure 4: Rotation of single movement

A servo consumed maximum of 0.2A when rotating to a specified angle, thus maximum power (P max) of the system is 12W while the process time for 1 complete cycle (range of angles covered are 60° to 120^0) of this robot arm is 8.37s. The process time varies as the range of angles differs. In a way, as the angle of movement increase, the time taken is also increasing.

The mechanism used to pick up a part and place it at specified destination is a magnetic actuator. The operation is when the IC output trigger the relay it will be transforms into a switching medium and will deliver lamp DC to the solenoid. The strength of the solenoid is depends on few numbers of factor as shown in Figure 5 which are the type of magnet wire that had been using, number of the turn, size of the wire, current flows in the solenoid, cross sectional area of the steel used.

Figure 5: Magnetic factors

If the current is varying with time, the magnetic field is varying with time where a time varying magnetic field induces voltage. For 135 turns the maximum payload is 53g meanwhile for 240 tu payload is 63g.



The 1-ARMBOT with single DOF using a magnetic actuator has been developed. It enables to pick and place any type of objects which are made of any material. This is because the end effectors that are magnetized will pick and place the object holder made of steel. This innovative design can be implemented and applied in any material industries. Based on encouraging results, it is said to be low cost, low power consumption and be able to operate in a small workplace area. This newly developed robot might have a demandable prospect in the industrial market especially in high-end and low-end operations.

REFERENCES

[1] Sarawanan Moorthy, "Pick and Place Robot Arm", B.Eng. Thesis, Dept. of Computer Eng., Univ. Tun Hussein Onn Malaysia, 2007.

[2] Vijaya Kumar Ratana Velly, Muhammad Suhaimi Sulong, Philips Dharmaraj, "Design and development of pick and place robot arm using magnetic actuator", in *Proceeding of Seminar on Science and Technology (SST),* Sarawak, October 2008, pp. 495-497.

[3] Martin Bates, *The PIC 16F84A Microntroller.* Arnold, London, 2000.

[4] Chandana Prasad *et al.*, *Computer System Organization and Architecture*. Pearson Prentice Hall, Selangor, 2003.

[5] Muhammad Suhaimi Sulong, Asmarashid Ponniran, Razali Tomari, Ariffuddin Joret, Handy Ali Munir, "The comparison of 3-DOF and 5-DOF Pick and Place Robot Arms", in *Proceeding of International Conference on Instrumentations and Mechatronics (CIM),* Johor, May 2007, pp.495-497.

[6] T. Huang, J. Mei, Z. Li, X. Zhao, and D.G. Chetwynd, "A Method for Estimating Servomotor Parameters of a Parallel Robot for Rapid Pick and Place Operations", *Journal of Mechanical Design*, Vol. 127, pp. 596-601, July 2005.

[7] Muhammad Ali Mazidi, Rolin D. McKinlay, Danny Causey, *PIC Microcontroller and Embedded System*. Pearson, 2008.