

Program for Control and Operation of PUMA Robot by 'C' and Microcontroller

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Abstract

Operation of robots is simply a combination of feedback controls. PUMA robot can be used in loading and unloading operations of industrial process. In this study, this robot is utilized, operated, and controlled with a 'C' program loaded in microcontroller, which is very cost effective and easy to operate. Furthermore, a microcontroller AVR Atmel8 is utilized under the scope of the study. The motion of three motors is controlled properly where time variation is considered flexible. The power supply of microcontroller is rated 220V as well as 6V motor relay is used successfully. This study covers the entire work for operation and control of loading and unloading robot with program incorporated with microcontroller and specific operation and delay time. The outcome of this research work will be a real beneficial to operate robots in many applications such as loading, unloading, and transferring of loads in the industries which will be efficient and cost-effective.

Keywords: PUMA, microcontroller, feedback, control.

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1. Introduction

Robot is widely used in industries of modern world. The word ‘robot’ was first used in 1921 in a drama named Rossum’s Universal Robot [1]. The drama was written by Czech playwright Karel Capek. It is originated from the Czech word “robata” which means ‘forced laborer’. The robot in this play is similar to C3-P0 in the 1977 film namely “Star Wars.”

In 1921 the word “robot” was first used, but the field of robot “robotics” was introduced in 1942 by Issac Asimov in his story [2]. He presented the three rules of robotics. His “Three rules of Robotics”:

- A robot may not injure a human being or though inaction allows one to come to harm.
- A robot must obey the orders given it by human beings except where such orders would conflict with the first law.
- A robot must protect its own existence as long as such protection does not conflict with the first law.

2. Objectives of the study

The main objectives of the study are set as follows:

- I. To develop program for PUMA robot with C.
- II. To run program for PUMA with microcontroller.
- III. To operate and test PUMA with developed program

3. Scope of the study

The application of robot in Bangladesh is being continuously growing very slowly for different situation as the labor cost is very low relatively to other places. But, in many industries where chemical processes are operated by some under-aged children and are appointed illegally in dangerous environment, robots can be utilized in those harmful situations due to exposures to high chemical reactions, high temperature, and pressure. When heavy load has to be operated in loading, unloading or transferring, robots can play very helpful role. Moreover, when high precision is critical in terms of large scale production, then it is profitable to use the robot in an efficient and effective manner.

The industrialists of Bangladesh will be able to join with multinational companies World-wide if robots become available in our emerging and promising industries. Assembling and other steps of work can be done in our country which will earn a great amount of foreign currency and open the doors for eligible market segment in the job arena.

In this study, the control and operation of robot is handled with a microcontroller although the control of robot can be done in many ways. Keeping the cost of controlling a robot low, the project highlights the major components of experimental set of such conditions. So, when a robot will be available in Bangladesh, control of them can be done with microcontroller.

4. Literature review

The literature review section is divided into the following sub sections.

PUMA robot

The PUMA robot (Programmable Universal Machine for Assembly or Programmable Universal Manipulation Arm) is very famous in industries. They are versatile, easy to operate, and program and seemingly last forever.

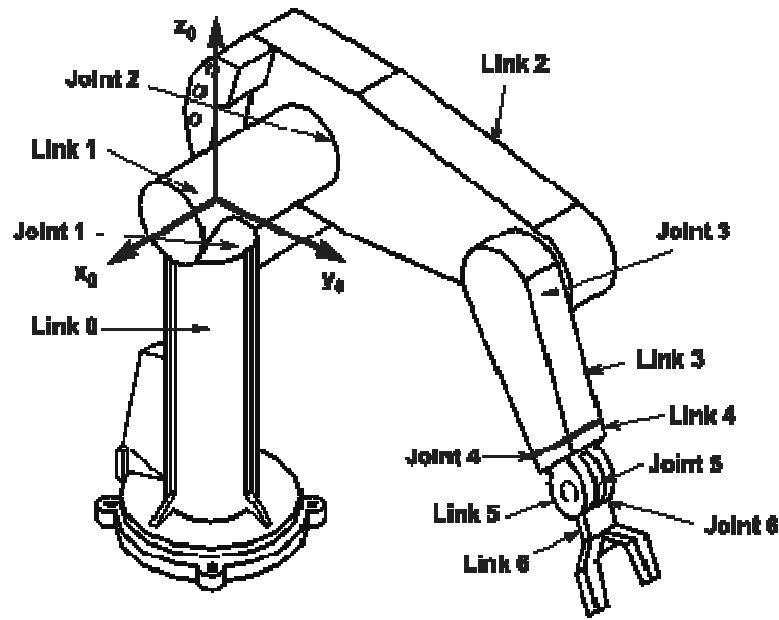


Fig.1. The schematics of PUMA robot

Microcontroller

A microcontroller is a computer -on-chip used to control electronic device. A typical microcontroller contains all the memory and interfaces needed for a simple application, whereas, a general purpose microprocessor requires additional chips to provide these functions. A microcontroller has following key features:

Central Processing Unit –usually small and simple –

- Output and input interface such as serial ports
- RAM for data storage
- Peripherals such as timers and watchdog circuits
- ROM for program storage
- Clock generator- an oscillator for a quartz timing crystal, resonator or RC circuit

Features of AVR microcontroller

The main features of AVR microcontroller are as follows:

- Less expensive.
- Operating voltage 2.7 to 5.5 v.
- 16 programmable I/O lines.
- Speed grades 8 MHz.
- 8k bytes In- System Self programmable Flash program memory
- 512 bytes EEPROM
- Fully static operation
- 32x8 general purpose registers

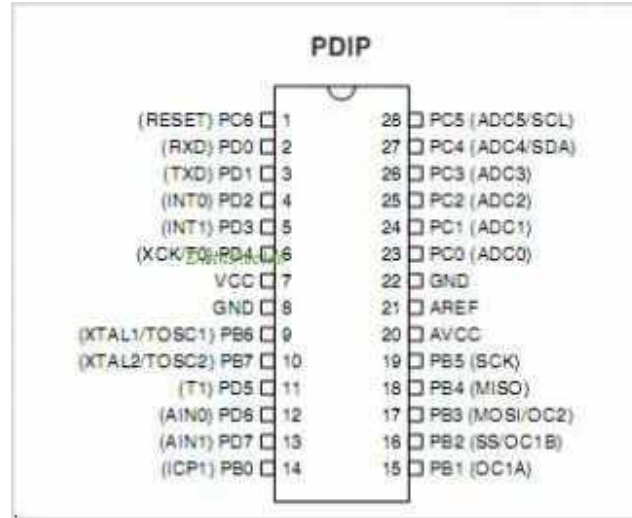


Fig.2. Pin configuration of ATmega8L

Servomotor

A servomotor is an electromechanical device in which an electrical input determines the position of the armature of a motor. Servomotors are DC motor equipped with a servo mechanism for precise control of angular position. The RC motor has rotation 90 degree to 180 degree, often 360 degree or more. A servo motor is an assembly of DC motor, a gear reduction unit, potentiometer and control circuit [3]. The servos are used precision positioning. They are used in robotic arms, legs, sensor scanners, RC toys like helicopter and cars.

5. Experimental setup

The main experimental set up is briefly described in the following subsections.

Necessary equipments

For a single PCB construction, the following components are required as shown in Table 1.

Table 1. List of components used in printed circuit board

Components	Ratings	Quantity
PCB	16x16cm	1
ATmega8L		1
IC	7805,7806	Each one piece
Crystal	8MHz	1
Capacitor	22pf,27pf,10uf,1000uf,1uf	Each one piece
LED	Green, Red	7
Transformer	12-0-12V,1amp	1
Transistor	BC547	6
Diode	1N4007	8
ON/OFF switch		3
Push switch		2
Resistor	4.7k,1k,10k	6,10,2
IC Base	14pin	2
Plastic Connector		16
Soldering Wire		1yrd
AC Cord		1
Connecting wire		1yrd

PCB

The schamtics of the PCB components are shown in Figure 3.



Fig.3. PCB attached on a wood board

6. Performance testing

Performance analysis

For performance testing first of all the base motor is placed with gear. Then PCB is connected with the motors of robotic arm and power supply (6V DC) is given through the DC power supply. Then, the base motor along with the first and second joint motor rotate sequentially .The motors stop working for three seconds. The motors work for three different time duration.

Cost analysis

The cost required for controlling the robotic arm by microcontroller is cheap than PLC control. Total cost breakdown is shown in Table 2.

Table 2. List of cost required to make the breadboard and PCB

Component	Unit price (Tk)	Quantity	Total price(Tk)
Printed Circuit Board	120	1	120
Breadboard	220	3	660
IC	12	10	120
Transistor	5	12	60
Transformer	250	1	250
Capacitor	5	10	50
Resistor	1	20	20
Microcontroller	130	2	260
Wire	50	5yrd	250
Switch	10	5	50
AC cord	70	1	70
PCB layout			500
Diode	6	15	90
Total Amount (BDT)			2500

7. Results

Microcontrollers are cores that will do anything once programmed them to do properly. They probably can be used in many applications, but with varying effectiveness. As always, one's work is in discerning which option will work best in a given situation. After completing the setup, the robot is tested and the program worked rightly the way it was expected. So, the motors ran according to the program installed in the microcontroller. This indicates that the test is conducted successfully.

8. Discussions

The construction of the PUMA robot has been conducted earlier. Only the control and operation is done in this project with microcontroller. While choosing the microcontroller the power required for running the controller itself and running the motor of robot are very crucial. Firstly, 8051 microcontroller was selected in this project. However, it did not meet all the criteria necessary to run a 24volt 21watt DC motor. So, microcontroller of AVR family has been chosen for this test. It meets all requirements and also it is cheap and easily programmable.

Programming could be done in both assembly language and C for a microcontroller. C is preferred here because of the availability of C compiler and the ease of the programmer.

While doing the wiring, a total of six relays are used. Although the program became complex, the program could be made is relatively easier when twelve relays are used.

Controlling of end-effectors is a difficult job as well as accurate positioning. Time is controlled from outside with the help of variable resistor. Often the hand strikes the base motor. However, this problem was overcome with the help of resistors.

9. Concluding remarks

The entire project consists of different steps of tasks as discussed above. To complete the project in a successful manner was a challenge. At first, program was developed for operation of robot by microcontroller. Then, PCB was designed and connected with the robot and it was tested. Thus, all the objectives are accomplished. Finally, the robotic arm moved satisfactorily.

10. References

- [1] Capek, K."Rossum's Universal Robot", English version by P Selver and N. Playfair. New York: Doubleday ,Page& company,1923.
- [2] Asimov, I."The Complete Robot" Garden city ,N.Y.: Doubleday &company,1982, pp209-220.
- [3] <http://en.wikipedia.org/wiki/Servomechanism> (accessed on May 12, 2013)