International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 05, May - 2017

Design and Construction of a Robotic Arm for Industrial Automation

Md. Tasnim Rana*,
Department of Mechanical Engineering,
Khulna University of Engineering & Technology, Khulna-9203, BANGLADESH

Anupom Roy
Department of Mechanical Engineering,
Khulna University of Engineering & Technology, Khulna-9203, BANGLADESH

Abstract **- The main concentration of the work was to make a cost efficient autonomous robotic arm in terms of industrial automation. It is a type of mechanical arm, usually programmable, with similar functions to a human arm; the arm may be a unit mechanism or may be a part of a more complex robotic process. The end effector or robotic hand can be designed to perform any desired task such as welding, gripping, spinning etc., depending on the application. For detective investigations and bomb disposal it can be used as an essential machine. In industry any kind of work which should be accurate and works continuously, normal programming algorithms and mechanical function can do the job perfectly .It can sense the co-ordinate of any object from conveyer and detect it. Its claw will grab the object and take it to a desire destination.**

Keywords: Robotic arm, Automation, Control, Program

1. INTRODUCTION

Industrial automation in terms of robotics is now a part and parcel of both industrial and human advancement. Robot arm is one off the most buzzing word in industrial automation. The arm is linked with some separate part. The links of such a manipulator are connected by joints allowing either rotational motion such as in an articulated robot or translational (linear) displacement. The links of the manipulator can be considered to form a kinematic chain. The terminus of the kinematic chain of the manipulator is called the end effector and it is analogous to the human hand. In the early days, people always try to overcome his limitation through machines and advanced engineering .In industry there are so many risky work that can hard workers. While risky works done by workers and while time is limited in terms of production and the product should be accurate robot arm is must. Moreover, accurate production can rarely obtain while the product is a technological or complex molding outcome. In terms of slow industrial production, it is the limitation for workers. In the solution the most and perfect solution would be a robotic arm. For example, robot arms in automotive assembly lines perform a variety of tasks such as welding and parts rotation and placement during assembly. In some circumstances, close emulation of the human hand is desired, as in robots designed to conduct bomb disarmament and disposal. In case of firefighting or rescue operation where human life is in danger robotic arm can be used as a rescue device. This can be functioned as required and can do works risky for human being. In case of rapid production the time limit for production will be shorten with the use of robotic arm**.**

2. BACKGROUND

At first robot was developed by Leo nartho the vence. Now an Japanese robotics company KAKU manufacturing robotic arm which are so high cost and very complex in work field to control. In 2007 the world market grew by 3% with approximately 114,000 new installed industrial robots. At the end of 2007 there were around one million industrial robots in use, compared with an estimated 50,000 service robots for industrial use [3]. Due to increase using of industrial robot arms, an evolution to that topic began trying to imitate human movements in a detail mode. For example a group of students in Korea made a design of innovations that robotic arm take account of dancing hand, weight lifting, Chinese calligraphy writing and color classification [4]. Another group of engineers at USA develop eight degrees of freedom robot arm. This robot is able to grasp many objects with a lot of shapes from a pen to a ball and simulating also the hand of human being [5].In space, the Space Shuttle Remote Manipulator System, known as SSRMS or Canadarm, and its successor is example of multi degree of Freedom robot arms that have been used to perform a variety of tasks such as inspections of the space shuttle Using a specially deployed boom with cameras and sensors attached at the end effector and satellite deployment and retrieval man oeuvres from the cargo bay of the space shuttle [6]. Some development was done on it.

3. SYSTEM COMPONENT

The whole system is based on two parts, mechanical part with functioned arm and signal processing part. Signal processing part will process the computing language uploaded to the microcontroller and mechanical part is the design concept using mechanics.
Signal processing part is given below:

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 05, May - 2017

3.1 Arduino Uno R3

Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins of which 6 can be used as PWM outputs, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller.

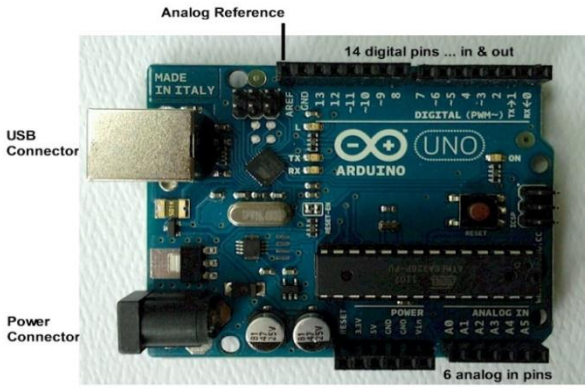

Fig.1: Arduino uno r3 microcontroller

3.2 Servo motor

A servomotor consumes power as it rotates to the commanded position but then the servomotor rests.
In case of this prototype robotic arm "Tower pro" MG 996R, 14kg/cm is used.

Fig.2: Servo motor

3.3 Stepper motor

The stepper motor is known by its property to convert a train of input pulses into a precisely defined increment in the shaft position. Each pulse moves the shaft through a fixed angle.

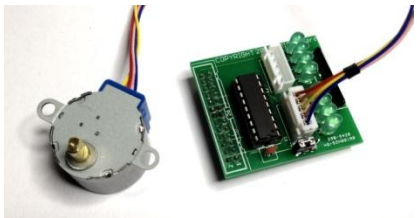

Fig.3: Stepper motor and motor driver

3.4 stepper motor driver

It controls the motor with the given algorithms my the microcontroller.

3.5 Robotic claw

Claw can reach objects up to 108mm away and trap highest 55mm wide objects securely in its clutches.

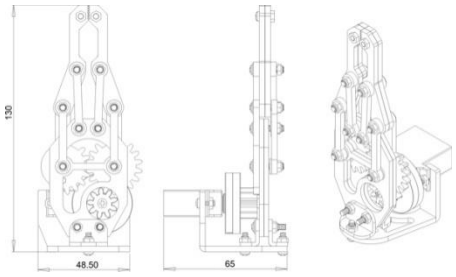

Fig.4: Robotic claw

3.5 10 k Ohm potentiometer

3.6 220 Ohm Resistor

3.7 Breadboard (full)

3.8 Jumper wire

3.9 9V DC power supply

4. METHODOLOGY

It is developed by using a simple microcontroller. In this case computerized scanning and figuring the required shape or simply functioning it with programming can make the work easier. The computer language uploaded to a microcontroller system will convert binary information to voltage variation which will function the joint of the arm by using mechanical component with calculated mechanics. For controlling the servo motor there will be three point of wire coming from the motor, two of them are ground and supply voltage and last one is for signal. In case of servo motor, it can rotate according to the programme and its range is 180 degree to 0 degree. This kind of servo loaded with the pin number 3,4,5,6 from the Arduino board. And both ground and supply voltage is given by the provided pin from Arduino called 5V and GND.4 servo work for joint movement and the movement is specified by objects position. A stepper motor which rotate 360 degree in 120steps is used controlled by a stepper motor driver L298D.5v supply and ground voltage is given by Arduino supply pin and the main four signal pins from stepper motor driver are connected with the pin number 7,8,9 and10 of arduino Uno R3. A sonar sensor HC-

Table 1:

SR04 is used for determining the position of the obstacle and finds the co-ordinate of the obstacle. It has two pin for ground and supply voltage connected with arduino board .And two signal pin named PNG and ECHO which will connected with analogue pin A0 and A1 from arduino board. In case of power supply to the arduino board a 9v battery is used which can be re charged by a solar panel and the terminal of ground and supply voltage is correctly done.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 05, May - 2017

5. MECHANICAL DESIGNING AND MODELING:

The mechanical design of the robot arm is functioned on a robotic movement with similar functions to a human arm [6-8]. The links of such a movement are connected by joints allowing rotational motion and the links of the manipulator is considered to form a kinematic chain. For designing the arm, its force distribution was very important to analysis. In case of force distribution

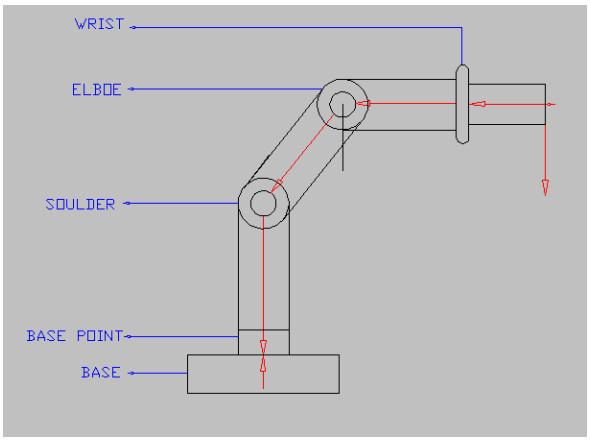

Fig.5: Free body diagram of the robot arm

5.1 Design of working steps

Arm functioning was done according to the Table 1.It was functioned steps by steps.

Activity step	Servo 1	*Servo 2*	*Servo 3*	Stepper motor (degree)
1st step (scan 360 degree)	0	0	0	0-360 (120 steps)
2nd step (if object detected)	0-120	0-40	0-80	
3rd step (grab the object)	120	40	80-0	Determined step
4th step (take to a position)	120-0	40-0	0	Determined
5th step (scan again)	0	0	0	0-360 (120 steps)

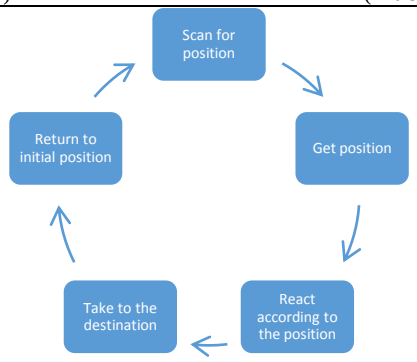

Fig 6: Designing scheme of control.

The robotic arm at first the loop starts by scanning its surroundings by rotating 360 degree .As a sonar sensor is used for determining the co-ordinate of any object. While the sonar find any object it will send a signal to the processing unit (Micro controller) then the output signal will stop the rotating stepper motor and start functioning the grabbing part. In case of grabbing a object the processor provided with arduino uno r3 gives voltage signal from binary coded information. In this case the moving arm will move by its servo motor according to object's co-ordinate. As this is a three dimensional co-ordinate system, this can be displayed in mat lab with graphical representation.

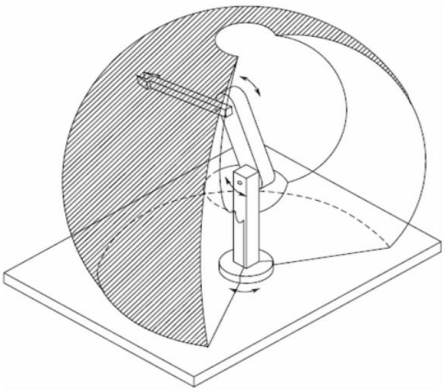

Fig.7: Work region of the robotic arm.

5.2 Construction of Main structure

In construction of robotic arm the kinematics are copied by usual arm movement capability of a general human being. All the force are distributed such a way that the base can have the load with 360 degree moveability.6 joints are attached through servo motor with mechanical support of hard board. For shaping the hard board of the prototype of normal hexose and a cutter is used .Where fixed joint is required glue gum and metal screw. The
business end of the kinematic chain of the manipulator is called the end effector or end-of-arm-tooling and it is analogous to the human hand. Figure shows the Free Body Diagram for mechanical design of the robotic arm. As shown, the end effector is not included in the design because a commercially available gripper is used. In the base, a ratable platform made of plastic is used where the platform can have a 360 degree access and it gives the freedom need for the arm to reach a certain co-ordinate. The sonar sensor is attached with the rotating platform for 360 degree scanning. For locating the servo motor with the arm, 15kg/cm servo was attached with the elbow and 14kg/cm servo was attached with the wrist .In case of end effector an 8kg/cm servo is used for mechanical claw. A serial communication system was introduced to the robot arm where the distance of any object can be displayed through serial monitor as unit in cm.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 05, May - 2017

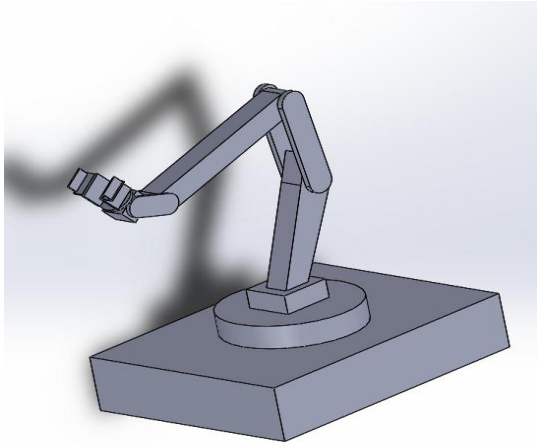

Fig.8: Robot arm 3D model.

6. RESULT AND DISCUSSION:

Result from different working operating condition and effects in return are given below:

6.1 Mechanical advantages in movement:

As metallic servos are used in case of functioning the arm, a servo can work with in the range of angle from 0 to 180 degree. But the program coded in the arduino allows the motor to move at some accurate angle.

Table 2: Servo movement range:

Angle	Range
Elbow	0-120
Wrist	0-40
arm	0-80

6.2 Current consumption:

The current consumption depends on the load and the position of the object.

Table 3: Load VS current consumption

Load	Current consumption(mA)
15gm	Low (0-200)
35gm	Normal(200-500)
45gm	Normal(500-800)
55gm	High(800-900)
75gm	Overloaded(above 900)
95gm	Overloaded(above 900)

8. CONCLUSIONS

This paper represents the design, development and implementation of robot arm in terms of industrial automation, which has the talent to accomplish simple tasks, such as it can sense any material and capable of light material handling. The robot arm was designed and built from acrylic material where servo motors and stepper motor were used to perform links between arms and execute arm movements. The servo motors include encoder so that no controller was implemented; how- ever, the rotation range of the motor is less than 180º span, which greatly decreases the region reached by the arm and the possible positions. But stepper motors which can rotate 360 degree at 120 steps make the arm easier to solve the problem. The design of the robot arm was limited to four degrees of freedom since this design allows most of the necessary movements and keeps the costs and the complexity of the robot competitively. The end effector is not included in the design because a commercially available gripper is used since it is much easier and economical to use a commercial one than build it. During design, we faced some difficulties due to the way of joining thin acrylic parts strongly. A mechanical junction based on screws and nuts is used and in order to accomplish that, a small feature was designed which allowed fastening the bolts with the nuts without having to screw in the thin acrylic layer. To control the robot an autonomous computer code is used and serial communication method give an access to the autonomous process.

9. REFERENCES

[1] Manipulating Industrial Robots—Vocabulary, International Organization for Standardization Standard 8373, 1994.

[2] Industrial and Service Robots, IFR International Federation of Robotics, 2010. http://www.ifr.org/home

[3] Case Studies and Profitability of Robot Investment, the IFR Statistical Department, 2008. http://www.ifrstat.org/downloads/2008_Pressinfo_english.pdf

[4] R. J. Wang, J. W. Zhang, et al., “The Multiple-Function Intelligent Robotic Arms,” FUZZ-IEEE Journal, Korea, 20-24 August 2009, pp. 1995-2000.

[5] L. B. Duc, M. Syaifuddin, et al., “Designing 8 Degrees of Freedom Humanoid Robotic Arm,” International Conference on Intelligent and Advanced Systems, Kuala Lumpur, 25-28 November 2007, pp. 1069-1074.