Design and Structural Analysis of Pick & Place Robotic Arm

Pushpendra Kumar Bhandari[1], Nitin Jain [2]
[1,2]*Department of Mechanical Engineering*

Abstract **- Now days in this fast-growing industrial age every company needs speed in manufacturing to cope up with the customer's requirements. Every industrialist cannot afford to transform his unit from manual to semi-automatic or fully automatic as automation is not that cheap in India. The basic objective of our project is to develop a versatile and low-cost robotic arm which can be utilized in any industry to eliminate this problem. Our robotic arm can be used in number of applications by changing the program of controller and the structure is designed in such a way that it is capable to lift light loads but can also lift medium loads. Our robotic manipulator would be used mainly in the packaging department and automatic assembly lines.**

Mankind has always strived to give life like qualities to its artifacts in an attempt to find substitutes for himself to carry out his orders and also to work in a hostile environment. The popular concept of a robot is of a machine that looks and works like a human being. The industry is moving from current state of automation to Robotization, to increase productivity and to deliver uniform quality. The industrial robots of today may not look the least bit like a human being although all the research is directed to provide more and more anthropomorphic and humanlike features and super-human capabilities in these. One type of robot commonly used in industry is a robotic manipulator or simply a robotic arm. It is an open or closed kinematic chain of rigid links interconnected by movable joints. In some configurations, links can be considered to correspond to human anatomy as waist, upper arm and forearm with joint at shoulder and elbow. At end of arm a wrist joint connects end effectors which may be a tool and its fixture or a gripper or any other device to work. Here how a pick and place robot can be designed for a workstation where loading and packing of lead batteries has been presented. All the various problems and obstructions for the loading process has been deeply analyzed and been taken into consideration while designing the pick and place pick and place robot.

Index Terms **- ROBOTIC ARM, pick and place operation, Analysis**

1.INTRODUCTION

1.1 Introduction of the thesis

Robotic structures are challenging because of the involving of dynamic forces. These dynamic forces further amplify themselves during emergency stop operation. Further a pick and place operation has its own operating frequency, if this frequency resonates with the structure it results in dramatic failure so a structure that supports such an operation needs to be stable both in static condition as well as in dynamic condition. The frequency analysis of the outer structure depends on the load by the pedestal and the robot which is totally mounted at the center. The main aim is to avoid the resonance occurrence between the structure with the robot and the conveyor.

Pick and place robotic arm is a system which can be designed in many different ways according to its applications. They heavily depend on joints, which are used to join or connect the two consecutive bodies in the robot and can be rotary joint. Joints define the movement of the arm. Arm decide the degree of freedom of the components. Consequently, all robotic arm consists of following basic components.

- Controller
- Manipulator
- Grippers
- Power source

A robotic arm has a mechanical structure that alters its form using a group of electric motors that behave like servo motors, pneumatic, or hydraulic actuators. They are usually programmable, with similar functions to a human arm; the arm may be the sum total of the mechanism or may be part of a more complex robot. 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.

1.2 PROJECT AIM AND OBJECTIVE:

The aim of this project is design an autonomous robot with complete system allow the robot wander about its environment and to interact with certain object that its encounter. In order to achieve the aim of this project, several objectives are needed to be complete.

IMPORTANCE OF WORK:

In this scenario, the industry having a problem by human life in some hazardous duty service. Robot can work in environments so hazardous that an unprotected human would quickly die

SCOPE OF PROJECT:

Industrial automation, equipment and goods carrier, tour guide in museum, deliver the mail in office building, delivers medication in the hospital, can be used in place of crane in various lifting and carriage application.

1.4 Problem Statement

This picks and place robot being designed to ease the sorting process of heavy materials. Usually the transfer process of the heavy materials is being carried out using man power and if the transfer process is repeated for a period of time, it can cause injuries to the operator. By using this particular robot, the operator will no longer have to bent and lift up heavy loads thus preventing injuries and increasing the efficiency of the work. Operator will make mistakes whether small or big every one in a while .In the industrial world, the industry cannot afford to take kind of mistakes. Every mistake is costly whether in time, money, and material.

1.3 Purpose of the robotic arm

This robot is a mechanical arm, a manipulator designed to perform many different tasks and capable of repeated, variable programming.

To perform its assigned tasks, the robot moves parts, objects, tools, and special devices by means of programmed motions and points. The robotic arm performs motions in space. Its function is to transfer objects or tools from point to point, as instructed by the controller

In manufacturing industry and nuclear industry, a large fraction of the work is repetitive and judicious application of automation will most certainly result in optimum utilization of machine and manpower.

A pneumatic `Pick and Place' Robot has been developed to achieve automation in applications where great sophistication is not needed and simple tasks like picking up of small parts at one location and placing them at another location can be done with great ease.

1.4 Scope of the robotic arm

- The machine will be of great use to perform repetitive tasks of picking and placing of small parts (up to 500 gms) in an industrial production line.
- Its use can be extended and exploited by few modifications to do difficult and hazardous tasks for industrial applications.
- It can be used to do small assembly work effectively due to its great added accuracy for placement of parts, which is further extended scope of our project

2. LITETURE SURVEYS

2.1 Development of Robotic Arm Using Arduino UNO by 1Priyambada Mishra,2Riki Patel, 2Trushit Upadhyaya, 2Arpan Desai:-

In this paper, they have used 4 servo motors to make joints of the robotic arm and the movement will be controlled with the help of potentiometer. The controller used is Arduino UNO. The analogue input signals of the Arduino’s is given to the Potentiometer. The arm has been built by the Cardboard and individual parts are attached to the respective servo motors. The arm is specifically created to pick and place light weight objects. So low torque servos, with a rotation of 0 to 180 degrees have been used. Programming is done using Arduino 1.6.10. Thus the paper basically focuses on creating a robotic arm with non useful materials and its application on small purposes.[1]

2.2 Design of Robotic Arm with Gripper and End effector for spot welding’ by Puran Singh, Anil Kumar, Mahesh Vashishth

According to the paper the robotic arm consists of 2 degrees of freedom is being made for the purpose of spot welding, gripper will be used in the arm. The end effector consists of an arrangement of spur gears and threaded shafts along with an AC motor. Aims considered while building the robotic arm are
1.To have a rigid structure.
2.Movement of parts to defined angles.
3.To attain consumption of power at optimum level.
4.To perform spot welding operation with the help of end effectors. The material used for manufacturing the bottom of robotic arm was plywood which has the dimensions as followsLength-48 cm, Breadth-28 cm, Thickness-2 cm. Arm manipulator will be made up of plastic and has the following description-
Weight=(30)2=60 g for big arm and (10)2=20 g for small arm.
Length=25 cm for big arm And 5cm for small arm. At the assembly point of wrist and end effector, 2 end effectors are used, in which one end effector is fixed and the other is movable, the end effector assembly has meshing of spur gears and worm gears which are connected to a 9 V stepper motor. The stepper motor has a step angle of 1.8 degrees and a speed of 100rpm. Force calculation on joints is done. This design of the robotic arm has two d.o.f. which performs the function of lifting, and for each linkage the center of mass was acting at the half of the length. Since there are many possible configurations for the robotic arm, the maximum degrees of rotation of each joint is 180 degrees. All the locations of the End Effector to which it can reach so that the workspace required can be calculated. This type of technology which is used in robotic arms can help in doing spot welding operation more efficiently. The material handling was carried out easily by picking and placing of the desired object. We can change the variation in the robot arm structure and their angle of movement.[2]

2.3 Review on Object-Moving Robot Arm basedon Color By Areepen Sengsalonga, Nuryono Satya Widodo
The objective of this finding is to make a manipulator which can sort objects on basis of color using specific motors and photodiode sensors programmed with a Arduino Mega series microcontroller. The light photodiode sensor can identify RGB colors. In this system the output of Arduino Mega 2560 is displayed on a LCD screen which is an indication of the observed color. The first step of object moving process is by distinguishing the RGB color. The gripper of robotic arm will move to pick objects based on color, depending on the color input given by the light photodiode sensor. Arduino Mega 2560 is a microcontroller that uses ATmega2560 which is installed in robotic arm having 54 digital i/o ports segregated into different types. In this paper a color sensor testing is also carried out ,having a target to determine the ability of Photodiode sensor for distinguishing of color .The resultant voltage from photodiode will be sent to ADC to process and show result on the LCD screen provided.[3]

2.4 Modeling and Simulation of Robotic Arm Movement using Soft Computing by V. K. Banga, Jasjit Kaur, R. Kumar, Y. Singh
In this research paper the authors successfully built a 4 degrees of freedom robotic arm using soft computing. They have formulated ways for controlled movement of robotic arm and planning of trajectory with the help of Genetic Algorithms (GAs) and fuzzy logic (FL). As optimal movement is critical for efficient autonomous robots. This architecture is used to limit the issues related to the motion , friction and the settling time of different components in robotic arm. Genetic optimization is used to find the finest joint angles for this four d-o-f robotic system. This type of optimization replaces the long process of trial and error in search of better combination of joint angles, which are valid as per inverse kinematics for robotic arm movement. These logic models (Fuzzy logic) have been developed for the joint movement, friction and least settling time attributes as the fuzzy logic input.[4]

2.5 Design and Development of a Self-Adaptive, Reconfigurable and Low-Cost Robotic Arm by Kemal Oltun Evliyaoğlu1, Meltem Elitaş
Variety of tasks can be performed by a robotic arm when we do some changes in it , i.e changing the number of links, it can be made self- adaptable , this aspects of a robotic arm is discussed by the author in this paper. The paper represents a basic robotic solution to fulfill different applications with the help of it. The Design consists of two panels which have there individual wiring with it, thus as per the application required the panels are arranged and servo motors are connected to perform the task.[5]

2.6 Design and Implementation of Wireless Robotic Arm Model using Flex and Gyro Sensor by Anughna N, Ranjitha V, Tanuja G

The paper represents the author using accelerometers to collect information. The controller used is Arduino Atmega328. Human arm motion, fingers are located by flex, gyro sensors and signals are sent to Arduino ATmega328 which in turn controls the servo motors and makes the movement of the arm possible. The programming of the Arduino was done with the help of embedded C language. The Flex and Gyro Sensors were placed near the fingers. Whenever the change is detected, the information by both the sensors is processed by the controller. The Future Scope of this paper includes using 5 Flex Sensors near the fingers and more Gyro for the ease of operation.[6]

2.7 A Geometric Approach for Robotic Arm Kinematics with Hardware Design, Electrical Design, and Implementation by Kurt E. Clothier and Ying Shang

In this paper, the author has taken a geometric approach in order to position the robotic arm in an autonomous manner. iRobot command model is the main controller for the robot. For additional hardware, there are four e-ports and it is built around Atmega 168 microcontroller. The number of sensors used externally to iRobot Create are three. Two SharpGP2D12 Range Finder sensors and one GP2D120 Range Finder sensor are used. An infrared beam is emitted from these sensors and the reflection angles are used to find the distance of the objects. Objects in the range of 10-80 cm are detected by GP2D12, whereas the objects as close as 4- 30 cm are detected by GP2D120. Element Direct, Inc is the screen used in this project, it came with four charactere Display which was designed for the use with command module. For scanning purposes, in the front of the robot, there are two infrared range finders. A distance in millimeters is received with the help of these sensors when anything blocks their line of sight, and hence we get the position of an object with the help of these distances.[7]

2.8 Design and Structural Analysis of a Robotic Arm by Gurudu Rishank Reddy and Venkata Krishna Prashanth Eranki

In this paper the authors have a successfully built a 4 degrees of freedom robotic arm used for handling metal sheet in a conveyor system. Reducing manual handling of sheet from stack to shearing machine is the main reason of designing this pick and place robotic arm. Two pneumatic cylinders for the feeding mechanism, and a robotic arm for the workers' safety were designed. Integration of the manipulator position sensor in the robot's control unit is done by RCC which is installed in the robotic arm. Robot's ability to interact with the surrounding is possible with the help of RCC control. A self-optimisation system is provided by the manipulator depending upon the given conditions. Self-awareness system of the robot will ensure safety on site. Suction effect is produced by the vacuum cup(which is at the end effector) on the surface of the object. Continuous path, acceptable degree of freedom, speed control, repeatability and high resolution were the major factors which were processed by the manipulator.[8]

2.9 Industry Based Automatic Robotic Arm by Dr. Bindu A Thomas, Stafford Michahial, Shreeraksha.P, Vijayashri B Nagvi, Suresh M

This paper includes the design of an automatic robotic arm which is based according to the industrial applications. A functional prototype was constructed. This framework would make it simpler for man to maintain a strategic distance from the danger of dealing with objects which could be unsafe at the working environment. The utilization of robots is strongly suggested for Businesses particularly for security and profitability reasons. In their design work, they included a manipulator with 5 Dof. The microcontroller issues order to the individual channels that makes up the link. The electric motor operates as per given command and the speed of the motor as well as the direction and motion is controlled by the microcontroller. Meanwhile, in the mode of operation of robot, an obstacle sensor was programmed by the microcontroller such that it detects the presence of the obstacle in 10cm of radius. If an obstacle is sensed for the first time it pauses the work. Again if the problem is not cleared, a feedback system such as buzzer gets turned on to bring this problem on notice of a personnel to clear the object. [9]

2.10 Robotic object recognition and grasping with a natural background by A Hui Wei and B Yang Chen

In this paper, the authors had developed an efficient grasp synthesis method that could be used for closed-loop robotic grasping with the help of only a single monocular camera, they had proposed an approach which can detect contour information from an image in real time and then determine the precise position of an object to be grasped by matching its contour with a given template. This approach was much lighter than the currently prevailing methods, especially vision-based deep-learning techniques which requires no prior training. They have used the state-of-the-art techniques of edge detection, superpixel segmentation, and shape matching. The visual servoing methods that the authors developed for this system did not rely on accurate camera calibration or position control and was able to adapt to dynamic environments. Experiments showed that this approach provided high levels of compliance, performance, and robustness under diverse experimental conditions and environment.[10]

III. WORKING OF THE ROBOTIC ARM

This work is able to successfully accomplish the defined functionality. A sample robot which can rotate, magnetize an object, lower and raise its arm, by being controlled by the microcontroller is built successfully. The development board is soldered and it used the required procedure for the correct operation of the controller. The development board has been interfaced to the servo & dc motors such that the anthropomorphic like structure can be controlled from the buttons at the base of the structure (robotic arm).
When signal come to robotic arm, it will activated and then it searching for the code object in storage area when it get confirmation of availability thus it call AGV to collect and dispatch that object to its destination of call at the instant of getting signal inbuilt program in AVR controller activate and check signal status incoming signal on USART terminal via RF module thus programmed AVR drive the servos with fix degree which have been place in programming for particular objects ,end effecter as a claw made up of dc geared motor and spar gear assembly with AVR via L293D motor driver h-bridge IC collect the object lift up and drop on AGV and its come back its original position which is mention in its program.

3.1 Mechanical Structure of the Arm

In constructing our arm, we made use of Two servo motors and a dc motors and gears since our structure is a three dimensional structure. A typical prototype that we employed is as shown in Figure. There is a servo motor at the *base*, which allows for circular movement of the whole Structure; another at the shoulder which allows for upward and downward movement of the Arm; while at last dc motor at the *wrist* allows for the picking of objects by the magnetic hand.

Block Diagram

The block diagram of our work is as shown in Figure

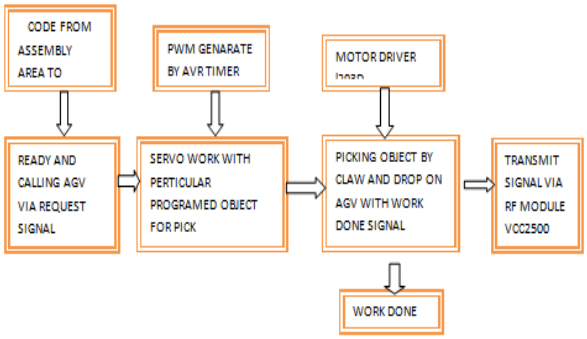

Figure 1: Block Diagram

The mechanical construction in this project is to build and assemble the robotic arm body. After giving a thorough consideration of all the preceding works in this field, a five degree of freedom manipulator having variable programmed motions to carry out variety of tasks in diverse environments is chosen. This is a five-axis manipulator designed to pick and place objects like chips, memory cards, processors, etc. It is driven by six servomotors and has a gripper as end effectors. The gripper has two fingers grasping and manipulation of objects as big as a 150 ml cylindrical bottle and having a weight of about 150 gm throughout the arm's workspace.

3.2 Design of Pick and Place Robot

Figure.2 Design of pick and place robot

IV. RESULT AND OUTPUT

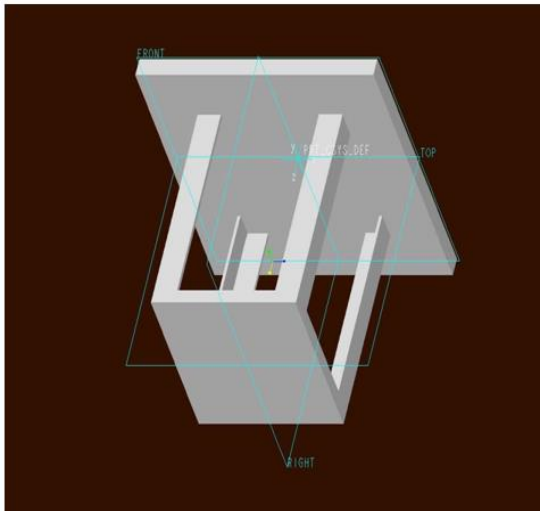

Figure 3: BASE PLATE WITH STAND

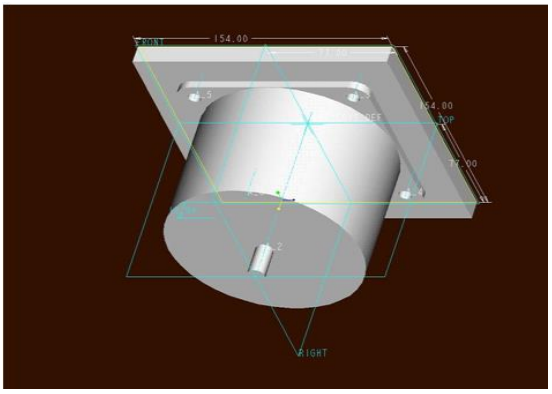

Figure 4: MOTOR WITH PLATE -2

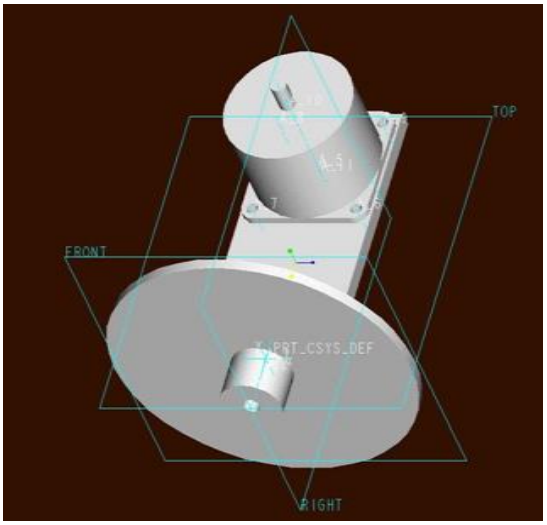

Figure 5: CIRCULAR PLATE WITH BOSS WITH PLATE-3

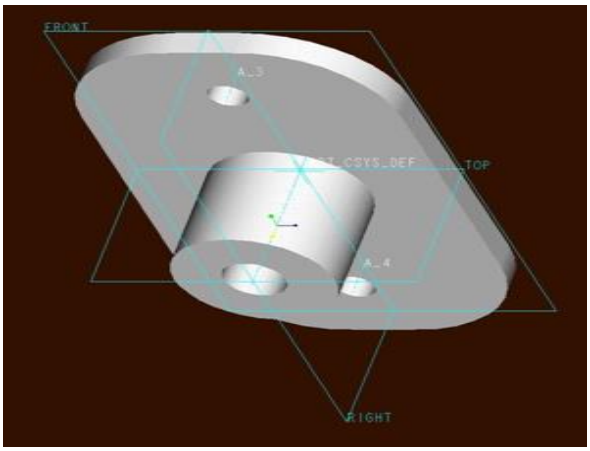

Figure 6: FLANGE WITH BOSS

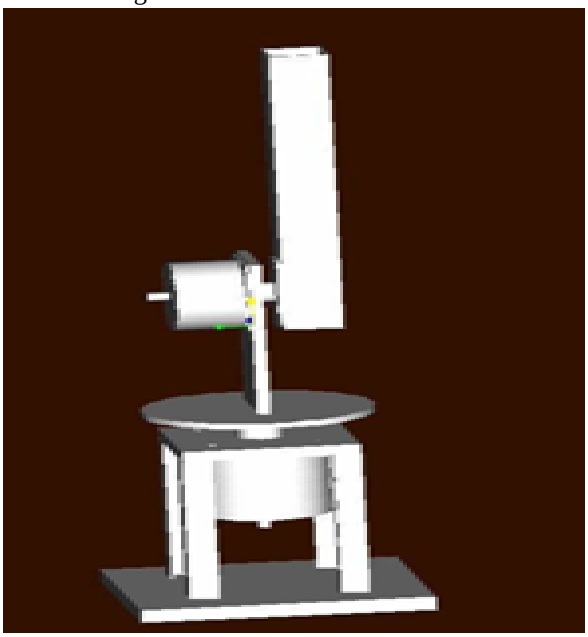

Figure 7: ASSEMBLY DRAWING

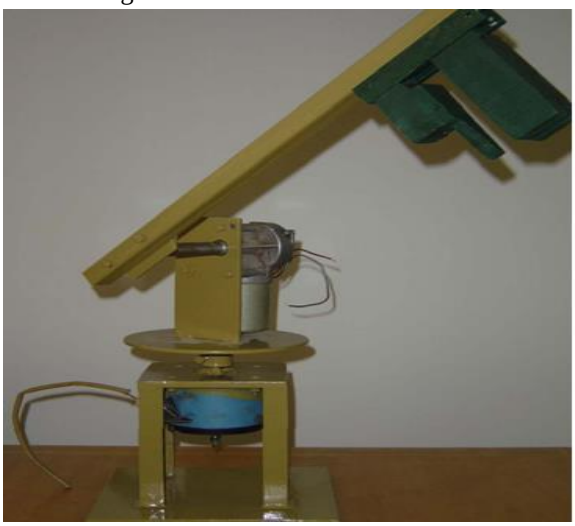

Figure 8: FINAL ROBATIC ARM STRACTURE

V. CONCLUSION

The objectives of this project has been achieved which was developing the hardware and software for an accelerometer controlled robotic arm. From observation that has been made, it clearly shows that its movement is precise, accurate, and is easy to control and user friendly to use. The robotic arm has been developed successfully as the movement of the robot can be controlled precisely. This robotic arm control method is expected to overcome the problem such as placing or picking object that away from the user, pick and place hazardous object in a very fast and easy manner.

1. Thus the aim for the atomization in manufacturing units by the mean of employing process or sequence of programmed operation with little or no human labor using electromechanical techniques is made.
2. The goal of less or no probability of error; with real time management is achieved.
3. Easy operating format by use of computer is obtained.
4. Elimination of the stressed watch by human operators on systematic working to achieve desired production in the industry is made.
5. By developing an autonomous nature of the system, the same is made a reliable one.
6. A solution for the simultaneous accomplishment of assembling work done in the industries by the means of single computes has not only provided ease in operation but also provides autocratic nature for monitoring purposes is designed.

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