X – Y Gantry mechanism for material handling in industry.

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Abstract— In industries the material handling is done manually but workers safety concerns it is danger to handle chemicals manually. So in the industries the automation plays very important role. In our project we are using the rack & pinion mechanism to move the material from one place to another in x direction. & to lift the material we are using the lead screw mechanism. In our project designing of the whole system is important part. It includes designing of lead screw, shaft, rack & pinion, gripper assembly. Various Types of X-Y control Positioning System is used in industries for many purpose. In industry this mechanism is operated by PLC and Microcontroller. But the cost of PLC is high. So PLC is replaced by arduino controller. Arduino controller operates on IDE programme. The goal of this project was to develop a XY Scanning stage to translate the motion stage along the X and Y axes of the gantry and to use this information as the output for a microcontroller that can modify the commanded position of the stepper motor as the input data provided.

Keywords: rack & pinion mechanism; lead screw mechanism; PLC; Arduino controller;

I. INTRODUCTION

The last two decades have witnessed a significant advance in the field of robots application. Many more applications are expected to appear in space exploration, battlefield and in various actives of daily life in the coming years. A robot is a mechanical device that performs automated tasks and movements, according to either pre-defined program or a set of general guidelines and direct human supervision. These tasks either replace or enhance human work, such as in manufacturing, contraction or manipulation of heavy or hazardous material. Robot is an integral part in automating the flexible manufacturing system that one greatly in demand these days. Robots are now more than a machine, as robots have become the solution of the future as cost labor wages and customers demand. Even though the cost of acquiring robotic system is quite expensive but as today's rapid development and a very high demand in quality with ISO standards, human are no longer capable of such demands. Research and development of future robots is moving at a very rapid pace due to the constantly improving and upgrading of the quality standards of products
II. PROBLEM STATEMENT

In the chemical processing industries, the handling of chemicals is now very harmful as it done manually. As safety concern it is required to find the alternative to handling of chemicals. So we are designing a system that can handle by the robotic arm which is automated system.

Design and develop the ‘Design and Manufacturing of material handling robot using X-Y gantry mechanism.’ which will do pick and place operation for material handling concern.

III. OBJECTIVE

- To design & developed the X- y mechanism for the application
- To manufacture the system.
- To perform pick and place operation.
- To reduce labour work & increase human safety
- To save material handling time and cost.
- To improve work efficiency.

IV. LITERATURE SURVEY

Biswa Palok, S. Anandan Shanmugam, “Design and Development of a 3 axes Pneumatic Robotic Arm”, Department of Electrical and Electronic Engineering, University of Nottingham Malaysia Campus, Malaysia, 2016, [1] In this paper an articulated robot arm was developed using pneumatic linear actuators to carry out material handling tasks for industries where the usage of electric components can be hazardous. The design of the arm employed crank mechanism in which linear displacement from actuation was converted to angular displacement of the joint efficiently. A 5/3-way proportional control valve proved to be very effective in controlling the highly nonlinear arm compared to normal 5/3-way directional control valve. Closed loop control using a microcontroller and feedback sensors provided precise and improved control of the joint angle with high accuracy which was previously unachievable by PLC. It was also found that the force changes with the position of the articulated arm dynamically.

S Senthilraja, R Gangadevi and M Thirugnanam, “Design and fabrication of three axis robot for material handling in chemical industries”, Department of Mechatronics engineering, SRM University, Chennai, 2016, pp 2700-2702, [2] A three degrees of freedom robot which has the talent to handle hazardous materials in chemical industries was designed and fabricated. The robot was designed and manufactured using stainless steel materials and the pneumatic linear actuators were used to actuate the links to perform arm movements. The material handling system has a huge future scope which includes that the number of axes can be further increased to provide a larger base and to carry heavier loads, the efficiency of the system can be increased by applying functions simultaneously to multiple grippers, the robot can be made calibrated to the vice further to pick completed jobs from the vices and dropping them to required places.

S. Premkumar, K.Surya Varman,b, R.Balamurugan, “Design and Implementation of multi handling Pick and Place Robotic Arm”, Department of Mechanical Engineering, IFET College of Engineering, 2016 pp 164-166, [3] In this paper the effective Design and Implementation of multi handling Pick and Place Robotic Arm has been performed. The operation of various arm linkages and the robotic arm has been extensively tested and the required corrective measures were taken. Hence the objective of designing and manufacturing of pick and place robot at low cost was successful and It’s been proved that running cost of the robot is also very less. This will help to cut down labor and improve profits at very low initial investment. The proposed model is demonstrated through an application of example of real world. By considering the above advantages and also by looking at various benefits, this project can be employed in the assembly industry. I hereby, conclude by saying that this project can be a factor for creating an impact on assembly sections.

4. Ravikumar Mourya. Amit Shelke, Sourabh Satpute, Sushant kakade, Manoj Botre, “Design and implementation of pick and place robotic arm”, Department of Mechanical Engineering, JSPM technical campus Pune, 2015, pp 232-240; In this paper, how the four degree of freedom robot works. There are numerous dimensions over which robotic arms can be evaluated, such as torque, payload, speed, range, repeatability and cost, to name a few. In this paper with reference to many available manipulators and mobile platforms in market, a practical design for manipulator has been perceived and computer aided designing software like creo1.0 and auto cad are used to model the desired manipulator.

V. COMPONENTS OF THE SYSTEM

1) Rac & pinion
2) DC motor
3) Structure
4) Lead screw
5) Gripper
6) Guided rod
7) Arduino controller

A. Rac & pinion
It is used to move the arm in the horizontal direction
The main work of the Rac & pinion is to convert the rotary motion to the reciprocating motion. We are converting the rotary motion of the motor to the linear movement of the arm.

![Figure 1. Rac & pinion](image1)

Specifications
Rac
Module=1mm No. teeth=42 L=127mm
Pinion
Module=1mm No. teeth=18 id=6mm

B. DC motor

![Figure 2. DC motor](image2)

Specifications
Voltage=12v,
Amp=2, T=3kg, Rpm=30

C. Structure

![Figure 3 Structure](image3)

D. Lead screw

- Lead screws are quiet, smooth, resistant to corrosion, self-lubricating, and often less expensive.
- They are favored in situations that require higher levels of customization. Because lead screws are virtually silent and vibration-free, they’re often used for medical equipment like insulin pumps and in personal computing devices like desktop PCs.
- Lead screws are self-locking; there is typically no need to apply additional brakes, even in situations where you’re lifting a vertical load during an electricity outage. However, the higher the friction is on the sliding surface, the more power is required to drive the load up or forward.
- Material: Mild Steel

![Figure 4 Lead screw](image4)

E. Gripper

![Figure 5. Gripper](image5)

F. Arduino controller

An Arduino board comprises of an Atmel 8-bit AVR microcontroller with integral segments that encourage programming and joining into different circuits. A critical part of the Arduino is its standard connectors, which gives clients a chance to associate the CPU board to an assortment of compatible extra modules known as shields. The Arduino board uncovered the vast majority of the microcontroller's I/O pins for use by different circuits. The Decimals and current Uno give 14 computerized I/O pins, six of which can deliver beat width balanced signs, and six simple inputs, which can likewise be utilized as six advanced I/O pins.
VI. WORKING MECHANISM

A Gantry mechanism

Gantry Robot Systems and Linear Modules For high speed automation, both gantry and articulated arm robots are widely used throughout industry. Because of the many inherent advantages of the gantry robot, it is rapidly becoming the preferred choice for: Parker offers seven standard gantry configurations to solve these and other automation applications. Utilization of these pre-engineered systems enables the user to redirect scarce engineering resources from motion system design to machine or process functionality. HPLA and HLE Linear Drive Modules are the primary building blocks for Parker’s seven standard gantry systems. With six different cross sectional sizes (60, 80, 100, 120,150, and 180 mm) and three bearing systems (polyamide or steel rollers, and square rail bearings), these modules can effectively, efficiently and economically satisfy the widest range of application requirements.

VII. CAD MODELING

Figure 6. Hardware structure of Arduino

Figure 7. 3D model

Figure 8 Front view

VIII. DESIGN AND CALCULATION

1. Pinion

Material-plastic
Ultimate tensile strength (Sut)= 40 Mpa
No of teeth (z) =18
Bending Stress (σb) = Sut /3= 40/3=13.333
Power (P) = Voltage*current=12*2=24 watt
Speed (n) =30 rpm
Levis form factor(Y) = 0.308
Face width (b) = 10m
Diameter (d) = m X z =18m
Where m=module of pinion

Beam strength (Sb)= Bending stress x face width x module x levis form factor
= σb x b x m x Y
=13.33 x 10m x m x 0.038
=41.0656 x m2 , N

Velocity (v)=πdn/60
=(3.142 x 18m x 30)/(60 x 1000)
= 0.0282m, m/s

Tangential force (Pt)=P/v
=(24 x 10^(-3))/0.0282m = 0.8510/m, N

Velocity factor (Cv)= 6/(6+v)
=6/(6+0.0282m)

Effective load (Pef)=Cs x Pt/Cv
=0.2836 x (6+0.0282m)/m

FOS=2

Beam strength= FOS x effective load
= m x 41.0656=2 x 0.2836 x (6+0.0282m)/m

Solving above equation we get module as
m= 0.43628

module=1 mm
m=d/z

If m increases then diameter increases as a result size of gear increases and other respectively

2. Rack
AS pinion is weaker than rack, module = 1 mm
We have Distance travelled in Y direction is 400 mm in 15 sec
As no of teeth on pinion is = 18 & module = 1
PCD of pinion = 18
1 rev = \(2\pi r = 2 \times 3.14 \times 9\)
= 56.54 mm
To move left most passion to right most passion we have to move 400 mm distance
So total revolutions required to the travel the distance
Rev = \(\frac{400}{56.54}\)
= 7.07 rev

Revolutions per minute
\[
\frac{7.07}{15} = \frac{X}{60}
\]

RPM = 28.28
Hence we selected 30 rpm speed motor

**Motor selection of lead screw**

We have to lift the object by max 150 mm

1 rev of screw = 1 pitch advance
1 rev = 1.25 mm

Total revolutions required to move the 150 mm distance
Rev = \(\frac{150}{1.25}\)
= 120 rev
We have to move this distance in 2 minute max
\[
\frac{120}{120} = \frac{X}{60}
\]

RPM = 60

Hence we selected 60 rpm speed motor

**IX. APPLICATION OF GANTRY MECHANISM**

- Gantry cranes
- Rubber Tyred Gantry Crane

**X. ADVANTAGES**

- Can be operated easily some distances.
- Carry all kinds of loads.
- Much simpler to maintain and don’t require any major lubrication system like chain conveyors.

- Their reliability has been proved over a long period by its use in the industry.

**XI. CONCLUSION**

We successfully designed the XY coordinate mechanism for the material handling in chemical industries for material handling. It reduces the time required to perform the application.

In this project we are designing and fabricating of a 4-DOF manipulator has been successfully completed. With reference to many available manipulators and mobile platforms in market, a practical design for the manipulator has been perceived and computer aided designing tools like Creo 1.0 and AutoCAD are used to model the desired manipulator. Theoretical analysis of the inverse kinematics was carried out to determine the end effectors position and orientation. FE Analysis is done by using ansys software.

**REFERENCES**


[2] S Senthilraja, R Gangadevi and M Thirugnanam, “Design and fabrication of three axis robot for material handling in chemical industries”, Department of Mechatronics engineering, SRM University, Chennai, 2016, pp 2700-2702