360^0 Pneumatically Operated Drilling Arm

Prof. Snehal S. Gholap[1] Kartik S. Jangid[2] Mudassir W. Khan[3] Arati S. Adhav[4] Bharat M. Kamale[5]

[1]Assistant Professor

[1,2,3,4,5]Department of Mechanical Engineering

[1,2,3,4,5]Pravara Rural Engineering College, Loni, Maharashtra-413736, India

Abstract— In previous drilling machine many of the problems arise during drilling. Some parts cannot drill due to small work space between drill bit and work piece. So we use hand drills in this cases but it cause alignment problems. So here we propose a 360 degree pneumatically operated flexible drilling arm that can be mounted on a table or wall and can be used to drill holes horizontally, vertically or even upside down. So this make it possible for easy drilling in even complicated parts and surfaces. The designed pneumatic arm consists of 3 actuators, a shaft works with lead screw mechanism capable of converting motion of piston to rotational motion of arm with help of using compressed air. The designed processes are carried out based on integrated information of kinematics dynamics and structural analysis of the desired robot configuration as whole. The highly dynamic pneumatic arm model can be easily set at intermediate positions by regulating the pressure using the flow control valve. As the arm is pneumatically operated so we can also use it where the electricity is not available. We will need only compressed air for doing operation.

Keywords: Pneumatic, 360^0, Flexible, Drilling

I. INTRODUCTION

Drill machines have been the heart of every industry. Drilling holes in parts, sheets and structures is a regular industrial work. Perfect and well aligned drilling needs fixed and strong drills. Some parts cannot be drilled using fixed drills due to low space between drill bit and drill bed. We need to use hand drills in such cases but hand drills have alignment problems while drilling. So here we propose a pneumatically operated 360^o arm that can be mounted on a table or wall and can be used to drill holes horizontally, vertically or even upside down. So this makes it possible for easy drilling in even complicated parts and surfaces. Thus we use rotating hinges and connectors with motor mount and supporting structure to design and fabricate the pneumatically operated 360 degree arm for easy operations.

A. Drilling Machine Construction

The basic parts of a drilling machine are its base, supporting arms, drill head and chuck. The base made of cast iron or other hard material may rest on a bench, floor depending upon the design. Larger and heavy duty machines are grounded on the floor. The arms are mounted on base with the help of hinge to rotate about it. It is accurately machined and the arms can move up, down and rotate about x-axis. The drill chuck, a pneumatic motor and the mechanism meant for driving the chuck at different speeds are mounted on the top of the upper arm. Power is transmitted from the pneumatic motor to the drill chuck. The movement of limbs of arm are operated by pneumatic mechanism. The actuators are attached over the limbs of arm, the flow control valves are connected to the actuators. The pipes are connected to the cylinders and to the compressor. The bottom end or the first limb is connected with stepper motor for 360 degree rotation.

B. Drilling Machine Working Principle

The working principle of this flexible drilling machine is initially started from the pneumatic motor for drill and DAC/SAC as an actuator for movement. In which there is one operating sources, received from the compressor. Then the arm rotates at 360 degree and moves anywhere when drilling is required up to its maximum arm length. With the help of our project we can drill in complicated parts accurately.

Pneumatics also holds advantages over electromechanical power transmission methods. Electric motors are often limited by heat generation. Heat generation is usually not a concern with pneumatic motors because the stream of compressed air running through them carries heat from them. Furthermore, because pneumatic components require no electricity, they don't need the bulky, heavy, and expensive explosion-proof enclosures required by electric motors. In fact, even without special enclosures, electric motors are substantially larger and heavier than pneumatic motors of equivalent power rating. Plus, if overloaded, pneumatic motors will simply stall and not use any power. Electric motors, on the other hand, can overheat and burn out if overloaded. Moreover, torque, force, and speed control with pneumatics often requires simple pressure- or flow-control valves, as opposed to more expensive and complex electrical drive controls. And as with hydraulics, pneumatic actuators can instantly reverse direction, whereas electromechanical components often rotate with high momentum, which can delay changes in direction.

1) Problem Statement

We have referred many paper regarding our project, the most common problem was the actuating source used. In every project the actuating source used was electric source, thus we have concluded to use pneumatic mechanism as our actuating source for drilling operation.

2) Objective

- With the help of this machine we can drill holes in any direction and dimension
- This machine reduces manufacturing and cycle time, the reclamping will be eliminate once the work piece is clamped.
- It can also be operated weather electricity is available or not.
- Elimination of human errors.

II. LITERATURE REVIEW

Pramod H. Sahare[1]:- Pneumatic robots are essential for material handling in chemical industries where electric or

hydraulic robots are unsuitable due to fire hazard. A 3 axes (3 Degrees of Freedom) articulated pneumatic robotic arm was designed and assembled in this project along with its control system. Pneumatic rod less linear actuators were used as the main drive system for the robotic arm and were controlled by pneumatic 5/3-way proportional directional control valve. The design of the arm for this project implements crank mechanism to convert linear actuation displacement to angular displacement about the joint. Material handling is a necessary and significant component of any productive activity. It is something that goes on in every plant all the time. Material handling means providing the right amount of the right material, in the right condition, at the right place, at the right time, in the right position and for the right cost, by using the right method. It is simply picking up, moving, and lying down of materials through manufacture. It applies to the movement of raw materials, parts in process, finished goods, packing materials, and disposal of scraps.

BCET, Durg, India[2]:- Drill machines have been the heart of every industry. Drilling holes in parts, sheets and structures is a regular industrial work. Perfect and well aligned drilling needs fixed and strong drills. Some parts cannot be drilled using fixed drills due to low space between drill bit and drill bed. We need to use hand drills in such cases but hand drills have alignment problems while drilling. So here i propose a 360º flexible drill that can be mounted on a table or wall and can be used to drill holes horizontally, vertically or even upside down. So this makes it possible for easy drilling in even complicated parts and surfaces. Thus i use rotating hinges and connectors with motor mount and supporting structure to design and fabricate a 360 degree drilling machine for easy drilling operations. The working principle of this flexible drilling machine is initially started from the D.C. motor through full wave rectifier. In which there is one power sources, received from the rectifier. Then the arm rotates at 360 degree and moves anywhere when drilling is required up to its maximum arm length. With the help of my project we can drill in complicated parts accurately.

PESIT-BSC, Banglore[4]:- The handling of materials and mechanisms to pick and place of objects from lower plane to higher plane and are widely found in factories and industrial manufacturing. There are number of pneumatic arms are available which consists of so many mechanisms hence becomes expensive. The designed pneumatic arm consists of two cylinders, a shaft works with lead screw mechanism capable of converting motion of piston to rotational motion of arm with help of using compressed air. The designed processes are carried out based on integrated information of kinematics dynamics and structural analysis of the desired robot configuration as whole. The highly dynamic pneumatic arm model can be easily set at intermediate positions by regulating the pressure using the flow control valve. It can be used in loading and unloading of goods in a shipping harbour as the movement of goods is done from lower plane to higher plane.

Biswas palok[3]:- Pneumatic robots are essential for material handling in chemical industries where electric or hydraulic robots are unsuitable due to fire hazard. A 3 axes (3 Degrees of Freedom) articulated pneumatic robotic arm was designed and assembled in this project along with its control system. Pneumatic rod less linear actuators were used as the main drive system for the robotic arm and were controlled by pneumatic 5/3-way proportional directional control valve. The design of the arm for this project implements crank mechanism to convert linear actuation displacement to angular displacement about the joint. Two control systems were designed for the robotic arm: Programmable Logic Controller (PLC) and Arduino UNO microcontroller. It employed open loop control with PLC at first and closed loop PID control using Arduino UNO in the latter part of the study. MPU-6050 sensor was used for feedback signals to the Arduino UNO. Point to point motion control method was adopted for this robot arm and simple pick and place applications were carried out using a pneumatic gripper as the end effector. Mainly, the compressibility of air and the overall nonlinearity of the pneumatic servo system made it very difficult to achieve accurate positioning and control with PLC. Closed loop PID control with microcontroller and accelerometer and gyroscope enabled better control with joint angle accuracy of ±1 degrees. The force required by the pneumatic linear actuator to move the robot arm about its joint varied nonlinearly due to the design of the arm. Also, 5/3 directional control valve proved to be ineffective compared to 5/3 proportional valve in controlling the position of the actuators. The joint's angular displacement was found to be varying roughly linearly with the stroke of the linear actuator and the pressure required to move the arm without any load was found to be around 2.75 bars.

DES'S COET, Dhamangaon Rly., India[2]:- The technology of pneumatics has gained tremendous importance in the field of workplace rationalization and automation from old-fashioned timber works and coal mines to modern machine shops and space robots. Certain characteristics of compressed air have made this medium quite suitable for used in modern manufacturing and production industries. The air is compressed in an air compressor and from the compressor plant the flow medium is transmitted to the pneumatic cylinder through a well laid pipe line system. Moving materials utilize time and space. Material handling is a necessary, but wasteful and expensive activity in manufacturing and distributing. Material handling is a specialized activity for a modern manufacturing concern. It has been estimated that about 60-70% of the cost production is spent in material handling activities. Insufficient material handling accounts for additional costs in two main ways: idle time and cost of labour. Effective material handling solutions can reduce a production or distribution cost by significant amounts.

III. METHODOLOGY

A. Construction

Pneumatic arm consist of following main components:-

1) Frame

We have used the ½ inch square pipe for the chassis of the pneumatic arm. When there are no suspension used in the pneumatic arm to lift the weight so the chassis must be able to absorb some of the jerks and vibrations, also it must be

stiff enough, not to break or twist during the lifting of loads. In order to reduce the weight and cost, simple square pipes had been used in this frame.

Fig. 1:

2) Tee Fitting Push (6mm)

Union push-to-connect fittings are available for use with 5/32, ¼, 5/16, 3/8 and 1/2 OD tube. Tubing connection and tightness are made possible by a stainless steel gripping collet and o-ring inside the fitting. Once inserted to the bottom of the fitting, the stainless steel collet grips the tube and prevents it from being disconnected until the release button is pushed.

Fig. 2: Tee Fitting

3) 5/3 Solenoid Valve

―22‖ Series 4-Way solenoid operated valves feature single or double 12 VDC, 1 Watt solenoids. These 1/8 NPT (F) ported valves are available in a 5-Port 2-Position (5/2) or a 5-Port 3- Position (5/3) configuration. A latching solenoid replaces two solenoid valves in a 4-way, 2-Position ―double solenoid‖ configuration; an energy and space saving option.

Fig. 3: Solenoid Valve [4]

4) Flow Control Valve

Port mounted flow controls are ideal for adjusting the speed of extension and retraction for virtually any actuator. Most double acting applications are best served with meter-out style flow controls, which control the flow of exhaust air as it leaves the cylinder. By reducing the exhaust air flow rate, the flow control reduces the speed of travel of the cylinder rod.

Fig. 4: Flow control Valve [5]

5) Pneumatic Polyurethane PU Hose Tube Pipe (Ø= 6MM).

The pipes are suited for use in oil and fuel lines and petrol tank, breather pipes, for pneumatic controls as lubrication lines and others. These pipes have properties of handling the wide range of temperature changes, thus making these suitable for use in different climatic areas.

Fig. 5: Pipe [4]

6) Silencer 1/8

It used to reduce dynamic noise of the pneumatic components or device exhaust Easy installation and high nose reduction result, Quick and Reliable connections Used with: Cylinders, Valves, Crank cases, gear boxes, oil tanks, reservoirs, air tools.

Fig. 6: Silencer [4]

7) Air Compressor

In both home and commercial applications, one of the main roles of an air compressor is to provide power for pneumatic tools. Pneumatic tools include drills, impact wrenches, riveters, sanders and more — in fact, almost any conventional powered hand tool is available in an air-powered configuration.

8) Direction Control Valve

A 5/2 way direction control valve, from the name itself has 5 ports equally speed and 2 flow positions. It can be used to isolate and simultaneously bypass a passage way for the fluid which for example shoud retract or extend a double acting cylinder. There are variety of ways to have this valve actuated. A solenoid valve is commonly used, a lever can be manually twist or pinch to actuate the valve, an internal or external hydraulic or pneumatic pilot to move the shaft inside, sometimes with a spring return on the other end so it

will go back to its original positions when pressure is gone, or a combination of any of mention above

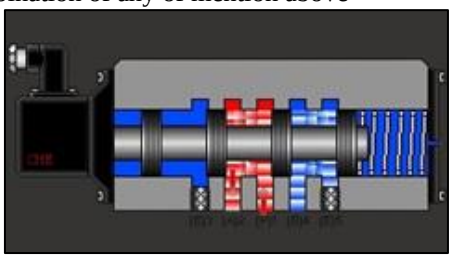


Fig. 7: [4]

B. Working Principle

Our project even be rotate easily drill at any direction. So that job setting operation is not complicated as well as reduces the setting time for the operation. It also takes into consideration the most effective method of controlling the drilling machine by manually. Materials like wood, plastic and light metals drilled with this. The work piece is fixed on the work table. As the machine tool exert Vertical pressure to original a hole it loosely called a ―drill press‖. This Drilling is performed for Different Position Drilling in the working job. Up/Down and rotating mechanism is available in this Drilling Machine. In this design, the robot arm has 3 axis of rotation and hence it has three degrees of freedom; axis-2 and axis-3 is pneumatically driven whereas axis-1 is electrically driven using an induction motor. The entire design of the pneumatic robotic arm revolves around the implementation of the rodless linear actuator which was available at the beginning of the design process. Upper arm is made with the rodless linear actuator but lower arm used a normal cylinder due to the unavailability of a second rodless linear actuator. Rodless linear actuators have a number of advantages over commonly used pneumatic muscle actuators including large stroke length and are double acting, meaning, it can provide force in both directions. The design of the robot arm for this study enables efficient conversion of linear stroke of actuator to angular displacement of the joint and hence provides a wide workspace volume, making it suitable for handling and transferring materials in the industries. The anthropomorphic configuration of the arm also makes it ideal for prosthetics. The design is however not limited to pneumatics actuators only, any linear actuators either driven by hydraulic or electricity can access its functionality.

IV. Design System

A. Calculations

– Design of Arm[1]

The arm is considered to be a cantilever beam fixed at one end Let F be the load =10N

Since bending is the significant case design is based on bending moment

M= Moment about fixed point I = Moment of inertia

σB =Bending stress

– [4]Cutting Speed (V) – V = πDN

Where, D = diameter of drill in mm = 5mm N = speed of rotation in mm = 400 rpm

V = 104.72 mm/sec

– Feed Rate (f) –

40 mm/min

– Depth of Cut (d) –

d = D/2

d = 2.5 mm

– Material Removal Rate –

MRR = (πD2/4)f N

MRR = 15707.96 mm3/min

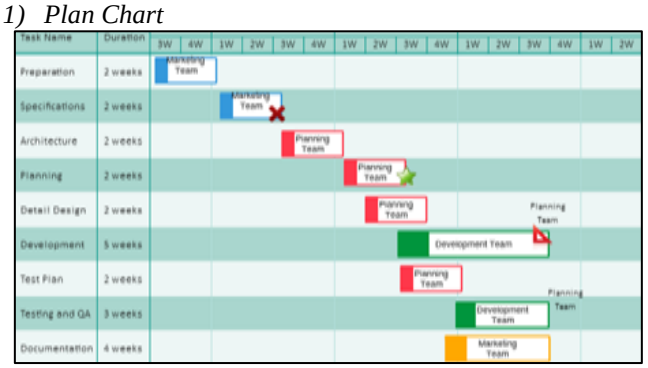
– Machining Time –

t = L/f

Where, L = length of the hole to be drilled = 5 f = feed of the drill = 40 mm/min

t = 0.25 min

1) Plan Chart



V. Advantages

– Elimination of human errors
– Proper alignment of holes and operations are obtained.
– High accuracy
– Can also be operated where electricity is not available.
– process cycle time is reduced in production line.
– Skilled operated is not required.
– More powerful and efficient.

VI. Summary

Measurements from the actual arm were carried out to determine the maximum and minimum reach of the arm both horizontally and vertically. All the measurements were taken by setting axis-2 as the reference point and is set to be zero position. Right and top directions are chosen to be positive with respect to axis-2 and any measurements to the left or bottom of axis 2 is hence negative. The measurements are tabulated in table

References

[1] Prof. Pramod H. Sahare, Assistant Professor, Dept. of Mechanical Engineering, RCERT Chandrapur Maharashtra, India

[2] Lokesh Kumar Sahu1, Pranesh Mohan Mishra2, Deepak Kumar Singh3, Vijay Kumar Yadu4, Sandeep Kumar Kansari5 Bharti College of Engineering and Technology, Durg, India

[3] Santosh C1, Manoj C S2, Akshay Peddarajula3, Abhishek R Shetty, Assistant Professor, Department of Mechanical Engineering, PESIT-BSC, Bangalore-560100 2,3,4 Graduate Scholar, Department of Mechanical Engineering, PESIT –BSC, Bangalore - 560100

[4] Biswas Palok, S. Anandan Shanmugan, Department of Electrical and Electronic Engineering, University of Nottingham Malaysia Campus, Malaysia
[5] Abhinav D. Khasale1, Akshay S. Kolhe2, Ajinkya A. Korde3, A. T. Bathe Student, Dept. of Mechanical Engineering, DES'S COET, Dhamangaon Rly., India

