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Design and Manufacturing of Low Cost Pneumatic Based Pick and Place Robot

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Abstract: The paper suggest a low in price and capability of producing a desired method for design and manufacturing of a three degree of freedom revolute jointed robotic arm The design process begins by enumerate top-level design criteria and passing down these criteria from the top level of the manipulator's structure to all succeeding components. With this suggest advance the sequential design aims are catching, organized and implemented depend on the whole system objectives, as opposed to the habitual design process which aims at individual components optimization. By in view the mechanical arm's performance objectives, the design starts with modelling the integrate of all the individual links constituting the manipulator. During the design process, remake are made based on integrated data of kinematics, dynamics and structural analysis of the desired robot configuration as a whole. An finest assembly design is then carry out with workable sub designs of the manipulator components. As an outcome, the suggested approach for manipulator design yields substantially less number of iterations, automatic propagation of design changes and great saving of design efforts. Further with finest machining operation and low cost material, catering the power and machining requirements suitable materials are selected to fulfill the objective.

Index Terms: cost, design, manufacturing, pneumatic, robot

1. INTRODUCTION

Robotics is the science of designing and structure robots appropriate for real life applications in automated manufacturing and other non- manufacturing environments. As per norms of International Standards Organisation (ISO). it can also be explained as, An Industrial Robot is an automatic, servo-controlled, freely, programmable,, multipurpose manipulator, with several spaces or the handling of work pieces. apparatus or special devices. Variably programmed operations make the accomplishment of a multiplicity of tasks possible. Here we are designing a robotic arm that is completely useful by pneumatic fundamentals and thus reducing the complication in designing, manufacturing and machining. This helps in reducing the overall cost of the robot right from designing to manufacturing since high cost electronic circuits are not used. When refer to electronic robot these pneumatic robots with simultaneous and sequential pneumatic circuits which are capable of performing the same task automatically with aid of even an unskilled labor which in go decreases the running cost of the machine. These types of pneumatic robots can be used in places where iterative action is required such as the assembly line and also in places where remote sequence of operation is required. The success and approach of these types of robot based mainly upon the complexity of the pneumatic circuit. Effective design enlarge the efficiency and application of these robots.

2.DESIGN CONSIDERATIONS

2.1 System identification

Reach

Range

Work envelop Load capacity

2.2 System configuration

Number of degrees of freedom

Joint configuration

Joint travel range

Driveconfiguration

2.3 System performance

System velocity andacceleration Repeatability

Resolution

Accuracy

Component life and duty cycle

2.4 Detailed design of various components

Robot structures

Robot joints Actuators Transmission

Wiring and routing of cables and hoses

3. DESIGN OF RELIABLE MECHANICAL JOINTS

The function of a joints is to permit relative motion between two links or arms of a robot. It provides direct relative motion between two links (input and output). Usually one joint provides the robot with one degree of freedom. There are many joints such as the linear joints, orthogonal joints, rotational joints. twisting joints and revolving joints. Of the noted joints the rotational joints are easy to manufacture and is best appropriate for our order. Thus hinged joints are used. The cost of hinged joints is very inexpensive and can best satisfy meets our requirement. However depend on the strength and weight to be lifted many types and quality of hinged joints is used.

4. MANIPULATOR DESIGN

A manipulator is commonly mounted on a track or suspended from a track that is capability of reaching various distances and locations. It is used to move substance, tools and objects from place to another without direct human contact. It consist of two part namely the body or arm and the wrist assembly.

4.1 Design of body

The body is used to arrangement the object in the robot's work envelop. And thus by employing the concept of value engineering proper design can help decrease the weight of the body and also the amount of materials used. Generally to optimization of both material cost and the manufacturing cost the arm is made up of different components and then is assembled together, thus saving the material and diminish the Cost.

4.2 Design of wrist assembly

It is used for the postioning of the object in the work envelop. The end effector is attached with the wrist assembly. Wrist assemblage has three degrees of freedom pitch, roll and yaw. However for simple pick and place of application keeping in mind that the complexity of manufacturing of the wrist assembly the end effector can be linked to the arm directly using hinged joints. Pneumatic cylinder is used for controlling the end effector Thus contributes consequential in reducing the cost of the robot.

5. DESIGN OF END EFFECTOR

The arm is responsible only for positioning the object. If the end effector that interacts with the object. The hand of the robot is think about as the end effector. There are many end effectors are grippers, sprayers, grinders. welders and vacuum. Here we select use either a gripper or a vacuum. A gripper used for elevate and placing objects is simple to design and manufacture. A vacuum can use me pneumatic power and thus reduce the running cost and also perform complex tasks.

6. ROTATION OF THE ROBOT

For the robot to reach various locations and perform the tasks it has to rotate about its own axis. Thus based up on the necessary either a stepper motor or a simple pneumatic cylinder can be used. A stepper motor requires electronic circuits for regulate and an additional bearing support for 360 degree rotation. However if a 90 degree span of rotation is adequate then a pneumatic cylinder can be used. Here only single bearing to stand by the rotation is required. Thus consequential reducing the cost of the robot.

7. PNEUMATIC CIRCUIT

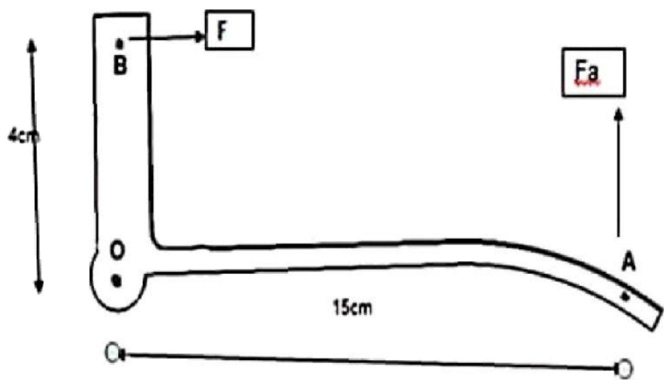
A pneumatic logic system is generally used to regulate the industrial robots. Since electronic circuits and not used thus exact and accurate pneumatic circuits are designed and implemented. Sequential circuits are designed so that each cylinder is actuated at proper sequence and are also kept vigorous for the desired period of time. This the only dispute in a low cost robotic arm is designing of the pneumatic circuit.

8. MATERIAL SELECTION

Material selection is one of the most significant factors in decreasing the cost of the robot. Materials as chooses in such a method that there is no compromise in minimum design Requirement. Here to we choose to use a combination of Iron and fiber reinforced plastic. Gripper and the upper body can be made of FRP because it provides sufficient strength to hold and lift the object end reduce the weight. The lower body and the base is made of iron in order to provide the required courier weight so that the stability of the robot in not lost. Depending upon the weight to be lifted the material selection varies. However to reduce the cost and ease of manufacturing *we* can use iron if weight considerations are not present.

9. CALCULATIONS

9.1 Calculations for endeffector



Force (Fa) required for holding the work piece Is 30N Fa = 30 N

From figure 13: Take moment aboutt point O,

Let the force at point B be F and this force is equal to the force applied by the cylinder. Fa is the force which is required to hold the object

Fa*15=F*4

F = 30*(15/4) F = 112.5 N

Thus,112.5N of force should be applied by the pneumatic

9.2 Selection of end effector cylinder Pressure (P) supplied by the cylinder=4 bar

Let area of cylinder be A.

A=F/P

= 112.5/(4*10^5)

=2.812*10^(-4) m2 A=3.14*d^2

d=18.9 mm

Since the present measure cylinder is of diameter 20mm and stroke length 75mm, the cylinder used for the end effectors are chooses with the dimensions of 20mm x 75mm.

9.3 Preference of body cylinders

Pressure supplied to cylinder = 10bar.

Assume factor of safety as 2 the pressure supplied is assumed as 4 bar.

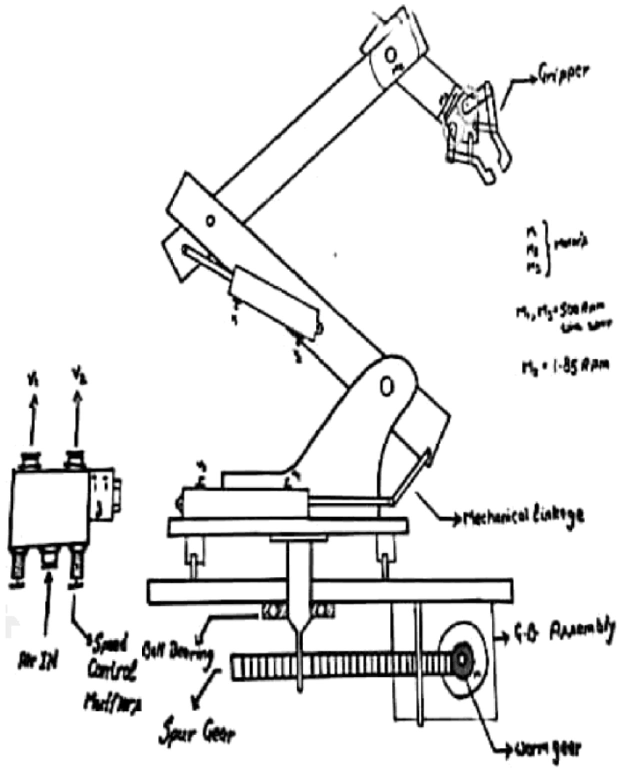
To lift an arm of 15 kg, Pressure= $4*10^5$ N/m2 Area =force/pressure A= 15*9.81/(4*10^4) A= 3.678*10^(-4) A=3.14*d^2

Therefore d= 21.6mm

Since the available standard cylinder is of diameter 25mm and stroke length 100 mm, the cylinder used for the arm lift are selected with the dimensions of 25mm x 100mm.

10. COST ESTIMATION

S.NO	PARTS	MATERIAL	QUANTITY	CDST (INDIAN RUPEES)
1	Cylinder 25*100	aluminium	3	2100
2	Cylinder (25*75)	aluminium	1	500
3	Upper body	Iron(Iron plates)	0.7 kg	31.5
	Lower body	Iron(iron plates)	0.7 kg	31.5
5	Base plate	Iron(iron plates)	3 kg	135
6	Gripper	Iron(iron plates)	0.5 kg	22.5
7	Bearing	Stainless steel	1	1650
8	Solenoid valve	Plastic	4	1780
9	Tubes	plastic	15 meters	150
10	Average labor (India)			590
11	Average machining costs (India)			230
12	Total			7220



The dimensions are for lifting a load of up to 4 kg (average weight of object used in pick and place of sequence of operations) and thus can be scaled to increase the load. Thus the robot can be manufactured at an approximate cost of $120. This can be decreased further in case of mass production. This robot can be used in small utlization for example an auxiliary mechanism during manufacturing and also for picking up objects less than 4 kg. However the capacity of the robot can be upgrade.

11. CONCLUSION

The productive design and manufacturing of 3 degree of freedom pick and place robot has been performed. The operation of many arm linkages and the end effector has been far reaching tested and the required set or put right measures were taken. Hence the objective of designing and manufacturing of a pick and place robot at low cost was successful and can be implemented to put in place the expensive electronic robots. It's been proved that running cost of me robot is also very less. This will help to cut down labor and better profits at very low initial Investment.

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