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Design and Manufacturing of Robotic Arm for Industrial Applications

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Abstract: Design and Development of Automation of Loading and Unloading to machine fixture" This Setup involves the use of automation solution to reduce operator fatigue and increase efficiency. Industries in the recent day concentrating on CNC machineries for mass production by replacing conventional lathes to improve productivity, but loading and unloading of job carried over by manual, However Present work, machine tool manufacturer are coming with solutions including automatic loading and unloading to reduce the fatigue of labour and reduce cycle time and increasing productivity. Productivity Improvement on a Production by Automatic Loading and Unloading of Component includes analysis and detailed study of manufacturing process including loading and unloading methods of components on a machine. Present work aims at improving the productivity of components on a CNC Fixture. Here emphasis is placed upon improving the existing time-consuming methods.

I. INTRODUCTION

Material handling is one of the tedious tasks in industry now a day. In the country like India, many industries prefer manually operated material handling. This is very time consuming and due to this production rate also decreases. Lathe machine is common machine tool found in almost all industries and engineering institutes for processing the cylindrical work piece. The operation like turning, drilling, boring, chamfering, knurling etc. can be performed on it. Loading and unloading of work piece on lathe machine is done manually, this may lead to less production in time. We can say that there are two times, referring to machine, one is machine utilization time and second is machine unutilization time. In first case, the machine is in running condition and in second case machine is in rest condition. If we consider 8 hours of shift per day then in that only 6.30 hours machine is in running condition and in rest 1.30 hours it is in rest. The rest time includes, operator or person working on machine time like going for lunch, toilet, talking with others etc. If we utilize this time for running machine continuously then there will be no delay in production.

The automatic material loading and unloading equipment is needed to run machine continuously. Robotic arm arrangement is best option for doing this. By implementing this robotic arm on lathe machine then whole operation can be automated, single person can then handle 4 to 5 machines at a time. A robotic arm can be any of a number of mechanical, programmable devices that are designed to manipulate objects in a way that is similar to the human arm.

The robotic arm is one of the most useful pieces of technology to be introduced in the 20th century, and quickly became a cornerstone in many areas of manufacturing. It can be used for many different jobs and functions that may be too tedious, difficult or dangerous for a human to do. You might first think of the automobile industry when thinking about robotic arms, but they can be used for many other useful tasks besides welding and painting auto parts.

While working in a fashion similar to the human arm, robot arms can still have a much wider range of motion since their design can be purely up to the imagination of their creator. The joint that connects the segments of a robotic arm, for example, can rotate as well as moving like a hinge. The end of the robotic arm designed to actually do the work that it was designed for is known as the end effectors, and can be designed for practically any task, for example gripping like a hand, painting, tightening screws and more. These robots can be fixed in one place, for example along an assembly line, or they can be mobile so they can be transported to do a variety of tasks in different places.

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Workspace simulation software is most widely used for designing and simulating the robots. There are two types of it one is Workspace LT and second is Workspace 5. Workspace LT software is designed for educational purpose for just giving introduction to students about how to make a robot and simulate it. The Workspace 5 is designed for industry use, in that software industrial professional designed their robots as per the machine considerations and simulate it to see the result.

1.3Methodology:

First, we will design the Robotic arm suitable to our application. we can use the following methods for achieving the Proper Utilization of System.

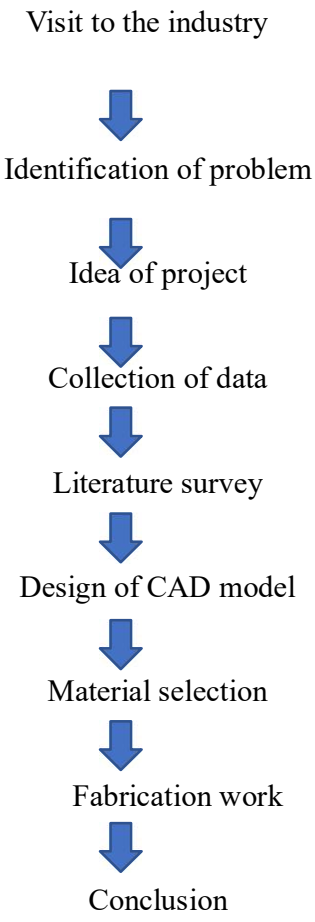
Analytical: Firstly, we need to analyse Conventional system taking into consideration the applications and operational conditions. Then we will analyse the design for factor of safety of the system.

Theoretical: Theoretically we will compare basic and operational parameter of existing conventional working with propose working.

Experimentally: In our project we will make a Robotic Arm for finding effective Working of system. In

Conventional Working in industry the loading and unloading of object from fixture is take place by the worker

manually. So, we design & manufacture the proper robotic arm which work automatically make working Easily in the industry



II. LITERATURE SURVEY

Gurudu Rishank Reddy Venkata Krishna Prashanth ErankiDesign and Structural Analysis of a Robotic Arm

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Automation is creating revolution in the present industrial sector, as it reduces manpower and time of production. Our project mainly deals around the shearing operation, where the sheet is picked manually and placed on the belt for shearing which involves risk factor. Our challenge is designing of pick and place operator to carry the sheet from the stack and place it in the shearing machine for the feeding. We have gone through different research papers, articles and had observed the advanced technologies used in other industries for the similar operation. After related study we have achieved the design of a 3-jointed robotic arm where the base is fixed and the remaining joints move in vertical and horizontal directions. The end effector is also designed such that to lift the sheet we use suction cups were the sheet is uplifted with a certain pressure. Here we used Creo-Parametric for design and Autodesk-Inventor 2017 to simulate the designed model.

Milind R. Shinde, V. N. Bhaiswar, B. G. Achmare, "Designing a suitable robotic arm for loading and unloading of material on lathe machine using workspace simulation software

Normally the loading and unloading of work piece on lathe machine is done with manual interface. Our aim is to make it automatic and fast for better accuracy and improved performance. Robotic work cell simulation is a modelingbased problem solving approach developed for the design, analysis and offline programming of robotic work cell. Robotic simulation covers the visualization of how the robot moves through its environment. This project deals with designing the robotic arm which is to be used for unload and load the work piece on lathe machine. The CAD model of robotic arm is made using CATIA V5 software and its simulation performed on Workspace Simulation Software. This will increase the total productivity of machine where there is continuous operation and complete machine utilization.

Use of Workspace LT software for designing the robotic components is very popular.

Kaushik Phasale, Praveen Kumar, Akshay Raut, "Design, Manufacturing and Analysis of Robotic Arm".

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 this project is to develop a versatile and low-cost robotic arm which can be utilized for Pick and Place operation. Here controlling of the robot has been done by using servo drives and arduino microcontroller. This robot is having 4 DOF and controlled by android app with Bluetooth interfacing. This Robotic arm can be used in number of applications by changing the program of controller and end effector, so that it would be used mainly in the automatic assembly lines.

Dr. Abdellatif Baba, "Robot Arm Control with Arduino".

Today, technology is developing in the same direction in line with rapidly increasing human needs. The work done to meet these needs makes life easier every day, and these studies are concentrated in robotic arm studies. Robot arms work with an outside user or by performing predetermined commands. Nowadays, the most developed field of robot arms in every field is the industry and medicine sector. Designed and realized in the project, the robot arm has the ability to move in 4 axis directions with 5 servomotors. Thanks to the holder, you can take the desired material from one place and carry it to another place, and also mix it with the material it receives. While doing this, robot control is provided by connecting to the android application via Bluetooth module connected to Arduino Nano microcontroller K. L. Voon, M. A. Ismail, N. Mustaffa Design and Development of a Mechanism of Robotic Arm for Lifting Part

The main focus of this project was to design and develop the mechanism for robotic arm for lifting. The robotic arm was designed with four degrees of freedom and programmed to accomplish accurately simple light material lifting task to assist in the production line in any industry. 3D printing method is used in this project to fabricate the components of the robotic arm. Therefore, it provided more precise dimensions and huge time and cost-saving in fabrication. The robotic arm is equipped with 4 servo motors to link the parts and bring arm movement. Arduino, an open-source computer hardware and software is applied to control the robotic arm by driving servo motors to be capable to modify the position. Wireless control was done by using a smart phone with android operating

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system through a Bluetooth module. The robotic arm was under testing and validating its performance and the results indicates that it can perform the lifting task properly.
Khaleda Sh. Rejab , Wassan Emad Rauf, "Wireless Mobile Robotic Arm Controlled By Ps2 joystick Based On Microcontroller".

In the last year, with a huge usage of wireless enforcementand where nearlyeverything which was controlled by humans is being automated by using robots. In this paper a control system of the mobile robotic arm was built by using a PS2 joystick and the microcontroller (Arduino UNO) and sends the command by the master Bluetooth (HC-05) that represents the transmitter part. Where the receiver receives the data by the slave Bluetooth (HC_05) to generate the specific motion by take the command from Arduino UNO. The purpose of this paper is to design and implement a mobile arm robot for dangerous and difficult places that humans can't reach it andmake the specific task.

III. THEORETICAL AND TECHNICAL ANALYSIS

1.1TYPES OF ROBOT

Types of robots as per applications are as follows –

Industrial Robot: Robots today are being utilized in a wide variety of industrial applications. Any job that involves repetitiveness, accuracy, endurance, speed and reliability can be done much better by robots so many industrial jobs that used to be done by humans are increasingly being done by robots.

Mobile robot: It is also known as Automated Guided Vehicles or AGV. These are used for transporting material over large sized places like hospitals, container ports and warehouses. It uses wires or markers placed on the floor, lasers or vision to sense the environment.

Agriculture robot: Although the idea of robots planting seeds, ploughing fields and gathering the harvest may seem straight out of a futuristic science fiction book nevertheless there are several robots in the experimental stages being used for agricultural purposes such as robots that can pick apples.

Telerobot: These robots are used in places that are hazardous to humans or inaccessible. A human operator located at a distance from a tele robot controls its action, which was accomplished with the arm of the space shuttle. Tele robots are also useful in nuclear power plants where they can handle hazardous material or undertake operations potentially harmful for humans.

Service robot: This is a category of robot that is used outside an industrial facility. They can be sub-divided into two main types of robots like robots used for professional jobs and for personal use.

1.2TYPES OF GRIPPER

Types of Robot Grippers:

1.Robot grippers with 2 fingers

These are the simplest robot grippers, suitable for many industrial products and easy to manufacture. Within this group, different alternatives can be found: with opening control, pressure control, with distance control in the opening and closing, picking up pieces by inserting the two fingers inside a hole.

Two finger grippers

2.Grippers with 3 fingers

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This type of robot gripper is not used that often since most automation cases can be solved with a two-finger gripper. However, when it is necessary to pick up delicate objects with strength and precision, three fingers' grippers are the solution. Besides, they adapt even better to non-flat surfaces with articulated fingers. This kind of robot grippers is essential when there are many different pieces to pick up since a versatile and adaptable gripper is needed

Three finger grippers

3.Robot grippers with flexible fingers

The robot grippers with flexible fingers are newer and more fit to pick up different objects. Although they are more limited in general regarding the volume and weight of the object to be picked, they are perfect for delicate things, like food.

IV. MATERIAL SELECTION

1.Selection of Gripper Material- Acrylic

Acrylic is a transparent thermoplastic homopolymer known more commonly by the trade name "plexiglass." The material is similar to polycarbonate in that it is suitable for use as an impact resistant alternative to glass. It was first produced in 1928 and was brought to market five years later by Rohm and Haas Company. It is generally considered one of the clearest plastics on the market.

Acrylic is an incredibly useful plastic for applications requiring transparency where high impact resistance is not an issue. Acrylic is very scratch resistant compared to other clear plastics. It is a lighter alternative to glass and an economic substitute for polycarbonate in applications where strength is not a crucial factor. It can be cut into extremely fine shapes using laser cutting technology because the material vaporizes upon impact with the concentrated laser energy.

Acrylic, like other plastics, starts with the distillation of hydrocarbon fuels into lighter groups called "fractions" some of which are combined with other catalysts to produce plastics.

2.Selection Of Baseplate Material- Mild steel

Mild steel is a type of low carbon steel Carbon steels are metals that contain a small percentage of carbon (max 2.1%) which enhances the properties of pure iron. The carbon content varies depending on the requirements for the steel. Low carbon steels contain carbon in the range of 0.05 to 0.25 percent.

There are different grades of mild steel. But they all have carbon content within the above- mentioned limits. Other elements are added to improve useful properties like corrosion resistance, wear resistance and tensile strength.

Carbon content is uniformly increased by heat treating steel. As carbon content increases, steel develops hardness but loses ductility. This means that the metal becomes brittle and may fracture instead of bending when applying an excess load. The manufacturing processes for mild steel are similar to other carbon steels. Higher carbon steels just contain more carbon, resulting in different properties like high strength and hardness values compared to mild steel. These processes have developed over time and are now much more cost-effective than before.

3.Selection of Guide Rod Material-Mild steel

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Mild steel is a ferrous metal made from iron and carbon. It is a low-priced material with properties that are suitable for most general engineering applications. Low carbon mild steel has good magnetic properties due to its high iron content; it is therefore defined as being ferromagnetic.

Mild steel has a carbon content of between 0.16% and 0.29 % maximum with a relatively high melting point of between 1450°C to 1520°C. Steels with a higher carbon content than mild steel, have a lower melting temperature. This high melting temperature means that mild steel is more ductile when heated, making it particularly suitable for forging, cutting, drilling, welding and is easy to fabricate.

4.Selection of Lead Screw Material-Mild steel

A leadscrew (or lead screw), also known as a power screw or translation screw is a screw used as a linkage in a machine, to translate turning motion into linear motion. Because of the large area of sliding contact between their male and female members, screw threads have larger frictional energy losses compared to other linkages. Mild steel has a carbon content of between 0.16% and 0.29 % maximum with a relatively high melting point of between 1450°C to 1520°C. Steels with a higher carbon content than mild steel, have a lower melting temperature. This high melting temperature means that mild steel is more ductile when heated, making it particularly suitable for forging, cutting, drilling, welding and is easy to fabricate.

Mild steel can be cleaned by „pickling“. This is a chemical surface treatment that removes stains, contaminants, rust and scale. Surface rust can also be removed by mechanical grinding and then treating with a surface protector such as red oxide primer, zinc primer and metal paints and sprays.

Mild steel is graded according to its chemical composition, how it is produced, and its properties, so we can easily choose the best product for our project.

Sr. NO.	Part Name
1	Frame
2	DC motor
3	Lead Screw
4	Jumper wire
5	Base plate
6	Gripper
7	Rack pinion gear

Component name

Material Selection Table

Sr.no	Material	Specification
1	Mild steel	Cost effective, easily available in market, available in standard sizes, good mechanical properties, high tensile strength.
2	Acrylic	Suitable for use an impact resistance alternative to glass, one of the clearest plastic, high scratch resistance, lighter

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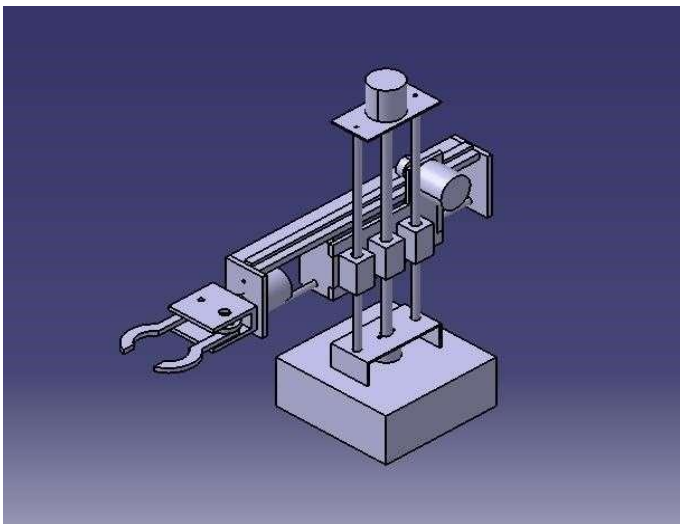
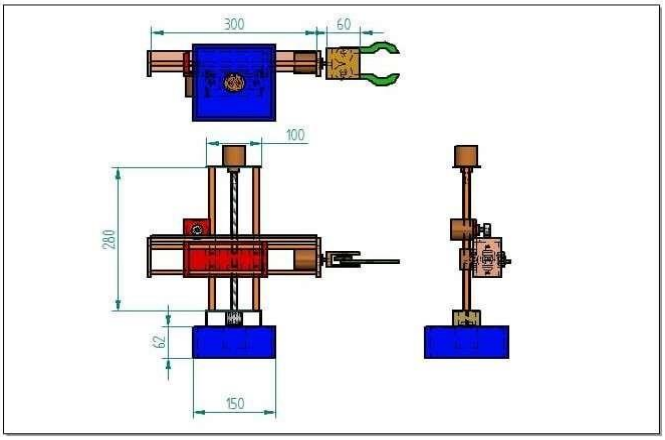
		in weight, cut into extremely fine shape using laser cutting technology.
3	Foam PVC	Durable, easy to work, easily available in market, light in weight.

Material Selection and specification

CATIA MODEL



Assembly



Model Drafting

Specification Of Components:

Sr. no.	Components parameters	Specification
1	Power transmission	Motor to lead screw
2	Power source	DC
3	Motor rpm	100rpm
4	Torque	100kg-cm

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5	Input voltage & current	12v,0.7A at no load, 2.5A at max load
6	Lead screw	L=500mm, D=22mm
7	Gripper type	Two finger grippers
8	Frame material	Mild steel
9	Base plate	Mild steel
10	Rack pinion gear	Acrylic material

component specification

Manufactured Parts

Manufactured Parts

Applications
Arc welding Spot welding Painting Picking & packing
Assembly Agriculture

Future Scope

- The robot so programmed for pick and place operation can be made versatile and more efficient by providing the feedback and making it to work on own than any human interventions. It can be made possible by image processing tool interfaced with this Arduino.
- The features that can be added on to improve its efficiency, make it operate on its own thought without any human intervention are line follower, wall hugger, obstacle avoider, metal detector, bomb diffuser etc.
- Best example of robotic arm in current year is Tesla production facilities.
- Tesla uses robotic arm made by KUKA.
- Very efficient robotics in essentially all part of making a vehicle.
- Industrial automation
- Health care sector
- Defence sector

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Conclusion

• The design and fabrication of robotic arm for pick and place is completed with economic and effective considerations.
• It is concluded that this robotic arm is working properly under the specified working envelope and at a given speed with good accuracy.
• It is successfully able to carry defined payload. This can be used for pick and place operation required in assembly line which will be helpful to increase productivity.

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