iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 4 **Issue:** V **Month of publication:** May 2016

DOI:

www.ijraset.com
IC Value: 13.98

Volume 4 Issue V, May 2016
ISSN: 2321-9653

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Design and simulation of robotic arm for loading and unloading of work piece on lathe machine by using workspace simulation software: A Review

Milind R. Shinde[#1], V. N. Bhaiswar[*2], B. G. Achmare[#3]

[1]*Student of MTECH CAD/CAM, Department of Mechanical Engineering, GHRCE Nagpur, MH, India*

[2]*Professor, Department of Mechanical Engineering, GHRCE Nagpur, MH, India*

[3]*Deputy General Manager, JSW ISPAT Steel Limited, Nagpur, MH, India*

Abstract— Performing various industrial task with the help of robots is common in most of mass production industries. One of the task is loading and unloading of work piece like pallets, food items, metal sheets etc. Loading and unloading of work piece on lathe machine is done manually in the industries, to do this task continuously we can implement a robotic arm. The designed robotic arm is very unique and it takes very less time to perform this task, this saves total processing time and increase productivity of company. The industries like JSW ISPAT where this operation is continuous for processing cylindrical work pieces. We used CREO PARAMETRIC 2.0 software for designing the CAD model of overall system and called it in Workspace LT for simulation. We have used Workspace LT software. We have designed total work cell as per the JSW ISPAT specification and simulated the whole system in it. Workspace LT software is used to design robotic work cell and performing its simulation.

Keywords— Robotic arm, Workspace LT, Work cell, Simulation, Productivity etc

I. INTRODUCTION

Robots are having wide range of application in the mass production industries. They can be used for performing tasks like material handling, spot welding, painting, palletizing etc. All these operations are repetitive operations and has to perform continuously. There is one more operation that is machine loading and unloading. This may be loading of metal sheet in punching press for punching operation or loading the work piece on lathe machine.

In many industries the task of loading and unloading of work piece is done manually. Manual loading increases process time hence there is delay in production and due to this company would not able to achieve their targets in desired time. One more thing is that after processing work piece on lathe machine, due to the tool and work piece interfacing the temperature of it will increase even after coolant application. If operator touches it with open hand then this may cause injury to his hand. To avoid these issue the continuous and repetitive task performing machine should be installed. This will reduce human interaction with machine and also helps in increasing work piece productivity and overall company profit.

Normally the machine time is categorized in two sub parts, one is machine utilization time and machine ideal time. Machine utilization time includes actual machine running and operation time during which the machine is in on condition. The machine ideal time includes the time when machine is in off condition. During 8 hours of shift normally machine is on for maximum 6:30 hours and off for 1:30 hours. To utilize this ideal machine time of 1:30 hours and to run machine continuously for 8 hours a robotic system is useful.

A. Workspace LT

MTAB industries has developed two software's for robotic simulation. One is Workspace LT and second is Workspace 5. The Workspace LT software is specially designed to develop robotic work cell for educational purpose. The Workspace 5 is designed for actual industrial application with collision detection system. In both this software we can create CAD models and can view the system in any direction with 3D mouse support. We can generate reports and files of our projects in it. The most important thing is we can do offline programming in this software and its simulation at the end.

Volume 4 Issue V, May 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

II. LITERATURE SURVEY

It is very difficult to do daily activities for disable people like taking water bottle from table then grasping an object in hand. In this paper they have developed an automatic robotic arm which is mounted on wheel chair and with this robotic arm the person sitting on that chair can able to pick the water bottle form the top of the table. This wheel chair and robotic arm is driven by motor which is fixed at the bottom of wheel chair[1].

Similar kind of project was done by these people. Their robotic hand has the capacity to reach up to four feet and can able lift a load of 2.5 kg. This robotic hand has ability to pick an object of very small size like needle and also some large size objects like water bottle, soda can, soft drink bottles, milk curtains. This is also developed for doing daily task for disabled people.

Multi degree of freedom robot assembly is the another example of design of robotic arm. This robotic arm is used for loading and unloading metal press sheets into the press shops. It is actuated by two stepper motors, out of which one stepper motor control arm movement and second stepper motor controls wrist movement. For controlling robot motion with respect to the machine press the proximity sensors are used. Micro control unit is used to control motor rpm[2].

Haptic technology operated four degrees of freedom robotic arm was developed by these experts. This robotic arm picks up the object of certain weight and place it at desired place. Robotic arm and its controllers are made from poly carbon mixed material. Potentiometer controls the joint rotation of each axis of this four axis robot. Atemega 328 microcontroller is used to convert input signal into digital pulse form which then drives servomotor of each joint of robotic arm[3].

Additive technology operated robotic arm is explained in this paper. This is low cost, light weight and customized robotic arm capable of doing various industrial tasks. Solidwork software is used by them for designing and optimizing the orientation of this robotic arm. PA 2200 material is used to manufacture the various parts of this robotic arm[4].

Pneumatic drive actuated robotic arm was developed by this team. This robotic arm looks like the human hand and used for picking up the objects of different sizes. The design of robot and other system and its simulation was done by this team[5].

III. METHODOLOGY

Design of robotic arm for this loading and unloading of work piece on lathe machine was very tedious, because you have to consider the all parameters like machine specification then work volume near machine and space available for designing this robotic arm. The actual machine calculations are taken from industry and as per that specification the overall work cell of robotic system is designed. Now various parts considered for designing this robotic arm are robotic table, on which robot will be mounted and its distance from machine and work piece table.

A. Design of Table

This CAD model was developed in CREO PARAMETRIC 2.0 modeling software. It has four legs with wheels at the bottom to move our robot from one place to another. In some cases if the robot having some technical difficulties and working properly then this table can be pulled or pushed to the service station to solve that problem.

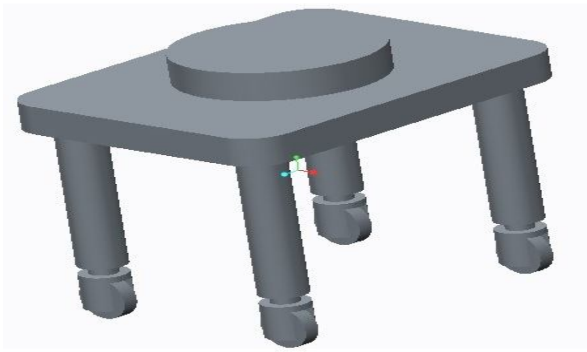


Fig-1: Table CAD model

The above figure shows the robotic table on which our robotic arm will be mounted. This table and robotic arm assemble then fixed in front of the machine to perform actual simulation. This design of table is unique having 1000mm length, 800mm width and 700mm height, The height of this table is same as that of the machine base height. The table height was decided by considering the machine base height and machine foundation height.

B. Robot Configuration

Before designing any robot one should know its final configurations. By studying robot configuration we can understand how many degrees of freedom to give to the robot, how many joints and linear and sliding movement of each joint etc. There are basically four robot configuration like Cartesian, Polar, Jointed arm and Cylindrical.

1) Cartesian Configuration

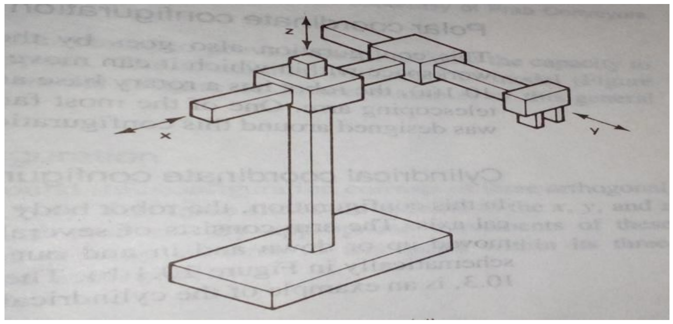


Fig-2: Cartesian configuration

All the links and joints of the robot slides or rotates around these three axes, one is x-axis, y-axis and z-axis. In Cartesian configuration there are three links and three joints. Link 2 slides up and down on link 1 along z-axis and also link 2 slides forward and backward along x-axis, therefore there are two sliding movement of link 2 with respect to link 1. Link 3 slides along y-axis on link 2. From this we can say that here three axis sliding movement and robot is called 3-axis robot.

2) Cylindrical Configuration

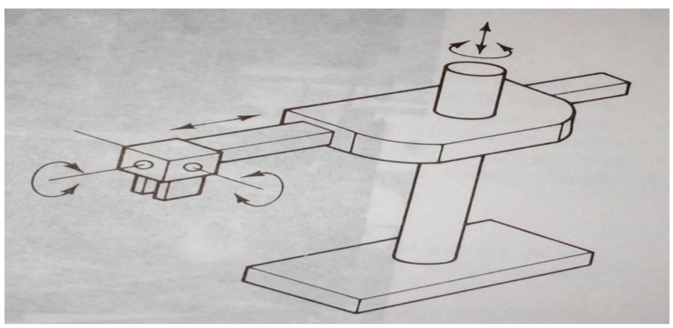


Fig-3: Cylindrical configuration

In cylindrical configuration the link 2 has two movement along z-axis on link 1, one sliding and other rotation. Link 3 slides forward and backward on link 2 along x-axis. Wrist of such configuration has two rotational movement along x-axis and y-axis. At the end we can say that this is five axis robot which is having three rotational and two sliding motion at its respective joint.

3) Polar Configuration

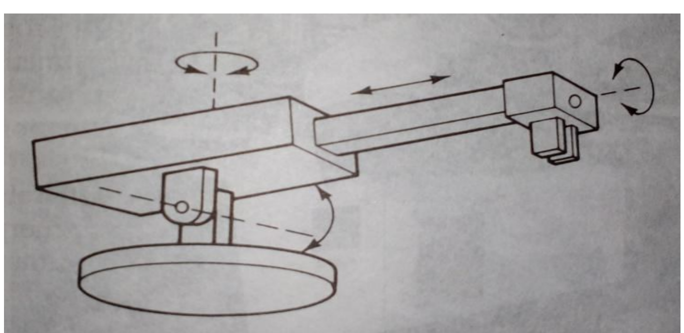


Fig-4: Polar configuration

The whole assembly rotates in complete 360° rotation on base. Limited rotational movement at joint 2. Link 3 slides in and out on

Volume 4 Issue V, May 2016
ISSN: 2321-9653

link 2. The wrist having rotational movement at the end on link 3. From this we can say this is four axis robot with three rotational and one sliding movement at respective joint.

4) Jointed Arm Configuration

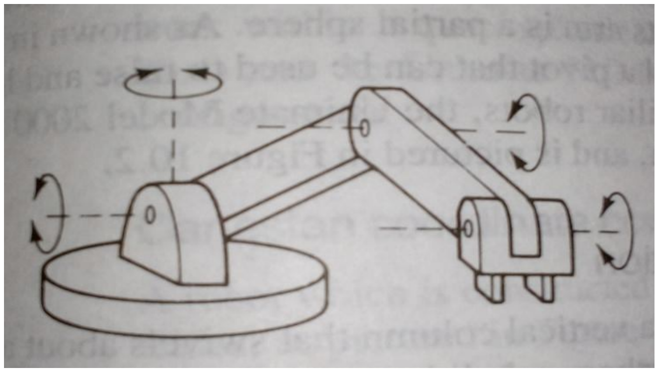


Fig-5: Jointed arm configuration

This is the last robotic configuration in which there are all rotational movement at all joints. It has complete 360° rotation at joint 1. Link 2 has complete rotation with respect to link 1, similarly the link 3 rotates completely at joint 3. The wrist has limited rotation at joint 4 on link 3. From this we can say that this is the four axis robot having rotational movements at all four joints.

After studying all this configuration we considered combination of jointed arm and polar configuration for designing the proposed robotic arm for loading and unloading of work piece on lathe machine. The proposed robotic arm will have 6 axis, hence it would be called as 6-axis robot and at all its six joints it has rotational movement. In this four joint rotation will be associated with links and two with wrist.

5) Lathe Machine at JSW ISPAT Steel Limited

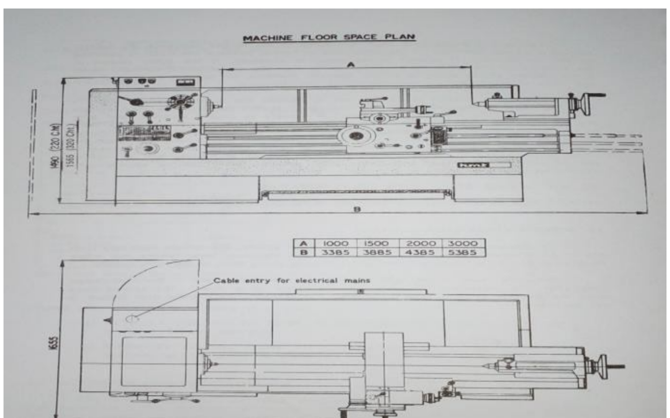


Fig-6: NH26 HMT Lathe machine (line diagram)

This is semi automatic type of machine tool having automatic carriage movement facility and automatic power chuck for holding the work piece at right place and with perfect alignment. We can also perform manual loading and unloading on this machine. In JSW right now this loading and unloading is done manually which takes time. It has four jaw chuck for holding very small and very large type of cylindrical work pieces very perfectly. The 20mm diameter work piece is the minimum size of work piece we can process on this machine and 575mm diameter work piece is the maximum size of work piece we can process on this machine. The distance between chuck centre and tailstock dead centre is 3000mm. The overall length of this machine is 4300mm. Width of this machine is 1000mm excluding support frame and height is 1540mm.

Volume 4 Issue V, May 2016
ISSN: 2321-9653

C. Work Piece

Fig-7: Drive shaft coupling finger

Company produces various type of products of different specification as per the requirement. The main operation performed in this company is coating the stainless steel sheets with zinc metal. This metal sheets were passes through rollers and these rollers are driven by drive shaft and to hold this drive shaft at a place this mild steel finger is used, hence it is called drive shaft coupling finger. This is the most processed part on this machine hence we considered for loading and unloading. Mostly this part fails during operation hence these finger are required in many no. Following are the specifications of this drive shaft coupling finger.

1) Drive shaft coupling finger specifications

Length (before processing)-	55mm
Length (after processing)-	50mm
Diameter (before processing)-	30mm
Diameter (after processing)-	25mm
Circular thread-	M24*3 pitch
Chamfer angle-	45°
Mass-	192gm
Material-	Mild steel

D. Gripper Design

The operation of picking and placing of work piece in to the machine will be carried out from this gripper hence while designing this gripper we must have to consider all aspects that what will be the size then how many fingers to be provided for gripping the object. In the given CAD model you can see the end wrist having two rotation at its two joints.

The gripper base is c-shaped to hold the coupling inside it and here the first wrist joint forms. This design is similar to the universal coupling design. Now the other end of this coupling is attached to the finger holder and here the next joint forms. The first joint has limited rotation of this coupling but second has complete 360°rotation.

Now you can see there are four fingers provided on cylindrical finger base, these finger slides into the slots provided in up down fashion. When these gripper comes near to the work piece then fingers expand externally and then come closer to hold that work piece, in similar fashion when gripper loads this work piece into the chuck again fingers expand and come back to its initial position.

The link 3 gives complete 360°rotation to the whole gripper assembly.

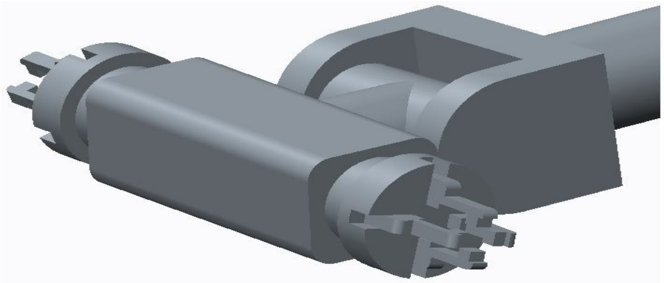


Fig-8: Gripper design

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

E. Proposed Robotic Arm Design

This proposed design shows the six axis robotic arm having all six axis rotary motion at each joint. Link 1 is mounted on the base and it is attached with link 2 by pin. The base joint is actuated by high torque low rpm dc servo motors with gear arrangement. All joints are actuated by dc servo motor with gear arrangement.

Link 1 has complete 360° rotation on base due to which whole assembly rotates around z-axis. Now link 2 has circular joint with link 1, here the joint has limited rotation around x-axis. Similarly link 2 forms third circular joint with link 3 on x-axis. This third joint also has limited rotation as that of second joint.

Link 3 and link 4 forms fourth joint along y-axis which rotates link 4 in 360°. This link 4 forms fifth joint with wrist ie. Gripper base and this joint rotates the gripper around x-axis. Now the last sixth axis and joint forms between the end link of gripper coupling and gripper finger base. This sixth joint rotates the finger assembly in complete 360° rotation around y-axis. This is how each joint performs its function and actuates all links for smooth operation.

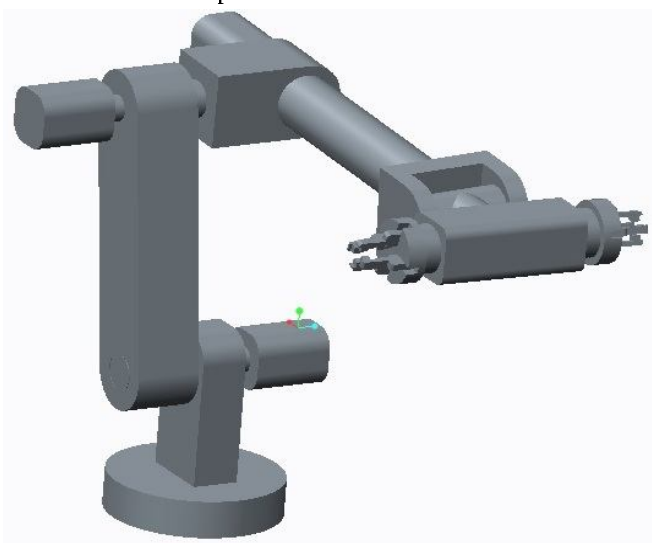


Fig-9: Robotic arm

F. Drive System

Driving system is main unit to operate whole robotic assembly. On the basis of load lifting capacity these drive system are having various types. Due to only this drive system we can able to move the robotic link from one point to another. In general for actuating robots there are three basic drive systems are used and these are explained below.

The hydraulic drive system is most commonly used to actuate almost all heavy duty industrial robots. Robots working in the industry which lifts heavy load for providing power to these robots hydraulic drive system is used. FUNAC type of robots are best example for this. The main disadvantage of using hydraulic drive is leakage problem through its joint. Due to this the work place becomes slippery, leakage fluid cause other difficulties also. These type of drive gives high power and speed. These are used for both linear and rotational joint.

The pneumatic drive system is used for low load application. The rotary joints are actuated by rotary cylinders and linear joints by piston cylinder assembly. Disadvantage of this system is that this is not used for faster link movements and high load application.

The electric drive system generates same power and speed as that of hydraulic drive. Hence this is used for high, medium and low load application. All robotic joints are actuated by DC servomotors, stepper motors and DC servomotors with gear arrangement.

After studying these drive system, as load to be lifted is very small ie.192gm hence the electrical drive system is better option for actuating robotic arm.

IV. CONCLUSIONS

This study deals with consideration of all parameters for designing the robotic arm. This robotic arm will be of less cost and very efficient in doing operation. The designed CAD model can be simulated on workspace simulation software. This software can give you the exact simulated view of operational space. The actual operation before doing whole setup can be seen in this. The proposed drive system for robotic arm is electric drive and the configuration is combination of polar and jointed arm configuration. Complete setup will be designed in CREO PARAMETRIC 2.0.

V. ACKNOWLEDGMENT

I wish to express my deep sense of gratitude and honor towards my respected guide V. N. Bhaiswar for his inspiring guidance and encouragement. Special thanks to my co guide Mr. B.G. Achmare for his technical guidance and support

REFERENCES

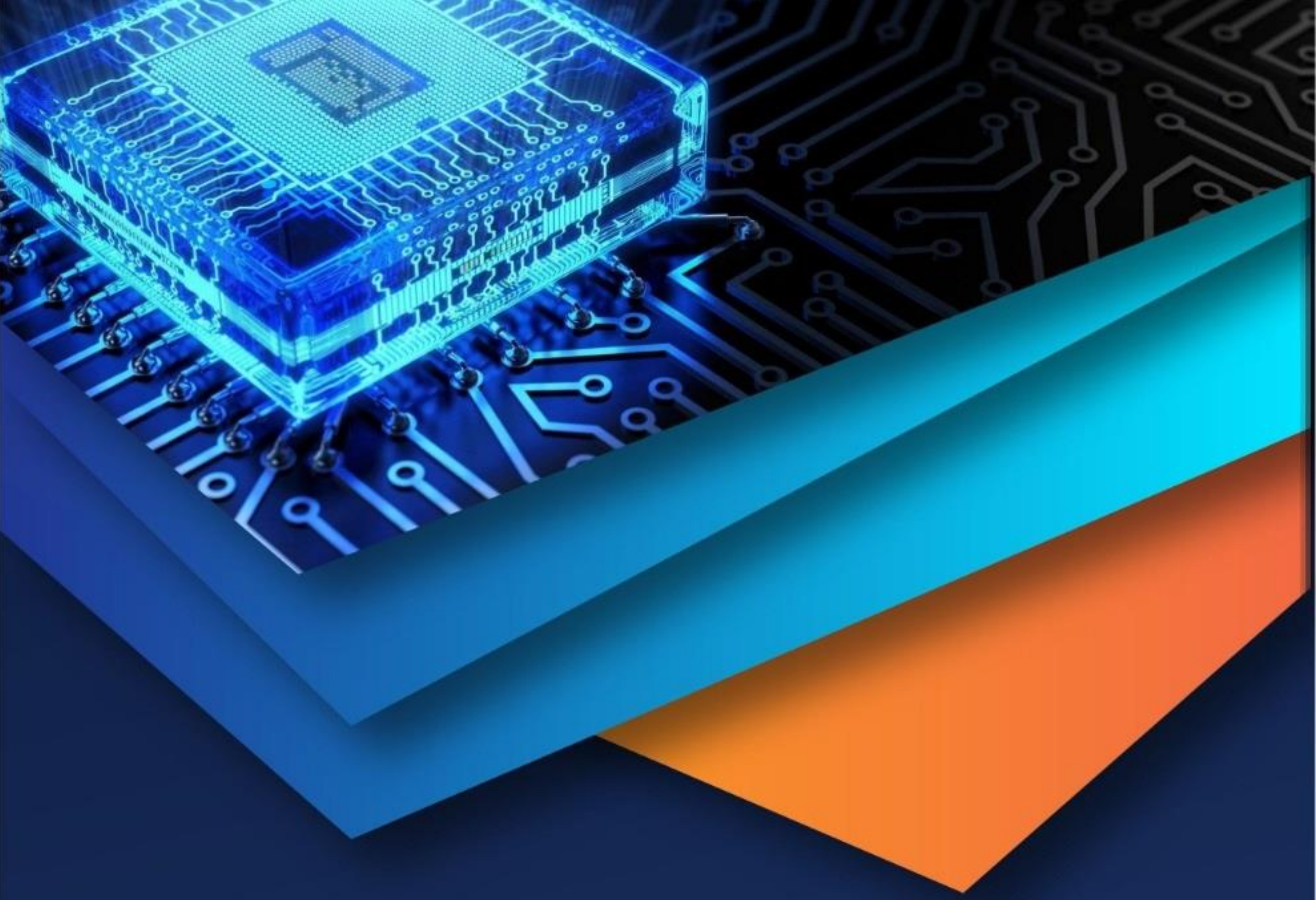
[1] A, Ali, M. Madariaga and D. McGeary. “Assistive robotic arm”, Final Year Project Report, (2007).

[2] M. Harshe, C. Menezes, B. Walzade and Prof. L. G. Navale, “An Innovative Multi-DOF robotic arm assembly for press shops”, Final Year BE Project Report, (2007).

[3] R. Krishna, G. S. Bala, A. S. C. S Sastry, B. B. P. Sarma and G. S. Alla, “Design and Implementation of a Robotic Arm based on Haptic Technology”, Int. J. of Eng. Research and Applications, vol. 2,no. 34, (2012).

[4] Aburaia, Mohamed, Erich Markl, and Kemajl Stuja. "New Concept for Design and Control of 4 Axis Robot Using the Additive Manufacturing Technology." Procedia Engineering 100, pp. 1364-1369, (2015).

[5] Maeda, Sho, et al. "Development and control of pneumatic robot arm for industrial fields." IECON 2011-37th Annual Conference on IEEE Industrial Electronics Society. IEEE, (2011).



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY