International Journal of Mechanical Engineering and Technology (IJMET)
Volume 9, Issue 1, January 2018, pp. 125–133, Article ID: IJMET_09_01_016
Available online at http://www.iaeme.com/IJMET/issues.asp?JType=IJMET&VType=9&IType=1
ISSN Print: 0976-6340 and ISSN Online: 0976-6359

 Scopus Indexed

ROBOTIC ARM FOR PICK AND PLACE APPLICATION

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ABSTRACT

This project is to design and develop a "Robotic Arm for Pick and Place Application" using NodeMCU controller. This project combines the knowledge of electronic and electrical. The objective of this project is to design and build a more compact, usable and cheaper pick and place robotic arm for educational purpose uses NodeMCU from Microchip Technology as the control system to control all the activities. Input devices such as Android application will send a signal to NodeMCU; then NodeMCU will make a response accordingly. The response normally involves turning ON or OFF an output signal to some devices such as servo motors.

Key words: NodeMCU, Robotic Arm, Servo Motor, Gripper, Pick and Place Robot.

Cite this Article: Kaustubh Ghadge, Saurabh More, Pravin Gaikwad and Shrenik Chillal, Robotic Arm for Pick and Place Application, *International Journal of Mechanical Engineering and Technology* 9(1), 2018, pp. 125–133.
http://www.iaeme.com/IJMET/issues.asp?JType=IJMET&VType=9&IType=1

1. INTRODUCTION

Robotics is the interdisciplinary branch of engineering and science that includes mechanical engineering, electronic &electrical engineering, computer science, and others. Robotics deals with the design, construction, operation, and use of robots, as well as computer systems for their control, sensory feedback, and information processing.

These technologies are used to develop machines that can substitute for humans. Robots can be used in any situation and for any purpose, but today many are used in dangerous environments (including bomb detection and de-activation), manufacturing processes, or where humans cannot survive. Robots can take on any form but some are made to resemble humans in appearance. It is said thatit helps in the acceptance of a robot in certain replicative behaviors usually performed by people. Such robots attempt to replicate walking, lifting, speech, cognition, and basically anything a human can do. Many of today's robots are inspired by nature, contributing to the field of bio-inspired robotics.

In the field of industrial robotics, the interaction between man and machine typically consists of programming and maintaining the machine by the human operator. For safety reasons, a direct contact between the working robot and the human has to be prevented. As long as the robots act out pre-programmed behaviours only, a direct interaction between man and machine is not necessary anyway. However, if the robot is to assist a human e.g. in a complex assembly task, it is necessary to have means of exchanging information about the current scenario between man and machine in real time. For this purpose, the classical computer devices like keyboard, mouse and monitor are not the best choice as they require an encoding and decoding of information: if, for instance, the human operator wants the robot to grasp an object, he would have to move the mouse pointer to an image of the object on a computer screen to specify it.

This way of transmitting information to the machine is not only unnatural but also error prone. If the robot is equipped with a camera system, it would be much more intuitive to just point to the object to grasp and let the robot detect its position visually. Observing two humans in the same situation reveals another Interesting effect: by detecting the partner's eye direction the person who points to an object can immediately control whether his intention has been interpreted correctly. If the partner looks at the wrong object, this becomes obvious immediately. In a robot system, this function can be implemented by providing the robot with a stereo camera head that actively find the human hand position in work area. To guarantee a smooth interaction between man and machine a task like this requires that the visual processing.

Types of robots as per applications are as follows –

INDUSTRIAL ROBOTS: 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 ROBOTS: It is also known as Automated Guided Vehicles or AGV. Theseare 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 they operate in

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

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

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

2. PROBLEM STATEMENT

- To design a robotic arm suitable to work with four degree of freedom and which is not too bulky and also compatible to use.
- This arm should be re-programmable according to the applications to be used for.

The number of Degree of Freedom that a manipulator possesses is the number of independent position variables that would have to be specified in order to locate all parts of the mechanism; it refers to the number of different ways in which a robot arm can move in the particular direction. Amanipulator is usually an open kinematic chain because each joint position is usually defined with a single variable so the number of joints equal to the number of degrees of freedom.

Moving the arm from the elbow only, holding the shoulder in same position constantly. The elbow joint has the equivalent of pitch in shoulder joint, thus the elbow has one degree of freedom. Now moving the wrist straight and motion less, we can bend the wrist and up and down, side to side and it can also twist a little. The lower arm has the same three degrees of freedom. Thus the robot has totally seven degrees of freedom. Three degrees of freedom are sufficient to bring the end of a robot arm to any point within its workspace, or work envelope in three dimensions.

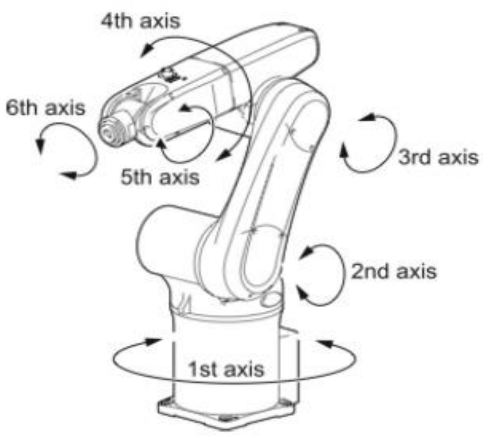

Figure 1 Degree of freedom

3. ROBOTIC ARM AND BASE DEVELOPMENT

The basic CAD design was developed using CATIA V5.0. The design was then drafted with rough dimensions which were then used for the calculations to find the accurate dimensions of the parts. The 3D CAD model was redrawn with the accurate dimensions.

3.1. Designing the Base

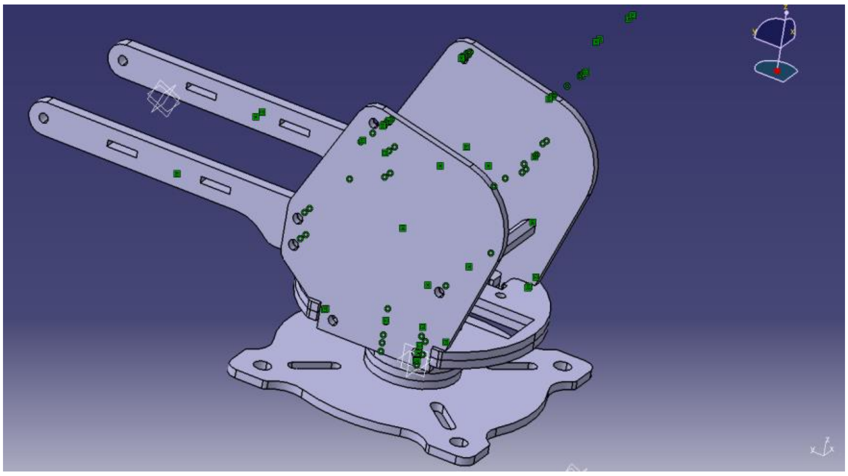

Figure 2 CAD model of the base

Base supports the whole assembly of the robot. The material used for the base is aluminium. Thickness of the material of the base plate is 3mm. Link assembly is connected to the base by means of the screws. The base rotates due to the motor. It rotates approximately 180 degrees. Brass standoff is fixed between the supporters of the robot assembly. Two motors are fixed in the base which is connected to the link.

The specifications of the motor selected for the base are as follows

Model no. Tower Pro MG945

- Weight: 55gm
- Dimension :40.7 × 19.7 ×42.9
- Torque :12 kg/cm
- Operating speed :0.23 sec/60 degree (4.8 v);0.2 sec /60 degree (5 v)
- Temperature range :0- 55 degree
- Gear type: Metal gear

3.2. Designing the Link 1

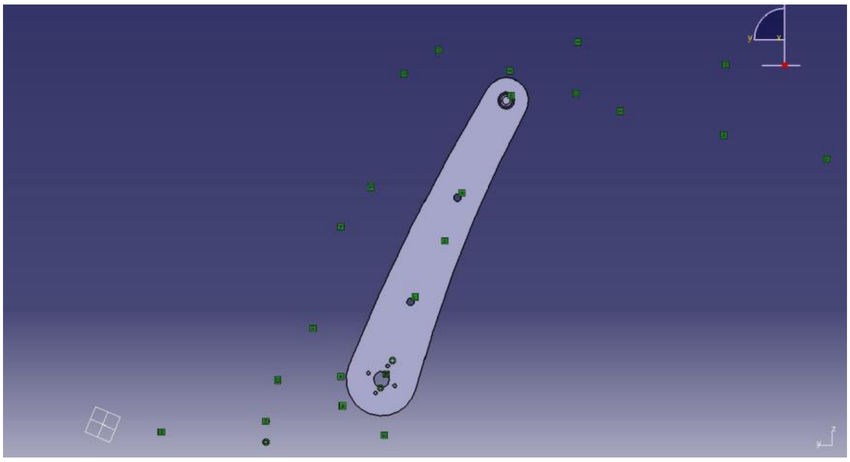

Figure 3 Cad model of link 1

Link 1 is made of aluminium material which transmits force to link 2. Link 1 is connected to motor 2. 2nd end of link 1 is connected to link 2. Power required for movement of link is provided by motor. Links are connected to each other by means of screw. Screw has diagram of 4 mm and length is 8 to 16mm by means of various application. DC motor is used for movement of link.

The specifications of the motor selected for the link 1 are as follows

Model no Tower Pro MG945

- Weight: 55gm.
- Dimension: 40.7×19.7×42.9mm
- Torque:12kg/cm (6v)
- Operating speed: 0.23sec/60degree (4.8v); 0.2sec/60degree (6.0v)
- Operating voltage: 4.8 ~ 6.6v

- Temperature range: 0- 55deg
- Gear Type: Metal gear
- Power Supply: Through External source.

3.3. Designing the Link 2

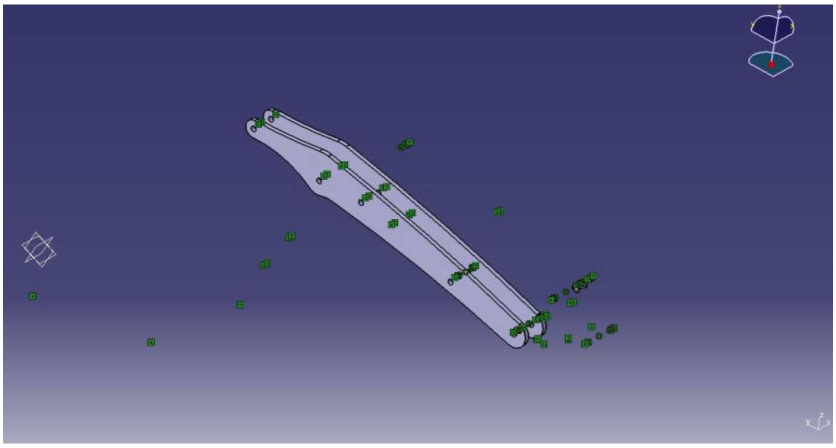

Figure 3 Cad model of link 2

Link 2 is connected to link 1. 2nd end of link is connected to gripper. Movement of link is controlled by DC servo motor 3. Link 2 is made of aluminium. Thickness of link 2 is 3mm.

The specifications of the motor selected for the link 2 are as follows

Model no Tower Pro MG945

- Weight: 55gm.
- Dimension: 40.7×19.7×42.9mm
- Torque:12kg/cm (6v)
- Operating speed: 0.23sec/60degree (4.8v); 0.2sec/60degree (6.0v)
- Operating voltage: 4.8 ~ 6.6v
- Temperature range: 0- 55deg
- Gear Type: Metal gear
- Power Supply: Through External source

3.4. Designing the Gripper

Gripper is used to pick the object and place it to desired destination. Gripper is combination of mechanical linkage as well as electrical motor. Gripper is designed for holding object of up to 200 grams. It is made up of aluminium. Servo motor of capacity 1.8Kg/cm is used.

The specifications of the motor selected for the gripper are as follows

Model no. SG90

- Weight: 9 gm.
- Dimension: 22.2 x 11.8 x 31 mm approx.
- torque: 1.8 kg/cm

- Operating speed: 0.1 s/60 degree
- Operating voltage: 4.8 V (~5V)
- Temperature range: 0 ºC – 55 ºC

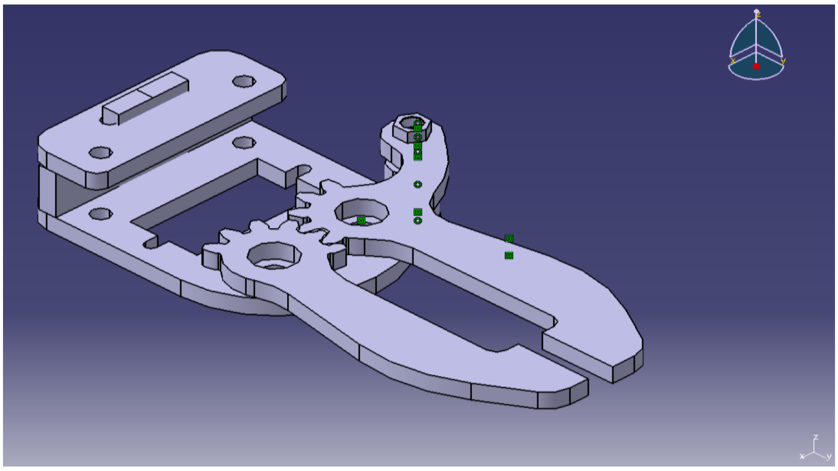

Figure 4 Cad model of Gripper

3.5. Assembly of Robot

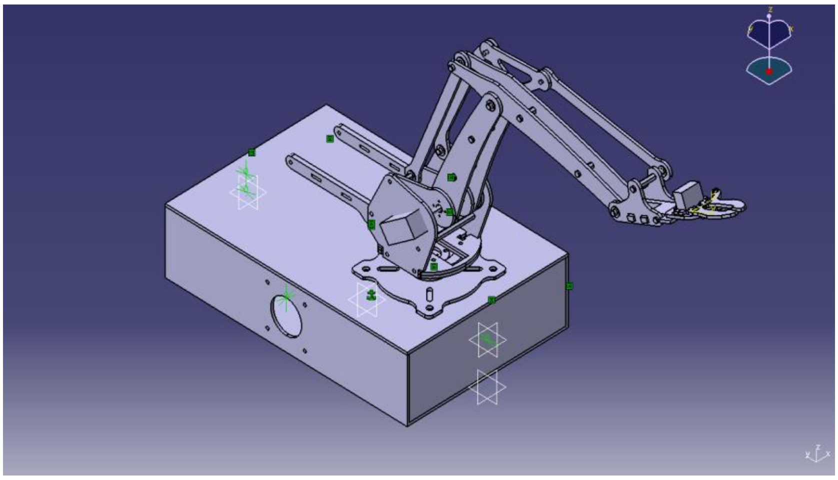

Figure 5 Assembly of robot

4. SELECTION OF MATERIAL

NodeMCU- is an open source platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. The term "NodeMCU" by default refers to the firmware rather than the dev kits. NodeMCU is used as controller. Its works as processor. NodeMCU generates output signal (PWM- Pulse width modulation) to motor. Power required to NodeMCU is 5 volts. NodeMCU is powered by external power source. NodeMCU comes with Wi-Fi. Digital pins are used for PWM signal. Digital pins from D0 to D3 are used for output of NodeMCU.

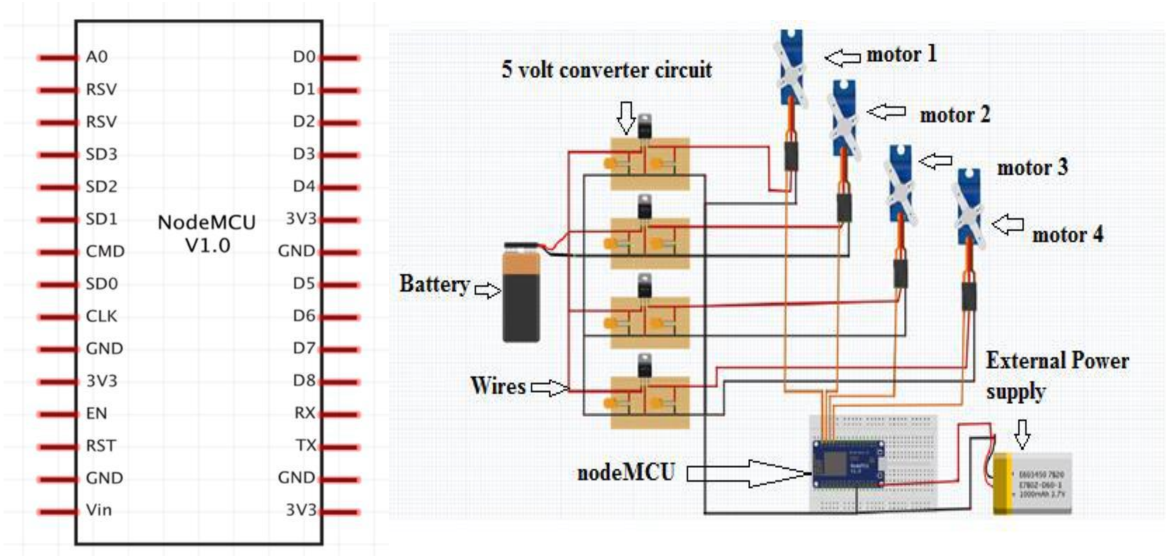

Figure 6 Node MCU and circuit diagram

BATTERY – A rechargeable battery is a type of electrical battery which can be charged, discharged into a load, and recharged many times, while a non-rechargeable or primary battery is supplied fully charged, and discarded once discharged. It is composed of one or more electrochemical cells. Rechargeable batteries are produced in many different shapes and sizes, ranging from button cell to megawatt systems connected to stabilize an electrical distribution network. Several different combinations of electrode materials and electrolytes are used, including lead-acid, nickel cadmium (NiCd), lithium ion (Li-ion).

Rechargeable batteries typically initially cost more than disposable batteries, but have a much lower total cost of ownership and environmental impact, as they can be recharged inexpensively many times before they need replacing. Some rechargeable battery types are available in the same sizes and voltages as disposable types, and can be used interchangeably with them.

Figure 7 Battery

12 VOLTS TO 5 VOLTS CONVERTER CIRCUIT - This type of converter is used for converting voltage of 12 volts to 5 volt. In this circuit capacitors and IC of 7805 are used. A capacitor is a passive two-terminal electrical component that stores electrical energy in an electric field. The effect of a capacitor is known as capacitance. While capacitance exists between any two electrical conductors of a circuit in sufficiently close proximity, a capacitor is specifically designed to provide and enhance this effect for a variety of practical applications by consideration of size, shape, and positioning of closely spaced conductors, and the intervening dielectric material. in this circuit we used capacitor of 10 farads as well as 1 farad.

The IC used is 7805 in this circuit. Voltage sources in a circuit may have fluctuations resulting in not giving fixed voltage outputs. Voltage regulator IC maintains the output voltage at a constant value. 7805 IC, a voltage regulator integrated circuit (IC) is a member of 78xx series of fixed linear voltage regulator ICs used to maintain such fluctuations. The xx in 78xx indicates the fixed output voltage it provides. 7805 IC provides +5 volts regulated power supply with provisions to add heat sink as well.

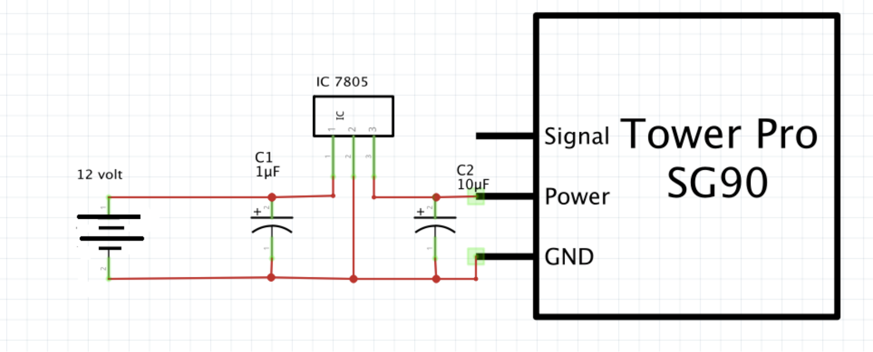

Figure 8 12V to5V converter circuit

Table 1 List of components in 12V to 5V converter circuit

Components	Quantity
IC7805	1
Capacitor 1µF	1
Capacitor 10µF	1
Pins	7

DC motor - The position of servo motors can be controlled more precisely than those of standard DC motors, and they usually have three wires (power, ground & control). Power to servo motors is constantly applied, with the servo control circuit regulating the draw to drive the motor. Servo motors are designed for more specific tasks where position needs to be defined accurately such as controlling the rudder on a boat or moving a robotic arm or robot leg within a certain range.

Servo motors do not rotate freely like a standard DC motor. Instead the angle of rotation is limited to 180 Degrees (or so) back and forth. Servo motors receive a control signal that represents an output position and applies power to the DC motor until the shaft turns to the correct position, determined by the position sensor.

PWM is used for the control signal of servo motors. However, unlike DC motors it's the duration of the positive pulse that determines the position, rather than speed, of the servo shaft. A neutral pulse value dependent on the servo (usually around 1.5milliseconds) keeps the servo shaft in the center position. Increasing that pulse value will make the servo turn clockwise, and a shorter pulse will turn the shaft anticlockwise. The servo control pulse is usually repeated every 20 milliseconds, essentially telling the servo where to go, even if that means remaining in the same position.

When a servo is commanded to move, it will move to the position and hold that position, even if external force pushes against it. The servo will resist from moving out of that position, with the maximum amount of resistive force the servo can exert being the torque rating of that servo.

Figure 9 DC servo motor

5. CONCLUSIONS

A novel robotic arm which is robust and light with four degrees of freedom and can be reprogrammed for various applications has been developed. This robotic arm uses NodeMCU controller and is especially developed for pick and place applications. The design is compact and cheap and has been proven practically also. However the present paper has discussed only the CAD modeling aspect of the robot and various parts of the assembly.

ACKNOWLEDGEMENT

We would like to thank Prof. Sanjay S. Deshpande from College Of Engineering, Pune for his valuable guidance and continuous support during this work.

REFERENCES

[1] Interactive Pick and Place Robot Control using Image Processing Method by Mr. Raskar D. S.1, Prof. Mrs. Belagali.

[2] Automatic Material Handling System Using Pick & Place Robotic Arm & Image Processing by Mr. Deepak L Rajnori, A.S Bhide.

[3] Design and Fabrication of Pick and Place Robot to Be Used in Library Anusha Ronanki. Vol. 4, Issue 6, June 2015

[4] Design Analysis of a Remote Controlled "Pick and Place" Robotic Vehicle B.O. Omijeh, RUhunmwangho and MEhikhamenle. Volume 10, Issue 5 (May 2014)

[5] RatheeshRajan "Foundation Studies for an Alternate Approach to Motion Planning of Dynamic Systems" M.S.E., the University of Texas at Austin, 2001

[6] Richard E. Pattis. Karel the Robot: A Gentle Introduction to the Art of Programming. John Wiley & Sons, 1981.

[7] P. Kamal Kumar, Taj, L. Praveen, Anoop Joshi and G Musalaiah. Fabrication of Pneumatic Pick and Place Robot. International Journal of Civil Engineering and Technology, 8(7), 2017, pp. 594–600

[8] S. Ananth, P. Vijayakumar, K. Guruprasath and V. Kalaiyarasan, Design and Fabrication of Material Handling Robot for Multi Station. International Journal of Mechanical Engineering and Technology, 8(3), 2017, pp. 142–148.