Design and Fabrication of Pick and Place Robotic Arm Controlled by Android Device

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ABSTRACT

This work is designed to develop a pick and place robotic arm with a soft catching gripper, which is meant to be constructed on hardware and software. A robotic arm is a type of mechanical arm, usually programmable, with similar functions to human arm. This proposed project is to build a robotic arm that is capable to pick an object with the help of an wireless device (Android device). Since the system that will be built will be divided into two circuits. Micro controller circuit and Driver Circuit.This system will be powered by 12v Battery.To create a systematic, faster and efficient operation,micro controller is used .

At the transmitting end using android application device, commands are sent to the receiver to control the movement of the robot either to move forward, backward and left or right etc. At the receiving end four motors are interfaced to the microcontroller where two of them are used for arm and gripper movement of the robot while the other two are for the body movement. The android application device transmitter acts as a remote control that has the advantage of adequate range, while the receiver end Bluetooth device is fed to the microcontroller to drive DC motors via motor driver IC for necessary work. Remote operation is achieved by any smart-phone/Tablet etc., with Android OS; upon a GUI (Graphical User Interface) based touch screen operation. The main advantage of this robot is its soft catching arm that is designed to avoid extra pressure on the suspected object for safety reasons.

Further the work can be enhanced by interfacing it with a wireless camera so that the person controlling it can view operation of the arm and gripper remotely.

Keywords— Android Device, Mechanical Arm. Micro Controller, Pick and Palce Robot

I.   INTRODUCTION

1.1 ROBOTICS:

Robotics is the science and technology of robots, their design, manufacture, and application. Robotics requires a working knowledge of electronics, mechanical, and software and a person working in the field has become known as a robocist. With growing developments in the field of mechatronics, mathematical modeling robotics has come long way from an iron piece that moves a few inches to machines capable of jumping from high buildings, detecting mines, performing various operations and trouble shooting. Robotics means the study and application of robot technology. The goal of robotics is to mimic natural world as closely as possible. The main elements in the robot are the moving elements and the sensors. The basic structure of a robot is the robotic arm. This paper deals with the evolution of robots, the elements of robotics, the limitation of robots and the various applications of robots. In the application part this paper expects to cover in detail rob surgery and robonauts (the robots used in space).It also deals with the importance of artificial intelligence in Robotic technology. Robots have always had a fascination in our mind. With their various applications in various fields, they have become a common part in our daily life. They are meant to ease our work and increase our comfort of living. Universal Robots denoted the birth of a superior race that had intelligence similar to that of humans. As Robots come in various forms and have application in various fields defining a Robot becomes that much difficult. There are various definitions for the term Robot. A robot is a reprogrammable multifunctional manipulator designed to move material, Parts, tools or specialized devices through variable programmed motions for the Performance of a variety of tasks. Robotics is that branch which involves with the study and applications of Robots. The goal of Robotics is to mimic natural world as closely as possible. Robotics is a relatively new field of engineering (about approximately 50 years old) and is

finding many applications in different areas. With growing developments in the field of mechatronics and mathematic modeling, Robotics has come a long way. From an iron piece that could move only a few inches, there are now machines capable of jumping from high rise buildings, detecting landmines, performing complicated operations, and troubleshooting.

1.2 Robotic arm:

A robotic arm is a type of mechanical arm, usually programmable, with similar functions to a human arm; the arm may be the sum total of the mechanism or may be part of a more complex robot. The links of such a manipulator are connected by joints allowing either rotational motion (such as in an articulated robot) or translational (linear) displacement. The links of the manipulator can be considered to form a kinematic chain. The terminus of the kinematic chain of the manipulator is called the end effecter and it is analogous to the human hand.

1.3 Robotic hand:

The end effecter, or robotic hand, can be designed to perform any desired task such as welding, gripping, spinning etc., depending on the application. For example robot arms in automotive assembly perform a variety of tasks such as welding and parts rotation and placement during assembly. In some circumstances, close emulation of the human hand is desired, as in robots designed to conduct bomb disarmament and disposal.

Fig1.1 Basic pick and place robot model

1.4 Types of robotic arms:

There are many different types of robotic arms, but most can be characterized into one of six major categories by their mechanical structure. Cartesian (also known as Gantry) robots have three joints that are coincident with the standard X-Y-Z Cartesian axes. Cylindrical arms have any number of joints that operate on a cylindrical axis, normally rotating about one fixed rod. Spherical (polar) arms are those with joints that allow it full rotation throughout a spherical range. SCARA robots have two parallel rotary joints to allow full movement throughout a plane, typically for pick-and-place work. Articulated robots are used for complex assembly operations, and consist of three or more rotary joints. Parallel robots have three concurrent prismatic or rotary joints, and allow for tilting of heavy or sensitive platforms.
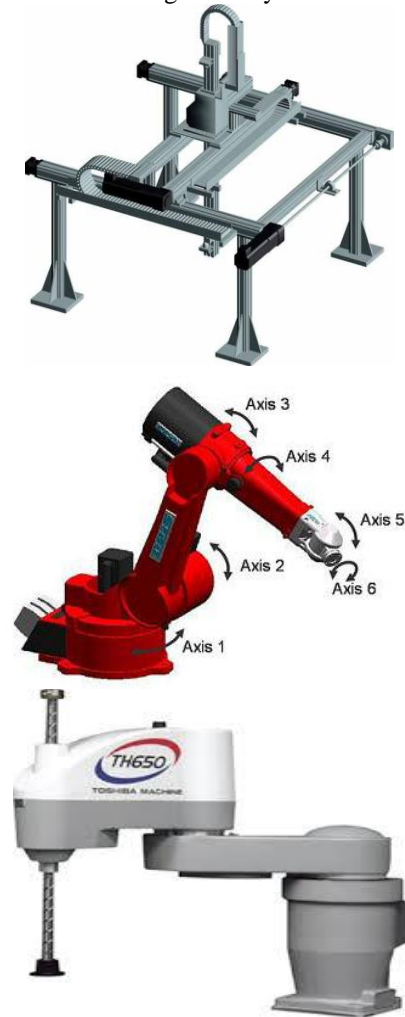

Fig 1.2 Types of robotic arms
Gantry Robot, Articulated Robot, SCARA Robot

1. Cartesian robot / Gantry robot: Used for pick and place work, application of sealant, assembly operations, handling machine tools and arc welding. It's a robot whose arm has three prismatic joints, whose axes are coincident with a Cartesian coordinator.

2. Cylindrical robot: Used for assembly operations, handling at machine tools, spot welding, and handling at die casting machines. It's a robot whose axes form a cylindrical coordinate system.

3. Spherical robot / Polar robot (such as the Animate): Used for handling at machine tools, spot welding, die casting, fettling machines, gas welding and arc welding. It's a robot whose axes form a polar coordinate system.

4. SCARA robot: Used for pick and place work, application of sealant, assembly operations and handling machine tools. This robot features two parallel rotary joints to provide compliance in a plane.

5. Articulated robot: Used for assembly operations, die casting, fettling machines, gas welding, arc welding and spray painting. It's a robot whose arm has at least three rotary joints.

6. Parallel robot: One use is a mobile platform handling cockpit flight simulators. It's a robot whose arms have concurrent prismatic or rotary joints.

7. Anthropomorphic robot: Similar to the robotic hand Luke Skywalker receives at the end of The Empire Strikes Back. It is shaped in a way that resembles a human hand, i.e. with independent fingers and thumbs.

II.   BASIC FUNCTION OF PICK AND PLACE ROBOT

2.1 The basic function of a pick and place robot is done by its joints. Joints are analogous to human joints and are used to join the two consecutive rigid bodies in the robot. They can be rotary joint or linear joint. To add a joint to any link of a robot, we need to know about the degrees of freedom and degrees of movement for that body part. Degrees of freedom implement the linear and rotational movement of the body and Degrees of movement imply the number of axis the body can move.
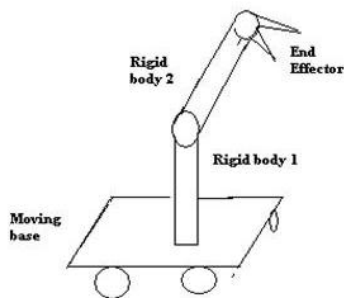

Fig 2.1 Simple pick and place robot

The end effector should accommodate all 6 degrees of freedom, in order to reach all sides of the component, to take up position to any height.

On a whole, the basic pick and place robot works as follows: The wheels under neath the base help to move the robot to the desired location. The rigid body supporting the end effector bends or straightens up to reach the position where the object is placed. The end effector picks up the object with a strong grip and places it at the desired position. Now that we have got a brief idea of the pick and place robot, the basic question is how it is actually controlled.

A simple pick and place robot can be controlled by controlling the movement of its end effector. The motion can be using hydraulic motion, i.e. using hydraulic fluid under pressure to the drive the robot, or using pneumatic motion, i.e. using pressurized air to cause mechanical motion. However the most effective way is using motors to provide the required motion. The motors have to be controlled in order to provide required motion to the robot and the end effector

III.   BLOCK DIAGRAM AND WORKING PRINCIPLE OF THE MODEL

3.1 The block diagram of the proposed system is shown in Figure2.2 .It consists of an AT89C2051 series Micro controller IC, Bluetooth module, four DC Motors with driver IC and power supply. The pick and place robotic arm consists of a robotic arm placed on a moving vehicle. The vehicle is able to move along any type of surfaces irrespective of it is smooth or rough. It uses two motors for the operation and a belt type tyre is attached to the vehicle liken the tanks, for the smooth and reliable operation. The pick and place robot uses four motors for the operation of the system, two for the operation of moving vehicle and two for the pick and place operation. The pick and place arm consists of an arm assembly with a jaw, which is only able to move in up and down direction. There are two motors are for the arm assembly, one for the up and down motion and other for jaw opening and closing. The maximum upward and downward motion is limited by a mechanical push button type switches. It breaks the motor circuit when the arm is at its maximum position beyond which the motor does not rotate. For the controlling of motor, motor driver IC and micro controller is used. The input signal or controlling signal is given from an android device, which is interfaced with the microcontroller by a blue tooth module. The program is so written i.e., while executed it sends commands to the motor driver IC as per its requirement for running the motor for the movement of the robot. Blue control android application is used for operation of robot, this application can be installed in any android device. The android device screen is used for sending commands for left, right, forward and backward and centre is for stop through its inbuilt Bluetooth system.12V battery powers the circuit in series with a diode D2 that nearly provides 5 through regulator IC LM 7805 for the microcontroller which has standard connections like crystal, reset arrangement indication LED etc. A blue tooth device being powered from a reversed biased Zener diode D1, is interfaced to the microcontroller that after being paired with any smart phone communicates with this Bluetooth device for taking appropriate actions as per the touch operation made on the smart phone. For the controlling of motor, motor driver IC and micro controller is used. The input signal or controlling signal is given from an android device, which is interfaced with the microcontroller by a blue tooth module.
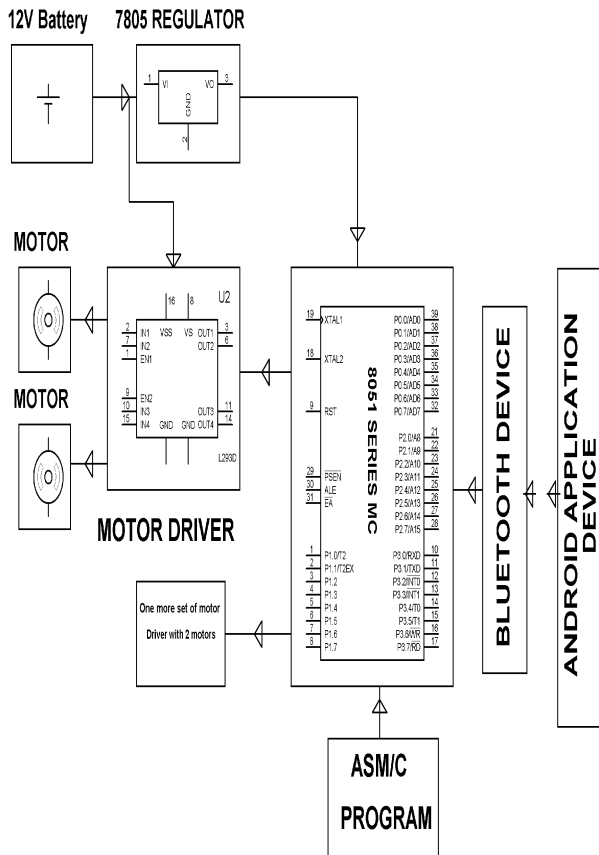
Fig 3.1 Block Diagram of Pick and Place Robot

3.2 WORKING OF THE MODEL

1) First of all search for Blue Control˙V2.0 (Figure 2.3) at Google Play and install the application in the android device

2) After installing, go to the applications and open the application.

3) Turn on the Bluetooth and scan for the device called "HC-05"and connected to the device by enter pin 1234.

4) Go to the Blue Control app and press the options button and click the connect option. Then it will give a list of devices available. See for"HC-05" and again enter the pin 1234 and then click "OK".

5) Wait for a while until it gives the confirmation "Connected to HC-05" then the application now ready for communication with the Bluetooth module in the pick and place robotic vehicle.

Below are the operation procedure

- Click up button for Robot Forward Movement
- Click down button for Robot Backward Movement
- Click left button for Robot Left Movement
- Click right button for Robot Right Movement
- Click A button for Robot Gripper Open
- Click B button for Robot Gripper Close
- Click C button for Robot Arm Up

- Click D button for Robot Arm Down
- Click centre button for Stop operation

Now consider the operation of *soft catching arm.* It sense pressure in the arm by measuring current. The motors used for an operation up and down and gripper operation open and closed pass through series resistor of 10 ohms/ 2 watt from the output of the motor driver IC L293D.While motor is operating the returning current from Driver IC is grounded through this resistance and the voltage across it is proportional to the current owing through it and this current is proportional to the load at the motor or pressure in the arm jaws. Thus by measuring the voltage we can measure the amount of pressure. Thus while motor operates in normal condition the running current results normal voltage drop across the 10R/2W ohm resistor as the motor can run in clockwise (or)anti-clockwise. When load increases the voltage across resistor get increased and is continuously monitored by micro controller. When it increases above a certain value, interrupt is produced thus stopping the motor. The program is so written that once interrupt zero occurs low, no such command would generate any input to the motor driver IC for any direction for that motor movement. Only the other direction rotation is possible from the command. This helps in soft catching arrangement of the arm gripper.

3.3 BLUE CONTROL ANDROID APPLICATION

Blue control is a basic universal remote control for blue-tooth enabled serial devices such as Blue Tooth modules connected to a micro-controller. For each button pressed the corresponding ASCII code for the label will be sent. The blue control android application works on based of touch screen operation it consists of eight alphabetical keys and four arrow keys which controls the robot movement and gripper.
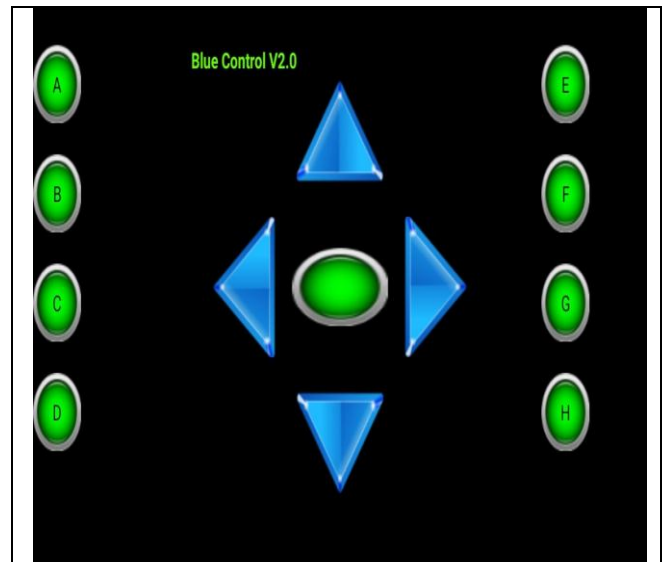

Fig 3.1 Blue control android application

IV.   FABRICATED MODEL

The complete **Pick and Place robot** is combination of three sub sections
1.   Robotic mechanism
2.   Hardware driver circuit
3.   Controlling software in VC++

Obviously, the main part will be the mechanism that actually forms the body of robot means moving robotic arm that picks or places any object.

Function of hardware driver circuit is to drive all three motors and actuates all the motions of robot. Controlling software is also an important part of this robot because it will take care of all controlling actions. The main functions of this section are

Rotate the hand to one specific angle from where the object should be picked or to be placed

Move the hand up or down to pick or place the object.

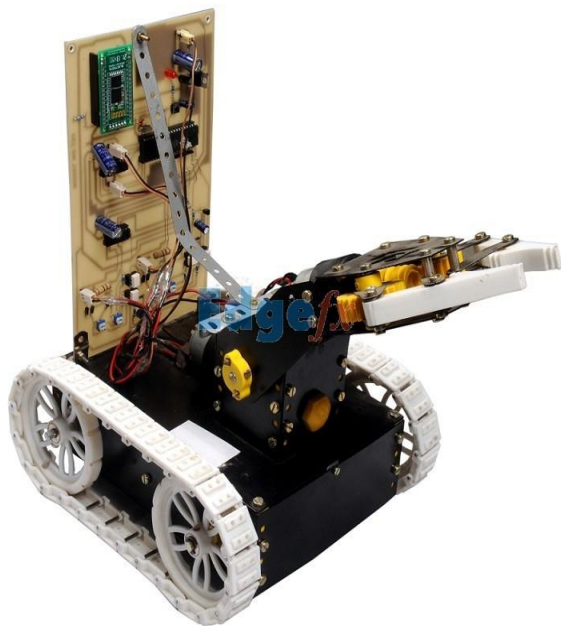Open or close the grip of hand depending upon size of object.

Fig 4.1 Fabricated model of Pick and Place Robot

## V.   RESULTS AND DISCUSSION

5.1 RESULT

In this work a Pick and place robot controlled by an Android application was made. We know that the whole digital devices in the world are transformed in to Android OS based systems , as it is more versatile ,flexible and easy to control and it is an open source software. Here The Pick and place robot is controlled wirelessly by an Android application called Blue control through a blue tooth module. The main feature of this pick and place robot is

the soft catching arm or soft catching Gripper. We know that when handling the explosive items like bomb it should be handled carefully, excessive pressure will cause explosion, so it is very essential to have a soft catching arm .This robotic arm has microcontroller based electrical pressure sensor which has higher sensitivity than mechanical pressure sensors. This robotic arm is designed to handle a maximum weight of 2kg.The weight handling capacity of Pick and Place Robot is determined by the capacity of DC motors used.

After successful fabrication, the robot arm was tested for a fixed distance of 5 meters for picking up of an object and placing with different loads and the results are

TABLE 1
Time taken to travel with different loads

Slno.	Weight of the object in grms	Time taken in seconds	Distance travelled in mts
1	50	36	5
2	100	39	5
3	200	42	5
4	400	43	5
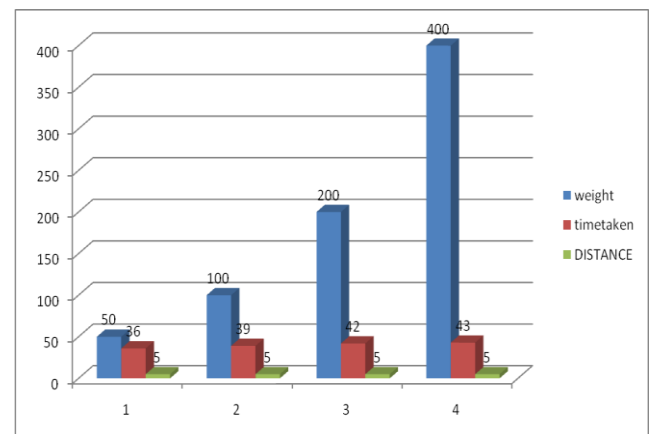
.5.1 Graphical representation of time taken to travel the robot with different loads

Various Weights are made to be griped by the robotic arm and move the links in constant path in bi directional way (i.e. clockwise and anti clockwise rotation) with a constant power source. The lifting force component variation can bring considerable changes in the motor power consumption at various joints. The experimental data so obtained was tabulated as follows:

TABLE 2
Power consumption of each motor in volts

S.No	Position of arm	Base rotation motor	Shoulder elbow motor	Gripper
50gms	Arm is straight	8.6	8.7	7.2
	Arm is at 90degrees	8.1	7.7	8.2
100grm	Arm is straight	8.6	8.7	8.6
	Arm is at 90degrees	8.1	7.5	7.9
200grm	Arm is straight	8.5	8.6	8.2
	Arm is at 90degrees	7.8	7.1	7.9
300grm	Arm is straight	8.2	8.5	8.2
	Arm is at 90 degrees	7.8	6.7	7.8

From the above results the gripper motor consumed less power than other motors at different joints. The gripper is used to hold the objects straightly. The base motor consumed more power because it will carry the load of the object and also and the other joints of the arms. The shoulder arm consumed less power than the base motor.
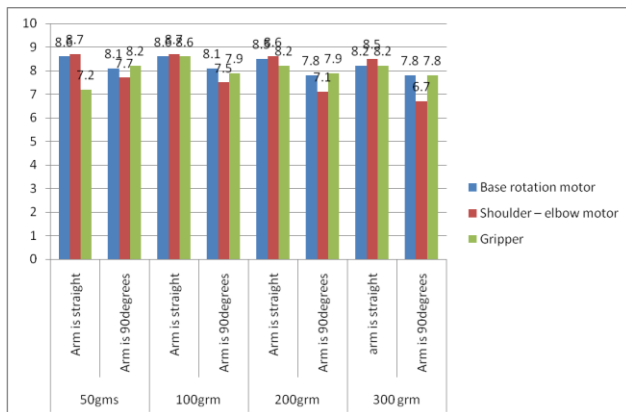

Fig5.2 Graphical representation of power consumption of motors

VI.   CONCLUSION

In this work, Pick and place robot controlled by an Android application was made. We know that the whole the digital devices in the world are transformed in to Android OS based systems ,as it is more versatile ,flexible and easy to control and it is an open source software. Here The Pick and place robot is controlled wirelessly by an Android application called Blue control through a blue tooth module. The main feature of this pick and place robot is the soft catching arm or soft catching Gripper. We know that when handling the explosive items like bomb it should be handled carefully. Excessive pressure will cause explosion. So it is very essential to have a soft catching arm .This robot has microcontroller based electrical pressure sensor which has higher sensitivity than mechanical pressure sensors. The hardware model functioned as desired and is shown in Figure .This is designed to handle a maximum weight of 2kg.The weight handling capacity of Pick and Place Robot is determined by the capacity of DC motors used. Very useful and interesting can be made by interfacing the "Pick and Place Robot" with explosive detectors, metal detectors, wireless cameras, night vision cameras...Etc. for finding the bombs and proper visual assistance.

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