IDEA LAB PROJECT ID - MOBILE CONTROLLED PICK AND PLACE ROBOT USING DTMF

IDEA LAB PROJECT

Submitted By

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DECLARATION

We do hereby declare that the technical project report submitted is original, and is the outcome of the independent investigations/research carried out by us and contains no plagiarism. The research is leading to the discovery of new facts/techniques/correlation of scientific facts already known. This work has not been submitted to or supported by any other University or funding agency.

We do hereby further declare that the text, diagrams or any other material taken from other sources (including but not limited to books, journals and web) have been acknowledged, referred and cited to the best of our knowledge and understanding.

Date: 14/04/16
Place: Ahmedabad

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ELECTRICAL ENGINNERING DEPARTMENT

Annual/Final Report of the work done on the Idea Lab Project.

(Report to be submitted within 3 weeks after completion of the project)

1. Idea Lab Project ID:
2. Project Title: Mobile Controlled Pick and Place Robot Using DTMF
3. Period of Project: Start Date to End Date
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5. Project Start Date: Project Start Date
6. a) Total Amount Approved: Rs. 690/-
   b) Total Expenditure: Rs. 3000/-

Achievements:

This is a two-degree-of-freedom robot that can be used to pick and place small objects. It has been designed as a device that can be used to reduce human efforts and time. The Robot is cheaper than the ones currently used. Its design with a minimum number of components ensures

high reliability. It can be easily controlled and used by anyone. With this system, we tested how correctly the robot could pick and place the small object and how easily it could be controlled. We are able to design a cost effective, small, application based pick and place robot. Whole structure is made using acrylic sheet which make it possible to reduce the cost as compare to when robotic arm is purchased readymade.

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1.1 INTRODUCTION

The project titled '**Mobile Controlled Pick and Place Robot**' is a very useful innovation and finds application in various fields. This can be used in industries as well for domestic purposes.

Conventionally, wireless controlled robots use circuits, which have a drawback of limited working range, limited frequency range and limited control. Use of mobile phones for robotic control can overcome these limitations. It provides the advantages of robust control, working range as large as the coverage area of the service provider, no interference with other controllers. Another reason for selecting mobiles to control the robot is the increasing popularity of mobile phone.

A simple pick and place robot consists of two rigid bodies on a moving base, connected together with rotary joint. A rotary joint is a one which provides rotation in 360 degrees around any one of the axes. The 1st rigid body is fixed and supports the second rigid body to which the end effector is provided. The 2nd rigid body is provided with movement in all 3 axes and has 3 degrees of freedom. It is connected to the 1st body with a rotational joint. 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.

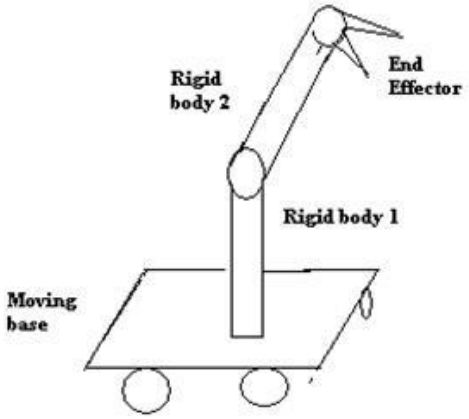


Fig 1.1 Simple Pick and Place Robot

Project Specifications:

- Maximum weight that can be picked – less than 200 grams
- Degree of freedom introduced – 2
- No. of motors used – 4

Motors specifications:

1. High torque DC geared motor:
   Speed – 60 rpm
   Torque – 38kgcm
   Weight – 180
   No-load current - 800 mA
   Load current - 7.5 A (Max)
   Shaft diameter – 6mm
   Purpose – used to drive the gripper
2. High torque DC geared motor:
   Speed – 10 rpm
   Torque – 120kgcm torque
   Weight - 180gms
   No-load current - 800 mA
   Load current - 7.5 A (Max)
   Shaft diameter – 6mm
   Purpose – used to drive the lever arm
3. DC geared motor:
   Speed – 60 rpm
   Torque – 2kgcm torque
   Weight - 125gms
   No-load current - 60 mA (Max)
   Load current -300 mA (Max)
   Shaft diameter – 6 mm
   Purpose – used for base movement (linear motion)

4. DC geared motor:

   Speed – 60 rpm

   Torque – 2kgcm torque

   Weight - 125gms

   No-load current - 60 mA (Max)

   Load current -300 mA (Max)

   Shaft diameter – 6 mm

   Purpose - used for base movement (linear motion)

- No. of gears used – 5 (2 worm gears and 3 spur gears)

  Gear specifications:

1. Spur gear:

   No. of Teethes – 25

   Diameter - 40 mm

   Center Shaft Diameter - 6mm

   Teeth Face Width - 12.5mm

   Purpose – used as link between motor and robotic arm for movement

2. Worm gear:

   Pitch Diameter - 40 mm

   Length - 32mm

   Center Shaft Diameter - 6mm

   Purpose – used as link between motor and robotic arm for movement

In the proposed system we are using wireless technology using an android mobile. **Pick and place robot** is controlled by a mobile phone that makes a call to another mobile phone attached to the robot. In the course of a call, if any button is pressed a tone is produced. The received tone is processed with the help of DTMF decoder IC MT8870. Assembly of microcontroller and motor driver is done such that output of the DTMF is programmed to drive the corresponding motor.

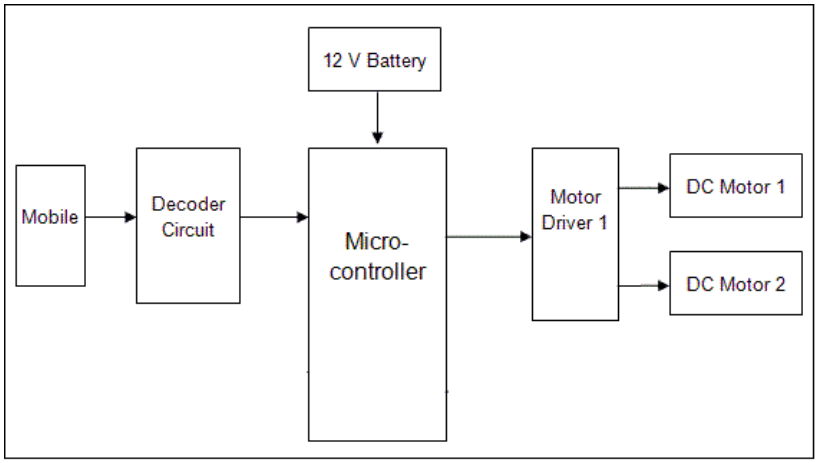


Fig.1.2 Block Diagram

1.2 LITERATURE REVIEW

Research on Robotics was done for the implementation. First, research was done on working of DTMF circuit and its connections from journals comprising past projects on robotics. The various frequencies received on pressing different keys were known and motion of the robot and its parts was set by coding.

The coding has been done in AVR Studio so a prior knowledge of AVR programming was necessary. Therefore, a study was done on AVR and its programming.

The next research was on the types of motors to be used and their speeds and torques. This can be decided on the application of the motor. Also, modifications can be done; type of motor can be changed for various applications.

For mechanical structure, a study of material to be used for the body, dimensions of nuts and bolts, etc was done. The shape of different connecting parts was decided. A software named **Solid Works** was used.

1.3 MAJOR OBJECTIVES PROPOSED

As many industries needs to carry heavy weights because their products and materials are heavy, we are focused on designing the prototype of pick and place robot which can be controlled without much physical work for carrying small weights. Reducing human efforts and time is the aim. With technical knowledge about designing of gripper for picking heavy weight, motor with required torque and speed can be selected and this project can be modified further for any application desired. The cost will depend upon the size of the vehicle, arms and its capability as arms are designed based on the weight it need to carry.

Applications of pick and place robot can be either domestic or industrial, not focusing much on industrial applications, we are targeting domestic customers. In domestic application pick and place robot is useful for carrying objects which are not as heavy as industrial materials. Designing the cost effective and reliable device which can make work easier is one of the objectives of this project. Physically disabled people and old age people are the targeted customers.

Advanced technology of wireless remote control using an android phone is proposed so that used need not to invest additionally for controlling device as smart mobile phone is the device everyone owns. This helps in cost effectiveness. Thus, this gives a new perspective of using mobile phone as a remote control to the world.

1.4 OBJECTIVES ACHIEVED

We are able to design a cost effective, small, application based pick and place robot. This robot can carry the maximum weight of 200 grams. Flexibility is provided to modify its design according to the speed torque requirement of the object that needs to be carried. Whole structure is made using acrylic sheet (dimensions: 2feet x 2feet), which make it possible to reduce the cost as compare to when robotic arm is purchased readymade. The physical shape, color and overall image of the robot is attractive, which adds to its features.

1.5 OBJECTIVES NOT ACHIEVED

Electrical circuit is not working and giving outputs as desired, due to which proper functioning and working of pick and place robot is not achieved.

1.6 TECHNICAL DIFFICULTIES FACED

Electrical circuit:

- At present the electrical circuit is not in working condition. Earlier DTMF circuit was giving the correct and required output i.e. LEDs were glowing in the different patterns on pressing a key after the call was made. But may be because of some human errors while soldering or may be because of some short circuit, electrical circuit is not giving desired output. Debugging of the circuit was carried out by checking the connectivity as well as by checking the output voltage at every IC and component but output of DTMF IC is not coming.
- While working with the micro-controller the expected output was not available from the micro-controller due to some minute change in the binary code in the internal circuit of the micro-controller but later on it was debugged.
- Sometimes we faced problems with the battery output voltage, at no load it showed 9V but on load it was showing only 5V.
- Also the resistors initially connected across some micro-controller pins reduce the terminal voltage of LEDs, so we removed them from the circuit for proper functioning.
- While fixing the electrical circuit on the chassis we need to make a hole of 6mm on the circuit board. The 6mm drill diameter of the drill was much bigger as compared to the thickness of the circuit board which created problem during drilling.

Mechanical circuit:

- In the design of mechanical parts there was problem in matching the holes of motors with the acrylic sheet. Initially, the cutting of the acrylic sheet was fragile.
- Many extra acrylic sheets were prepared in order to meet the actual dimensions required for making of gripper.

- While joining two acrylic sheets we used an adhesive named **bondtite**, but the contacts were loose many times.
- The chassis turned somewhat short in fixing both the electrical circuit as well as the lever arm, so we need to fix another acrylic sheet to create a hold for the electrical circuit.
- Making the hole in the shaft was very difficult as compared to making other holes just because of the strength of the shaft.
- On connecting the different small parts of gripper the model get bent ahead. Thus we fixed more bolts in the gripper model to balance the force.
- Initially the gap between the two worm gears of the gripper was more thus the motor was not able to rotate the spur gears, so we need to shift the holes of the gripper by few "mm" so as to synchronize the movement of the spur and worm gear.

1.7 EXPERIMENTAL SETUP AND RESULTS

The setup consists of three parts:

1. Robotic mechanism.
2. Electrical hardware driver circuit.
3. Controlling software code in C language.

1.7.1 Robotic Mechanism

Under this, is the mechanism that actually forms the body of robot i.e. moving robotic arm that picks or places consisting of a gripper (End Effector) and a lever arm and a base to support the whole structure. The complete structure is made up of acrylic sheets only the gears are made up of plastic and chassis is made up of metal. Following are the part of mechanical assembly of the robot –

1. Fixed Base:

It provides the complete housing to the electrical driver circuit and provides support to rotating and moving hand. It has a metal chassis on which complete robotic arm is mounted. Lever arm is

fixed to the metal chassis to which shaft is connected to move the gripper. The base is attached with wheels which provide linear movement.

2. Wheels:

Two wheels of width 4cm is used to drive the fixed base. One castor wheel is used to provide support to the base and to move the robot freely.

3. Gripper:

This is the End-Effector used to pick and place any object. This consists of different gears i.e. two spur gears and one worm gear. They are arranged in such a way that this mechanism will pick (move in) and place (move out) when motor moves in clockwise or anticlockwise direction respectively. One DC geared motor is connected for the movement of the gripper.

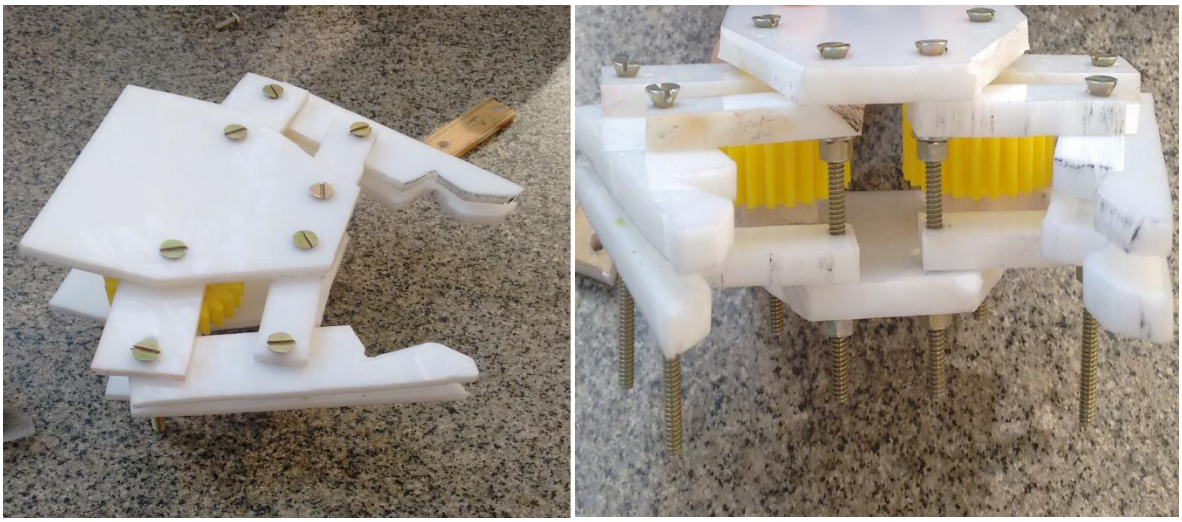


Fig. 7.1 Gripper

4. Lever Arm:

The purpose of this lever arm is to move the gripper up and down so as to make gripper reach to required point. The lever arm is controlled by one DC geared motor which moves either in clockwise or in anticlockwise direction to make the movement of gripper upwards or downwards

respectively. Motor is connected through the mechanism of a spur gear and a worm gear for the required movement.

5. DC Motors:

Motors are the link between electrical circuit and mechanical structure. Electrical signal given by electrical hardware circuit is converted to the mechanical movements of robotic arm by these DC motors. Two motors are used for base movements i.e. forward, backward, right and left. One motor is for lever arm movement and other motor is for gripper movement i.e. opening and closing.

Fig.7.2 Complete Structure of Robot

1.7.2 Electrical Hardware Driver Circuit

It consists of the Microcontroller and the DTMF and motor driver circuit. The DTMF circuit will receive input from the user and binary output is obtained. This output is received by microcontroller. Programming of microcontroller is done such that it will drive the motors according to the key pressed in the mobile phone. The output of the microcontroller is given to the motor driver circuit, which rotates the motor accordingly (clockwise or anticlockwise).

A CM8870 series DTMF decoder is used here. All types of the CM8870 series use digital counting techniques to detect and decode all the 16 DTMF tone pairs into a 4-bit code output. The built-in dial tone rejection circuit eliminates the need of pre-filtering. The MT8870

DTMF (Dual Tone Multi Frequency) decoder IC uses this digital counting technique to determine the frequencies of the limited tones and to verify that they correspond to standard DTMF frequencies. DTMF dialing uses a keypad available in the mobile phone. Each key pressed on the keypad generates tones of particular frequencies; one tone is generated from a High DTMF frequency group of tones and the other from Low DTMF frequency group. 4 digit binary outputs corresponding to the number dialed on the keypad will be produced as the output of a DTMF IC. The mechanical arrangement of the robotic wheels consists of DC motors, which will be operated in required directions through a motor driver circuit connected from the microcontroller. The decoded bits can be interfaced to a computer or microcontroller. The DTMF decoder IC sends signals to the microcontroller and microcontroller gives signals motor driver IC l293d according to the input given by the user, which drives the motor in different directions – forward, backward, clockwise or anticlockwise.

Fig. 7.3 Keypad for DTMF

DTMF Frequencies generated on Key press

The frequencies generated on pressing different phone keys are shown in the

Button	Low DTMF frequency (Hz)	High DTMF frequency (Hz)
1	697	1209
2	697	1336
3	697	1477
4	770	1209
5	770	1336
6	770	1477
7	852	1209
8	852	1336
9	852	1477
0	941	1336
*	941	1209
#	941	1477

Fig. 7.4 Frequency Table for DTMF

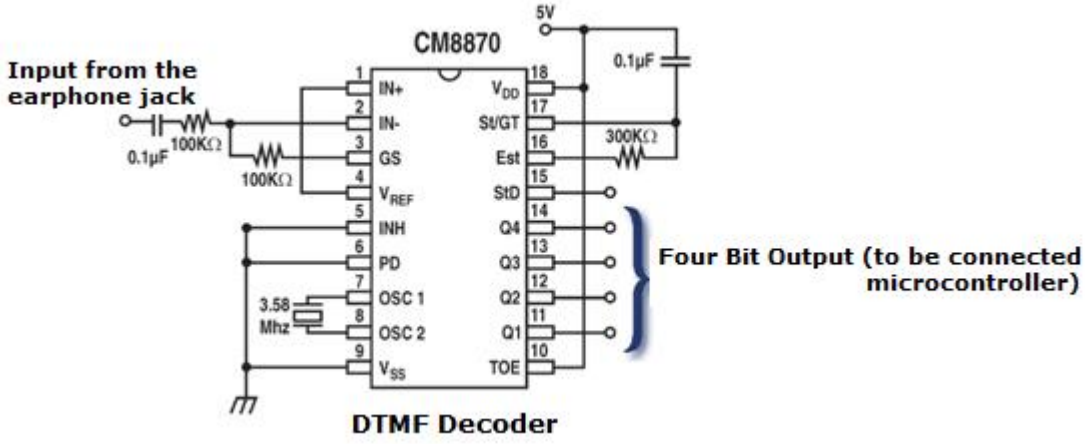


Fig 7.5 DTMF Circuit

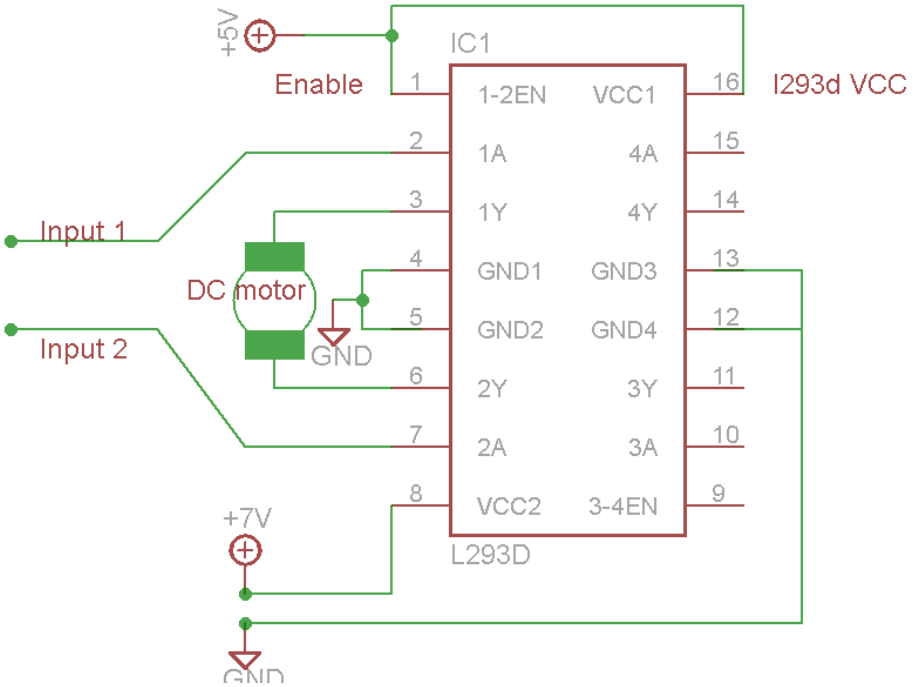


Fig 7.6 Motor Driver Circuit Diagram

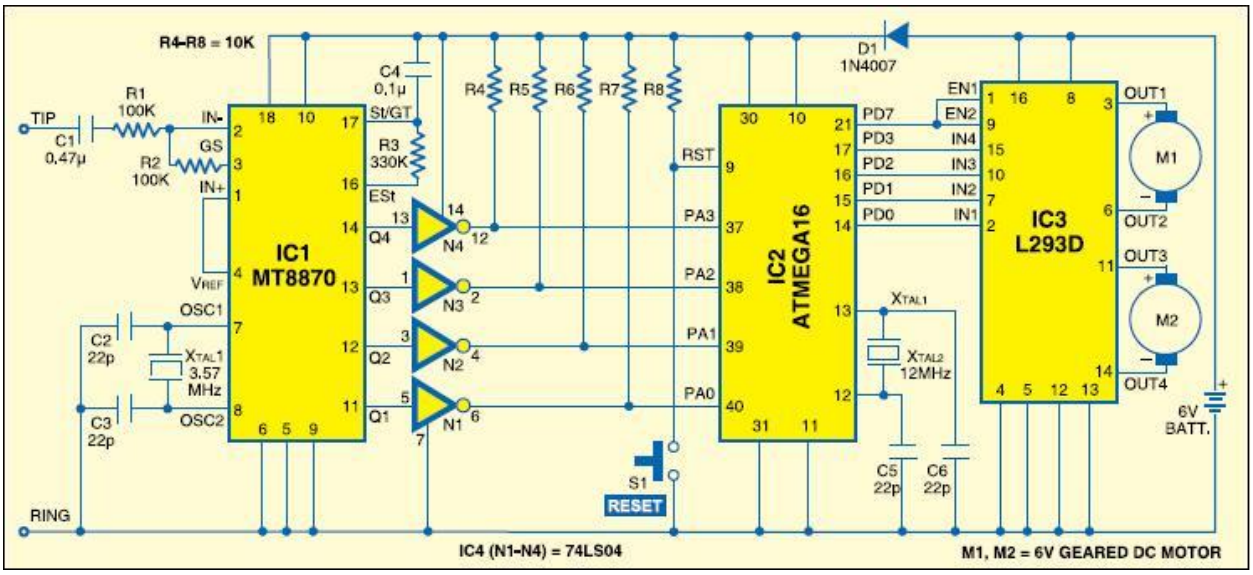


Fig. 7.7 Complete Circuit Diagram of the Project

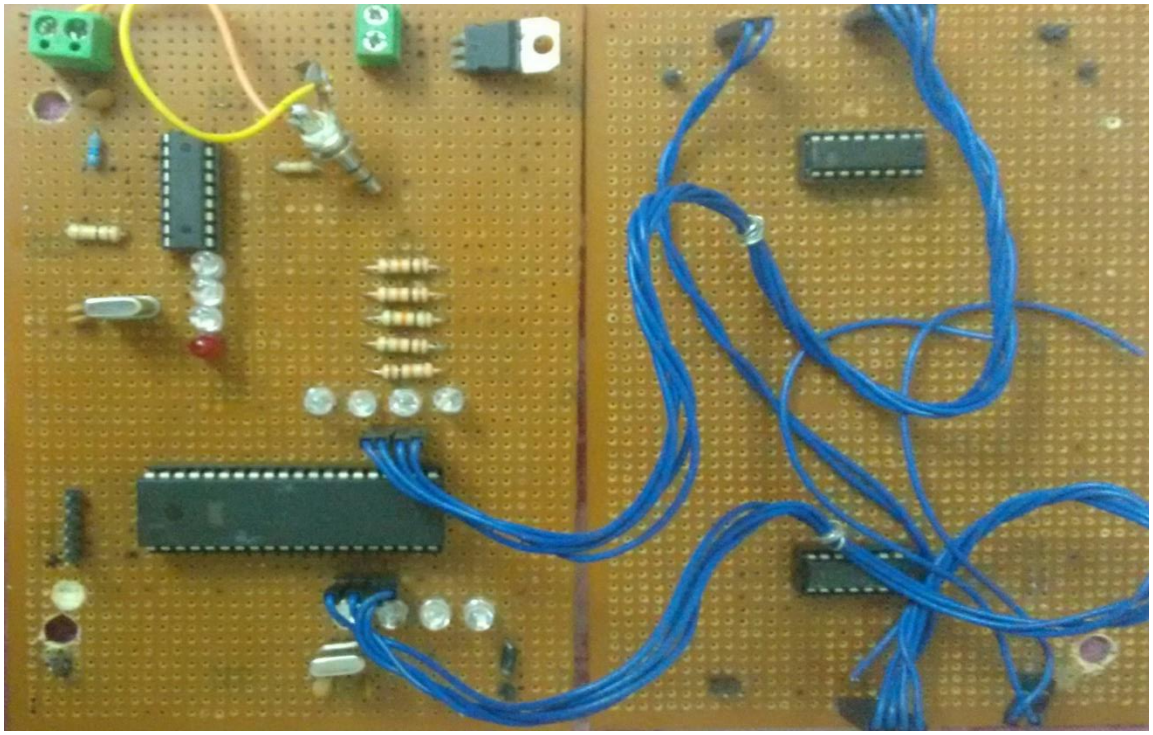
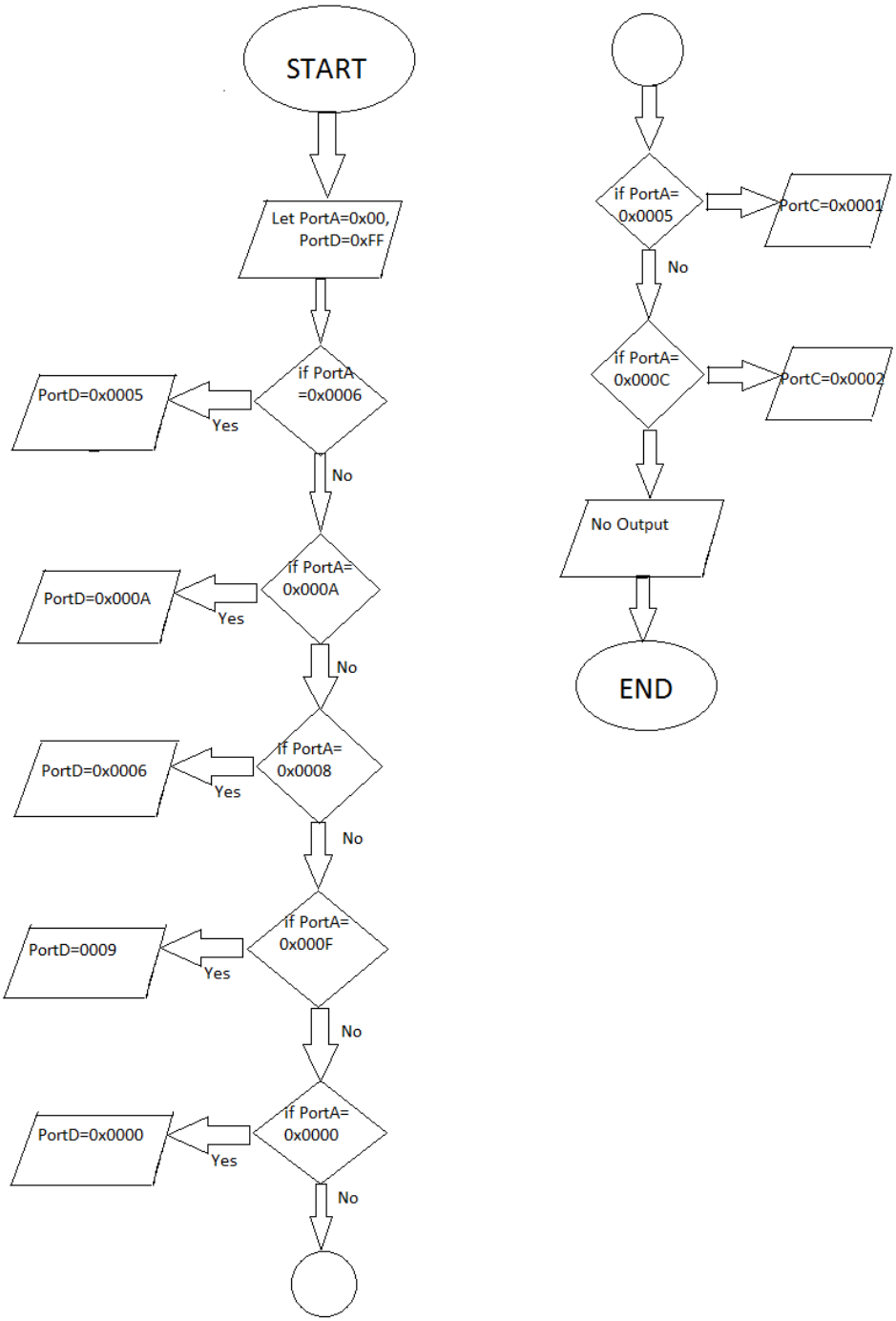


Fig. 7.8 Soldered Electrical Circuit

1.7.3. Controlling software code in C language

Programming of microcontroller is required to run the desired motor when particular key is pressed. Programming is done in software named **AVR Studio** used for coding of AVR controllers. Programming is done in C language. Output of microcontroller is given to motor driver IC L293D, which is used to drive the 12V DC motors.

Flowchart for the code for the microcontroller is as follows:



1.8 BUDGET ANALYSIS

The cost of electrical circuit of our project was very less as compared to cost of the mechanical parts.

Components for Robotic Arm of Mobile Controlled Pick and Place Robot:

	ITEM	QUANTITY	APPROX. COST	Actual Cost
1.	5 mm thick plate of acrylic material	1	300/-	735/-
2.	Spur gears	3	150/-	100/-
3.	Worm gears	2	100/-	70/-
4.	SS Shaft	2	150/-	50/-
5.	Bondtite	2	100/-	80/-
6.	DC geared motor of torque: 120 Kg-cm, speed: 10 rpm	1	800/-	840/-
7.	DC geared motor of torque: 38 Kg-cm, speed: 60 rpm	1	800/-	840/-
8.	Nuts & Bolts	50	200/-	150/-
9.	Microcontroller Atmega16	2	120/-	120/-
10.	9V Battery	3	150/-	120/-
11.	L293D IC	2	100/-	80/-

Fig.8.1 Budget Analysis

1.9 CONCLUSION AND FUTURE WORK

By developing such an unmanned surface vehicle, we have overcome the drawbacks of the conventionally used RF circuits. The model includes advantages such as robust control, minimal interference and a large working range. The car requires five commands for motion control. The remaining controls are available to serve purposes dependent on the area of application of the

RCV. The pick and place robot with android application control will be a smart robotic implementation in the field of robotics. It will be very useful in industrial purposes and domestic purposes. The android application interface added a smart finish to the pick and place robot. This robot is also an economic one where the featured phones in people hands are replacing by smart phone everywhere these days. We have tried to reduce the circuit complexity and improve upon the human machine interface. The cost analysis of the project described in section clearly indicates a huge improvement in the cost expenditure of the production of these unmanned vehicles. Moreover handling these USVs does not require much skill on the part of the user. Even an ordinary person can operate these USVs without having to know much about the internal circuitry. In this way the cost involved in training people to use such USVs can also be saved.

The design procedure of an unmanned surface vehicle as presented here can be further extended to include IR sensors and also a system to include password protection for the USV. IR sensors can be used to automatically detect & avoid obstacles if the vehicle goes beyond line of sight, avoids damage to the vehicle if we are operating it from a distant place. Project can be modified in order to password protect the vehicle so that it can be operated only if correct password is entered. Either cell phone should be password protected or necessary modification should be made in the assembly language code. This introduces conditioned access and increases security to a great extent. In case the vehicle can be used in surveillance as a spy car, a camera can also be mounted on the car. Such basic improvements can be made on the existing system as and when the requirement arises without making any major changes in the principle design of the USV.

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