

Cell Phone Operated Robotic Car

Awab Fakh, Jovita Serrao

Abstract — Conventionally, wireless-controlled robots use RF circuits, which have the drawbacks of limited working range, limited frequency range and limited control. Use of a mobile phone 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 and up to twelve controls. Although the appearance and capabilities of robots vary vastly, all robots share the features of a mechanical, movable structure under some form of control. The control of robot involves three distinct phase namely perception, processing and action. Generally, the preceptors are sensors mounted on the robot, processing is done by the on-board microcontroller or processor, and the task (action) is performed using motors or with some other actuators.

Index Terms — Dual-Tone Multi-Frequency (DTMF), radio control, remote control vehicle, Touch-Tone, Perception, Flash Override

1. INTRODUCTION

Radio control (often abbreviated to R/C or simply RC) is the use of radio signals to remotely control device. The term is used frequently to refer to the control of model vehicles from a hand-held radio transmitter. Industrial, military, and scientific research organizations make use of radio-controlled vehicles as well.

A remote control vehicle (RCV) is defined as any mobile device that is controlled by a means that does not restrict its motion with an origin external to the device. This is often a radio control device, cable between control and vehicle, or an infrared controller. A RCV is always controlled by a human and takes no positive action autonomously.

One of the key technologies which underpin this field is that of remote vehicle control. It is vital that a vehicle should be capable of proceeding accurately to a target area maneuvering within that area to fulfill its mission and returning equally accurately and safely to base.

This project includes a robotic car consisting of a cell phone, DTMF decoder and microcontroller. The transmitter is a handheld mobile phone. The technology used is explained in section II, the circuit design, construction and working are in section III and IV. The applications and future scope of the project is explained in the further sections.

2. TECHNOLOGY USED

2.1 Dual-Tone Multi-Frequency (DTMF)

Dual-tone multi-frequency (DTMF) signaling is used for telecommunication signaling over analog telephone lines in the voice-frequency band between telephone handset and other communications devices and the switching center. The version of DTMF used for telephone tone dialing is known by the trademarked term Touch-Tone (canceled March 13, 1984), and is standardized by ITU-T Recommendation It is also known in the

UK as MF4. Other multi-frequency systems are used for signaling internal to the telephone network [1].

2.2 Telephone Keypad

The contemporary keypad is laid out in a 3×4 grid, although the original DTMF keypad had an additional column for four now-defunct menu selector keys. When used to dial a telephone number, pressing a single key will produce a pitch consisting of two simultaneous pure tone sinusoidal frequencies. The row in which the key appears determines the low frequency, and the column determines the high frequency [1].

frequencies	1209Hz	1336Hz	1477Hz	1633Hz
697Hz	1	2	3	A
770Hz	4	5	6	B
852Hz	7	8	9	C
941Hz	*	0	#	D

Fig. 2.1: DTMF system assignments

For example, pressing the '1' key will result in a sound composed of both a 697 and a 1209 hertz (Hz) tone as shown in Fig. 2.1. The original keypads had levers inside, so each button activated two contacts. The multiple tones are the reason for calling the system multi frequency. These tones are then decoded by the switching center to determine which key was pressed [1].

2.3 Tones #, *, A, B, C, and D

The engineers had envisioned phones being used to access computers, and surveyed a number of companies to see what they would need for this role. This led to the addition of the number sign (#, sometimes called 'octothorpe' in this context) and asterisk or "star" (*) keys as well as a group of keys for menu selection: A, B, C and D. In the end, the lettered keys were dropped from most phones, and it was many years before these keys became widely used for vertical service codes such as *67 in the United States and Canada to suppress caller ID.

The U.S. military also used the letters, relabeled, in their now defunct Autovon phone system. Here they were used before

- Awab Fakh is currently pursuing masters degree program in electronics and telecommunication in Mumbai University, India, PH-0919923021424. E-mail: awaabfakh0@gmail.com
- Jovita Serrao is currently pursuing masters degree program in electronics and telecommunication in Mumbai University, India, PH-0917507976443. E-mail: joviserrao@gmail.com

dialing the phone in order to give some calls priority, cutting in over existing calls if need be. The idea was to allow important traffic to get through every time. The levels of priority available were Flash Override (A), Flash (B), Immediate (C), and Priority (D), with Flash Override being the highest priority [1].

3. CIRCUIT DESIGN

Fig. 3.1 resembles the simple block diagram of the system. A hand held mobile phone is used as the transmitter. The receiver is the robotic car that includes a mobile phone on the auto answer mode, DTMF decoder, microcontroller and motor drivers.

The blocks of the receiver model are explained in detail in this section.

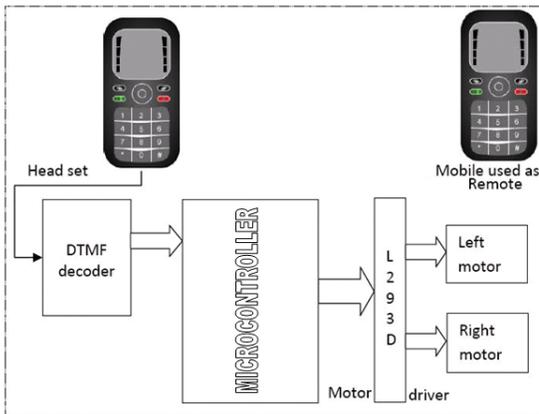


Fig. 3.1: Block Diagram

3.1 Motor Driver

The L293D (Fig. 3.2) is a quad, high-current, half-H driver designed to provide bidirectional drive currents of up to 600 mA at voltages from 4.5V to 36V. It makes it easier to drive the DC motors.

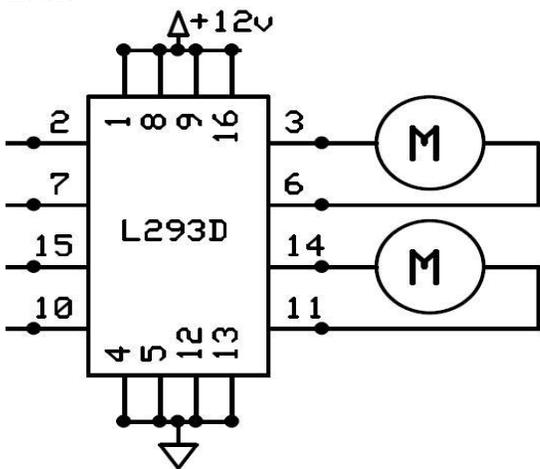


Fig.3.2: Motor Driver

The L293D consists of four drivers. Pins IN1 through IN4 and OUT1 through OUT4 are input and output pins, respectively, of

driver 1 through driver 4. Drivers 1 and 2, and drivers 3 and 4 are enabled by enable pin 1 (EN1) and pin 9 (EN2), respectively. When enable input EN1 (pin 1) is high, drivers 1 and 2 are enabled and the outputs corresponding to their inputs are active. Similarly, enable input EN2 (pin 9) enables drivers 3 and 4 [2], [3].

3.2 DTMF Decoder

An MT8870 (Fig. 3.3) series DTMF decoder is used here. All types of the MT8870 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 for pre-filtering. When the input signal given at pin 2 (IN-) in single-ended input configuration is recognized to be effective, the correct 4-bit decode signal of the DTMF tone is transferred to Q1 (pin 11) through Q4 (pin 14) outputs D0 through D3 outputs of the DTMF decoder (IC1) are connected to port pins of Microcontroller [4].

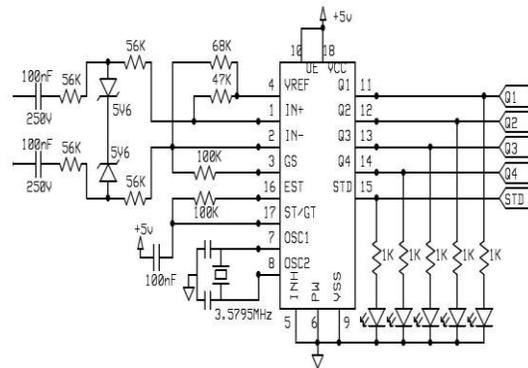


Fig. 3.3: DTMF Decoder

3.3 Microcontroller 89C51

Microcontroller 89C51 (Fig. 3.4) is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash Programmable and Erasable Read Only Memory PEROM). The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the MCS-51™ instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel microcontroller is a powerful microcomputer, which provides a highly flexible and cost effective solution so many embedded control applications.

Outputs from port pins the microcontroller are fed to inputs IN1 through IN4 and enable pins (EN1 and EN2) of motor driver L293D, respectively, to drive two geared DC motors. The microcontroller output is not sufficient to drive the DC motors, so current drivers are required for motor rotation [5].

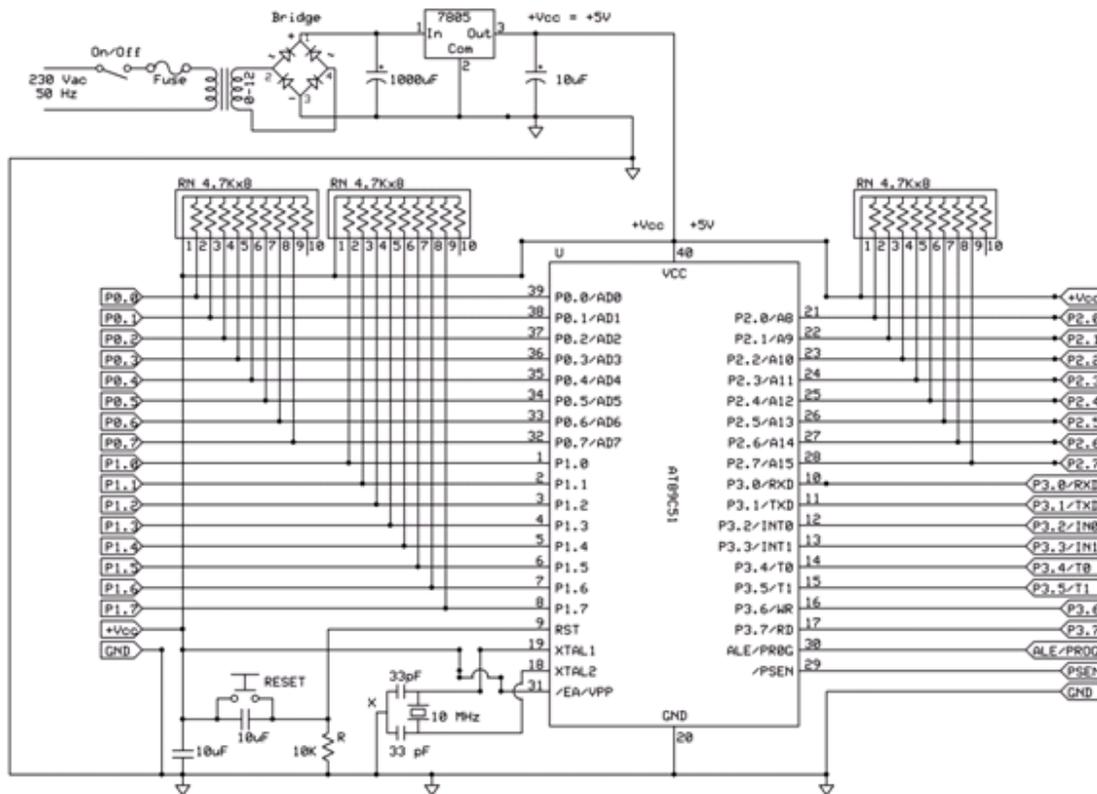


Fig. 3.4: Microcontroller Circuit Diagram

4 CONSTRUCTION

While constructing any robot, one major mechanical constraint is the number of motors being used. You can have either a two-wheel drive or a four-wheel drive. Though four-wheel drive is more complex than two-wheel drive, it provides more torque and good control. Two-wheel drive, on the other hand, is very easy to construct. Motors are fixed to the bottom of this sheet and the circuit is affixed firmly on top of the sheet. A cell phone is also mounted on the sheet. In the four-wheel drive system, the two motors on a side are controlled in parallel. So a single L293D driver IC can drive the Robotic Car.

In order to control the robot, you need to make a call to the cell phone attached to the robot (through head phone) from any phone, which sends DTMF tones on pressing the numeric buttons. The cell phone in the robot is kept in 'auto answer' mode.

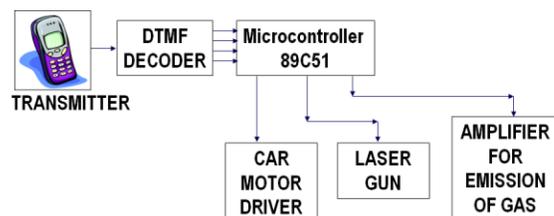


Fig. 4.1: Transmitter and Receiver Blocks

So after a ring, the cell phone accepts the call. Now you may press any button on your mobile to perform actions. The DTMF tones thus produced are received by the cell phone in the robot. These tones are fed to the circuit by the headset of the cell phone. The MT8870 decodes the received tone and sends the equivalent binary number to the microcontroller. According to the program in the microcontroller, the robot starts moving.

When key '2' is pressed on the mobile phone, the microcontroller outputs for forward motion. When you press key '8' on your mobile phone, the microcontroller outputs for Reverse motion. When you press key '4' on your mobile phone, the microcontroller outputs for Left direction motion. When you press key '6' on your mobile phone, the microcontroller outputs for Right direction motion. Four keys on the keypad are used for motion control of the robotic car. The rest can be configured to serve various other purposes depending on the area of application of the vehicle.

5 APPLICATION

5.1 Scientific Use

Remote control vehicles have various scientific uses including hazardous environments. Majority of the probes to the other planets in our solar system have been remote control vehicles, although some of the more recent ones were partially autonomous. The sophistication of these devices has fueled greater debate on the need for manned spaceflight and exploration. The Voyager I spacecraft is the first craft of any kind to leave the solar system. The Martian explorers Spirit and

Opportunity have provided continuous data about the surface of Mars since January 3, 2004.

5.2 Military and Law Enforcement Use

Military usage of remotely controlled military vehicles dates back the first half of 20th century. Soviet Red Army used remotely controlled Tele tanks during 1930s in the Winter War and early stage of World War II. There were also remotely controlled cutters and experimental remotely controlled planes in the Red Army.

Remote control vehicles are used in law enforcement and military engagements for some of the same reasons. Exposure to hazards is mitigated to the person who operates the vehicle from a location of relative safety. Remote controlled vehicles are used by many police department bomb-squads to defuse or detonate explosives.

Unmanned Aerial Vehicles (UAVs) have undergone a dramatic evolution in capability in the past decade. Early UAVs were capable of reconnaissance missions alone and then only with a limited range. Current UAVs can hover around possible targets until they are positively identified before releasing their payload of weaponry. Backpack sized UAVs will provide ground troops with over the horizon surveillance capabilities.

5.3 Search and Rescue

UAVs will likely play an increased role in search and rescue in the United States. Slowly other European countries (even some developing nations) are thinking about making use of these vehicles in case of natural calamities & emergencies. This can be a great asset to save lives of both people along with soldiers in case of terrorist attacks like the one happened in 26 Nov, 2008 in Mumbai, India. The loss of military personnel can be largely reduced by using these advanced methods. This was demonstrated by the successful use of UAVs during the 2008 hurricanes that struck Louisiana and Texas.

5.4 Forest Conservation

In the recent times, there has been a serious endangerment to the wildlife population. A lot of animals are on the verge of becoming extinct, including the tiger. The spy robotic car can aid us in this purpose. Since it is a live streaming device and also mobile, it can keep the forest guards constantly updated about the status of different areas which are prone to attack. As a result, it can help to prevent further destruction of the forest resources by enabling correct prohibitory action at the appropriate time.

6 FUTURE SCOPE

6.1 IR Sensors

IR sensors can be used to automatically detect & avoid obstacles if the robot goes beyond line of sight. This avoids damage to the vehicle if we are maneuvering it from a distant place.

6.2 Password Protection

Project can be modified in order to password protect the robot 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.

6.3 Alarm Phone Dialer

By replacing DTMF Decoder IC CM8870 by a 'DTMF Transceiver IC CM8880, DTMF tones can be generated from the robot. So, a project called 'Alarm Phone Dialer' can be built which will generate necessary alarms for something that is desired to be monitored (usually by triggering a relay). For example, a high water alarm, low temperature alarm, opening of back window, garage door, etc. When the system is activated it will call a number of programmed numbers to let the user know the alarm has been activated. This would be great to get alerts of alarm conditions from home when user is at work.

7 CONCLUSION

By developing a cell phone operated robotic car, we have overcome the drawbacks of the conventionally used RF circuits. This RCV includes advantages such as robust control, minimal interference and a large working range. The car requires four commands for motion control. The remaining twelve controls are available to serve purposes dependant on the area of application of the RCV.

8 REFERENCES

- [1] L. Schenker, "Pushbutton Calling with a Two- Group Voice-Frequency Code", *The Bell System Technical Journal*, 39(1), 1960, 235–255, ISSN 0005-8580
- [2] S. A. Nasar, I. Boldea, *Electric Drives* (CRC/Taylor and Francis, 2006)
- [3] V. Subramanyam, *Electric Drives* (Mc-Graw Hill, 1996)
- [4] Edwin Wise, *Robotics Demystified* (Mc-Graw Hill, 2005)
- [5] K. J. Ayala, *8051 Microcontroller* (Delmar Learning, Thomson, 3rd Edition)

