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Development of a Wireless Controlled Robotic Vehicle

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ABSTRACT

This paper is on the development of a GSM (global system for mobile communication) and radio frequency remote controlled robotic car. It is very useful for accessing industrial areas that are prone to health hazards. They can also be used as a spy and for search and rescue missions in cases of emergencies or natural disaster. The robotic car uses a two-way control system which is the DTMF and radio frequency (RF) control. When a mobile phone is pressed the keypad tone which is heard is a frequency. These frequencies are sent out from a sound clip (head set) of the phone to the DTMF decoder IC MT8870D; this decoder converts the frequencies from the keypad tone to a 4 bit digital binary codes readable by the microcontroller AT89C52. The microcontroller AT89C52 by a software program (assembly language program) uses these bits to assign a particular instruction or command to the relay driver to either turn ON or OFF. The relay drivers control the rotation (direction) of the motors which control the wheel of the robotic car either turn clockwise or counter clockwise.

Key words: GSM, Radio Frequency, robotics, dual tone multifrequency, remotely operated vehicle

INTRODUCTION

According to [1] the field of robotics encompasses a broad spectrum of technologies in which computational intelligence is embedded in physical machines, creating systems with capabilities far exceeding the core components alone. Such robotic systems are then able to carry out tasks that are unachievable by conventional machines, or even by humans working with conventional tools. The ability of a machine to move by itself, that is, "autonomously" is one such capability that opens up an enormous range of applications that are uniquely suited to robotic systems. Robotic vehicles are machines that move "autonomously" on the ground, in the air, undersea, or in space. Such vehicles are "unmanned" in the sense that no humans are on board. In general, these vehicles move by themselves, under their own power, with sensors and computational resources onboard to guide their motion. However, such "unmanned" robotic vehicles usually integrate some form of human oversight or supervision of the motion and task execution. Such oversight may take different forms, depending on the environment and application. It is common to utilize so-called "supervisory control" for high-level observation and monitoring of vehicle motion.

In other instances, an interface is provided for more continuous human input constituting a "remotely operated vehicle," or ROV. In this case, the ROV is often linked by cable or wireless communications in order to provide higher bandwidth communications of operator input. With the advancement in technology wireless communication systems have been prevalent. Wireless communication systems include Bluetooth, Infrared, Radio Frequency (RF) and GSM (DTMF). Although each of them has its own advantage, the GSM system is arguable the best because it provides large working range and has minimal interference.

A Remote controlled robotic car is defined as an unmanned car which can be controlled by means that does not restrict its motion with an origin external to the car [1]. With the advancement of technology, wireless communication systems has been the preferred system used which includes the infrared(IR), radio frequency(RF) and Global system for mobile communication(GSM).The IR system follows the line-of-sight approach of actually pointing the remote at the device being controlled. This makes communication to be impossible over distance barriers and obstacles. The RF system has better range of control and can be used without a GSM network while GSM system uses dual -tone-multi-frequency (DTMF) signals which can be used to control robots anywhere around the world as long as there is GSM network. Thus, the GSM system overcomes the distance barrier problems and communication over obstacles of the infra-red, IR.

In this project, we combine the advantage of the RF system which is communication without GSM network and that of GSM which is communication over long distance barrier and obstacles to great effect in designing and constructing an RF and GSM based remote controlled robotic car.

LITERATURE REVIEW

In the work [2] a robotic car with infrared TV remote controller was constructed. The car was able to move in all four directions but the IR remote control limits its efficiency as it could not be controlled with an object blocking its line-of-sight from the controller. The robotic car was also not controllable from a considerable far distance. The authors in [3] worked on IR Remote Controlled Car which uses an IR Remote system to control a robotic car having two PWM channels of ATmega8 microcontroller for controlling the speed and direction of the car. Although speed control of the car was made possible the car was unable to make a turn. Poor range of control and line-of-sight alignment was also a problem.

The research in [4] is on the design and implementation of an Unmanned Vehicle using a GSM Network without Microcontroller. The author proposed a model to remotely control an unmanned vehicle using DTMF technology without the use of a microcontroller. In this model, a DTMF decoder (MT8870) was used to decode the DTMF signals. The output of the decoder was fed directly to an L293D motor driver IC which drives two dc motors. The vehicle was expected to move in all four directions. The model has the advantage of reduced circuit complexity and manpower to program the microcontroller. The absence of a microcontroller made it nearly impossible for a password protection system, sensors and wireless camera system to be included. Similar works by [5, 6] were able to control a robotic car using DTMF signals with the use of a microcontroller. In these works, the received tone is processed by an ATmega16 microcontroller with the help of DTMF decoder MT8870. The decoder decodes the DTMF signal into its binary equivalent and this is sent to the microcontroller programmed to take a decision for a particular input and outputs it's decision to the motor drivers in order to drive the robot forward, backward, left or right.

METHODOLOGY AND DESIGN ANALYSIS

Robotic vehicle System has both hardware and software part, fig. 1 shows the block diagram of the project

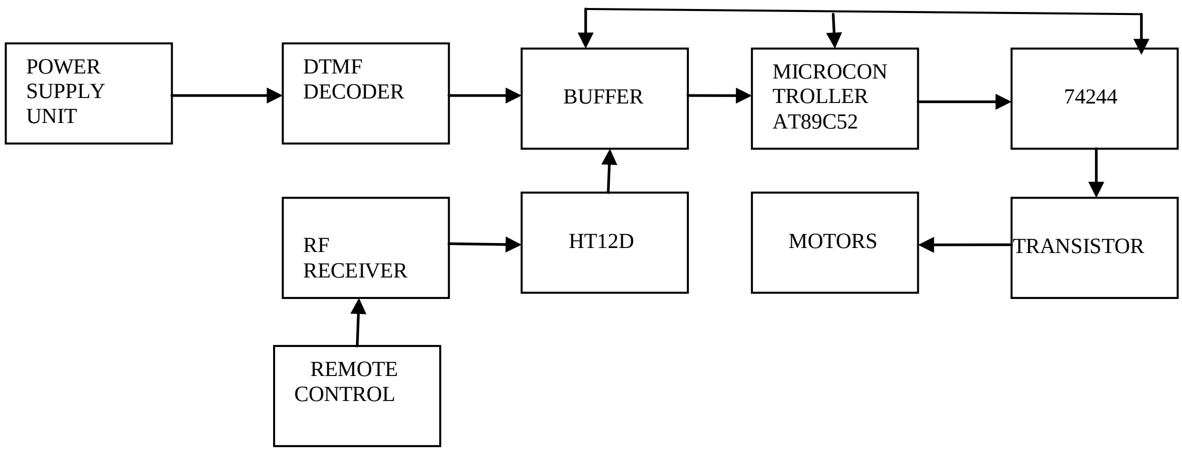

Fig. 1 Block diagram of GSM/Remote Controlled Based Robotic Car

The system made use of an embedded system and wireless module in controlling several loads. The circuit has four sections, power supply unit, the input unit, the control unit and the output unit.

Power supply unit

This made up of a dc battery, voltage regulator and a power indicator. The circuit diagram is shown in fig.2

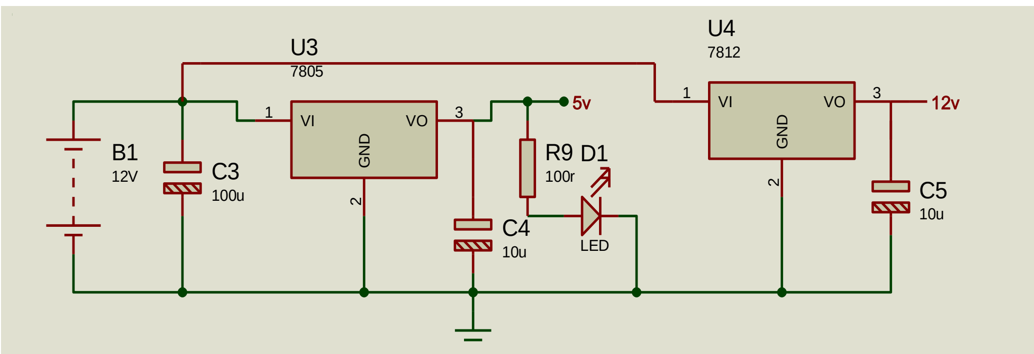

Fig. 2 Circuit diagram of the power supply

The battery used is a 12Vdc battery with current rating 0f 6.5 amp. A filter capacitor of 100uf is connected in parallel to filter off noise from the battery supply. Two voltage regulators were used 7805 and 7812. The 7805 regulator is used to supply 5 volts to the microcontroller, 74244 IC, HT12D IC and the RF receiver. The 7812 is used to supply 12 volts to the relays. A light emitting diode is connected to the 7805 voltage regulator via a limiting resistor connected in series to it. The resistor limits the amount of current entering the light emitting diode. The light emitting diode is used as an indicator to show that there is power in the circuit. The value of the resistor is gotten from the calculation below.

$V = V_d \ I_R$

$V = Supply\ voltage$

$V_d = Operating\ voltage\ of\ of\ light\ emitting\ diode\ (LED_S)$

$I = Allowable\ current\ through\ the\ LED_S\ (20mA)$

$R = Limiting\ current\ \mathrm{Re}sistor$

$V = 5_v$

$V_d = 2_v$

$I = 20mA$

$$\therefore R = \frac{V - V_d}{I} = \frac{5 - 2}{20mA} = \frac{3}{20\ x\ 10^{-3}} = \frac{3\ x\ 1000}{20}$$

$R = 150\Omega$

100Ω resistor was used in place of 150 ohms due to unavailability of the 150 ohms resistor.

Input Unit

This is made up of the remote control, and the DTMF decoder

Remote control unit

This consists of a matrix keypad that inputs a digital signal into the microcontroller. The microcontroller sends an 8-bit signal via an RF module to the receiver circuit. The diagram is shown in fig.3.

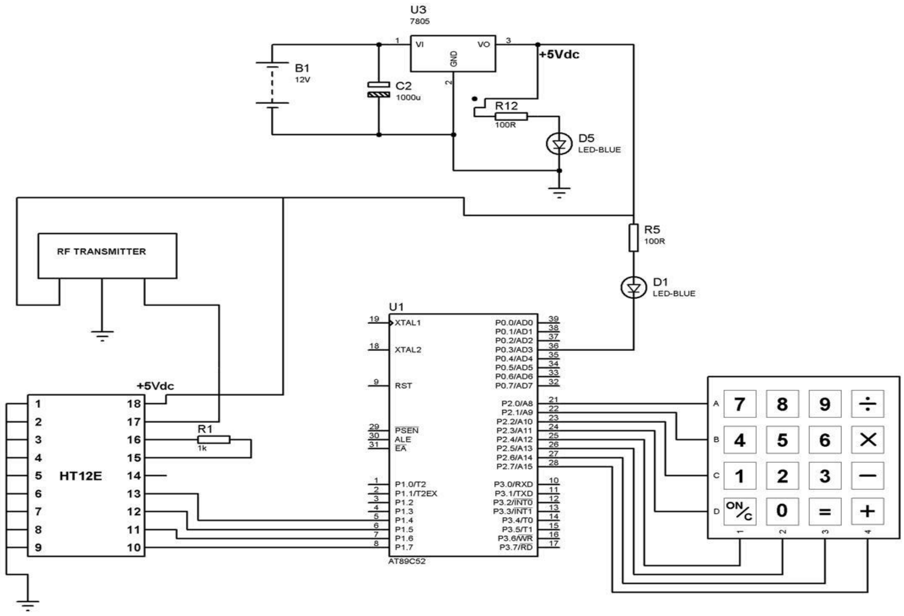

Fig. 3 Circuit Diagram of Remote Control

The circuit made use of an encoder IC that encode the eight bit from the microcontroller with its address bits and send this code to the receiver unit via the RF transmitter, within a frequency of 434 MHz (the carrier frequency of the RF module), 12 bit data (four bits from the microcontroller, eight bit from the address of the encoder IC) is sent via this transmission line. The values and component and circuit diagram were gotten from the manufacturer datasheet [9]

DTMF Unit

This comprises of the DTMF decoder and an octal buffer. This is the point where signal is being received and decoded to output the required signal to the microcontroller unit.The phone will be set to auto-redial and its keypad turn on and set to the highest volume. Each corresponding key in the keypad have a distinct tone that is been converted by the DTMF decoder IC (mt8870) to four digit binary tones. The table below shows the conversion.

Table -1 The status of outputs on pressing Keys on the GSM Keypad.

Key No.	Q3	Q2	Q1	Q0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
0	1	0	1	0
*	1	0	1	1
#	1	1	0	0
A	1	1	0	1
B	1	1	1	0
C	1	1	1	1
D	0	0	0	0

The outputs from the DTMF IC are feed directly into the input of the octal buffer which increases the current to 10ma which the microcontroller will respond to. When a call is received the phone will automatically answer and the person will start to operate the circuit by pressing the corresponding key to control the movement of the robotic car. The circuit diagram of the DTMF section is shown below.

Control Unit

The microcontroller is the power house of the circuit. It receives input from the DTMF circuit and the remote. The microcontroller use is a 40pin IC from Atmel 89c52. Port 1 of the microcontroller is connected to the DTMF decoder and the decoder IC from the RF receiver. Each of this send a code in four bits, which the microcontroller processes and execute the command. The circuit diagram is shown in fig.4.

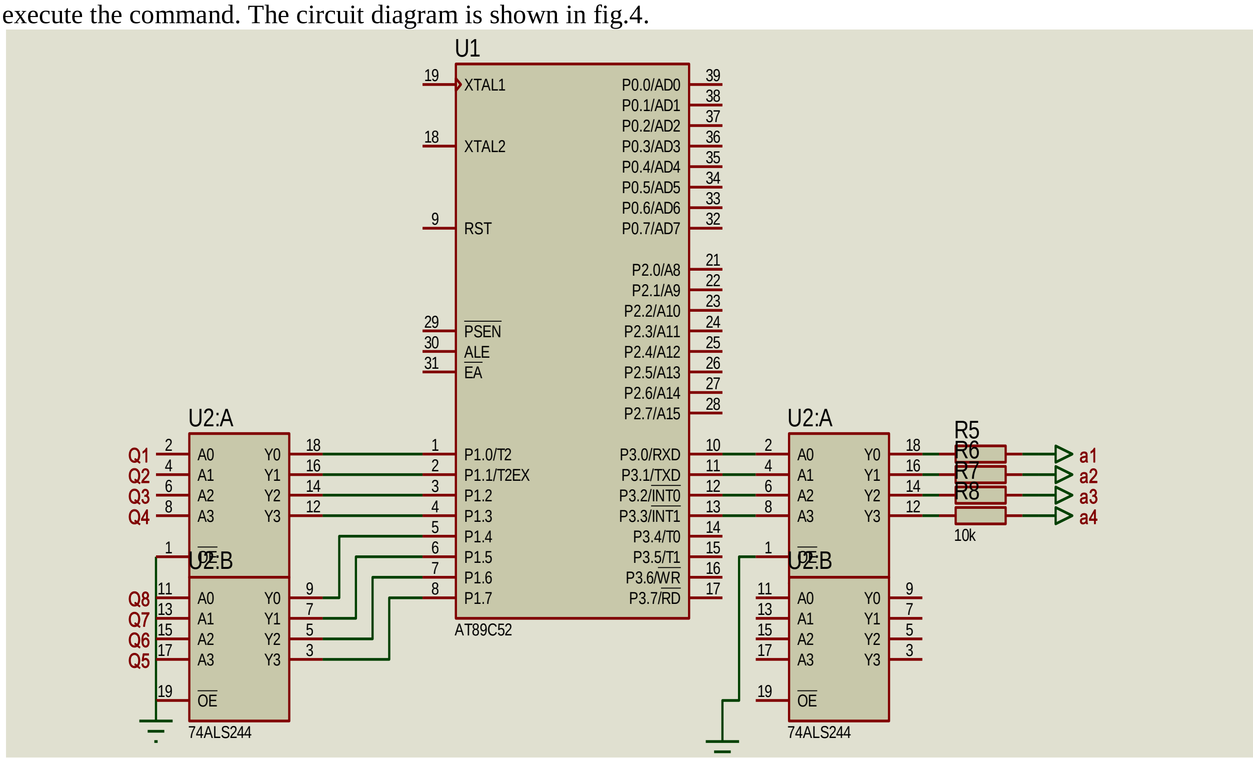

Fig. 4 Circuit Diagram of Control Section

Output Unit

These sections consist of the relay driver and the motor. The relays are switched on and off via transistors. The circuit diagram of the output unit is shown below.

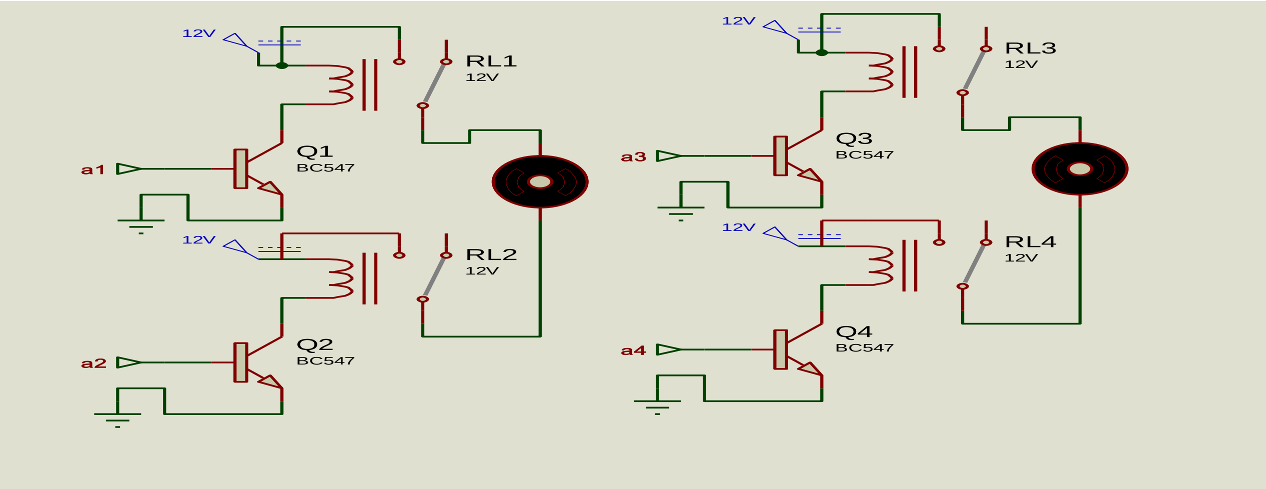

Fig. 5 Circuit Diagram of the Output Unit

The calculation used for the transistor to drive the relay is shown below. The transistors take input from the microcontroller via a 74244 output for high signal strength. An NPN TIP41 transistor is used in this project to drive (switch) the relays ON and OFF. For the transistor configuration, since the transistor is biased to saturation

$V_{CE} = 0, When\ the\ transistor\ is\ ON$

$This\ implies\ that\ V^{+} = I_C R_C + V_{CE} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$

$V_{IN} = I_B R_B + V_{BE} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .2$

$h_{fe} = \frac{I_C}{I_B} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$

$R_B = \frac{V_{IN} - V_{BE}}{I_B} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 4$

$Where;$

$I_C = collector\ current$

$I_B = Base\ Current$

$V_{IN} = input\ voltage$

$V_{CE} = collector\ emitter\ voltage$

$h_{fe} = current\ gain$

$V^{+} = supply\ voltage$

The switching is done by a transistor (TIP41) *npn* transistor. It has a gain of β=100, maximum collector current of 200*mA*.

Analysis for the relays switching;

Relay

Required voltage, $V = 12V$

Coil resistance, $R = 400\Omega$

From Ohms' law, the required current can be calculated.

Required current, $I_C = \frac{V}{R} = \frac{12}{400} = 0.03A = 30mA$

$I_B = \frac{I_C}{\beta}$

$= \frac{30 \times 10^{-3}}{100}$

$= 300\mu A$

$the\ Base\ resistor;\ R_B = \frac{12 - 0.7}{300\ \times 10^{-6}} = 3.7k\Omega$

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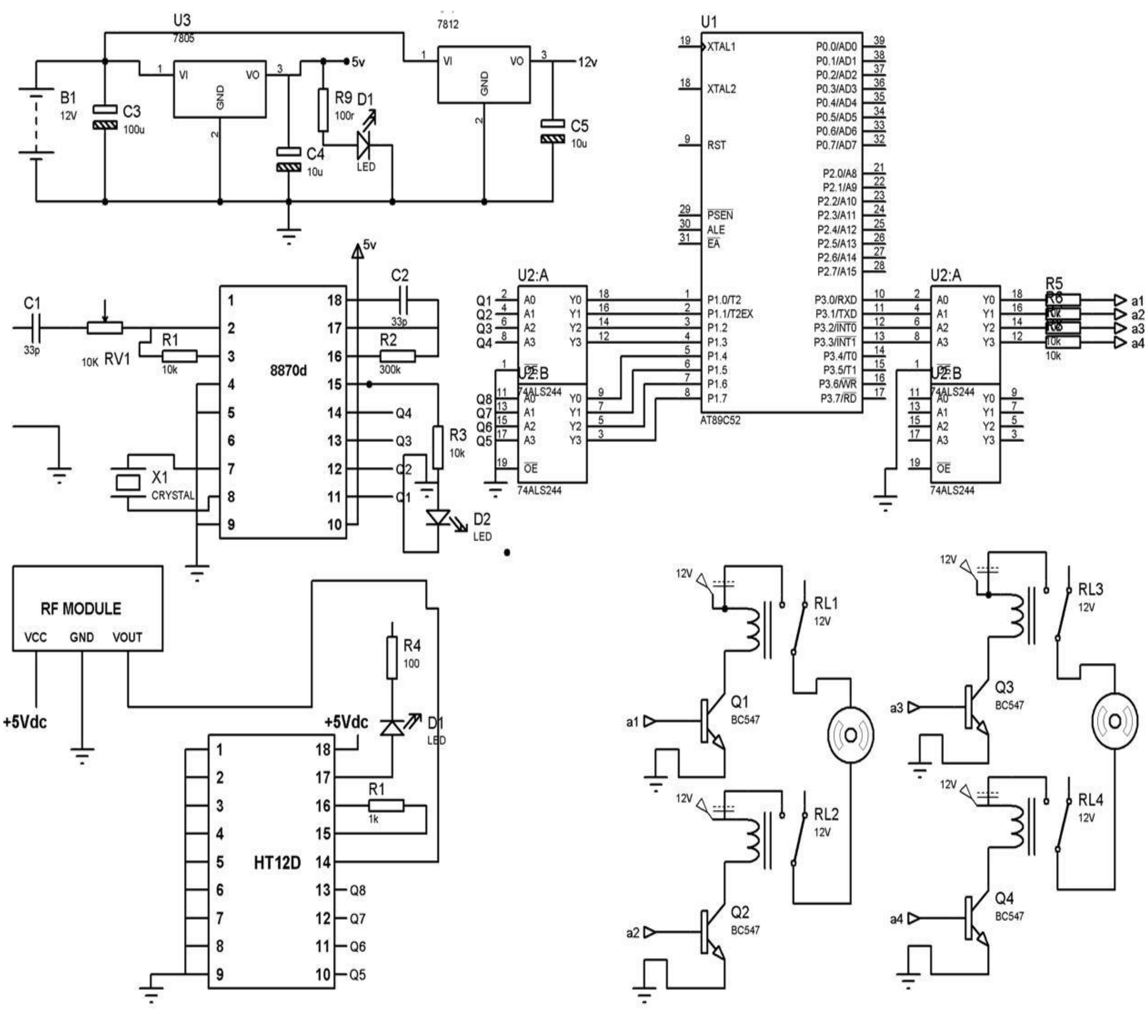

Fig. 6 Circuit Diagram of GSM/Remote Controlled Based Robotic Car

RESULTS AND DISCUSSION

A prototype robotic car was developed in this work. The circuit diagram of the robotic car is shown in fig.5. The robotic car uses a two-way control system which is the DTMF and radio frequency (RF) control. When a mobile phone is pressed the keypad tone which is heard is a frequency. These frequencies are sent out from a sound clip (head set) of the phone to the DTMF decoder IC MT8870D; this decoder converts the frequencies from the keypad tone to a 4 bit digital binary codes readable by the microcontroller AT89C52. The microcontroller AT89C52 by a software program (assembly language program) uses these bits to assign a particular instruction or command to the relay driver to either turn ON or OFF. The relay drivers control the rotation (direction) of the motors which control the wheel of the robotic car either turn clockwise or counter clockwise.

To achieve proper movement, the drivers are made to come ON and OFF. The commands are achieved as follows:

i. Backward Left movement: the drivers (relays and transistors) controlling the left motor of the wheel is switched OFF and the drivers controlling the right wheel is put on counter clockwise (reversed). This is achieved with Button 1 of DTMF and Key 1 of remote control.
ii. Forward Movement: both motors are clockwise to achieve this movement. This movement is achieved with Button 2 of DTMF and Key 2 of remote control.
iii. Backward Right Movement: this movement is achieved with DTMF button 3 and Key 3 of remote control. The right motor is stopped while the left motor is on reverse.
iv. Forward Left Movement: this movement is achieved with DTMF button 4 and Key 4 of remote control. The right motor is clockwise while the left motor is on stop.
v. Stop: to stop the robotic car from moving both drivers are should be in halt. This state can be achieved by switching OFF the system or pressing DTMF button 5 or remote control Key 5.
vi. Forward Right Movement: DTMF button 6 and remote control Key 6 is pressed to achieve the forward right movement. The left motor is on OFF and the right motor is clockwise.

vii. Backward straight movement: the drivers are made to turn the motor which controls the wheels to turn counter clockwise to achieve a backward movement. This is achieved with DTMF button 7 and remote control button 7.

CONCLUSION

In this paper, a prototype robotic vehicle controlled by a mobile phone that makes a call to the mobile phone attached to the car was developed. When a call is originated if any button is pressed, a tone corresponding to the button pressed is generated at the receiving end. The car is also controlled by RF remote. This wirelessly controlled vehicle removes the limitation of wired control. It was overcome by using gsm and RF module. However, there are still lots of scopes to improve the stability and ability of this system.

REFERENCES

[1]. Sourangsu Banerji, Design and Implementation of an Unmanned Vehicle using a GSM Network with Microcontrollers, *International Journal of Science, Engineering & Technology Research*, 2013, 2 (2).

[2]. Awab Fakih, Jovita Serrao, Cell Phone Operated Robotic Car, [online] Accessed 12/02/2019. https://www.ijser.org/researchpaper/Cell-Phone-Operated-Robotic-Car.pdf

[3]. Dharmani, C.C. Design with microcontrollers: IR Remote Controlled Car (PWM motor control using ATmega8)”[online] Available from:www.dharmanitech.com/2009/01/ir-remotecontrolied-car-pwmmotor.html?m=1.[Accessed 1801/2019].

[4]. Banerji, Sourangsu. Design and Implementation of an Unmanned Vehicle using a GSM Network without Microcontrollers. Journal of Electrical Engineering, Vol. 14, Issue. 1, 2014

[5]. Sabuj Das Gupta, Arman Riaz Ochi, Mohammad Sakib Hossain, Nahid Alam Siddique, Designing & Implementation of Mobile Operated Toy Car by DTMF, International Journal of Scientific and Research Publications, Volume 3, Issue 1, January 2013 1 ISSN 2250-3153

[6]. Ranu Kaushik and Renuak Singh, “Gsm Mobile Conrol Robo Car”. 2nd conference in intelligent computing and communication, 2013. ISBN9788175157538.