Solar powered vehicle under GSM Network by using solar tracking & Monitoring

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***Abstract* - This paper presents the construction of a vehicle that controlled by the GSM communication network. The designed vehicle could be operated from anywhere under GSM network which is powered by solar energy using 5-watt photo voltaic (PV) panel, stored in 12V rechargeable batteries. The operation starts with a call generated from a phone which is auto answered by another phone. In the course of a call, if any of the key 1, 3, 2, 4, 6, 8, or 5 is pressed a tone corresponding to the key pressed is heard at other end of transmission which is called Dual Tone Multiple Frequency (DTMF) tone. The received signal (tone) in the cell phone at vehicle end is processed by 8051 microcontroller. These signals are sent to the motor driver which drives the motors. Most important as the car will be runs by solar energy, tracking systems naturally provide the best performance, given that the components have high enough accuracy as well. So the vehicle can be sent to a long distance and not worrying about the charge of the batteries, since it accumulates the energy required from the external Photo Voltaic panel that absorbs the sun light and converts energy to generate the driving power, though there will be battery as a backup.**

***Index Terms* - GSM, DTMF, solar tracking**

I. INTRODUCTION

A vehicle is typically defined as any mobile device that is controlled by a means that doesn't to restrict its motion. This is often called a radio control device, in which there is a cable between controller and vehicle, or an IR controller. A remote control vehicle that differs from a robot in that is always controlled by a human and attains no positive action autonomously. One of the important technologies in this field is that of remote vehicle control. It is vital that a vehicle should be capable of driving accurately to a destination area and maneuvering within that target area to attain its missions and come back accurately and safely to base station.

The first general purpose use of radio control systems started in the 1940s with mono channel self-built equipment and commercial equipment came thereafter. Initially remote control systems are used escapement, mechanical actuation. In commercial sets often used ground standing transmitters and long whip antennas with separate ground poles and single vacuum tube receivers. The first kit had two tubes for more selectivity. Therefore such early systems were invariably super regenerative circuits, which meant that controllers are used in close proximity would interfere with one another.

II. DESIGN AND CONSTRUCTION OF VEHICLE

In this project, the robotic vehicle is connected with a cell phone under GSM network which is controlled by a user cell phone. With the help of user's cell phone we can control the vehicle in desired directions as per our requirements. This project is developed from a compact dual tone multiple frequency (DTMF) based decoder IC. The GSM network controlled robotic vehicle organizes the switching from the decoded dtmf signal and power switching device for controlling the motor driver of the vehicle using two cell phones.

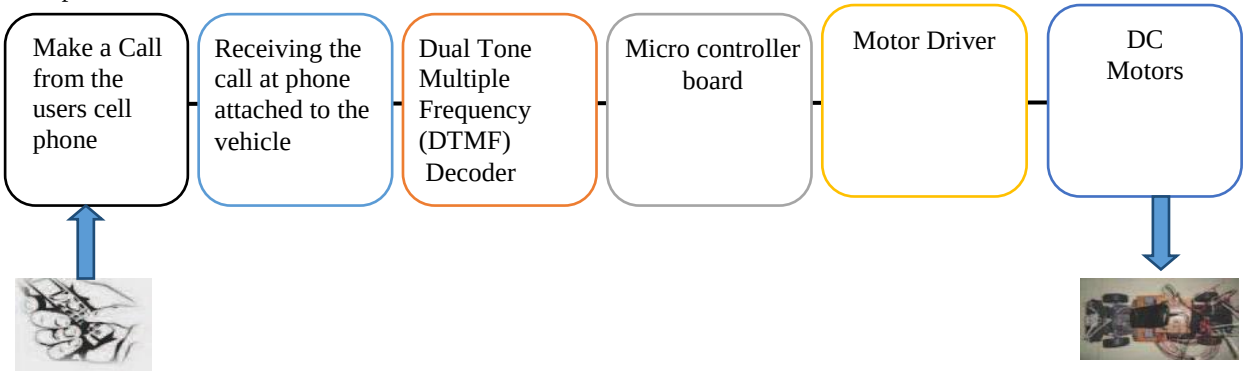


figure 1: - Block diagram of GSM network controlled vehicle

We know that in earlier, Remote Controlled cars or vehicle do not have a high coverage of wireless network. This means that the user has to be in touching distance to the receiver of the vehicle. Thus, it is clearly a remote controlled vehicle cannot reach to an array of duty due to its lacking of controlling range. Here a GSM controlled vehicle steps in. Using two GSM enable mobile phones we can develop a controlling mechanism for the vehicle. Here we don't have to worry about the range of operation,

instead of sensors such as IR sensors and cameras so a 3G enabled mobile phones are used, as most of the world is under the coverage of GSM network. By using this project we can consider this vehicle and turned it for human benefits around the world. These vehicles can be used as real-time battle vehicles firefighting robots are applied in vast places where it's not possible or dangerous for any human being to go.

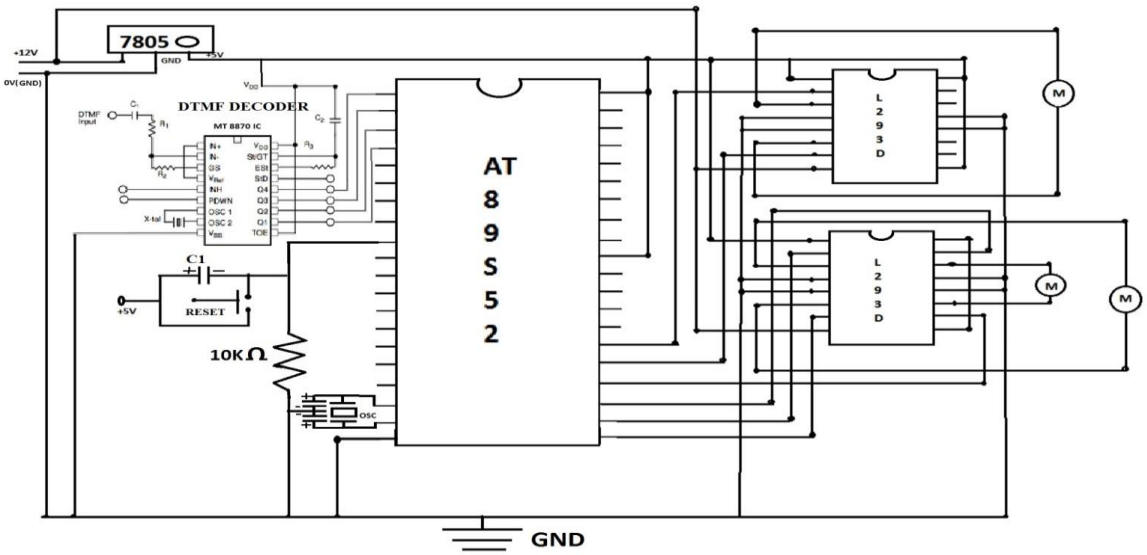


figure 2:- Circuit diagram for DTMF controlled Vehicle

The vehicle was controlled by mobile phone and that can made calls to another mobile phone connected to the vehicle. In the course of the call if any key was dialed, the pulse sound corresponding to the dialed key was heard at the other end of the call. This tone is called dual tone multi frequency (DTMF).

The vehicle received the DTMF tone with the help of phone connected in the vehicle. The connection between the cell phone and the dtmf decoder is made with the help of a universal 3.5mm audio jack. The received tone was processed by the microcontroller. The microcontroller is wired such that for a particular pulse from the DTMF, then voltage will pass through motor driver and the motors are activated. Thus it's possible for the motor driver to drive the motors for forward or backward movement or make a left or right turn. The mobile that makes a call to the mobile phone stacked in the vehicle acts as a remote controller.

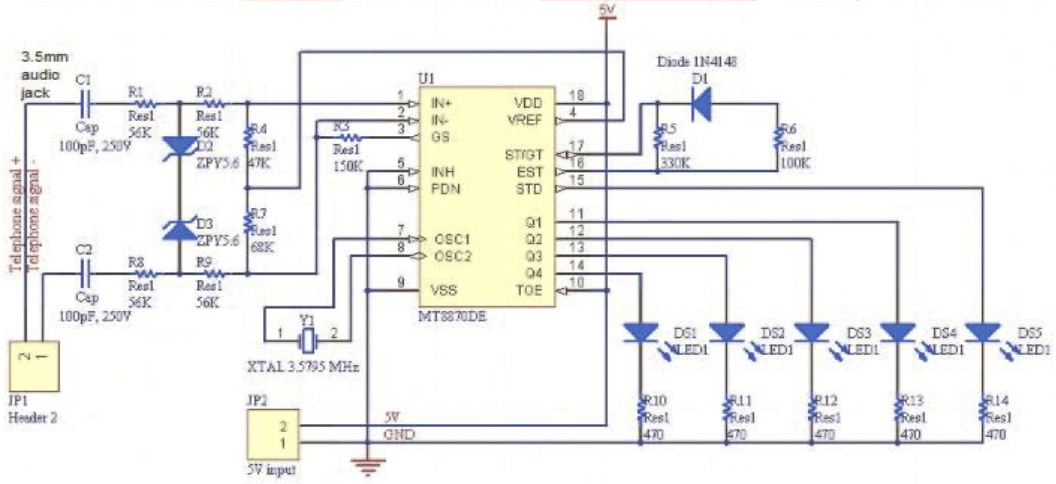


figure 3:- Circuit diagram of DTMF circuit

The DTMF decoder and the micro controller circuit is designed to permit a digital signal processing device control motors by issuing commands encoded as audio DTMF signals. The motor driver directs the overall operation of the DTMF decoder to perform the actual DTMF audio tone decoding. When a valid tone is detected by the DTMF decoder, DTMF signaling is commonly used for IVRS systems and telephone signaling over line-in voice-frequency band to the switching call center. The version of DTMF used for telephone dialing is known as touch-tone. DTMF assigns a unique frequency to each key when it pressed. So that it can be easily identified by many electronic circuits.

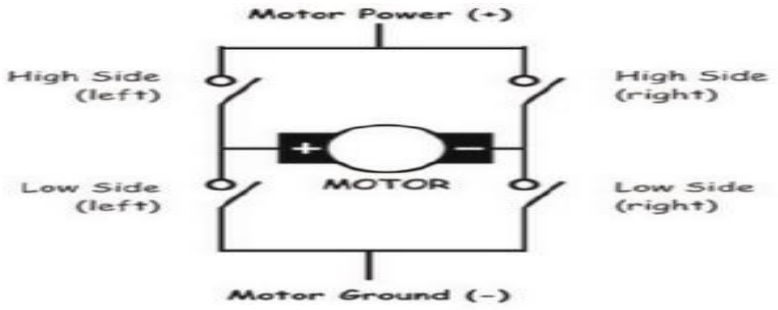


figure 4:- working principle of motor driver L293D

L: Low (Logic 0)
H: High (Logic1)

The signal was generated by the DTMF decoder is a direct algebraic summation of the amplitudes of two sine or cosine waves of different frequencies i.e., by pressing '5' it will send a tone made by summation of 1336 Hz and 770 Hz to the other end of the mobile phone. The tones and assignments in a DTMF system are shown in Table1

Digit	High Frequency (in Hz)	Low Frequency (in Hz)	D4	D3	D2	D1	D0
1	1209	697	H	L	L	L	H
2	1336	697	H	L	L	H	L
3	1477	697	H	L	L	H	H
4	1209	770	H	L	H	L	L
5	1336	770	H	L	H	L	H
6	1477	770	H	L	H	H	L
7	1209	852	H	L	H	H	H
8	1336	852	H	H	L	L	L
9	1477	852	H	H	L	L	H
0	1209	941	H	H	L	H	L
*****	1366	941	H	H	L	H	H
#	1477	941	H	H	H	L	L
A	1633	697	H	H	H	L	H
B	1633	770	H	H	H	H	L
C	1633	852	H	H	H	H	H
D	1633	941	H	L	L	L	L
Any	---	---	L	0	0	0	0

table 1: Logic table for MT 8870 DTMF Decoder

Here, the motor driver L293D switching the motors that can rotate clockwise or anti-clockwise directions electronically. Drivers are required for motor rotation. The L293D is a quad, high-current, half-H driver designed to provide bidirectional drive currents of up to 600mA at voltages from 4.5 V to 36V.

The driver makes it easier to drive the DC motors. The L293D consists of four drivers. Pins IN1 through IN4 and OUT1 through OUT4 are input and output pins, respectively, of Driver 1(D1) through Driver 4(D4).drivers 1 and 2, and drivers 3 and 4are enabled by enabling pin 1 (EN1) and pin9 (EN2), respectively. When enable input EN1 (pin1) is high, drivers1 and 2 are enabled and the outputs corresponding to their inputs are active. Similarly, enable input EN2 (pin9) enables drivers 3 and 4.

In this case, by applying electrical current to the contacts will change their state. Here Motor Drivers are generally used to switch smaller currents in a control circuit and do not usually control power consuming devices except for small motors and Solenoids that draw low amps.

DTMF KEY PRESSED	CAMERA MOTOR	LEFT MOTOR	RIGHT MOTOR	MOVEMENT
2	00	10	10	**FORWARD**
4	00	00	10	**LEFT SIDE**
6	00	10	00	**RIGHT SIDE**
8	00	01	01	**BACKWARD**
5	00	00	00	**STOP**
1	01	00	00	**ANTI CLOCKWISE**
3	10	00	00	**CLOCKWISE**

table 2**:-** Logic table of L293D motor driver for DTMF vehicle

III. SOLAR TRACKING SYSTEM

I. DESCRIPTION

In this project to keep the solar photovoltaic panel perpendicular to the sun throughout the day in order to make it energy more efficiently. The dual axis solar tracking system takes light intensity data as reference and the tracking system has the capability to always point perpendicular to the solar panel array towards the sun and can be installed in various positions and regions with minor modifications. The vertical motion and horizontal motion of the solar panel is obtained by comparing the difference between the two sensors as reference. The fuzzy logic controller has been used to control the position of DC motors autonomously. The simulation control of dual axis solar tracking system and ensures the point to point movements of the DC motors while tracking the sun.

To charge the battery, a solar energy can be used in the project and an external solar tracking system is implemented to charge the battery efficiently. The solar cell that was used is a mono 5 watt solar powered photo voltaic cell with voltage rated of 12V. A charge controller, or charge regulator is basically a voltage and/or current regulator to keep batteries from overcharging and under discharging. It regulates the voltage and current coming from the solar panels going to the battery. Most batteries need around 14 to 14.5 volts to get fully charged.

A photovoltaic solar cell consists of a light absorbing material which is connected to an external circuit in an asymmetric manner. Charge carriers are generated in the material by the absorption of photons of light, and are driven towards one or other of the contacts by the built-in spatial asymmetry. This light driven charge separation establishes a photo-voltage at open circuit, and generates a photocurrent at short circuit. When a load is connected to the external circuit, the cell produces both current and voltage and can do any electrical work.

Module Type- Mono 5W	
Dimensions (mm)	100X 200 X 10
Maximum Power (P_{max})	5W
Tolerance of (P_{max})	0 - 3%
Rated Voltage (U_{mpp})	12V
Rated Current (I_{mpp})	0.41A
Weight (Kg)	0.30

table 3**:-** specifications of the solar cell

II. TYPES OF SOLAR TRACKERS

there are many solar trackers exists but here we are mention some few and efficient solar trackers

A. PASSIVE TRACKING SYSTEMS

The passive tracking system realizes the motion of a system by using a low boiling point of a liquid. This liquid is vaporized by the applied heat of the sun and the center of mass of the solar panel is shifted leading to that the system finds the new equilibrium position.

B. ACTIVE TRACKING SYSTEMS

Mainly, the two basic types of active solar trackers are single-axis and dual-axis. Passive tracking system is only Single axis trackers. A single-axis tracker can only pivot in one plane either horizontally or vertically. This makes it less complicated and generally cheaper than a two-axis tracker, but also less effective at harvesting the total solar energy available at a site.

Trackers use motors and gear trains to direct the tracker as commanded by a controller responding to the solar direction. Since the motors consume energy, one wants to use them only as necessary. Single axis trackers have one degree of freedom that acts as an axis of rotation. There are several common implementations of single axis trackers. These include horizontal single axis trackers (HSAT) and vertical single axis trackers (VSAT).

A horizontal-axis tracker consists of a long horizontal tube to which solar modules are attached. The tube is aligned in a north-south direction only, and is supported on bearings mounted on pylons or frames, and rotates slowly on its axis to follow the sun's motion across the sky.

Figure 5: dual axis solar tracker

This kind of tracker is most effective at equatorial latitudes where the sun is more or less overhead at noon. In general, it is effective wherever the solar path is high in the sky for substantial parts of the year, but for this very reason, does not perform well at higher latitudes. For higher latitude, a vertical-axis tracker is better suited. This works well wherever the sun is typically lower in the sky and, at least in the summer months, the days are long. Dual Axis Trackers Dual axis trackers as shown in the figure have two degrees of freedom that act as axes of rotation.Double-axis solar trackers, as the same suggest, can rotate simultaneously in horizontal and vertical directions, and so are able to point exactly at the sun at all times in any location. These tracking systems naturally provide the best performance, given that the components have high enough accuracy as well.

C. Circuit Description:

The electrical system consists of four LDR sensors which provide feedback to a micro controller. This micro controller processes the sensor input and provides four input signals for the movement of DC motors. This DC motors moves the solar panel towards the higher intensity of solar light. The entire system is powered by a 12volt source power supply. Here we are using 8051 family microcontroller AT89s52 IC and L293D IC for driving the motors.

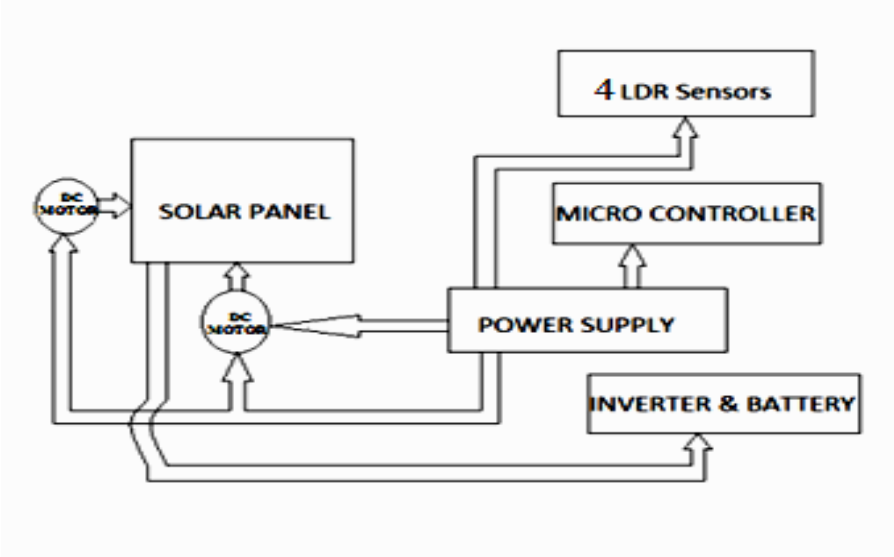


figure 6:- Block diagram of Solar tracking system

The four LDR sensors outputs are connected to the port0 of microcontroller as input and output obtained is connected to the motor driver L293D and for each motor driver two motors are connected.As per the programming (coding) in the microcontroller the instruction as compiled and output is observed in the motors as shown in the circuit diagram.

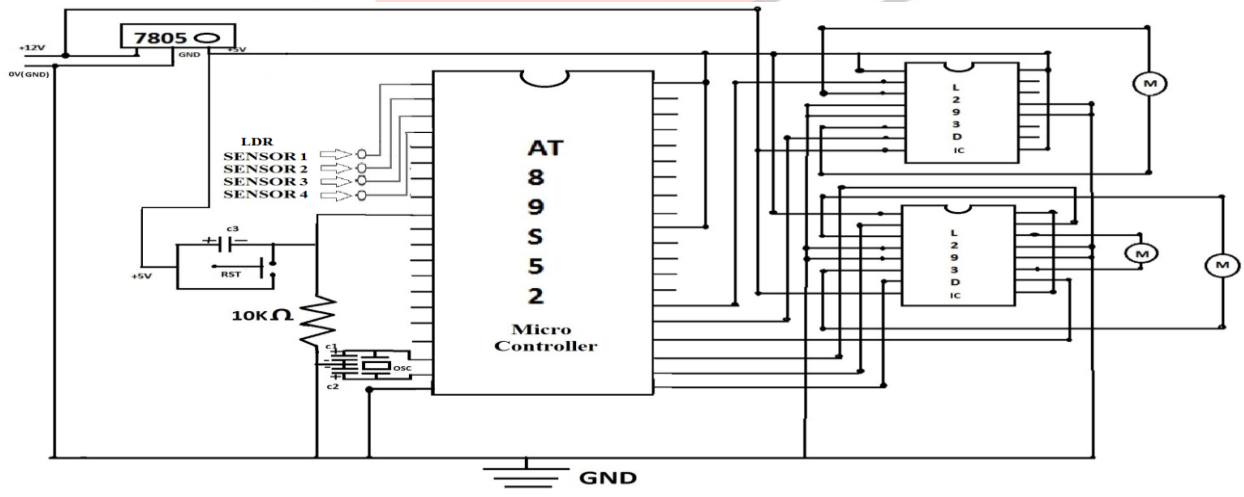


figure 7:- Circuit diagram for solar tracking system

A. Working of solar tracking system:

Let us consider Sun is moving from EAST to WEST and the robot is facing in the NORTH direction. So the LDR sensor placed in east side is activated because it receives high light intensity with comparing to other LDR sensors placed in different directions. So the motor driver drives the motor in east direction and stop up to the solar panel is parallel to the sun. At that time all LDR sensors receiving high intensity and gives the input as ‘ 1 ’. So the motor driver stops the all motors

SENSOR	MOTOR 1	MOTOR2	MOVEMENT

INPUT			TOWARDS
0001	00	01	**NORTH**
0101	01	01	**NORTH-EAST**
0100	01	00	**EAST**
0110	01	10	**SOUTH-EAST**
0010	00	10	**SOUTH**
1010	10	10	**SOUTH-WEST**
1000	10	00	**WEST**
1010	10	01	**NORTH-WEST**
1111	00	00	**STOP**
0000	00	00	**STOP**

table 4:- Fuzzy Logic Table for solar tracking system

IV. METHOD OF STUDY

The information on designing and development of the circuits were collected from many resources, i.e. websites, books, papers, etc. and was studied well to get an idea. Previously we have studied on different kinds of remote controlled vehicles and also the use of GSM communication networks. Photovoltaic panels were implemented to recharge the rechargeable batteries. And also a solar charge controller is designed and implemented to regulate the power flowing from a photovoltaic panel to a battery. The solar charge controller consists easy setup with potentiometer for the float voltage adjustments and an equalize function for periodic overcharging of voltages.

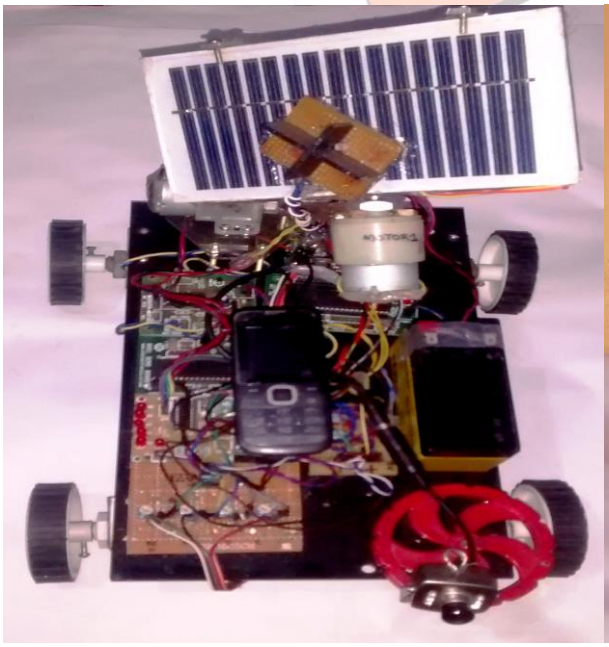
The steps involved to finish this project are listed below:

Step 1: Collecting the information and content about the topic from many sources like websites, Books, papers, etc.
Step 2: Choosing appropriate equipments and components available for the study and developing an idea about cell phones to act as a remote controlling device and also for solar tracking system
Step 3: Designing the circuit using circuit stimulating software like "Multisim" and "PSpice"
Step 4: Implementing the circuit in the breadboard, and then on vero board to minimize the size of the circuits
Step 5: Observing the output signals through a digital multimeter by varying the input signal with respect to output and recording the charging and discharging time
Step 6 Reducing the errors if exist

The performance and mode of operations of the vehicle were observed carefully. Thus the study and development of the project were successfully completed and overcoming the limitations to some extent.

B. SUGGESTED MODIFICATION & COMPLETED SYSTEM

Previously, we had seen some researches involved vehicles which would be remotely controlled by user, but it should have been kept under a network coverage where it could be supervised. Here as we are willing to make it mobile phone based remote control vehicle (RCV) it can be operated almost everywhere if the GSM network exists. Moreover, it can recharge its battery by its own by the using of solar tracking system. so it is itself a standalone system.



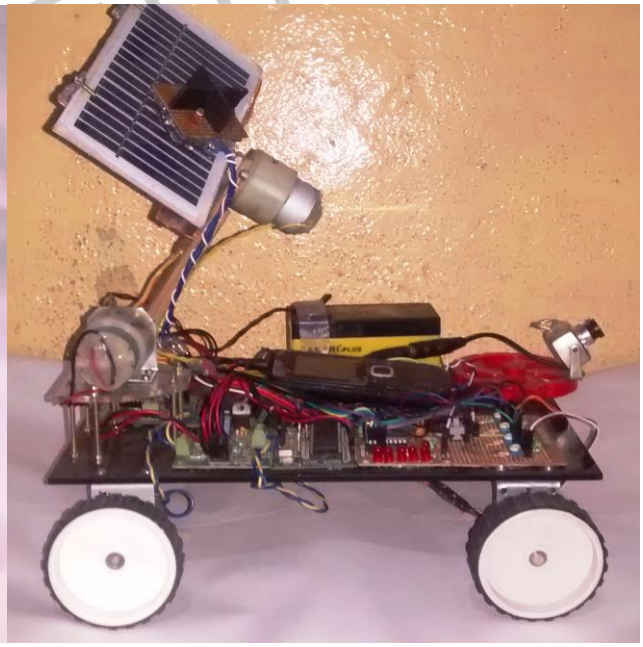


figure 8:- Implemented GSM controlled vehicle with audio and video transmission
figure 9:- Implemented Solar Tracking System

Since the vehicle will be running by solar energy, then vehicle can be sent to a long distance and not worrying about the fuel, since it will try to gather most of the energy by solar power from sun, though there will be a DC battery as backup. As it will be dependent on solar energy and it is quite obviously is an eco-friendly project. In addition to the solar charge controller we will make the project even more efficient.

On the other hand, for the operation of this system always two mobile phones are required so that every time the remote has to dependent on another mobile phone that has to be connected and stacked to the vehicle chassis and by default it was assumed that the mobile phone number is a secured one, which is only accepted by the system.

Here a prototype of the remote system controlling has been developed in this project as shown in the figure 6 and figure 7. Although the construction is just a automatic vehicle utilizing solar renewable energy as its power source, and it may be a pathway for more such researches.

By evaluating this complete project and thesis paper, it is clearly noticeable that this project has opened the window for enormous future researches in this field for the next researchers.

A) Substituting of 2G CDMA or GSM mobile phone with 3G handset mobile

3G or 3rd Generation is the generic term used for the next generation of mobile communications system. 3G technology is commonly used in smart phones, where a strong emphasis is put on multimedia services and internet while its predecessor, second generation or 2G technology emphases mostly on the voice applications like talking, call waiting, etc. 3G technology has major advantages over 2G which enables continuous connectivity to internet. Hence finally it can be stated that by replacing the existing mobile phone with a 3Ghandset will not only extends instructions of the developed circuit but will also enable some more extra features and functions to be employed alongside the present one.

B) Modification in the System Design

Here in this project we can also be made perfect by means of conducting three simple modifications in this existing system design

i. ***By implementing the DTMF Transceiver the DTMF Decoder:*** In future, researchers can develop this project by substituting the DTMF Decoder IC 8870 by a DTMF Transceiver IC 8880, accessing the system to generate a DTMF tone by itself. If an additional security system like alarm circuit along with sensors is implemented along with the existing system, then system will be able to notify the user when an alarm initiates by calling a fixed number or by sending SMS.

ii. ***Password Protection:*** In order to restrict unauthorized access of this vehicle, the project can be employed by means of protection via password. In case of anyone interested in implementing the present circuit, the mobile phone connected should be password protected.

C) Implementation of PWM Charge Controller

Future researchers can work out to implementing a Pulse Width Modulation (PWM) based solar charge controller circuit for managing the charging and discharging of the battery not only using photovoltaic energy but also wind energy.

D) Modifications in the System Operations

The operations of the system can be easily modified and the vehicle can be used for variety of purposes. By conducting some adjustments in the design of the system will enable this vehicle to serve as remote control vehicle performing other wide range of operations. Some of such operations are highlighted below:

- **Remote Control Racing Vehicle:** Robotic Race Cars can easily be redesigned by some simple modifications in this vehicle design. The cars will be travel in a pre-designed track and users will be in good command of the navigation of the car.
- **Bomb Detector Vehicle:** In future, researchers can easily modify this vehicle as robot and use it as bomb detection robot. It can be done effectively by implementing a program to trace out the exact positions of bombs on a predesigned map. The robot will be developed to sense bombs in a remotely controlled way, and user will navigate the robotic vehicle and locate the landmines and automatically update information into the computer's database.
- **Remote Control Fire Fighter robot:** This project can modified easily by implemented as a prototype model for firefighting robotic vehicle. The microcontroller operated robot will detect the fire and move through a structure, and then extinguish water with the help of blower.

CONCLUSION

The main purpose was to implement a circuit that can drive an electric vehicle in any directions using GSM network based mobile phones as a distant controller. This system utilizes a renewable solar energy based battery management system and a GSM technologically operated mobile phone for its operations. The second part of this project highlights on deploying a battery management system using renewable photovoltaic energy as its power source from which the system can charge its batteries using solar panels as a standalone system.

This system can be a test-bed for any future projects and or appliances interested to work with both renewable energy and remote control communication technology together. Robot will move and monitored temperature, metal detection, gas detection through a structure in particular area, and if detect fire and then extinguish it with the help of blower and notify the condition by an bulgur alarm.

REFERENCES

[1] M.Callaha Jr, "Integrated DTMF Receiver," IEEE Transactions on communications, vol. 27, pp. 343-348, February, 1979.

[2] Y. C. Cho and J. W. Jeon, "Remote Robot control System based on DTMF of Mobile Phone" IEEE International Conference INDIN 2008, July 2008.

[3] Saravanan C. , Dr .M.A. Panneer selvam, I. William Christopher, "A Novel Low Cost Automatic Solar Tracking System", International Journal of Computer Applications (0975 – 8887) Volume 31– No.9, October 2011.
[4] Hasan A Yousaf, "Design and Implementation of a Fuzzy Logic Computer- Controlled Sun Tracking System", Proceedings of the IEEE International Symposium on Industrial Electronics, Volume 3, 12-16 July 1999, pp 1030-1034