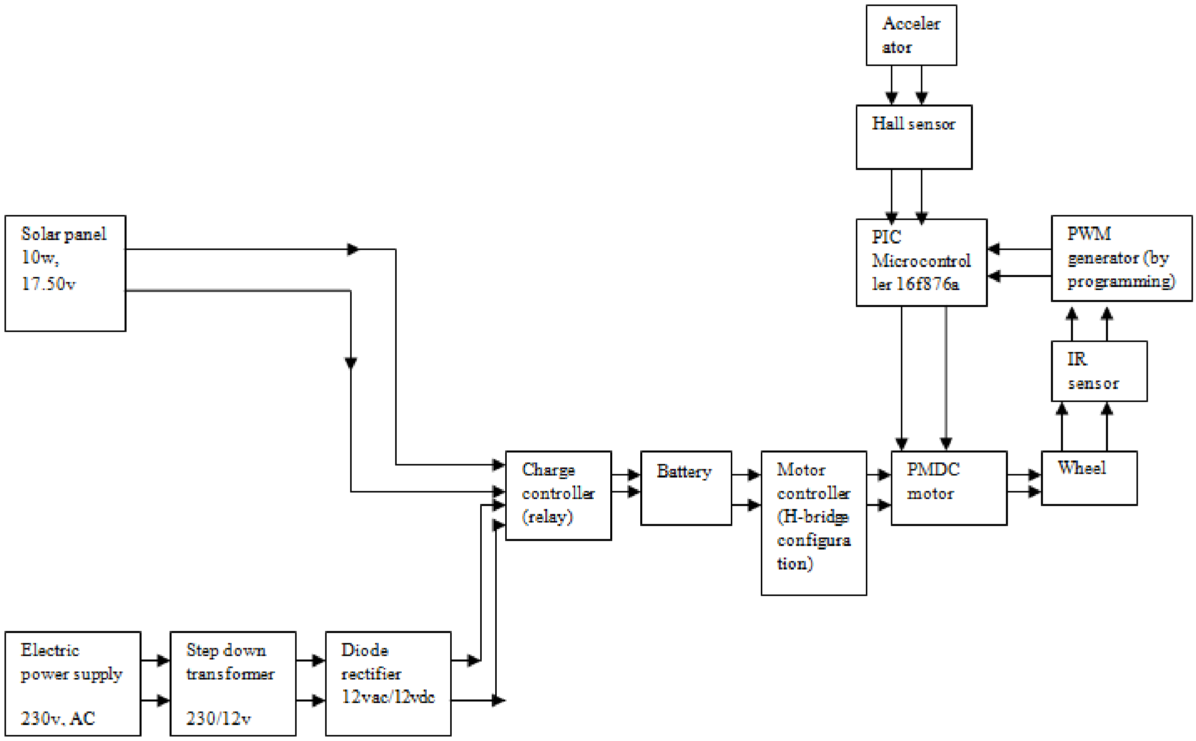

Figure 1: Overall Design of System Configuration

4. Hardware Implementation

The hardware implementation of proposed solar/electric hybrid vehicle's working model is shown in fig. 2, fig. 3 and fig. 4.

Figure 2: Hardware implementation of working model

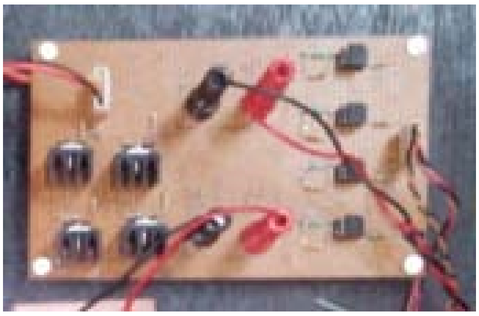

Figure 3: Connections of MOSFETs with battery and motor

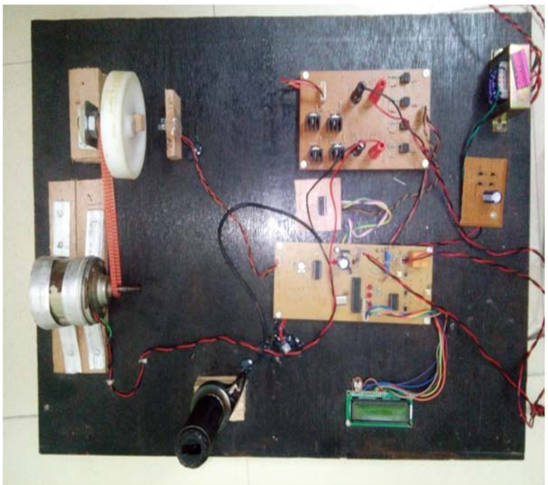

Figure 4: Close view of circuit connections of working model

In order to confirm the benefits of the proposed system, an experimental prototype for an hybrid electric vehicle is developed. As shown in figure, the solar panel with a rating of 10w is connected to the working model of hybrid electric vehicle. In the actual hybrid electric vehicle we can place solar panel on the top of the vehicle to seize the solar energy and then control it with charge controller. During sunless condition, the battery is charged from household supply of 230V by converting it into 12V with the help of step- down transformer and with the help of rectifier circuit 12V a.c. supply is converted into 12V d.c. supply to charge the battery. The battery is charged always from the solar panel and it provides power to drive the wheel of the working model. Four N-channels MOSFET are used in circuit to drive D.C. motor. The MOSFETs are connected in the H-bridge configuration to drive the D.C.

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motor. To derive the motor in forward direction two MOSFETs are connected in positive to negative direction and to derive the motor in reverse direction remaining two MOSFETs are connected in negative to positive direction. The PWM signals are generated using programming in c language and that programming is burn into microcontroller 16f876A. The advantage of using microcontroller 16F876A is that it is having inbuilt ADC (analog to digital converter), port A is completely ADC having a capacity of 10bit. The PWM modulation frequency is set to be 5 KHz. The crystal oscillator frequency installed in microcontroller having a value of 3.57MHz. ADC having a capacity of 10 bit means 210 bit equal to 1024. It divides the value into tenth part and its resolution is 5/1024 equal to 0.00482V (maximum voltage of microcontroller is 5V).

5. Test and Result

For the working model of hybrid electric vehicle, we are using permanent magnet direct current motor (PMDC) having 4 poles, 0.125 horse power at 12V and 50 Hz. During the test, working model is fed through a 220V rectified dc- power supply, with the help of batteries. The battery can also be charged from solar panel having a rating of 10W. During test wheel is rotated at its full speed having a cyclic RMS of 256.9mv and positive duty cycle of 23.1%. Controlled acceleration is achieved by pulse width modulation (PWM) technique with the help of IR sensor placed in front of wheel. The wheel is driven with the help of accelerator and waveforms have been recorded through cathode ray oscilloscope (C.R.O.). Fig. 5 showing the waveform when wheel is at rest means when we are not accelerating the working model of hybrid electric vehicle. This time positive duty cycle is 11.2% and cyclic RMS of 252.7mv. Fig. 6 is showing the waveform on CRO when wheel is rotating at full speed that time positive duty cycle is 23.1% and cyclic RMS is 256.9mv. This time however, control algorithm limit the motor's acceleration by imposing pulse width modulation. Therefore, the efficiency and battery life of grid solar hybrid electric vehicles can be improved by using the technique PWM (pulse width modulation) and by using solid state switches like MOSFETs having a capability of limiting current transients.

Figure 5: Waveform achieved at zero accelerator

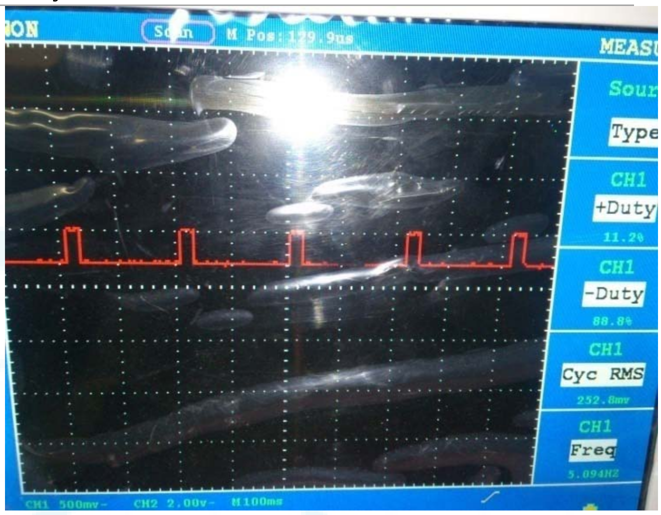

Figure 6: Waveform achieved at full accelerator

6. Conclusion

In this paper the working model for grid solar hybrid electric vehicle has been presented. The pulse width modulation speed control method is simple and inexpensive for D.C. motor control, implemented with a microcontroller 16F876A having an inbuilt analog to digital controller. This experimental result shows that hardware implementation of working model design prototype is suitable for actual designing of grid solar hybrid electric vehicle and this design is feasible and reliable for this kind of application. The aim of this project was to demonstrate that grid solar hybrid vehicle could be viable alternative to conventional vehicles and this could help to improve air quality in big cities, through the reduction in carbon dioxide emissions and by using renewable sources of energy (solar energy) we can reduce the world dependence on fossil fuel. The prototype realization is carried out successfully and the results have shown that the speed controller performs a stable and efficient motor control.

Future Scope

1. Battery technology: battery technology should improve so that vehicle runs more efficiently. Life of battery should increase so that more consumers attract towards the hybrid vehicles with keep in mind that battery does not harm the environment.
2. Simulation software and testing equipment: simulation software like MATLAB and VBB are present to simulate electric vehicles but they are not giving exact result. For this improved simulation software will be design and testing equipment could also be design.
3. Renewable fuels: hybrid electric vehicles running on electricity that is not emitting pollution on the tail pipe but at the time of generation of electricity it is emitting pollution at the power stations and at last polluting the environment. So, for this renewable fuels like biodiesel and ethanol should be use.
4. Solar panels: solar panels designing should be improved making it more efficient. Reflecting mirror can be used for absorbing more sunlight so that more electricity will be generate and PV tracking system

could be used for trapping more energy from sunlight and making vehicle more efficient.

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