JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

An Electric Vehicle using a Super-Capacitor as its Traction System

[1]Prof.Shivanand Konade, [2]Prof. Arun Gawande, [3]Prof. Shradha Harshal Chaudhari, [4]Dr. Karuna Kirwale, [5]Assistant Teacher. Sudhanjali S. Konade

1,2,3, Assistant Professor, Electrical Engineering Department, Smt. Indira Gandhi College of Engineering. 4Assistant Professor in Amity Institute of Information Technology, Amity University Mumbai,5 Assistant Teacher St. Joseph High School,Panvel

Abstract

This study focuses on the design of an electric vehicle's (EV) traction system, which solely uses supercapacitors as energy sources. The purpose of this effort is to construct a small electric vehicle (EV) prototype in order to investigate the viability of utilizing EVs with supercapacitors in Mexico City's public transportation system. This undertaking is supported by Mexico City's Institute of Science and Technology. The car's Permanent Magnet Synchronous Motor (PMSM) provides rear traction. Antennae of the car, including lights, instrument cluster, and energy distribution system contactors, were powered by a tiny battery. The traction system's design is validated by the results of experiments and simulations.

Keywords- Super capacitors, electric vehicles, and permanent magnet synchronous motors.

I. INTRODUCTION

An electric motor of 3.83 kW, 220/240 V, and 12.2 N-m powers the EV's electric traction system. A 300 V POWEREX inverter powers the motor. A bidirectional two-phase interleaved DC/DC converter supplies the DC voltage. During the braking stage, the converter lowers the motor's regenerated voltage and raises the voltage supplied by the supercapacitors (SCs), which are the only energy source. It was decided to design and deploy an external SC charger. The SCs can be recharged in five minutes, giving the car the independence it needs to get to the next stop and get recharged once more, and so on. The necessary safeguards were incorporated within the electricity distribution system.

II.Two Systems of Electric Traction

The EV's electric traction system is shown in Fig. 1. When the SCs require recharging, contactors (1) are closed and (2) are opened.

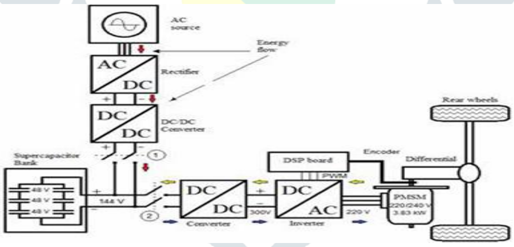

Figure 1: Electric traction system

The AC supply, rectifier, and DC/DC converter make up the SC charger. The SCs receive continuous current charging up to 144 V, the SCs have delivered ¾ of their energy at the minimal SC voltage of 72 V. During the traction stage, contactors (1) and (2) are opened and closed, respectively. The SC charger's DC/DC converter is step-down (unidirectional), unlike the DC/DC

A two-headed converter permits energy to move in both directions: from the SCs to the DC bus during the traction stage and from the DC bus to the SCs during the regeneration stage. A TMS320F28335 DSP system was used to program the PMSM control. The DC/DC converters were controlled through the use of analog circuits. The PWM DC/DC converter was implemented using an integrated circuit, the Texas Instruments UCC 28220. As switching devices, APT100M50J MOSFETS with a 40 kHz commutation frequency were employed. Six Maxwell BMOD0165 (165 F, 48V) modules are arranged in two parallel branches, with three series modules connected to each branch, to form the bank of SCs. Figure 2 depicts the SC bank,

Figure 2: Supercapacitor bank

Figure 3: Electric vehicle

III.Drive Motor

As seen in fig. 4, the motor drive is based on a PMSM vector control. The throttle produces the reference speed signal. The throttle regulates the stages of acceleration and braking to improve safety. An additional pedal was used to apply the mechanical brake.

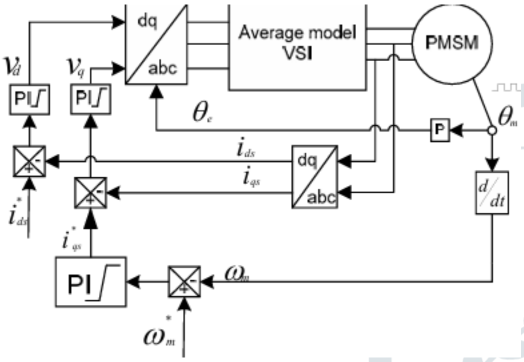

Figure 4: PMSM vector control

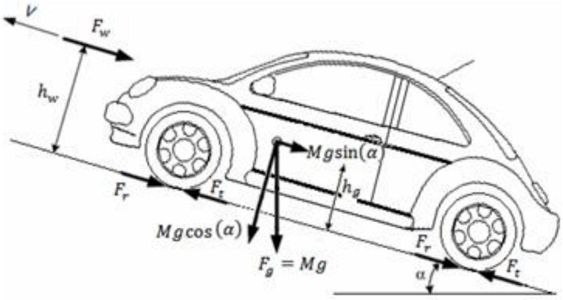

Figure 5: Forces acting on the vehicle

IV.Model of the EV's Dynamics

It is feasible simply by examining the forces at work while the vehicle is moving (see fig. 5) to obtain the EV's dynamic model, which leads to the torque equation (1) that characterizes the EV's dynamic model [1]:

$$\frac{d\omega_m}{dt} = \frac{T_m - \frac{d_f\, r_d}{n\, eff}\left(F_r + F_g + \frac{1}{2}\,\rho\, A_f\, C_d\, \frac{r_d^{\,2}}{n^2}\,\omega_m^{\,2}\right)}{J_m + \frac{1}{n^2\, eff}\left(J_w + d_f\, r_d^{\,2}\, M\right)} \quad \text{----------------------------------1}$$

Where

The wheel and motor rotor inertia (N.m.s), angular speed (rad/s), and mean wheel radius (m) are represented by the variables w, Jm, ωm, and rd, respectively. Fr and Fg are the sum of The vehicle's rolling resistance and the grading resistance (N.m.) are the same. The air density, vehicle frontal area, aerodynamic drag coefficient, and total mass (kg) of an electric vehicle are represented by the variables ρ, Af, Cd, and M. The transmission gear ratio, transmission efficiency, traction machine torque, and factor that proportions the torque distribution on the rear axle are denoted by the letters n, eff, Tm, and df, respectively.

Figure 6: Driving cycle

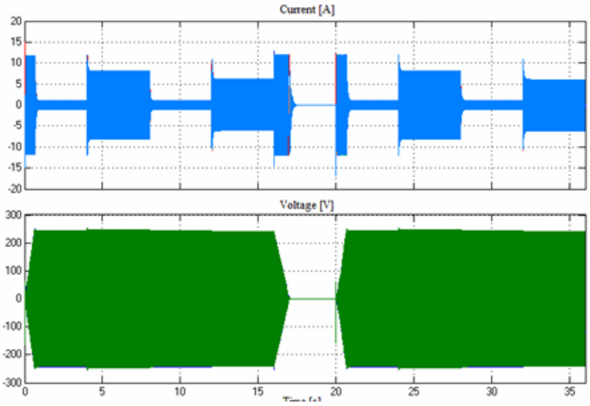

Figure 7: Instantaneous motor voltage and current values

Electrodynamometers (EDs) were used for the experimental experiments, as shown in Fig. 9. The two inverters that make up the ED are Unidrive These inverters (SP3201), which are connected by the DC bus, are in charge of controlling the load machine's regeneration. The NI USB6211 Data Acquisition Board served as an interface between a PC and the Unidrive, and LabView was utilized to implement the ED control. The dynamic load profile of an EV can be replicated by the ED. The load machine was mechanically linked to another PMSM that was utilized as a traction motor. An electric Powerex motor powered the traction motor.

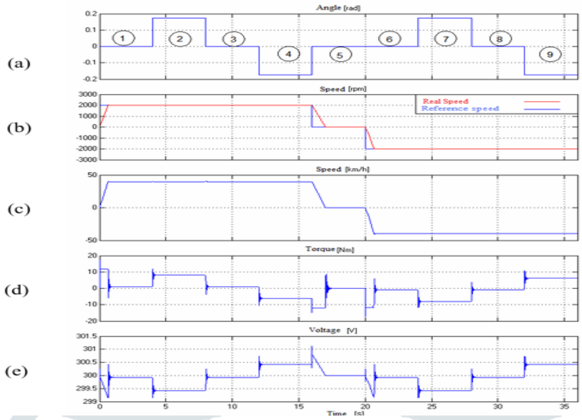

Figure 8: Simulation results of the vehicle performance

TDK Lambda GEN 300-17 power supply supplied power to the PP75T120 inverter. The power supply is connected in series with diodes. to prevent the traction motor's regeneration from reaching the power source. Braking resistors are required to disperse the regenerated energy in order to simulate the regenerative braking stage of an electric vehicle. For the motor control, a Freescale DSCMC56F8357 was programmed with vector control methods. The motors' data are as follows: Servomotors with 7.75 kW, 26.35 arms, 36.9 Nm, 220/240 V, and 2000 rpm control techniques. The experimental setup as it was used in the lab is shown in Fig. 10. The traction motor's control algorithms may be tested thanks to the ED.

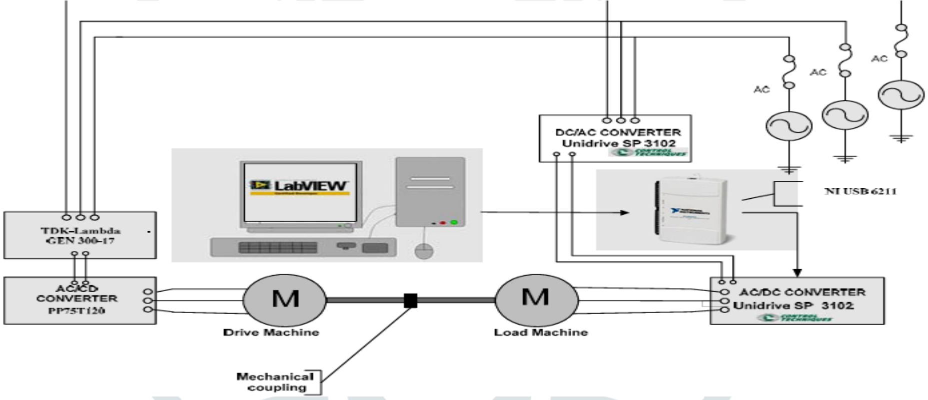

Figure 9 shows the experimental setup's block diagram.

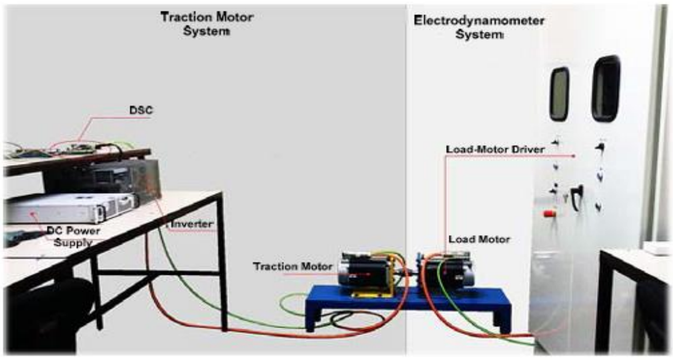

Figure 10. Experimental setup

the motor's speed, power, electromagnetic torque, and DC bus voltage depicts the EV speed profile that was utilized. variations in the torque of the traction motor. The electromagnetic torque of the traction motor Tem, the reference torque of the ED Te*_el, and the torque generated by the load machine Teel are all displayed in this figure. They all exhibit excellent correlation, indicating that the system is operating as intended. Because this signal is obtained from a PWM output of the DSC, where the traction motor control was performed, the torque-Tem variations of the traction motor can be attributed to this. After filtering, an NI USB 6211 was used to capture the signal so that it could be plotted. the electrodynamometer's recovered power being fed back into the grid (electric traction) and the traction motor's regenerative braking is responsible for the positive numbers. Regenerative braking of the EV is the cause of the increase in voltage in the DC bus of the inverter that powers the traction motor. The Unidrive (Fig. 9) was used to drive the electrodynamometer load machine. It was set up in servo mode, which allowed it to regulate the torque of the load motor. The Unidrive's terminal 7, which was set up as the input reference torque, was coupled to an analog signal generated by the NIUUSB621 electronic board. The second Unidrive's primary purpose is to operate as an inverter; it was designed to run in the regenerative mode. The experimental outcomes by the use of the EV. For over seven seconds, a reference speed of 2000 rpm was established, which led to the acceleration. of the EV, after which the vehicle enters the braking phase and comes to a complete stop with the reference speed set to zero. correspond favourably with the simulated outcomes displayed in Figures 8b and 8c. When regenerative braking occurs, the energy that would have gone to the SCs is unavailable. They will be discussed in a later paper; they are not covered in this one.

Conclusion

The design, simulation, and experimental validation of an electric vehicle (EV) with supercapacitors as its sole energy source were covered in this work. The project's goal was to show that this kind of electric transportation is feasible in Mexico City. The SCs may be recharged while the bus is at the stop; however, the amount of electric charge must be sufficient to enable the vehicle to continue on to the next stop for another recharge. The motor control algorithms used in the traction and regenerative stages are validated by the simulation results. Electrodynamometers were used to acquire the experimental results.

References

[1] M. Ehsani, Y. Gao, E.E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles. Fundamentals, Theory and Design” CRC Press, 2005.

[2] Z. Mihailovic, H. V. Prasad, and D. Borojevic, “Computer Modeling and Analysis of VSI Fed Permanent Magnet Synchronous Motor Drive Systems with Adjustable Levels of Complexity”, APEC´97 Conference Proceedings, Vol. 2, pp. 728-735, 1997.

[3] R. Krishnan, “Electric Motor Drives. Modeling, analysis and Control”. Prentice Hall, 2001.

[4] R .A. Espinoza-Arredondo, J.J. Rodriguez Rivas and E.P. Sánchez, “Experimental Electrodynamometer to Emulate Dynamic Performance of an Electric Vehicle”, 2012 IEEE 27-th Convention of Electrical and Electronics Engineers in Israel, Nov. 14-17, 2012..