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Recent Development on Electric Vehicle

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***Abstract*: This paper provides an overview of the recent work of electric vehicle in the region. The paper describes the development and the comparison of different part of components. The major components in battery technology, charger design, motor, steering and braking are examined. The paper finally shows some electric vehicle prototype as a conclusion of the papers.**

***Keywords*: Electric vehicle, AFS, steering system, braking system, ABS, battery management systems, BMS, Inverter**

1. Introduction

Electrical vehicle (EV) based on electric propulsion system. No internal combustion engine is used. All the power is based on electric power as the energy source. The main advantage is the high efficiency in power conversion through its proposition system of electric motor. Recently there has been massive research and development work reported in both academic and industry. Commercial vehicle is also available. Many countries have provided incentive to users through lower tax or tax exemption, free parking and free charging facilities.

On the other hand, the hybrid electric vehicle (HEV) is an alternative. It has been used extensive in the last few years. Nearly all the car manufacturers have at least one model in hybrid electric vehicle. The questions come to us: Which vehicle will dominate the market and which one is suitable for future? This paper is to examine the recent development of electric vehicle and suggest the future development in the area.

2. EV AND HEV

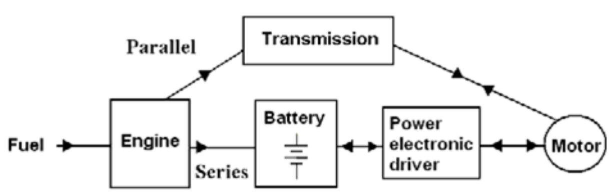

Fig. 1. The series or parallel path of an HEV

HEV has been promoted extensively in the last decade. Nearly each manufacturer has at least one HEV in the market [1]. It is supposed to rescue the battery energy storage problem at that time. Using hybrid vehicle, it allows the electric power can be obtained from engine. The HEV is broadly divided into series hybrid and series hybrid. The engine power of the series hybrid is connected totally to the battery. All the motor power is derived from the battery. For the parallel hybrid, both the engine and motor contribute the propulsion power. The torque is the sum of both motor and engine. The motor is also used as a generator to absorb the power from engine through the transmission. Bothe series or hybrid can absorb power through regeneration during braking or deceleration.

Nevertheless, HEV still has emission. The introduction of plug-in HEV that solves some of the problem [2]. It accepts the electric power to battery through plug in from the mains. Therefore, when convenient, users may charge the battery using AC from the mains.

3. The key components in EV

The electric vehicle is rather simple in structure. The key components are the propulsion parts. Fig 2 shows the configuration.

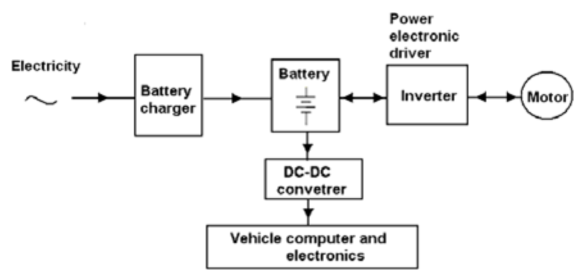

Fig. 2. The key components of an electric vehicle

The battery is the main energy storage. The battery charger is to convert the electricity from mains to charge the battery [3]. The battery voltage is DC and I is inverted into switched-mode signal through power electronic inverter to drive the motor. The other electronic components in a vehicle can be supplied to the battery through DC-DC converter that step down the voltage from the battery pack to lower voltage such as 5V-20V.

4. The motor

There are a number of motors available for electric vehicle: DC motors, Induction motor, DC brushless motor, Permanent magnetic synchronous motor and Switched reluctance motor.

1) DC motors

It is a classical motor and has been used in motor control for a long time. All the power involved in electromechanical conversion is transferred to the rotor through stationary brushes which are in rubbing contact with the copper segments of the commutator. It requires certain maintenance and has a shorter

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life time. However, it is suitable for low power application. It has found applications in electric wheel-chair, transporter and micro-car. Today, most of the golf-carts are using DC motors. The power level is less than 4kW.

2) Induction motor

It is a very popular AC motors [4]. It also has a large market share in variable speed drive application such as air-conditioning, elevator or escalator. Many of the higher power electric vehicles, for more than 5kW, uses induction motor. Usually a vector drive is used to provide torque and speed control.

3) DC brushless motor

The conventional DC motor is poor mechanically because the low power winding, the field, is stationary while the main high power winding rotates. The DC brushless motor is "turned inside out [5]-[6]. The high power winding is put on the stationary side of the motor and the field excitation is on the rotor using a permanent magnet. The motor has longer life time than the DC motor but is a few times more expensive. Most of the DC motor can be replaced by the brushless motor with suitable driver. Presently, its applications find in low power EV.

4) Permanent magnetic synchronous motor

The stator is similar to that of an induction motor. The rotor us mounted with permanent magnets. It is equivalent to an induction motor but the air-gap filed is produced by a permanent magnet. The driving voltage is sinewave generated by Pulse Width Modulation (PWM).

5) Switched reluctance motor

It is a variable reluctance machine and its famous recently because of the fault tolerance because each phase is decoupled from other. The power stage is different from other the motor discussed in 2-4. Each phase winding is connected in a flyback circuit style [7].

5. Direct drive and in-wheel motor

Direct drive reduces the loss in the mechanical units of the drive train. The motor is connected directly to the shaft to reduce needs of transmission, clutch, and gear box. Recently the in-wheel motor is promoted by researcher [8]. The in-wheel motor is to turn the rotor inside out and attached to the wheel's rim and the tire. There is no gear box and drive shaft. Fig 3 shows the in-wheel motor.

a) Hardware b) FEM model
Fig. 3. The in-wheel motor

The motor is also called wheel-hub motor. Its main advantage is the independent control of each wheel. Fig 4 shows the 4-wheele drive vehicle. Each of the wheels works any speed and direction. Therefore, the parallel barking can be achieved easily. The Anti-lock braking system can be implemented easily by the technology. It has been shown that it can successfully prevent spinout. The whole vehicle is much simpler in structure.

Many different types of motor can be used for in-wheel motor. The prominent one is the switched-reluctance types. Its phase-winding is independently from each and therefore the fault tolerance is much more advanced that the other. There is no permanent magnetic in the motor, it reduces any interference by permanent field and the fluctuation of the permanent magnetic materials.

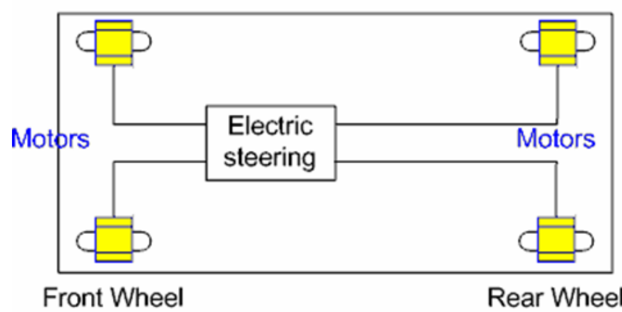

Fig. 4. True 4-wheel drive vehicle

6. Energy storage

A. Batteries

The battery is the main energy storage in the electric vehicle. The battery in-fact governs the success of the electric vehicle [9]. Recently there are massive works being reported in battery development. The battery such as Li-ion is now being used by new generation of electric vehicle. The danger of the instability of the battery has been studied by many reported. It seems that the $LiFePO_4$ type is preferable because of its chemically stable and inherently safe. Other Li-ion such as $LiCoO_2$, $LiMn_2O4$ and $Li(Ni_{1/3}Mn_{1/3}Co_{1/3})O_2$ may has the thermal and overcharge concern [10]. For low cost solution, the lead-acid battery is still dominant part of the market. The battery has found applications in electric wheel chair, Golf-cart, micro-car and neighborhood town air. The recent RoHS has also stopped the use of NiCd battery.

All the research is looking towards the fast charging for batteries. MIT reported [11] the technology of a crystal structure that allows 100 times of charging speed than conventional Li-ion battery. Other alternative is to use ultra-capacitor.

B. Ultra-capacitor

Capacitor is basically a static component. There is no chemical reaction in the components. Its charging and discharging speeds are very fast. However, the energy storage is limited. Its energy storage density is less than 20% of the lead-acid battery. Although the expected ultra-capacitor density

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will go up in next few years, its total solution for main energy storage is a challenge. The number of cycles and the temperature range is excellent. Table 1 shows the comparison.

Table 1
Comparison of different energy storage unit

	Lead-acid	NiMH	Li-ion	Ultra-capacitor
Energy density Whr/kg	40	70	110	5
Cycle life	500	8,00	1,000	500,000
Working temperature (°C)	-30 ~+50	-40 ~+50	-40 ~ +60	-40 ~ +85
Cost $/kWhr	1,000	2,400	5,000	50,000

Therefore, ultra-capacitor is useful for fast speed or transient energy storage. As it allows high current charging, its charging time can be shortened to within a few minutes.

The ultra-capacitor is still in the initial stage of development. It is expected that the cost will be going down and the energy density will go up rapidly in next few years.

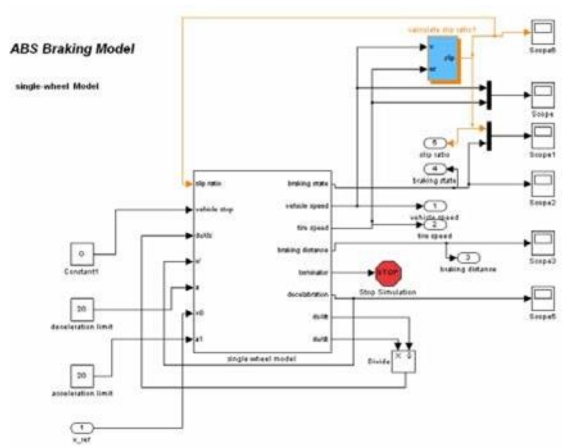

Fig. 5. ABS braking system model

The ABS optimization consists to maximize the tire forces whatever the conditions of the road. Therefore, it must to localize the wheel slip ratio which corresponds to the peak tire road adhesion characteristic. The location and the value of these peak values varies in large range depending on the road, tire and many other different factors, for any rolling conditions, the optimal wheel slip rate, which will be used as control reference to optimize the braking force. Fig. 5, shows a scheme of ABS based on all electrical motor drive system.

3. Skid Steering

Steering is achieved by differentially varying the speeds of the lines of wheels on different sides of the vehicle in order to induce yaw. To satisfy the requirement of the turn radius, the longitudinal slip must be controlled, so a method of slip limitation feedback is used in the simulation. When the vehicle is turning on a slippery surface, because of the drop at the coefficient of road adhesion, the drive wheels may slip. The traction control system reduces the engine torque and brings the slipping wheels into the desirable skid range. Fig. 6, shows the locus of skid steering for different turn radius.

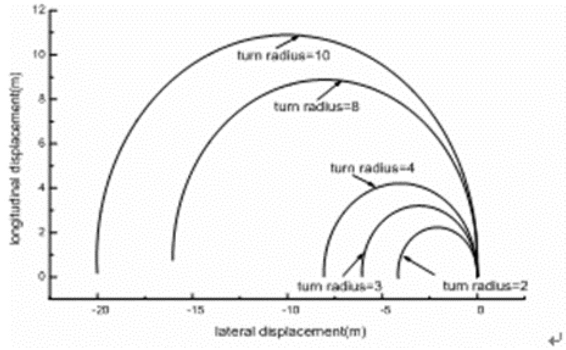

Fig. 6. Locus of different turn radius achieved by skid steering

7. Suspension

The developed direct-drive linear motor actuator for the automobile active suspension systems can generate control forces to absorb road shocks rapidly, suppress the roll and pitch motions, and ameliorate both safety and comfort, while maintaining the vehicle at a horizontal level. For conventional passive suspension systems, it is difficult to be achieved, since a soft spring allows for too much movement and a hard spring causes passenger discomfort due to road irregularities. Thus, significant improvement of suspension performance is achieved by the direct-drive linear switched reluctance actuator. Comparing with hydraulic active suspension systems, the developed active suspension system based on the direct-drive linear switched reluctance actuator is simpler since it needs fewer devices and mechanical parts. Due to no hydraulic devices, this is an oil-free system. Furthermore, it can include the energy generation from the suspension. The development includes the design of direct-drive linear switched reluctance actuator, its characterization, and the design of the automobile active suspension system. The converter drive is also needed to develop to match with the linear switched reluctance actuator. The drive is expected to fit the driving pattern of the suspension system and to provide suitable force control, energy generation control and position control.

8. Other accessories


Fig. 7. An LED front-lighting unit

The front lighting system based on LED and Adaptive front-lighting systems (AFS) is a vital security lighting system in vehicles. An AFS functionality is divided into three parts, one is the headlamp leveling subsystems, which work to keep light parallel to the road surface when the vehicle's tilt state changes in dynamic and static mode; the another one is swiveling subsystem, which matches the light distribution with the vehicle's turning angle so as to produce the best illumination effect for driver. The last one is dimming system, which fade or dim up illumination along with the ambient light and lane environment changes. Fig. 7, shows a sample of an LED front-light.

9. Electric vehicle show cases

Recently there are a number of local and overseas companies and institutions have been working on electric vehicle. The development on electronic parts and accessories from propulsion, safety and control has been reported. A local university has recently reported their EV development. Fig. 8, shows the private car, security car, micro-car and motorcycle.

Fig. 8. Electric vehicles developed

10. Conclusion

This paper discussed the recent development in electric vehicle. The paper first describes general structure and discussed the energy storage. It then extends to the future vehicle components. The paper provides an overview of the recent EV work in the region.

References

[1] Jones, W.D., "Hybrids to the rescue [hybrid electric vehicles]", IEEE Spectrum, Vol. 40(1), 2003, pp. 70 – 71.
[2] Jones, W.D., "Take this car and plug it [plug-in hybrid vehicles]", Spectrum, IEEE, Vol. 42, Issue 7, July 2005, pp. 10 – 13.
[3] Hyunjae Yoo; Seung-Ki Sul; Yongho Park; Jongchan Jeong, "System Integration and Power-Flow Management for a Series Hybrid Electric Vehicle Using Supercapacitors and Batteries", IEEE Trans. on Industry Applications, Vol. 44, Issue 1, Jan.-Feb. 2008, pp. 108 – 114.
[4] Haddoun, A.; Benbouzid, M. E. H.; Diallo, D.; Abdessemed, R.; Ghouili, J.; Srairi, K., "A Loss-Minimization DTC Scheme for EV Induction Motors", IEEE Trans on Vehicular Technology, Vol. 56(1), Jan. 2007, pp. 81 – 88.
[5] Jinyun Gan; Chau, K.T.; Chan, C.C.; Jiang, J.Z., "A new surface-inset, permanent-magnet, brushless DC motor drive for electric vehicles", IEEE Transactions on Magnetics, Vol. 36, Issue 5, Part 2, Sept 2000, pp. 3810 – 3818.
[6] Chau, K.T.; Chan, C.C.; Chunhua Liu, "Overview of Permanent-Magnet Brushless Drives for Electric and Hybrid Electric Vehicles", IEEE Trans. on Industrial Electronics, Vol. 55, Issue 6, June 2008, pp. 2246 – 2257.
[7] Rahman, K.M.; Fahimi, B.; Suresh, G.; Rajarathnam, A.V.; Ehsani, M., "Advantages of switched reluctance motor applications to EV and HEV: design and control issues", IEEE Transactions on Industry Applications, Vol. 36, Issue 1, Jan.-Feb. 2000, pp. 111 – 121.
[8] Jones, W.D., "Putting Electricity Where the Rubber Meets the Road [NEWS]", IEEE Spectrum, Vol. 44, Issue 7, July 2007, pp. 18 – 20.
[9] Affanni, A.; Bellini, A.; Franceschini, G.; Guglielmi, P.; Tassoni, C., "Battery choice and management for new-generation electric vehicles", IEEE Trans. on Industrial Electronics, Vol. 52(5), Oct. 2005, pp. 1343 – 1349.
[10] Chan, C.C. The Present Status and Future Trends of Electric vehicles, Science and Technology Review, Vol. 23, No. 4, Feb 2005
[11] Andrew Williams, "MIT Battery Breakthrough Could Revolutionize Electric Cars", March 12th, 2009 in Batteries, Electric Cars (EVs), http://gas2.org/2009/03/12/mit-battery-breakthrough-could-r evolutionize-electric-cars/
[12] Y. Lu, Cheng K.W.E., S. L. Ho, J F Pan, "Passivity-Based Control of Phase Shifted Resonant Converter", IEEE Proc. Elect. Power Appl., Vol. 152(6), Nov. 2005, pp. 1509–1515
[13] K. W. E. Cheng, "Tapped inductor for switched-mode power converters", 2nd Int. Conference on Power Electronics Systems and Applications, 2006, pp. 14-20.
[14] F. Chikhi, A. El Hadri and J. C. Cadiou, "ABS control design based on wheel-slip peak localization," *Proceedings of the Fifth International Workshop on Robot Motion and Control, 2005. RoMoCo '05.*, Dymaczewo, 2005, pp. 73-77.