Literature review of electric vehicle technology

Technology

The system consists of power switching devise, power converter topology with its switching strategy and the closed-loop control system of the motor as shown in figurer. These components are very important for developing efficiency and high-performance of electric vehicles. In the part of transferring current device, inverter/converter is the key part. Currently, all the Eves are using a three-phrase bridge inverter technology for converting the DC voltage of the battery to variable voltage and variable frequency to power a three-phase AC motor.

The genealogy is simple and well proven and will continue to be the technology of future with different types of power devices. One example of the inverter is GM EVE inverter able to achieve the power 26 k/keg densities as shown in figure 4. Fig. 4 Progress of GM propulsion inverter Electric motor Another important part in electric vehicle technology is electric motors. The role of electric motor is converting the energy supplied by the battery into mechanical energy to provide traction power to wheels.

The motors has many requirements: ruggedness, high torque to inertia ratio, high torque density, wide speed range, low goose, little or no maintenance, small size, ease of control, and low cost. Now several types of electric motor technologies have been investigated for automotive propulsion: permanent magnet (PM), induction motor, switched reluctance, synchronous reluctance motors and PM-assist Synonyms. Among these motors, PM synchronous motor is widely used in automotive propulsion because of its high efficiency, high torque, high power density, and relatively ease of field weakening operation.

PM motors have copper windings wrapped around stator. The copper wire assemblies make up the diameter of the stator. Permanent magnets are inserted which are rare earth-based magnets in the PM motors. PM motors provide an energy savings because the magnets have a permanent field at the rotor. Figure 5 shows the parts of a PM motor cutaway. Fig. 5 The parts of a permanent magnet motor cutaway In terms of efficiency of PM motors, it is high in operating region because the constant magnet field which eliminates many of the ERR losses of the induction motor.

However, due to the concerns of rare earth-based magnets and their increasing cost. Many companies and industries are working to other motors that do not use AMPS but to achieve the same performance as PM motors. There are four options to achieve this. 1. Induction Motors In the past, induction motors are used in many types of Eves including the GM EVE with reasonably good performance. Now, the motors are being used in Tests Eves such as Roadster, Model S, and Toyota/Tests RAVE. In the Aims, copper wires are wrapped around stator and rotor with insulated copper or aluminum bars inserted in the rotors.

A voltage in the motor windings creates current flow that produces a magnetic field. The field flows through the rotor at the same point. The motor controller switches the voltage from one winding to the next winding, causing the genetic field to change location, and the rotor follows the magnetic field. Thus the rotor rotates. The rotors of IM motors are similar with PM motors'. However, the differences between them are in the rotors. Figure 6 shows the differences between them. Fig. 6 Structures of PM motors and IM motors.

Because the induction motors only have copper or aluminum bars inserted in the rotor, the motor can produce low torque values at high speed with high efficiency. At high speed and low torque, both the stator field and the rotor field can be small, so the magnetic losses are low. 2. Switched Reluctance Motors square wave unpopular currents. Although the mechanical integrity of the rotor permits high-speed and high-power density operation and the SRAM has the simplest mechanical design, the machines are extremely noisy during the operation.

Besides, due to their higher torque pulsations, lower efficiency, and larger size and weight (than PM machine), the design is not advanced. Although the motors are used by automotive companies from early sass for EVE propulsion, because of several problems with the motors and the development of IMP motors, the use of the motors declined. However, since the cost of rare earth magnets soaring, the interest of SRAM genealogy for EVE applications increases. Now, several automotive companies Japan Ended are in the process of studying SRAM for EVE propulsion system.

One of the methods to reduce noise in SRAM is to use a double-stator configuration, which features high torque density, low inertia, and reduced acoustic noise compared with the conventional SRAM. The motor has an optimized pattern of magnetic flux paths within the electrical machine that is claimed to provide at least twice the torque density of conventional SIR machines. Two stators inside machine cancel the radial force that would minimize the noise during normal operation. . Synchronous Reluctance Motors Synchronous reluctance motors (Synonym) technology which operates at synchronous speed combines the benefits of IM motors and PM motors.

It also provides the robustness of induction motor: the size, efficiency, and synchronous speed operation of PM motor. The stator of the Synonym is similar to an induction motor or a PM motor with distributed windings. The rotor is designed to produce the smallest possible reluctance in one direction and the highest reluctance in the perpendicular direction. These motors are fault tolerant like induction motors because there is no lug in the rotor when the stator windings are not energize. One disadvantage of Synonym is poor power since it increases the size of the motor drive.

To achieve a high power factor in these machines, a large saliency ratio is required, but this results in a relatively large reactive power that will cause the size of the inverter to increase. The large saliency can be achieved by both axial and transversally laminated Synonym rotor structures. Figure 7 shows a modern axially laminated rotor. With a high direct axis inductance Old and a low quadrate axis inductance LLC, the saliency ratio could be sigh to enable the Synonym operate at a better power factor. Fig. 7 Axially laminated synchronous reluctance machine 4.

PM-ASSiSt synonyms In order to achieve higher power factor, a small amount of AMPS to the synchronous reluctance motors has been investigated. This calls PM-Assist Synonyms. Through the right selection of permanent magnets and the suitable efficiency optimization control, the performance could be similar with PM motors. Figure 8 shows a version of PM-assist Synonyms in EVE applications developed by Brush of Switzerland. Fig. 8 PM-assist synchronous reluctance machine. PERFORMANCE OF ELECTRIC VEHICLES Generally, the maximum and continuous velocity, grade ability, acceleration and vehicle is determined by the battery energy content.

In contrast, the energy conversion efficiency for internal combustion energy and diesel combustion energy only has about 30% and 40%. Besides, electric vehicles can be finely controlled and provide high torque from rest and do not need multiple gears to match power curves. This removes the need for gearboxes and torque converters, which is unlike internal combustion engines. Eves almost release no air pollutants when they are operated. Due to their high efficiency of electric energy compared to combustion engines, the net CO production from an electric car is only about one-half to one-third of that from a combustion vehicles.

Compared to the combustion energy, the design and placement of electric motors is relatively flexible. Due to different conditions, motor could be more than one, and it could be placed in main reducing gear, gearbox, wheel hubs, etc. The design could extremely enable vehicle design more flexible according to various vehicle types. 2. Disadvantages Many electric designs have limited range because their low energy density of batteries compared to the fuel of internal combustion engine vehicles. Batteries of Eves have long recharging time compared to short process of refueling a tank of combustion energy vehicles.

Besides, motors could not be used a long time as the coil could overheat. The damage of overheating batteries is serious. A battery " comfort zone" lines between CHIC and CHIC. However, temperature of operating a battery is usually at CHIC instead of CHIC which could halves its service life. So far, conventional cooling systems have not reached their full potential, either by air cooling or water cooling. In addition, electric vehicles also have weaknesses such as omelet electric energy transferring from battery to wheels, controlling system and high requirements for electric management.

CONCLUSION Through searching a large amount of references, the paper has reviewed electric vehicle technology. Electric vehicle technology experiences a long time developments. Structure of electric vehicles could be different according to number of motors. As the critical part of the technology in Eves, propulsion system consists of energy storage system, power electronics system, electric motor. Since the role of motor is converting energy supplied by battery into energy to provide power to wheels, the paper gives more details about motors. PM motors are widely used in model cars.

However, due to rare material and cost, researchers are planning to find more motor options which can replace PM motor. There are four options listed in the paper to motors, pm-assist synonyms. The performance of electric vehicle technology in cars is also shown in the paper where smaller cars have higher better results. After comparing advantages and disadvantages, EVE technology has more pros than cons. In a short time, Eves technology might not be used widely, it might be accepted as main rend due to increasing environmental and cost concerns with development of vehicle.