Recent Development on Electric Vehicles

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Abstract

This paper provide 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, brakingsystem,ABS,batterymanagementsystems,BMS,Inverter

1.INTRODUCTION:-

Electricalvehicle(EV)basedonelectricpropulsionsystem.No internal combustion engine is used.All thepowerisbasedonelectric powerasthe energysource.Themainadvantageisthehighefficiencyinpowerconversionthroughitspropositionsystemofelectricmotor.Recently there has been massive research anddevelopment work reported in both academic and industry.Commercialvehicleisalsoavailable.Manycountrieshave provided incentive to users through lower tax or taxexemption,freeparkingandfreechargingfacilities.
On the other hand, the hybrid electric vehicle (HEV) is analternative.Ithasbeenusedextensiveinthelastfewyears.Nearly all the car manufacturers have at least onemodel in hybrid electric vehicle.The questions come tous: Which vehicle will dominate the market and whichone is suitable for future?This paper is to examine therecentdevelopmentofelectricvehicleandsuggestthefuturedevelopment inthearea.

2.EVANDHEV:-

HEV has been promoted extensively in the last decade.Nearly each manufacturer has at least one HEV in themarket.It is supposed to rescue the battery energystorageproblematthattime.Usinghybridvehicleitallowstheelectricpowercanbeobtainedfrom engine.The HEV is broadly divided into series hybrid and serieshybrid. The engine power of the series hybrid is connectedtotally to the battery.All the motor power is derived fromthe battery.For the parallel hybrid, both the engine andmotor contribute the propulsion power.The torque is thesum of both motor and engine. The motor is also used as agenerator to absorb the power from engine through thetransmission.Bothe series or hybrid can absorb powerthroughregenerationduringbrakingordeceleration

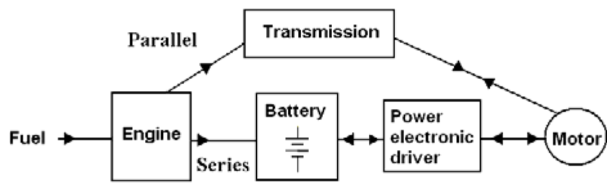


Fig1:TheseriesorparallelpathofanHEV

Nevertheless, HEV still has emission. The introduction ofplug-inHEVthatsolvessomeoftheproblem. Itaccepts the electric power to battery through plug in fromthe mains.Therefore when convenient, users may chargethebatteryusing ACfromthe mains.

3.THEKEYCOMPONENTSINEV:-

The electric vehicle is rather simple in structure.The keycomponents are the propulsion parts.Fig 2 shows theconfiguration.

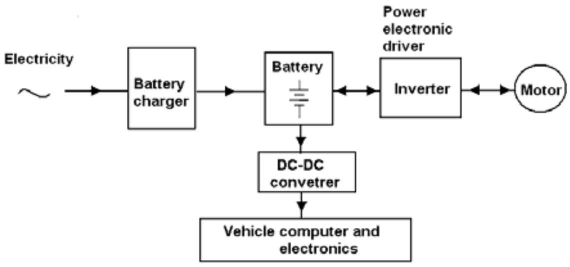


Fig2:ThekeycomponentsofanElectricVehicle.

Thebatteryisthemainenergystorage.Thebatterycharger is to convert the electricity from mains to chargethebattery.ThebatteryvoltageisDCandIisinvertedintoswitched-modesignalthroughpowerelectronicinvertertodrivethemotor.Theotherelectroniccomponents in a vehicle can be supplied to the batterythrough DC-DC converter that step down the voltage fromthebatterypack tolower voltagesuch as5V-20V.

5.THEMOTO:-

Thereareanumberofmotorsavailableforelectricvehicle:DCmotors,Inductionmotor,DCbrushlessmotor,Permanentmagneticsynchronousmotorandswitchedreluctancemotor

A.DCmotors:-

It is a classical motor and has been used in motor controlforalongtime.Allthepowerinvolvedinelectromechanical conversion is transferred to the rotorthrough stationary brushes which are in rubbing contactwith the copper segments of the commutator. It requirescertainmaintenanceandhasashorterlifetime.However, it is suitable for low power application.It hasfound applications in electric wheel-chair, transporter andmicro-car.Today, most of the golf-carts are using DCmotors.Thepower levelis less than4kW.

B.Inductionmotor:-

It is a very popular AC motors.It also has a largemarket share in variable speed drive application such asair-conditioning,elevatororescalator.Manyofthehigherpowerelectricvehicles,formorethan5kW,usesinductionmotor.Usuallyavectordriveisusedtoprovidetorqueand speed control.

C.DCbrushlessmotor:-

The conventional DC motor is poor mechanically becausethe low power winding, the field, is stationary while themain high power winding rotates. The DC brushless motoris "turned inside out.The high power winding isputonthestationarysideofthemotorandthefieldexcitationisontherotorusingapermanentmagnet.The motor has longer life time than the DC motor but is afew times more expensive.Most of the DC motor can bereplacedbythebrushlessmotorwithsuitabledriver.Presently,itsapplicationsfindinlowpowerEV

D.Permanentmagneticsynchronousmotor:-

The stator is similar to that of an induction motor.Therotor us mounted with permanent magnets. It is equivalenttoaninductionmotorbuttheair-gapfiledisproducedbya permanent magnet.The driving voltage is sinewavegeneratedbyPulseWidthModulation(PWM).

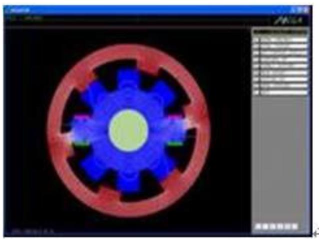
E.Switchedreluctancemotor:-

It is a variable reluctance machine and its famous recentlybecauseofthefaulttolerancebecauseeachphaseisdecoupled from other.The power stage is different fromother the motor discussed in 2-4.Each phase winding isconnectedinaflybackcircuitstyle

6.DIRECTDRIVEAND IN-WHEELMOTOR:-

Direct drive reduces the loss in the mechanical units of thedrivetrain.Themotorisconnecteddirectlytotheshafttoreduceneedsoftransmission,clutch,andgearbox.Recently the in-wheel motor is promoted by researcherThe in-wheel motor is to turn the rotor inside out andattached to the wheel's rim and the tire. There is no gearboxanddriveshaft.Fig3showsthein-wheel motor.

a)Hardware



b) FEM model

Fig3:The in-wheelmotor

Themotorisalsocalledwheel-hubmotor.Itsmainadvantage is the independent control of each wheel. Fig 4shows the 4-wheele drive vehicle.Each of the wheelsworks any speed and direction.Therefore the parallelbarking can be achieved easily.The Anti-lock brakingsystem can be implemented easily by the technology.Ithas been shown that it can successfully prevent spinout.Thewholevehicle is much simpler in structure.

Many different types of motor can be used for in-wheelmotor.Theprominentoneistheswitched-reluctancetypes.Its phase-winding is independently from each andtherefore the fault tolerance is much more advanced thattheother.Thereisnopermanentmagneticinthemotor,itreduces any interference by permanent fieldandthefluctuationofthepermanentmagneticmaterials.

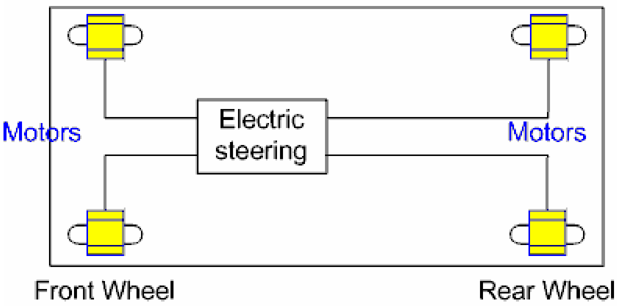


Fig.4:True4-wheeldrivevehicle.

7.ENERGYSTORAGE:-

A.Batteries-

Thebatteryisthemainenergystorageintheelectricvehicle.The battery in-fact governs the success of theelectric vehicle .Recently there are massive worksbeing reported in battery development. The battery suchas Li-ion is now being used by new generation of electricvehicle.The danger of the instability of the battery hasbeenstudiedbymanyreported.ItseemsthattheLi$FePO_4$ type is preferable because of its chemically stableandinherentlysafe.OtherLi-ionsuchas$LiCoO_2$,$LiMn_2O4$ and $Li(Ni_{1/3}Mn_{1/3}Co_{1/3})O_2$ may has the thermaland overcharge concern .For low cost solution, thelead-acid battery is still dominant part of the market.Thebatteryhasfoundapplicationsinelectricwheelchair,Golf-cart,micro-carandneighborhoodtownair.TherecentRoHShasalsostoppedtheuseofNiCdbattery.

All the research is looking towards the fast charging forbatteries.MIT reported the technology of a crystalstructurethat allows 100timesofchargingspeedthanconventionalLi-ionbattery.Otheralternativeistouseultra-capacitor.

B.Ultra-capacitor:-

Capacitorisbasicallyastaticcomponent.Thereisnochemical reaction in the components.Its charging anddischarging speeds are very fast.However, the energystorage is limited.Its energy storage density is less than20%ofthelead-acidbattery.Althoughtheexpectedultra-capacitordensitywill go upin next fewyears,itstotal solution for main energy storage is a challenge.Thenumber of cycles and the temperature range is excellent

8.CHARGINGSYSTEMS:-

1. Generalcharger:-

Thechargerneededforthebatterysystemforslowchargingor fast charger are both required to handle highpower.TheH-bridgepowerconverterisneeded.Fig5showstheconverter.Theconverterisfamousforits efficiency and has found application in charger andDC-DCconverter.

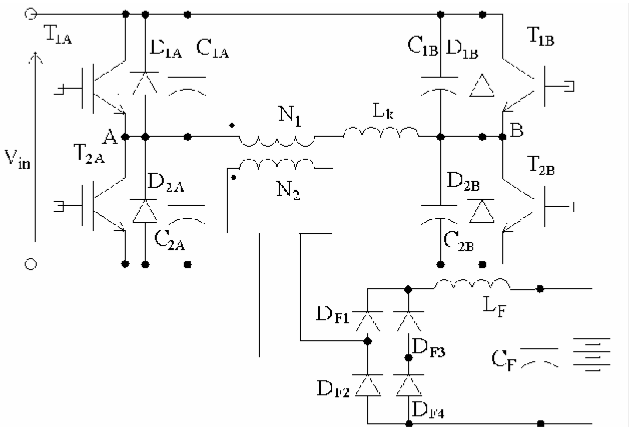


Fig5:TheH-bridgeconverterforcharger

2. Ultra-capacitorcharger:-

Thevoltageontheultra-capacitorvariousfromthefull-voltage to zero when nits energy storage varies fromfulltozero.Thisisdifferentfromthebatteryasitsvoltage will only varies within 25%. The capacitor voltageis internal point and is not in contact with users.Thetransformer isolated converter is not necessary.A tappedconverter should be used as it will have higher efficiencyfor power conversion.The efficiency of the powerconverter is higher than the transformer-isolated version.Thestructure is simple.

3. Energymanagementsystems

Evenforultra-capacitorsystem,theenergystorageismade by a number of capacitors or in a combination withother energy storage devices such as battery. The sameconditioning monitoring and management system will beused.

9.CHARGINGNETWORK:-

1. Chargingnetwork

The charging method of EV is controversial because of theuncertainty of the power needed, location and the chargingtime.The charging time of batteries has been reported tobeshorterintherecentdevelopment.Thelead-acidbatteries are restricted by its technology. The chargingrate is less than 0.2C and quicker charging rate seriouslyshortens its life time.Other battery such as Li-ion hasrecommendedchargingrateof0.5C.

Usually most of the electric vehicles have an on-boardbatterycharger.A power cableisconnectedfrom thevehicle to a charging point.A charging station shouldprovideanumberofpowerpointsandasuitabletransactionprogramtocalculate thetariff.

Thepowerneededforthechargingstationisnotaconcern.Usually for private car, a standard charging power is lessthan 2.8kW. Single-phase power line is used. In average avehicleisneededtobechargedevery3days.UsingHongKongasanexample,itwillonlyaffectthepowerconsumption of less than 2% even all the private cars arechargedto EV.

10.BRAKINGANDSTEERING:-

1. Brakingandpowerregeneration

The braking of a vehicle in the past based on mechanicalsystem such as disc brake.The braking method of an EVshouldbeintegratedwithbothmechanicalandtheelectricalbraking.Intheinitialregionofthebrakingpedal, it electrical power regeneration braking should beapplied.This is usually for deceleration or going down aslope, the kinetic energy of the vehicle can be returned tothe battery. The final region of the braking, mechanicalbrakingisused.Thisprovidesacompromiseoftheenergysavingand safety.

Today,wecanmakemotorswithhighpowerofregeneration that is in the expenses of the motor size, acompromisebetweenthemotorweight,cost,powerregenerationefficiencyandsafetyareneeded.Toincrease the region of the power regeneration, the motorshould be made with acceptance of the high power designplugging mode which is to provide high reverse torque tostopthevehicle.Themotordriveshouldalsobeimplemented with high frequency decoupling capacitor toabsorbthefasttransientof thereversecurrent.

2. SkidSteering

Steering is achieved by differentially varying the speeds ofthelines of wheels on different sides ofthevehicleinorder to induce yaw. To satisfy the requirement of theturn radius, the longitudinal slip must be controlled, so amethodofsliplimitationfeedbackisusedinthesimulation.Whenthevehicleisturningonaslipperysurface,becauseofthedropatthecoefficientofroadadhesion, the drive wheels may slip. The traction controlsystem reduces the engine torque and brings the slippingwheels into the desirable skid range. Fig 7 shows thelocusof skidsteering fordifferentturnradius.

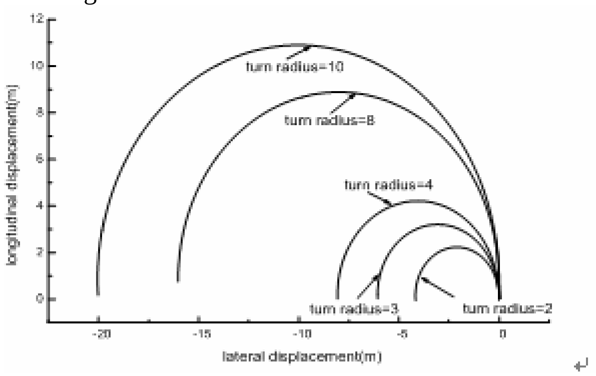


Fig6:Locusofdifferentturnradiusachievedbyskidsteering

11. SUSPENSION

The developed direct-drive linear motor actuator for theautomobile active suspension systems can generate controlforces to absorb road shocks rapidly, suppress the roll andpitchmotions, andamelioratebothsafety andcomfort,while maintaining the vehicle at a horizontal level. Forconventional passive suspension systems, it is difficult tobeachieved,sinceasoftspringallowsfortoomuchmovement and a hard spring causes passenger discomfortduetoroadirregularities.Thus,significantimprovementof suspension performance is achieved by the direct-drivelinearswitchedreluctanceactuator.Comparingwithhydraulic active suspension systems, the developed activesuspensionsystembasedonthedirect-drivelinearswitchedreluctanceactuatorissimplersinceitneedsfewer devices and mechanical parts. Due to no hydraulicdevices,thisisanoil-freesystem.Furthermore,itcaninclude the energy generation from the suspension. Thedevelopmentincludesthedesignofdirect-drivelinearswitched reluctance actuator, its characterization, and thedesign of the automobile active suspension system. Theconverter drive is also needed to develop to match with thelinear switched reluctance actuator. The drive is expectedto fit the driving pattern of the suspension system and toprovide suitable force control, energy generation controland position control. Fig 8 shows a prototype design ofanactivesuspension system.

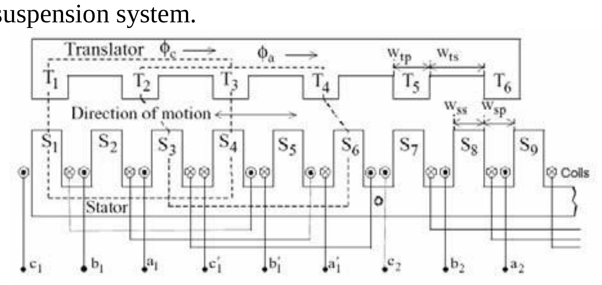


Fig7:Active suspensionbasedonlinearmotor.

12. CONCLUSION:-

This paper discusses the recent development in electricvehicle.Thepaperfirstdescribesgeneralstructureanddiscusses the energy storage.It then extends to the futurevehicle components.The paper provides an overview oftherecent EVworkin theregion

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