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Individual Wheel Drive in Electric Vehicles

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ABSTRACT: Electric motors offer great potential towards a high control individual wheel drive system. By driving each wheel by a separate motor, a very high precision control over speed and torque on individual wheel can be achieved. A small model controlled by a Bluetooth module has been made to study the effect to steering the vehicle with and without differential drive. The system uses 4 PMDC motors connected to four wheels through reduction gears to increase the torque, and a stepper motor for steering. This model is controlled by a smartphone via Bluetooth.

KEYWORDS: Individual wheel drive, greater traction, high control, high efficiency, 360˚ rotation.

I. INTRODUCTION

Nowadays there is a need for sustainable development due to the scarcity of fuel. The best possible solution is to use renewable sources of energy. Electricity is readily available from renewable sources like wind, solar, etc. and can be easily replenished through batteries. Electricity has the added advantage of not producing any pollutants unlike fossil fuels.

Electric motors have advantage of producing instant torque. It can be easily controlled through power electronics circuits. Electric motors can replace IC engines along with transmission systems. As electric motors do not have gears, the losses in transmission system are entirely removed. The electric motors controlled by power electronics circuits produce linear torque without any interruptions or disturbances.

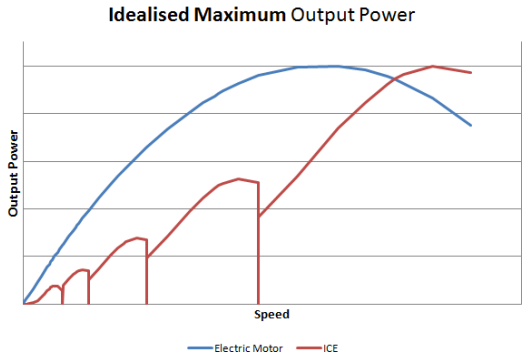

Fig 1: characteristics of motor vs IC engine with transmission.

The car model, the authors are working on, is able to make a 360˚ on the spot rotation using differential drive (rotating say right sided wheels forward and the left sided wheels backward).

The pros of electric cars are as follows:

They are energy efficient.Electric vehicles typically convert 59%-62% of the electrical energy from the grid to power the wheels, compared to conventional gas vehicles, which typically convert 17%-21% of the energy stored in gasoline to power at the wheels.

Electric motors are easy to maintain.Electric motors have fewer moving parts than internal combustion engines, so they're often easier to maintain. They also don't require oil or air filter changes.

Electric motors have low fuel costs and are eco-friendly. Electricity is cheaper than petroleum. Electric cars are about one-third cheaper to operate than gas cars on a cost-per-mile basis.With no exhaust system, electric cars typically have zero emissions. Their rechargeable batteries are also almost 100% recyclable.

Electric cars are safe to drive. Electric cars undergo similar testing as gas-powered cars. In an accident, airbags will deploy and electricity is cut from the battery. Plus, the fluid batteries actually take impact better than a gas car.

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While electric vehicles are advantageous, they also have their own disadvantages. They are as follows:
Electric vehicles have a shorter driving distance when compared to IC engine powered vehicles.The average range on one battery charge is 50-100 miles – not ideal for those with a substantial commute.
Batteries used have a long recharge time.Several hours to recharge compared to simply filling up at the gas pump.the batteries used are expensive.The high density battery is a lot more expensive when compared to IC engines.
Lastly, Electric vehicles have limited space for users.Electric cars often have room for only 2 occupants.

II.MECHANICAL CONSTRUCTION

The figure below shows individual wheel drive system.As each wheel is powered by a separate motor, greater traction control is achieved, compared to Front wheel drive or Rear wheel drive, in which, the non-powered wheels also contribute to the resistance but doesn't contribute much to traction. The gears are only used to increase the torque.
An Electric vehicle with individual wheel drive has greater control. These vehicles don't need long and heavy duty shafts, central gear system, and mechanical differentials which makes it much lighter and efficient.

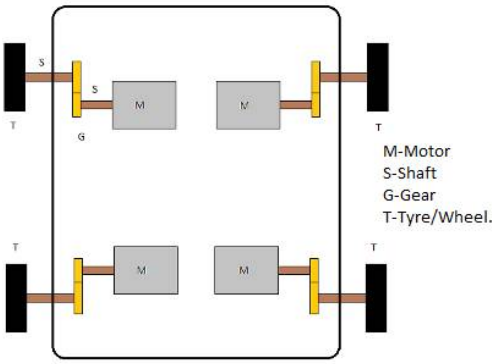

Fig 2: Individual wheel drive.

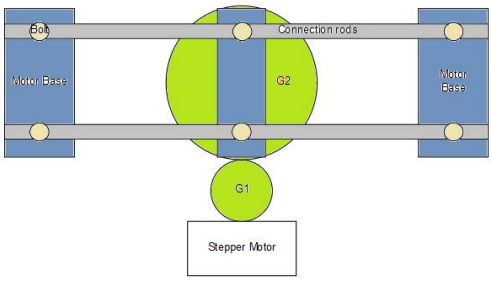

Fig 3: Basic steering system.

The motors that are used in these vehicles are commonly Wheel hub motors, since no transmission components are then required. The figure below describes the basic steering system incorporated in the model car. When the stepper motor rotates, the gears and so the central support rotates. This makes the motor base and hence the entire wheel assembly rotates.

III.LOGICAL CIRCUIT & POWER CIRCUIT

The model car consisting of 4 PMDC motors and 1 stepper motor has 12V power circuit and 5V logical circuit. It has an ATmega328P microcontroller (master) assisted by an Atmega8A microcontroller (slave, only controls stepper motor).
The Atmega328P receives signal from user via Bluetooth module HS05 and for the steering purpose alone sends signal to Atmega8A.
The motors used for driving are PMDC motors with rating of 12V, 2A and 1200rpm.And for steering a stepper motor with 5V, 200mA, and 1.8 ˚ / step is used with half step algorithm.
To control the power delivered to the PMDC motors, L298 driver circuit is used, which multiplexes 5V logical signal from microcontroller with 12V power supply (fed to motors).
To control the stepper motor, L293 circuit is used. L293 in comparison to L298 produces lesser drive current. As the stepper motor used needs lesser drive current, L293 is used to drive it.
The battery used in this prototype is high density Li-ion battery, which gives a net output current of 5.2A at 5V with a net capacity of 11000mAh.
The XL6009 chopper circuit is capable of both buck and boost conversion. The circuit in this model steps-up 5V input from the battery to 12V for the operation of power circuits.
The regulators along with capacitors make the output voltages stable. To get 5V output, IC 7805 is used, and for 12V is IC 7812.

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The Bluetooth module HS-05 is used. It gets signals from the smartphone with the user and sends it to the microcontroller.

IV.CLOSED LOOP CONTROL

To achieve greater control over the speed of the PMDC motors, a closed loop control is required.
The loop consists of a shaft encoder, which detects rotation of motor shaft and sends pulses to microcontroller. These encoders are mounted onto the shafts of the motors. It has two parts, Optical encoder disk and Detector (MOC 7811).The detector detects the breaks in the disks and sends pulses to microcontroller which then calculates the speed of motor shaft in rpm.

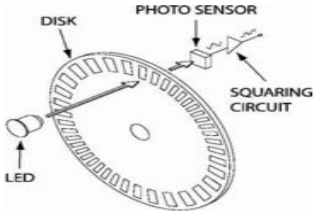

Fig 4: Optical shaft encoder.

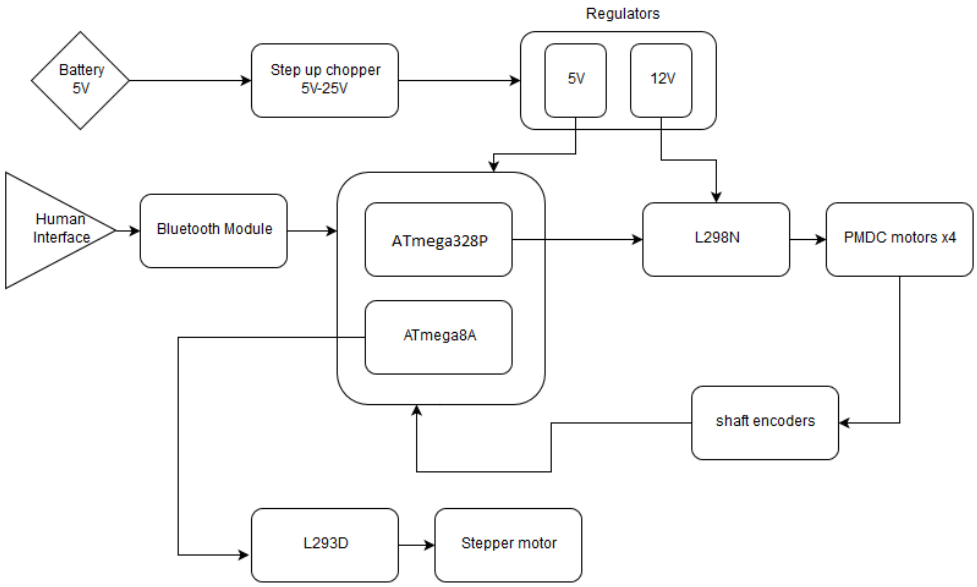

Fig 5: Block diagram of the Electric car model.

V.APPLICATIONS

It can be used in Fast and zippy cars for the average consumer for use on roads.
The concept can be used for space rovers.
Individual wheel drive has an advantage in surveillance bot's control, etc.
Also it can be used in Military purposes where agile vehicles are required (the war tanks generally uses all-wheel drive which almost resembles individual wheel drive).

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VI.CONCLUSION

The electric vehicles perform better than IC engine powered vehicles. With increased control on traction, torque, speed, it is more advantageous. Incorporating differential drives in the vehicles increases its efficiency and stability.

VII.RESULT

The individual wheel drive performs better than IC engine powered vehicles as, in individual wheel drive, by using power electronic circuits, all the wheels are powered and controlled and can make use of differential drive which makes it more stable and more tractive without introducing the weight of any transmission or differentials used in vehicles with IC engine, and can perform a 360˚ on the spot rotation using differential drive, which makes it easier for the user to park the vehicle.

VIII.ACKNOWLEDGEMENT

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