

ANALYSIS OF CONTINUOUS VARIABLE TRANSMISSION BY USING BLDC MOTOR IN ELECTRIC SOLAR VEHICLE

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Abstract:

The objective of electric car project is to make an eco-friendly car with optimum efficiency. The team work of solar car that is capable of operating exclusively off solar power. The current stage of paper is at power transmission. Working on the component required in the power transmission and accurate alignment. The electrical connection is required for the transmission of power from battery to rear wheel through DC shunt motor.

Introduction:

The development of electric vehicle dynamics control technology has been remarkable in recent years. Several types of motors have been used in EV applications among the most promising of them is the permanent magnet brushless motor. With an interior PM installation on the rotor, as well as the elimination of brushes and slip rings, the PM brushless motor provides greater efficiency, higher power density and a simpler structure than other motors. For most, mechanical transmissions such as unitary stage transmissions, multistage transmissions or continuously variable transmissions are needed for the power transfer between the load wheels and the driving motor to achieve a wide range of speed control required for Electric vehicle. Recently CVTs have been used more due to their smooth transmission. However, the CVT has higher friction losses, and its efficiency is lower than the mechanical transmissions mentioned previously. In order to overcome this problem, this paper considers the case of using a single stage transmission and uses a so-called controlled CVT. This combines normal operation, phase advance and field weakening control for driving the interior type motor in an electric application.

The BLDC motor is widely used in applications including appliances, automotive, aerospace, consumer, medical, automated industrial equipment and instrumentation. The BLDC motor is electrically commutated by power switches instead of brushes. Compared with a brushed DC motor or an induction motor, the BLDC motor has many advantages:

1. Higher efficiency and reliability.
2. Lower acoustic noise.
3. Smaller and lighter.
4. Greater dynamic response.
5. Better speed versus torque characteristics.

6. Higher speed range and Longer life.

STATOR

The stator of a BLDC motor consists of stacked steel laminations with windings placed in the slots that are axially cut along the inner periphery. Traditionally, the stator resembles that of an induction motor; however, the windings are distributed in a different manner. Most BLDC motors have three stator windings connected in star fashion. Each of these windings are constructed with numerous interconnected coils, with one or more coils are placed in the stator slots. Each of these windings are distributed over the stator periphery to form an even numbers of poles. As their names indicate, the trapezoidal motor gives a back trapezoidal EMF.

ROTOR

The rotor is made of permanent magnet and can vary from two to eight pole pairs with alternate North (N) and South (S) poles. Based on the required magnetic field density in the rotor, the proper magnetic material is chosen to make the rotor. Ferrite magnets were traditionally used to make the permanent magnet pole pieces. For new design rare earth alloy magnets are almost universal. The ferrite magnets are less expensive but they have the disadvantage of low flux density for a given volume. In contrast, the alloy material has high magnetic density per volume and enables using a smaller rotor and stator for the same torque. Accordingly, these alloy magnets improve the size-to-weight ratio and give higher torque for the same size motor using ferrite magnets.

HALL SENSOR

Unlike a brushed DC motor, the commutation of a BLDC motor is controlled electronically. To rotate the BLDC motor, the stator windings should be energized in a sequence. It is important to know the rotor position in order to understand which winding will be energized following the energizing sequence. Rotor position is sensed using Hall Effect sensors embedded into the stator. Most BLDC motors have three Hall sensors embedded into the stator on the non-driving end of the motor. Whenever the rotor magnetic poles pass near the Hall sensors, they give a high or low signal, indicating the N or S pole is passing near the sensors. Based on the combination of these three Hall sensor signals, the exact sequence of commutation can be determined.

CONTINUOUS VARIABLE TRANSMISSION (CVT)

A continuously variable transmission (CVT), also known as a single-speed transmission, step less transmission, pulley transmission. A continuously variable transmission, or CVT, is a type of automatic transmission that provides more useable power, better fuel economy and a smoother driving experience than a traditional automatic transmission. Conventional automatic transmissions use a set of gears that provides a given number of ratios. The transmission shifts gears to provide the most appropriate ratio for a given situation. Lowest gears for starting out, middle gears for acceleration and passing, and higher gears for fuel-efficient cruising.

The CVT replaces the gears with two variable-diameter pulleys, each shaped like a pair of opposing cones, with a metal belt or chain running between them. One pulley is connected to

the engine as input shaft and the other to the drive wheels as output shaft. The halves of each pulley are movable as the pulley halves come closer together the belt is forced to ride higher on the pulley, effectively making the pulley's diameter larger.

Changing the diameter of the pulleys varies the transmission's ratio the number of times the output shaft spins for each revolution of the engine, in the same way, that a 10-speed bike routes the chain over larger or smaller gears to change the ratio. Making the input pulley smaller and the output pulley larger gives a low ratio a large number of engine revolutions producing a small number of output revolutions for better low-speed acceleration. As the car accelerates, the pulleys vary their diameter to lower the engine speed as car speed rises.

NEEDS OF CVT

Engines do not develop constant power at all speeds; they have specific speeds where torque speed power or fuel efficiency are at their highest levels. Because there are no gears to tie a given road speed directly to a given engine speed, the CVT can vary the engine speed as needed to access maximum power as well as maximum fuel efficiency. This allows the CVT to provide quicker acceleration than a conventional automatic or manual transmission while delivering superior fuel economy.

NEEDS FOR SPEED

The belt used in CVT transmission system would be able to take any shape whether it is allowed to perform any motion. The consideration of belt is just used for amplifying the transmission. It is a constant scale that makes it variable scale within same dimensions.

CALCULATIONS

On the basis of our electric car, there is a great beneficial result by acquiring the motion transmission by using CVT. There is a calculation of CVT using BLDC motor. There is a starting torque and ending torque calculation and calculations of top speed.

- **STARTING TORQUE**

1. TOTAL TORQUE ON MOTOR = 35N-m. # motor to pulley ratio size=1/1.25
2. SPROCKET MULTIPLIER= $35/2.5=14$
3. CVT MULTIPLIER = $14*2=28\text{N-m}$
4. SPROCKET MULTIPLIER ON WHEEL END = $28\text{Nm} *6 = 168\text{N-m}$.

- **ENDING TORQUE**

1. TOTAL TORQUE ON MOTER = 35N-m.
 2. SPROCKET MULTIPLIER = $35/2.5=14\text{N-m}$ # motor to pulley ratio is 0.5
 3. CVT MULTIPLIER = $.5 * 14\text{Nm} = 7\text{N-m}$
 4. SPROCKET MULTIPLIER ON WHEEL END = $7\text{N-m} * 6 = 42\text{N-m}$
- TOP SPEED
 1. SPEED OF MOTOR = 3000rpm
 2. SPROCKET MULTIPLIER = $2.5 * 3000\text{rpm} = 7500\text{rpm}$
 3. CVT MULTIPLIER = $7500*2=15000\text{rpm}$.
 4. SPROCKET MULTIPLIER ON WHEEL END = 2500rpm.

By the above calculation it is noted about all the starting and ending torque on CVT transmission by using BLDC motor. In comparison with the vehicle without CVT there is calculation for that by taking an optimum value as possible as 3.

- Typical Scenario

Starting torque on motor = 35N-m

End torque = 14N-m

Top speed = 3000rpm

By acquiring an optimum value as 3 thereafter

1. Starting torque = $35\text{N-m} * 3 = 105$
2. Ending torque = $14\text{N-m} * 3 = 42$
3. Top speed = $3000/3 = 1000\text{rpm}$

CONCLUSION

Hybrid vehicle composed of a fuel cell and battery is enough to guarantee energy supply. The driving performance of electric vehicle is closely related to the torque-speed. The BLDC motor has several benefits when it will come across in automobile industries. It creates high dynamics response and having high efficiency. It generates long operating life due to a lack of electrical and friction losses. The cost of the Brushless DC Motor has declined since its presentation, because of progressions in materials and design. This decrease in cost, coupled with the numerous focal points it has over the Brush DC Motor, makes the Brushless DC Motor a popular component in numerous distinctive applications.

Wheels	Without cvt	with cvt
Torque	105N-m	168N-m ↑
rpm	1000rpm	2500rpm ↑

REFERENCE

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- www.autoshop101.com
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