Technical Review Paper Evaluation Form

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_____ / 30 Technical Content

- Current state-of-the-art and commercial products
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- Implementation of the technology
- Overall quality of the technical summary

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ECE4011–Culminating Design Project

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Electric Motor Control for Solar Commuter Car

Introduction

Commute Car had been the top popular choice of transportation, but most of the Commuter car is using gas as fuel. It is usually is small in size when carpool is absent and it will be not suitable to run on gas which producing a large volume of greenhouse gases. Therefore, it will not be good in the long run. Sun radiation is kind of "free energy" that provided to everyone and it is can easily be harvest during the day and it will be the alternate source for cleaner fuel for cars. This technical review will briefly summarize the difference between AC and DC motor, the design for motor control, and commercial of the electric motor for Commute Car.

AC motor vs DC motor

In the physical world, the AC motor and DC motor vary differently. DC motor has high efficiency and about 30% more efficient than AC motor, but it loses efficiency in initial resistance in the winding and brush friction and eddy current losses [1]. DC motor also beneficial in basic motoring and generating modes without any power electronic converter, if the battery is used as an electrical source or load [3]. On the other hand, AC motor is consuming additional energy due to the magnetic field is generated by the current in the rotor, but it required minimal maintenance [2] because AC motor does not have brushes and since the mechanism is completely different with DC motor. Brushes that located in the DC motor must be replaced periodically and the commutator needs to be clean. Furthermore, DC motor is having a strong heat produced due to the current flow in the windings, large friction due to contact between brushes and commutator which is difficult to remove because the winding is installed on the rotor rather than stator [3]. During the operation, DC motor might produce lots more noise compare to AC system due to the large friction that available in DC motor.

In consideration for customer usage and maintenance for solar commute car, AC motor will be a better choice as it required little maintenance. Even AC motor had a lower efficiency, it still outweighs the DC motor.

Motor control

Motor control for AC motor is much complicated compared to DC motor because AC motor is a multivariable coupling, time-varying, and non-linear system. J-M transformation strategy is one of the strategies to control the AC motor with the strategy of vector, and torque control strategy. The main reason for this strategy is to separate the torque into positive and negative torque and controlled it directly to increase the efficiency of the motor control but it doesn't have much real-time performance of the ac motor [4]. Besides, AC motor also required a real-time sensor to control precisely, some research is developed on the way to control AC motor sensorless. Sliding- mode observer is one of the sensorless vector control for AC motor with using the Lyapunov theory as an observer. This method provides good performance for low and high-speed motor operation and the experiment control scheme is suitable to the field that requires high performance of torque response such as Electric vehicle [5].

Presently, there are lots of motor control for the DC motor. For example, a brushed DC motor can be controlled using Robust Indirect Adaptive Control which relies on on-line identification of plant parameter. The controlled system efficiency can be increased, as the exact parameter is required to design the system, however, this is hard to perform in real life because it does not implement the actual DC motor as the stimulation is still under ideal case [6].

Commercial Motor controller

AC motor controller is much complicated compared to DC motor controller due to the complexity of the AC system and the average pricing for it is about USD900. The Curtis Instruments have an AC motor controller (Curtis 1234 SE) that is suitable for daily usage for Solar Commuter Car for USD 844.99 [7]. This Controller has high efficiency and field-oriented motor control algorithms and included PWM technology that is more efficient to use of battery voltage to produce low motor harmonics and low torque ripple [8].

The DC motor controller is cost much cheaper, for example (KBWM-120 (9380)) which is cost about USD 98 for each controller and can supply a voltage range from 0V to 90 V. This controller is designed specifically for permanent magnet DC motor. The maximum horsepower is about 0.33 and the controller also included a safety feature like interrupt to determine whether the motor is under the normal condition [9].

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[2] MET Motors, “Why use DC motors instead of AC motors?,” *MET Motors*, 2017. [Online]. Available: https://www.metmotors.com/use-dc-motors-instead-ac-motors/ [Accessed: Sept. 28, 2019].

[3] D. G. Taylor. ECE4550. Class Lecture, Topic: "Essentials of DC Machine Systems." School of Electrical and Computer Engineering, Georgia Institute of Technology, Atlanta, GA, Sept. 24, 2019.

[4] J. Shen and W. Dai, “A New AC Motor Control Strategy--J-M Transformation Control,” *IEEE Potentials*, vol. 30, no. 1, Jan., pp. 39 - 44, 2011.

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[8] Curtis Instruments, Inc., Manual Models 1234, 1236 &1238 AC Induction Motor Controller OS 11with VCL, Ver. 1. [Online]. Available: http://www.thunderstruckev.com/Manuals/1234_36_38%20Manual%20Rev%20Feb%2009.pdf

[9] “KBWM-120 (9380) DC Drives, NEMA-1, 115 Vac, Thru 0.33 HP, 0-90 V,” *KB – Controls.* [Online]. Available: https://www.kb-controls.com/product.sc;jsessionid=EE453FA4A9FABAD5E8864EEAE64B0104.p3plqscsfapp001?productId=10 [Accessed: Sept. 28, 2019]