FOC ESC

About the problem statement/reason for innovation of the product

Electric vehicles (EVs) are poised to revolutionize the automotive industry, representing the future of sustainable transportation. Central to the functionality of any electric automotive are its electric motors and their accompanying drivers.

These components are critical in ensuring the efficient management of electric current, as improper power regulation can lead to significant inefficiencies, resulting in reduced vehicle range and diminished speed.

To tackle the diverse challenges faced by EVs in various driving scenarios, such as highway cruising, hilly terrains, or navigating speed bumps, different driving modes are essential.

Cruising mode optimizes speed on highways, while torque mode efficiently handles challenging terrains and obstacles.

The development of efficient motor drivers is necessary for the long-term viability and environmental sustainability of electric vehicles, including maximizing battery life.

Battery life is a pressing concern in the world of electric automotives, with electric motors being the primary power consumers. Any inefficiencies in motor operation can lead to substantial power wastage, ultimately shortening the battery's lifespan and limiting the vehicle's overall range and performance.

Our electronic speed controller (FOC-ESC) design plays a pivotal role in mitigating these issues. Optimizing motor control, contributes significantly to enhancing the performance, range, and efficiency using torque and velocity control modes in electric motors, thereby helping shape a greener and more sustainable automotive future.

How can we solve the issues faced?

WHAT IS FOC, its advantages of being implemented in an ESC?

FOC or field-oriented control or vector control is a method/technology used to control the speed and torque components of the motor, especially used for BLDC motors, induction motors, and synchronous motors.

FOC splits the speed and torque into mathematical vector components that can be controlled individually to achieve a high degree of accuracy with the rotation of the motor.

FOC is designed to improve the performance, efficiency, and controllability of these motors by aligning the motor's magnetic field with the rotor's magnetic field, allowing for precise control of both motor speed and torque.

The use of FOC-based electronic speed controllers can ensure a higher rate of efficiency, and provide precise control of the electric motors' current and voltage. The operation noise of a motor is significantly reduced.

The torque of the motor can be controlled and varied according to the necessity of the vehicle while navigating over challenging terrains and carrying heavy loads. Anti-cogging(reducing the torque ripple) of the motor can be achieved with the help of an FOC-based ESC.

FOC uses mathematical concepts of Clarke transform and Park transform. These concepts play a crucial role in induction motors, AC three-phase motors, and synchronous motors. The Clarke transform helps in converting three-phase quantities to a phase stationary frame as the Parks transform aligns the frame with the rotor's magnetic field orientation.

They help accurately control the motor by independent control over the frames of reference of the current and voltage component.

How is this ESC different from that existing in the market/design innovation done in the project?

The FOC-based ESC and its algorithm/firmware that we have developed is capable of position control and velocity control in both open and closed loops, both with sensor and sensorless.

Any BLDC, PMDC, or synchronous motor has magnets on its stator. The continuous use of the motor can result in the heating of the rotor and the magnets.

Heating causes the magnet of the motor to lose its magnetic property, thereby decreasing the lifespan of the motor. To avoid this we have included a thermistor with a negative temperature coefficient.

The per-phase current can be set and monitored, in order to protect the motor from any unwanted surges of current.

The ESC comes with an onboard MCU that controls the switching of the MOSFETS, this avoids any accidental short circuits that can potentially damage the ESC or batter.

A minimum limit can be set for the battery below which the functioning of the motor is stopped, this helps avoid the draining of the battery completely thereby protecting the chemical composition of the battery.

The ESC can handle an input ranging from 7 volts to 58 volts and can provide 50 amps of current ranges which is sufficient to drive all EV motors.

Future of this technology / With advancements in tech how will this product improve / vision of the product

With the growing power of technology, we can have improved hardware such as powerful and efficient microcontrollers and high-performance MOSFETs, advanced sensors to achieve an overall higher efficiency in the esc's.

Powerful microcontrollers with higher processing speeds can compute the data from the feedback sensors with accuracy and faster processing time. The faster processing speed of the microcontrollers can enable them to have much smoother control over the switching of the MOSFETS.

With advancements in wireless connectivity IOT integration, the condition of the electronics can be remotely monitored, and we can have real-time data analysis and predictive maintenance of the ESCs.

The power of technology can enable us to make the design of the ESC much smaller and compact, saving space where space is constricted.

The energy efficiency of the ESC can be improved by taking real-time power factor correction, regenerative breaking, advanced power management techniques, and better active and passive cooling techniques