Permanent Magnet Synchronous Motor with Innovative Stator-Rotor Structure to Extend Torque and Speed Range

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The innovative structures of the paramagnet synchronous motor in this project makes the BEMF constant be adjustable to reach higher efficiency and mechanical performance of electric cars. One of the innovative structure is the conical magnetic gap, which allow the magnitude of flux in the motor can be adjusted. The torque and speed ratio at a specific input voltage and current changes while adding displacement between stator and rotor. Another innovative structure is adjusting the angle between two set of magnets inside the rotor to control the magnitude of the magnetic vector sum to realize the same purpose. The adjustable flux adapts PMSM motor to various operating conditions without using gearbox. The maximum speeds using different magnetic gaps are tested. Without changing PWM and DC voltage, the speed changes caused by adjusting the magnetic gap proves that adjusting the magnetic gap successfully causes the flux change, and realizes the purpose of changing the back EMF constant (KV value). The experiment used a 24V 50W motor and 24V DC-Link voltage with 100% SVPWM. The no load speed of the motor is approximate 1850, 2240 and 3980 rpm under conditions that no displacement, 0.31mm and 0.62 mm displacement applied to the rotor. The KV value are 77.0, 93.3 and 165 respectively, successfully adjusted BEMF constant using displacement at the rotor. The project realized strengthening the torque at low speed and achieve high speed and high efficiency without flux weakening or gearbox. It improves the efficiency and mechanical performance of electric cars significantly.

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