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A Development of Short-Time Initial Rotor Position Estimation Technology Based on the Magnetic Saturation and Saliency of PMSM for xEV Applications

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Recently, electric motor driven vehicles(xEV) such as hybrid electric vehicle, plug-in hybrid electric vehicle and pure-electric vehicle have been paid attention because of environmental issues. It is important for xEV to improve vehicle's relaiability against electric component failure. In particular, improvement of pure-electric vehicles reliability is important because pure-electric vehicles have only electric motor as its power source. Quality such as low failure rate of each electric component is important but also taking measures to prevent unsafe vehicle's behavior is important in case of electric component failure from viewpoint of reliability imporovement. The one of the taking measure is limp-home mode that enables a vehicles to reach a safe place in case of a vehicle component failure and reduces the possibility of becoming unable to drive. It is necessary to keep the vehicle driving without the failure of one part spreading to other parts in limp-home mode. The faliure of the rotation sensor of electric motor is one of the serious failures because PMSM(Permanent Magnet Synchronous Motor) is often used as power source of pure-electric vehicle and needs rotation sensor to achieve field oriented control. Therefore, it is necessary rotor position sensor-less control considering the failure of rotation sensor. This paper proposes initial rotor position estimation technology based on the magnetic and saliency of PMSM to achieve limp-home mode.

As a method of initial rotor position estimation, various methods have been reported such as based on magnetic saliency or magnetic saturation. A method based on magnetic saliency can estimates initial rotor position acculately but the method can't identify magnetic polarity, thus this method uses magnetic polarity identification after rotor position estimation. Therefore, this method takes time to complete initial rotor position estimation. On the other hand, based on the magnetic saturation method, this method can estimate initial rotor position including magnetic polarity thus this method complete the estimation in a short time. However, accuracy of the initial rotor position is affected by magnetic saturation characteristics.

This report proposes a initial rotor position technology based on magnetic saturation and magnetic saliency. This method uses voltage injection to each electric motor phases and extracts initial rotor position characteristics including magnetic polarity from the motor current. The motor current while injecting voltage includes rotor position information based on magnetic saturation and saliency. This method extracts both information from the motor current at the same time. Therefore, this method can estimate the initial rotor position acculately in a short time. Fig. (1) shows the block diagram of the proposed method. This method uses conventional method based on the magnetic saturation as magnetic polarity identification and extracts rotor position information based on magnetic saliency at the same time. Fig. (2) shows a simulation results using proposed method. The estimation error is within 4° and this method can complete estimation in 7.4 ms.

This report consists of five chapters. Firstly, research background and objectives are discribed. The second chapter shows a conventional initiral rotor position estimation technology and its factor of estimation error. The third chapter introduces an initial rotor position technology based on the magnetic saturation and magnetic saliency at the same time. The forth chapter shows simulation results. Lastly, conclusion and future works are discussed.

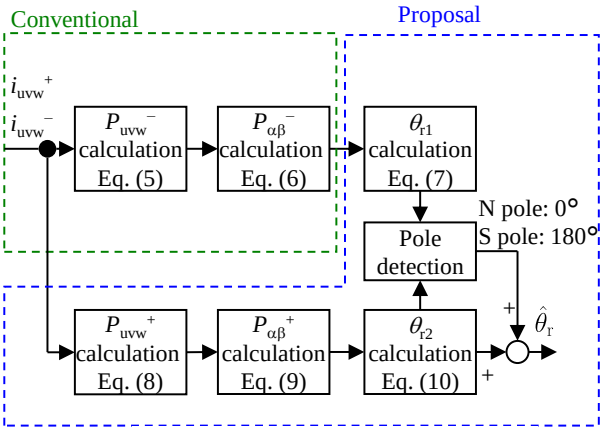

Fig. (1) Block diagram of proposal.

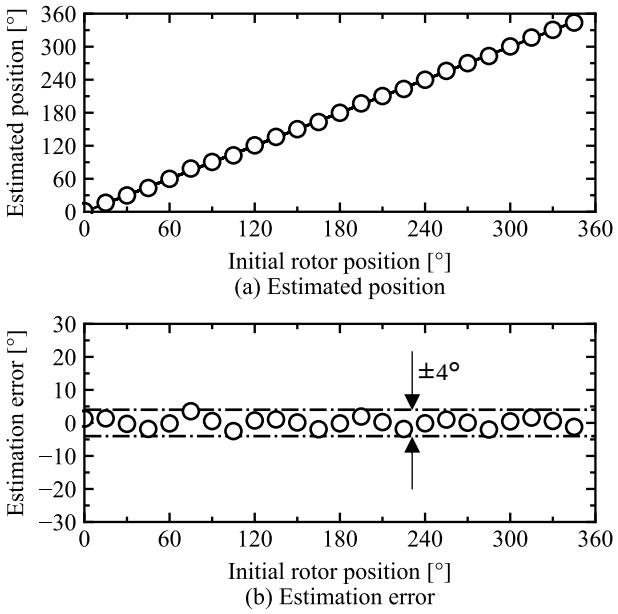

Fig. (2) Simulation results.