

Development of an Abnormality Detection and Recovery Method for Position Sensorless Control of a Generator Motor

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Position sensorless control is an effective approach for reducing system cost and improving reliability by eliminating mechanical position sensors and associated wiring. However, transient estimation abnormalities may occur under unexpected disturbances or parameter variations. When position sensorless control is applied to a generator motor in a 100% electric-drive hybrid vehicle, estimation abnormalities can cause excessive current, torque fluctuations, and increased vibration. In addition, resonance in a damper-equipped rotating system may amplify vibration and deteriorate vehicle performance. Therefore, rapid abnormality detection and an appropriate recovery method are required to ensure system reliability.

This study proposes an abnormality detection and recovery method for position sensorless control of a generator motor. The overall control strategy is illustrated in Fig. 1. Simulation and experimental analyses revealed rapid estimated-speed variation during estimation abnormalities. Based on this characteristic, abnormalities are detected using estimated-speed variation. To prevent false detections caused by transient disturbances, abnormality judgment is performed only when threshold exceedance continues for a specified period. Motor current is also used because it may increase before the estimated-speed variation reaches the primary threshold. By combining estimated-speed variation and current information, both reliable and rapid abnormality detection can be achieved.

After abnormality detection, the estimated rotor position can no longer be used for normal motor control. Therefore, the recovery control method is activated. Gate-Off control is first applied to suppress overcurrent, followed by three-phase short circuit control to increase braking torque and accelerate motor deceleration. This shortens the passage time through the resonance region and suppresses vibration and rattle noise. If the induced current exceeds a predefined threshold, the control mode returns to gate-off operation. Through this switching strategy, both overcurrent suppression and vibration reduction are achieved.

Vehicle experiments were conducted using a generator motor system installed in a 100% electric-drive hybrid vehicle. Fig. 2 shows the response immediately after abnormality detection, while Fig. 3 shows the response during deceleration and stop detection. The results confirmed successful abnormality detection based on estimated-speed variation and current behavior. The proposed recovery control suppressed overcurrent, reduced vibration during deceleration, achieved reliable stop judgment, and enabled restart after motor stop. These results demonstrate the effectiveness of the proposed method in achieving reliable abnormality detection, overcurrent suppression, vibration reduction, and restart capability for automotive generator-motor applications.

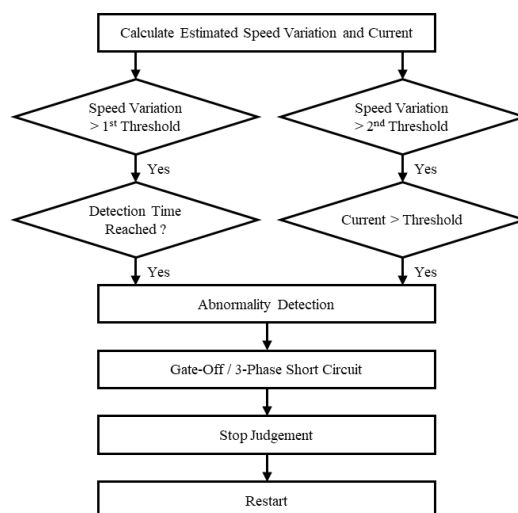


Fig. 1 Proposed Abnormality Detection and Recovery Control Method

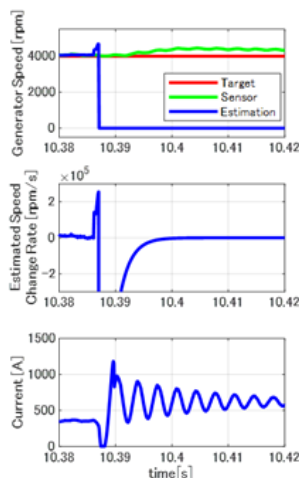


Fig. 2 Response Immediately After Abnormality Detection Control

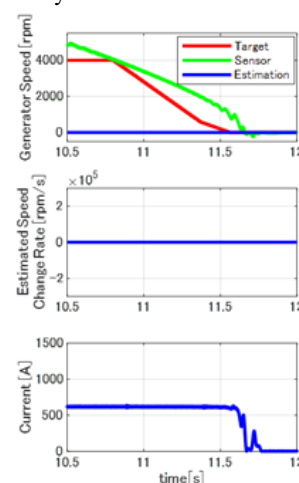


Fig. 3 Response During Deceleration and Stop Detection