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Current Drainage Attack Correction via Adjusting the Attacking Saw-Function Asymmetry

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Abstract : Current drainage attack suggested previously is further studied in regular settings of closed-loop controlled Brushless DC (BLDC) motor with Kalman filter in the feedback loop. Modeling and simulation experiments are conducted in a Matlab environment, implementing the closed-loop control model of BLDC motor operation in position sensorless mode under Kalman filter drive. The current increase in the motor windings is caused by the controller (p-controller in our case) affected by false data injection of substitution of the angular velocity estimates with distorted values. Operation of multiplication to distortion coefficient, values of which are taken from the distortion function synchronized in its periodicity with the rotor's position change. A saw function with a triangular tooth shape is studied herewith for the purpose of carrying out the bias injection with current drainage consequences. The specific focus here is on how the asymmetry of the tooth in the saw function affects the flow of current drainage. The purpose is two-fold: (i) to produce and collect the signature of an asymmetric saw in the attack for further pattern recognition process, and (ii) to determine conditions of improving stealthiness of such attack via regulating asymmetry in saw function used. It is found that modification of the symmetry in the saw tooth affects the periodicity of current drainage modulation. Specifically, the modulation frequency of the drained current for a fully asymmetric tooth shape coincides with the saw function modulation frequency itself. Increasing the symmetry parameter for the triangle tooth shape leads to an increase in the modulation frequency for the drained current. Moreover, such frequency reaches the switching frequency of the motor windings for fully symmetric triangular shapes, thus becoming undetectable and improving the stealthiness of the attack. Therefore, the collected signatures of the attack can serve for attack parameter identification via the pattern recognition route.

Keywords : bias injection attack, Kalman filter, BLDC motor, control system, closed loop, P-controller, PID-controller, current drainage, saw-function, asymmetry
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