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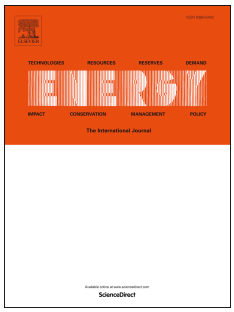

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Adaptive Model Predictive Control with Propulsion Load Estimation and Prediction for All-Electric Ship Energy Management

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Abstract

Electric ships experience large propulsion-load fluctuations on their drive shaft due to encountered waves and the rotational motion of the propeller, affecting the reliability of the shipboard power network and causing wear and tear. To address the load fluctuations, model predictive control has been explored as an effective solution. However, the load torque of the propulsion system, knowledge of which is essential for model predictive control, is difficult to measure and includes multi-frequency fluctuations. To deal with this issue, an adaptive model predictive control is developed so that the load torque estimation and prediction can be incorporated into model predictive control. In order to evaluate the effectiveness of the proposed adaptive model predictive control, an input observer with linear prediction is developed as an alternative approach to obtain the load estimation and prediction. Comparative studies are performed to illustrate the importance of the load torque estimation and prediction, and demonstrate the effectiveness of the proposed adaptive model predictive control in terms of improved efficiency, enhanced reliability and reduced wear and tear.

Keywords: Propulsion-load Torque Estimation and Prediction; Adaptive Model Predictive Control; All-electric Ship; Hybrid Energy Storage; Energy Management Strategy.

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