

## Machine Learning–Based Fault Detection and Health Monitoring of Brushless DC Motors for Electric Propulsion in Civil Aviation Using Experimental Data

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### Abstract

The rise of electric propulsion in civil aviation introduces new maintenance challenges for reliable assessment of propulsion system health. Data driven approaches offer promising capabilities for analyzing relationships among electrical and mechanical parameters and identifying changes in motor behavior prior to failure. This study presents a custom-developed experimental test stand representing a scaled model of a light electric propulsion aircraft. The stand is equipped with standard motor analysis instrumentation and sensors to measure brushless DC (BLDC) motor parameters, including voltage, current, rotational speed, thrust, temperature, and noise under controlled throttle inputs. On the test stand, the BLDC motor’s performance was first validated under off-load conditions by comparison with manufacturer specifications. For on-load conditions, the motor was equipped with the manufacturer recommended propeller to generate a normal operating dataset. Additional datasets were generated under intentionally introduced fault scenarios, including rotor imbalance, thermal anomalies, and power-source disturbances. Supervised machine learning techniques, including Support Vector Machines, were applied to classify normal and abnormal operating states, supporting condition monitoring and fault detection. Also, this approach can help explore unsupervised learning methods and predictive maintenance frameworks, including remaining useful life estimation.