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基于图像的发动机滑油滤磨屑定量分析技术

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Image-based Quantitative Analysis Technique of Aero-engine Filter Debris

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摘要

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摘要 定量分析滑油滤磨屑是提高航空发动机内部磨损故障诊断成功率的有效技术途径。为满足某型航空发动机使用维护中滑油滤磨屑快速定量分析和磨损状态诊断的实际需求,设计制造了油滤磨屑自动清洗收集装置,采用电荷耦合器件(CCD)获取油滤磨屑数字图像,运用二维最大熵遗传算法对磨屑图像进行阈值分割后提取磨屑目标的特征量,将磨屑特征量与反映铁磁性磨屑当量质量的磨损烈度值进行关联,用以确定发动机内部磨损状态。实际分析过程中,首先针对大量已知磨损烈度值的油滤磨屑图像案例样本,通过多元回归分析法确定磨屑图像特征量和磨损烈度值之间的线性关系;然后针对待测磨屑图像样本,运用已得到的回归公式计算出磨损烈度值,与设定的磨损烈度阈值进行比较,实现对发动机磨损状态的分析诊断;最后,通过某型发动机维护过程中滑油滤磨屑定量分析诊断的实际案例验证了所提方法的有效性。

关键词: 航空发动机 滑油滤 磨屑 图像分析 磨损 诊断

Abstract: Filter debris in a lubricating system contains important wear information of an aero-engine, and its quantitative study through image analysis is an effective means for engine wear condition monitoring and fault diagnosis. In order to meet the practical requirements of quantitative filter debris analysis for a certain type of aero-engine, a special automatic device for oil filter rinsing and debris collecting is designed. The collected debris is distributed on a fabric film according to its magnetic properties, and the digital image of the debris is obtained through a charge coupled device(CCD). The features of the debris image are extracted through the 2D maximum entropy genetic algorithm image thresholding, and then these features are used to obtain wear degree, which reflects the wear condition of an aero-engine. In the machine learning process, by means of analyzing a lot of case images of filter debris, the relationship between features of filter debris images and wear degrees of aero-engines is established through multiple regression. In the test process, the features of the filter debris image taken from the CCD are obtained via image analysis, and then the wear degree of an aero-engine is calculated directly through the regression formula. The wear degree derived from the filter debris image analysis can be used to diagnose the wear condition of an aero-engine by comparing it with the threshold of wear degree. Finally, actual application of the quantitative filter debris analysis during the maintenance of an aero-engine certifies the effectiveness of this new technique.

Keywords: aero-engine oil filter debris image analysis wear diagnosis

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