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Purposeful Failure Methodology for Machinery (2021-023)

Machine Learning Enabled Purposeful Failure Methodology Enabling Enhanced Predictive Maintenance for Retrofitted Legacy Equipment and Modern Industry 4.0 Equipment Integration

Market Overview

This failure methodology utilizes purposeful generation of labeled failure mode datasets via surrogate purposeful failure twin (SPFT) simulations. Machine learning powered performance analysis, predictive maintenance, and production management capable of reducing unexpected failure and unnecessary downtime are enabled via this innovation. This technology revolutionizes the manufacturing operations management (MOM) system market, which currently suffers from a gap in the availability of diagnostic and predictive failure data for manufacturing equipment. Current failure data generation methodologies are time consuming and costly, or do not represent all possible failure modes experienced by the equipment. Failing equipment can lead to safety hazards, reduced product quality, and avoidable reduction in output capacity. Improving failure metrics, real-time analysis, and incorporating artificial intelligence methodologies can alleviate these negative occurrences and bring manufacturers into the Industry 4.0 future with significantly improved overall equipment effectiveness (OEE). Clemson University researchers have developed a Purposeful Failure Methodology, which generates labeled relevant datasets via SPFT simulation and utilizes machine learning to not only improve prescriptive equipment maintenance, but also pinpoint equipment failure modes through real-time data collection from in-line equipment.

Technical Summary

The Purposeful Failure Methodology standardizes failure data generation. This enables machine learning backed diagnosis and prognosis of equipment failure modes. The methodology utilizes intentional component and system damage growth from identified points of failure that is tracked by commonplace sensors. The generated data is labeled prior to input into machine learning algorithms, which are then utilized to inform diagnostic and prognostic systems. The methodology reproduces operational component environments during the generation of failure data via SPFT models leading to direct in-line equipment monitoring and failure prediction translatability. The nature of the methodology is conducive for rapid labeled failure dataset generation, equipment monitoring, and informed predictive maintenance scheduling. This provides potential cost and downtime savings, increased production, and improved employee safety.

Application

This technology standardizes failure mode methodologies and generates labeled failure mode datasets that are utilized with machine learning algorithms to improve equipment maintenance protocols and provide insightful, component-level, failure mode analysis.

Development Stage

TRL 4: Research Prototype

Advantages

- Standardized generation of failure data, reducing the need for costly run-to-failure testing
- Operationally relevant growth of damage analysis, enabling earlier detection of equipment progression towards failure
- Artificial intelligence dataset analysis, revealing component-level failure modes

App Type	Country	Serial No.	Patent No.	CURF Ref. No.	Inventors
Provisional	United States	63/280,023	NA	2021-023	Ethan Wescoat Dr. Laine Mears

About the Inventors

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Ethan Wescoat is a Ph.D. Graduate Research Assistant at Clemson University's International Campus for Automotive Research. He earned his Bachelor's Degree in Mechanical Engineering from the Georgia Institute of Technology and Master's Degree in Mechanical Engineering from Clemson University. His previous industry experience includes working with Moog Inc., Gulfstream Aerospace, and BMW Manufacturing Co. His current research focuses on controls and manufacturing for vehicles.

Dr. Laine Mears

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Dr. Laine Mears is the BMW SmartState Endowed Chair of Automotive Manufacturing, Professor and founding faculty member in the Automotive Engineering department at Clemson University. He earned Ph.D. in Mechanical Engineering from the Georgia Institute of Technology. Prior to joining Clemson, he worked 10 years in industry with Tier-1 and Tier-2 automotive and bearing manufacturers in Engineer, Manager, and Product Launch Coordinator roles. Applicable work in industry includes power optimization of hard machining processes, multi-spindle turning analysis and startup of a bulk deformation rolling process for bearing rings, and successful launch of 7 new products to automotive OEMs. Some of her accomplishments include being a member of the American Society of Mechanical Engineers and a Senior Member of both the Society of Manufacturing Engineers and the American Society for Quality. He is an SME Certified Manufacturing Engineer (CMfgE), an ASQ Certified Quality Engineer (CQE), and a licensed Professional Engineer.

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