Hidden Markov Models to Detect Early Equipment Failure

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Abstract

Failure Detection and diagnosis is critical for maintaining the health of a system. Therefore, most of the production industries today try to follow Condition Based Maintenance (CBM) which works on the strategy that monitors the actual condition of the asset to decide what maintenance needs to be done. CBM monitors the health of the mechanical components through measurements of different kinds of sensor data such as vibration, temperature and pressure, etc. By using this status data, it can be determined whether maintenance is required or not indicated by decreasing performance or upcoming failure. Compared with preventive maintenance, this increases the time between maintenance repairs, because maintenance is done on an as-needed basis. In this research, we employ Hidden Markov Models (HMM) to recognize the different health states of a mechanical component. The transition between states is probabilistic in HMM which helps in estimating the future state of the component. The proposed health state estimation method has been validated on a time-series sensor signal of compressors.

Keywords
Equipment Failure, Hidden Markov Model, Condition Based Maintenance, Anomaly Detection

Biographies

Prince Agarwal is currently pursuing Bachelors of Technology in the Department of Industrial & Systems Engineering at Indian Institute of Technology, Kharagpur. His project work mostly includes the applications of machine learning, data-mining and embedded electronics techniques to solve real-world problems in Supply Chain Management and Failure detection. He had also worked on the behaviour-based analysis of Malware. He had been a part of a robotics-based research group of IIT Kharagpur which aimed at designing and fabricating Soccer playing robots. He also worked as an associate member of a society of his college named External Relations Cell which aimed at promoting career opportunities to students. At present, he is working on a collaborative project with an Oil and Petroleum based Company.

K Subash Nirmal is currently pursuing Bachelors of Technology in the Department of Industrial & Systems Engineering at Indian Institute of Technology, Kharagpur. His projects were mostly based on the application of machine learning, data-mining techniques and embedded electronics to solve real-world problems in Supply Chain Management and Failure detection. He also worked on predicting gross of Bollywood movies, Indian Premium league Auction price prediction. He carried out research on Vehicle Routing problem by collaborating with Kaizing Delivery Services, a startup of IIT Kharagpur. He got an appreciation for his work on image processing based soundless honking system in KPIT-Sparkle. At present, he is working on a collaborative project with Shell India Markets Private Limited.

K Nageswara Reddy is the Doctoral Student in Department of Industrial and Systems Engineering at Indian Institute of Technology, Kharagpur, India**.** He has published journal and conference papers. His publications appeared in such journals as International Journal of Production Economics, International Journal of Production Research and European Journal of Operational Research. His research interests include operations research (optimization), transportation, logistics and supply chain management. He is a member of IEOM, INFORMS, IISE, POMS and IEI.

Akhilesh Kumar is an Assistant Professor in the Department of Industrial and Systems Engineering at Indian Institute of Technology, Kharagpur, India. Previously, he worked as a Solution Architect in the Pricing Revenue Management, Consulting Team at JDA Software, Bangalore. His research interest includes the application of machine learning, statistical learning and data-mining techniques to solve real-world problems pertaining to Conditioned-based maintenance, logistics and Supply Chain Management. He has published journal and conference papers. His publications appeared in such journals as International Journal of Production Economics, International Journal of Production Research, Computers and Industrial Engineering, European Journal of Operational Research, Expert System with Applications, IEEE.