Proceedings of the ASME 2012 11th Biennial Conference On Engineering Systems Design And Analysis
ESDA2012
July 2-4, 2012, Nantes, France

ESDA2012-82676

THE USE OF ADAPTIVE PCA-BASED CONDITION MONITORING METHODS IN MACHINING PROCESSES

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ABSTRACT

In different manufacturing applications the assessment of the health conditions of a machine tool, together with the quality and stability of the process, requires the capability of dealing with response variables described in terms of profile data. In the frame of in-process monitoring of sensor signals this is the case, for instance, of monitoring either series production of large lots of parts or machining processes characterized by cyclic signals, where both the condition of the machine components and the final quality of the worked piece may be correlated with the stability of repeating signal profiles in time. However, as far as real time data acquisition is concerned, and when measurements are performed with high sampling frequency, data are likely to be auto-correlated, and hence it is of fundamental importance to develop adaptive monitoring tools robust with respect to non-steady state conditions. The paper deals with the utilization of profile monitoring approaches for in-process monitoring of manufacturing operations and investigates their applicability to the problem of monitoring auto-correlated signals. In particular Principal Component Analysis (PCA) is applied in combination with an adaptive approach based on a moving time window for continuously revise the reference model is evaluated and discussed.

A real case study is used to test the performances of the method: the task is to detect tool chipping and breakage in end milling operations by means of real-time monitoring of cutting force signals. The evolution of tool wear imposes a trend in observed signals which leads to the need for an adaptive