Fault Diagnosis and Prognosis in Gas Turbine Engines

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ABSTRACT

This paper presents the fault diagnosis and prognosis methods of gas turbine engines. Depending on the unique symptoms that each failure exhibits, the different combination of soft computing techniques is applied. The methods shown here include the fuel supply system failure prediction based on the startup profile characterization and the starter system failure prediction based on the discrete event modeling. The presented methods are implemented on a web server based service and have demonstrated their robustness by isolating the failures successfully in the field.

I. INTRODUCTION

With broadly understood consensus on its benefits, fault diagnosis/prognosis has become a widely favored technical thrust in numerous industries. In this paper, the methods are demonstrated on the turbine engine only but we have developed the fault diagnosis/prognosis system successfully to the other domains as well such as the electronics, the automobile, the wind turbine, and the software.

II. FAULT DIAGNOSIS SYSTEM

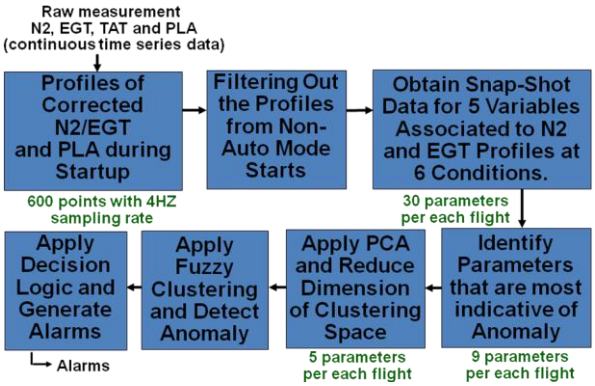

Figure 1 Fault Diagnosis Method for Fuel Supply System

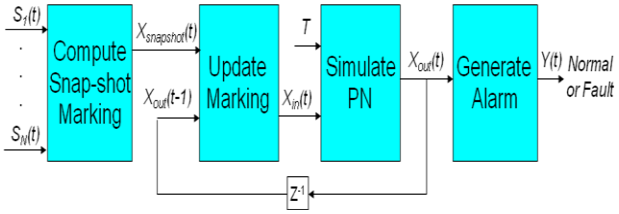

Figure 2 Fault Diagnosis Method for Starter System

A. Fuel Supply System

As shown in Fig. 1, the engine startup profiles of the core speed (N2) and the exhaust gas temperature (EGT) collected with high speed sampling rate are processed into the features extracted at the critical-to-characterization instances. The instances are identified by characterizing the engine dynamics [1]. PCA is applied on the extracted features to produce the smaller number of parameters, which are clustered by the fuzzy clustering method. The fault is detected by differentiating the clusters matching the failures.

B. Starter System

The evidence associated with starter system failure is based on the aggregation of three dynamic events occurring in different time windows. The unsynchronized occurrence of the events is observable from speed at peak EGT, peak EGT, and start time. Fig. 2 shows the fault diagnosis method for the turbine engine starter system based on the Petri Net, which can model the timing and the sequencing relationship of the events.

REFERENCES

1. K. Kim, “Fault Diagnosis and Prognosis for Fuel Supply System in Gas Turbine Engines,” *Proc. IMechE, Part C: J. Mechanical Engineering Science,* 2009, 223(C3), 757 – 768.