Project Number:

Department of Communication Systems

Project Title: Monitoring Machine Health of engines using advanced signal processing techniques

Degree Scheme for which the project is applicable:

DSP ☑ PMRC ☑ SSC ☑

Industrial Support: Yes ☑ No ☐

First Supervisor: Dr. P Angelov Second Supervisor: Mr. X. Zhou

Project Description:

This project will focus on a practical problem formulated by the company Specialist Electronics Services Ltd which is interested in advanced signal processing for automatic and real-time monitoring engine health (faults). The research will aim to study and develop methods based on recent results in evolving rule-based systems. Initially the student will work on classifying engine operating modes, through the use of evolving fuzzy classifiers, to identify exceedances to usual operating conditions, based on measurements of engine temperature, pressure and RPM, etc. The student will then move on to look at methods of predicting the occurrences of these faults, using these same signals. Once completed, the student will have the opportunity to move the simulated algorithms into real-time hardware.

The typical approach to machine fault detection is based on identification of anomalies between the current and nominal values of certain etalon machine characteristics. This assumption requires detailed knowledge of the structural and dynamic properties of the engine, its components, and their failure modes. The nominal characteristics, however, along with the failure modes, change over time due to wear off, maintenance, and the repair/replacement of parts and components. This reality calls for alternative approaches by applying learning to autonomous self-monitoring and prognostics. On-line learning [1-3] allows real-time anomalies detection by continuous monitoring, classification, and prognostic algorithms to identify a trend of departure from a normal machine behaviour and predict a potential fault state. Conventionally, methods such as such as the use of Learning Vector Quantization, Self-Organizing Maps, Hidden Markov Models, Gaussian Mixture Models, k-Nearest Neighbour, Fuzzy C-Means, Minimum Spanning Tree, Parzen Density Estimators etc. are used to fault detection. In this project some of these methods will be approbated as well as the newly developed evolving fuzzy methods.

This work is novel, and is of interest to the company Specialist Electronic Services Ltd.

Skills required: Optimisation, control theories, adaptive systems, programming in Matlab or C

References:

[1] Filev D., F. Tseng, Novelty detection-based Machine Health Prognostics, *Proc. 2006 Intern. Symposium on Evolving Fuzzy Systems*, pp.193-199, IEEE Press, 2006, ISBN 0-7803-9719-3.

[2] Angelov**,** P. et al., An Approach to Model-based Fault Detection in Industrial Measurement Systems with Application to Engine Test Benches, *Measurement Science and Technology*, **v.17** (7), July 2006, pp.1809-1818.

[3] Angelov, P., D. Filev, An Approach to Online Identification of Takagi-Sugeno Fuzzy Models, *IEEE Trans. on Systems, Man, and Cybernetics*, part B – Cybernetics, v.34 (1), pp. 484-498, 2004.

Supervisor Signature…….

Student Signature…….