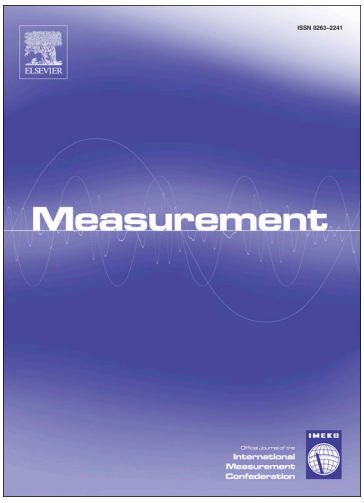

Development of a prediction model for estimating tractor engine torque based on soft computing and low cost sensors

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Development of a prediction model for estimating tractor engine torque based on soft computing and low cost sensors

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Abstract

Torque estimation needs intensive efforts and costly sensors. In this research, a model was proposed based on soft computing to estimate the ITM285 tractor engine torque using some low cost sensors. To this end, two models including the radial basis function (RBF) neural network and adaptive neuro fuzzy inference system (ANFIS) were used. Thirteen training algorithms were examined to train the RBF. These algorithms were compared using three statistical methods, namely k-fold cross validation, completely randomized design (CRD) and least significant difference (LSD). Moreover, three methods, namely grid partitioning (GP), sub-clustering (SC) and fuzzy c-means (FCM), were used to construct the fuzzy inference system (FIS). However, the FCM was the most suitable method. The sensitivity analysis showed that only measuring engine speed, fuel mass flow and exhaust gas temperature was sufficient for proper engine torque estimation. The RBF had a better performance (R^2=0.99, RMSE=0.5 and EF=0.99) than the ANFIS and hence, was suggested for estimating the engine torque.

Keywords: ANFIS; RBF; Engine torque; Tractor

1. Introduction

Diesel engines are widely used in vehicles, ships, power generators, military equipment, heavy industries and agricultural machinery, especially tractors. They offer a better fuel to power conversion efficiency than spark ignition (SI) types [1] and the lower volatility of their fuel makes them safer to handle [2]. The engine is the heart of such equipment and thus, keeping it in a good working condition is vital for a good overall efficiency [3]. Most of agricultural implements with active tillage tools (e.g., rotary tiller, power harrow), balers, choppers, mowers, threshing machinery, sprayers, spreaders, etc., are powered by a power-take-off (PTO) shaft. On the go estimation of rotary power consumption in these implements is very important for the farm power management purpose. Monitoring the tractor engine load is crucial for engineers to design implements as well as for farm experts to manage machinery and make proper decisions. Furthermore, accurate measurement of the engine rotary load is time intensive and costly. Hence, the condition monitoring (CM) of the transmitted torque and power of the tractor engine can be beneficial for control system