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Μάθημα 3C: Νευρωνικά Δίκτυα - Εφαρμογές

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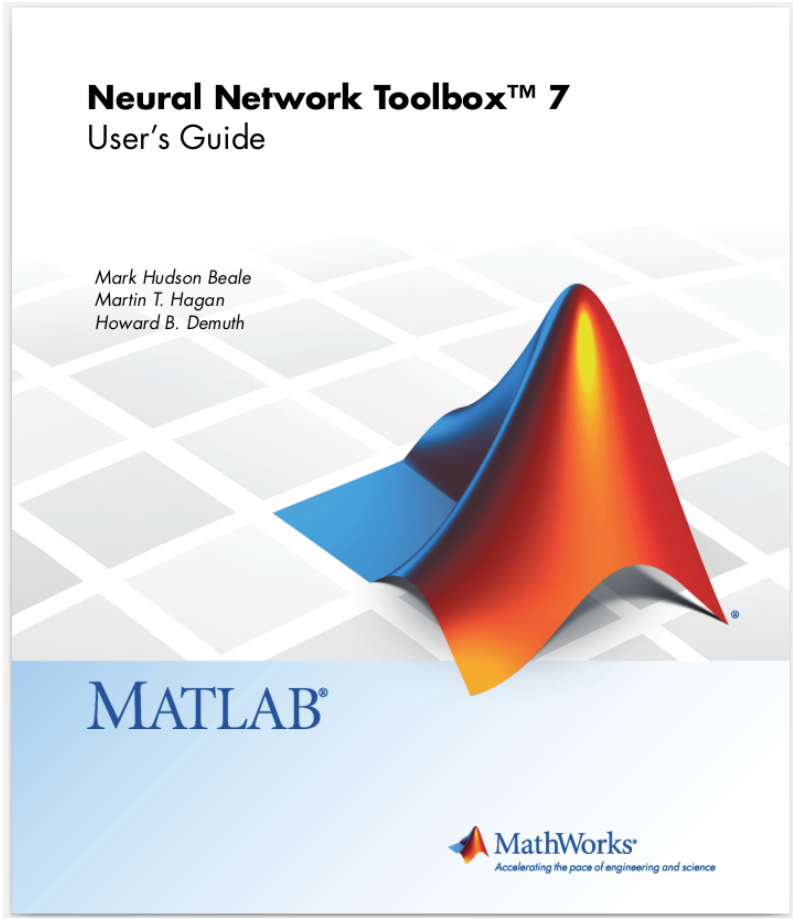
Περιεχόμενα

Περιεχόμενο Μαθήματος

- Μ3Α: Εισαγωγή στην Μηχανική Μάθηση, Νευρωνικά Δίκτυα. Βιβλιογραφία.
- Μ3Β: ΝΔ: Υπολογιστικά εργαλεία
- Μ3Γ: Εφαρμογή ΝΔ σε μηχανές εσωτερικής καύσης/virtual sensors

MATLAB, User's Guide, ver. 7 (pdf)

- 1:Εισαγωγή, 2:Network Objects, Data and Training Styles, 3: Multilayer Networks and Backpropagation Training, 4: Dynamic Networks.



Volumetric Ef.

Pergamon

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MODELLING THE VOLUMETRIC EFFICIENCY OF IC ENGINES: PARAMETRIC, NON-PARAMETRIC AND NEURAL TECHNIQUES

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Abstract: The volumetric efficiency (η_v) represents a measure of the effectiveness of an air pumping system, and is one of the most commonly used parameters in the characterization and control of four-stroke internal combustion engines. Physical models of η_v require the knowledge of some quantities usually not available in normal operating conditions. Hence, a purely black-box approach is often used to determine the dependence of η_v upon the main engine variables, like the crankshaft speed and the intake manifold pressure. Various black-box approaches for the estimation of η_v are reviewed, from parametric (polynomial-type) models, to non-parametric and neural techniques, like additive models, radial basis function neural networks and multi-layer perceptrons. The benefits and limitations of these approaches are examined and compared. The problem considered here can be viewed as a realistic benchmark for different estimation techniques.

NN-Combustion

NEURAL NETWORKS FOR MODELLING AND CONTROLLING FUTURE LOW TEMPERATURE COMBUSTION TECHNOLOGIES

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Modern internal combustion engines with a low peak combustion temperature suffer from instabilities of the process and a highly nonlinear behaviour. These make a closed loop control a necessity. In order to build and tune a controller a model is needed, which has to be able to reproduce the nonlinear behaviour. The paper presents the application of offline trained NNSSIF nets, a neural networks architecture with state space attributes. These are combined with an extended Kalman filter and a nonlinear model-based predictive controller to a research internal combustion engine. *Copyright © 2007 IFAC*

Keywords: Neural Network, Predictive control, Extended Kalman filter, MIMO, Identification, Internal Combustion Engine (ICE), Generalized state space, Prototyping

RNN-NOx

2009-24-0110

Development of recurrent neural networks for virtual sensing of NOx emissions in internal combustion engines

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ABSTRACT

The paper focuses on the experimental identification and validation of recurrent neural networks (RNN) for virtual sensing of NO emissions in internal combustion engines (ICE). Suited training procedures and experimental tests are proposed to improve RNN precision and generalization in predicting NO formation dynamics. The reference Spark Ignition (SI) engine was tested by means of an integrated system of hardware and software tools for engine test automation and control strategies prototyping. A fast response analyzer was used to measure NO emissions at the exhaust valve. The accuracy of the developed RNN model is assessed by comparing simulated and experimental trajectories for a wide range of operating scenarios. The results evidence that RNN-based virtual NO sensor will offer significant opportunities for implementing on-board feedforward and feedback control strategies aimed at improving the performance of after-treatment devices.

INTRODUCTION

Automotive engines and control systems are more and

model-based controllers or in diagnostics schemes. Virtual sensors (VSs) can be used as substitute of real sensors providing useful information about the actual process. In this scenario, virtual sensors are an interesting opportunity in achieving more challenging control and diagnostics targets.

In the last decade virtual sensors have been developed for many applications e.g. aerospace, biotechnological systems, environmental monitoring systems, to mention just few cases (Goodwin, 1999). VSs can be especially useful when: i) the direct measurements are impossible to perform, such as highly hazardous chemical or nuclear plants, (Sevilla and Pulido, 1998); ii) the available sensor might not guarantee the required sensing characteristics (i.e. accuracy, dynamic performance); iii) the sensor is too expensive or iv) does not fit within the sensing location. It is also evident that VSs can be used as feedback signal generators and their use provides opportunities to implement innovative control schemes and diagnostic. Actually, VSs must be designed in such a way as to simulate time-dependent processes and guarantee accuracy, stability and short computational time. In this work it will be shown that the proposed virtual sensor also allows a limited recourse to

RNN-NOx

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Real-Time Estimation of Engine NOx Emissions via Recurrent Neural Networks

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Abstract: The paper focuses on the experimental identification and validation of recurrent neural networks (RNN) for virtual sensing of NO emissions in internal combustion engines (ICE). Suited training procedures and experimental tests are proposed to improve RNN precision and generalization in predicting engine NO emissions in transient operation. The reference Spark Ignition (SI) engine was tested by means of an integrated system of hardware and software tools for engine test automation and control prototyping. A fast response analyzer was used to measure NO emissions at the exhaust valve. The accuracy of the developed RNN model is assessed by comparing simulated and experimental trajectories of NO emissions for a wide range of operating scenarios, with an estimation error lower than 2 % throughout the test transients. The results evidence that RNN-based virtual NO sensor offers significant opportunities for improving the performance of SCR after-treatment devices.

Keywords: engine control, NOx emissions, SCR control, neural network models, virtual sensors.

RNN-NOx-LSE

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Neural network models for virtual sensing of NO_x emissions in automotive diesel engines with least square-based adaptation

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ABSTRACT

To meet current Diesel engine pollutant legislation, it is important to manage after-treatment devices. The paper describes the development of Neural Network based virtual sensors used to estimate NO_x emissions at the exhaust of automotive Diesel engines. Suitable identification methodologies and experimental tests were developed with the aim of meeting the conflicting needs of feasible on-board implementation and satisfactory prediction accuracy. In addition, since the prediction of control-oriented models is typically affected by engine aging and production spread as well as components drift, least square technique features were exploited in order to overcome these issues by adapting the virtual sensor output. The NO_x adaptive virtual sensor was tested via comparison with experimental data, measured at the engine test bench on a turbocharged common-rail automotive Diesel engine. Furthermore, besides model validation, the experimental measurements were modified to simulate a sensor drift in order to enable full assessment of the proposed LS-based algorithm adaptation capabilities.