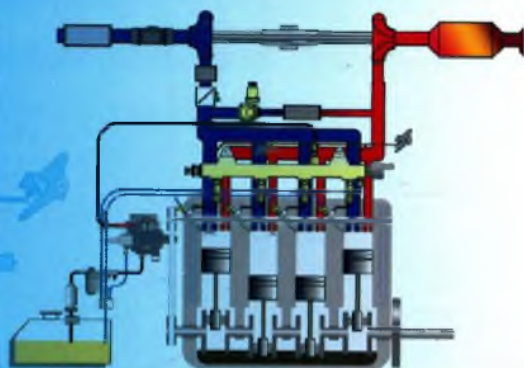


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Rolf Isermann



Combustion Engine Diagnosis

Model-based Condition Monitoring of
Gasoline and Diesel Engines and their
Components

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Darmstadt, Germany

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Preface

During the last decades internal combustion engines have developed to rather complex systems through an increasing number of components and variabilities. Therefore, more actuators, sensors and many more electronic control functions were implemented. This resulted together with constructive and thermodynamic designs in a considerable improvement of performance and reduction of fuel consumption and emissions. However, because of the increased complexity improved monitoring and troubleshooting is a well-known challenge.

The increasing requirements on the coverage and precision of fault detection and diagnosis for internal combustion engines and powertrains therefore need systematic procedures for the development. Compared to the classical on-board diagnosis (OBD) for emission-related faults advanced methods with signal models and process models allow a considerable expansion of the detection and localization performance for engine component faults.

Advanced engine diagnostic methods support also the workshop-based diagnosis (off-board) to find the root causes of faults more quickly and to reduce vehicle downtime. It also opens remote access to be used by service stations and manufacturers. Hence, these methods enable to improve the engines reliability, maintenance and lifetime.

After an introduction to current developments for powertrains, on-board and off-board diagnosis systems and some failure statistics the book gives in Part I a brief survey on advanced supervision, fault detection and diagnosis methods. Part II first describes structures for combustion engine control and diagnosis. Then, model-based diagnosis methods for gasoline and diesel engines are treated for the main components, like the intake system, fuel supply, fuel injection, combustion process, turbocharger, exhaust system and exhaust gas aftertreatment. In general, series production sensors are used:

The fault diagnosis of electrical DC, AC and PMSM motors, electrical, pneumatic and hydraulic actuators is compiled in Part III. Theoretical as well as experimental results from test benches are shown and many experimental studies display the applicability and the diagnosis quality for implemented faults. In the last part IV on fault-tolerant systems, fault-tolerant sensors and actuators are considered.

The book is dedicated to graduate students of mechanical, electrical and mechatronic engineering and computer science and is especially focused for automotive engineers in practice.

The author is grateful to his research associates, who have performed many theoretical and experimental research projects on the subjects of this book, among them S. Leonhardt, C. Ludwig, M. Willimowski, F. Kimmich, A. Schwarte, E. Hartmannshenn, M. Leykauf, S. Clever, C. Eck, A. Sidorow and P. Kessler.

Without their continuous work on new methods and building up and maintaining the combustion-engine test bench, measurement and computer equipment many results of this book would not have been obtained. Great appreciation goes also to our precision mechanics workshop guided by A. Stark.

We also would like to thank the research organization Forschungsgemeinschaft Verbrennungskraftmaschinen (FVV), within the Arbeitsgemeinschaft industrieller Forschungsvereinigungen (AiF) who supported many projects. Several results were obtained in cooperation projects with industrial companies. Among them are Adam Opel AG, GM Europe, and Volkswagen AG. We appreciate these cooperations strongly as they contributed positively to our own research.

Finally, I would like to thank Kerstin Keller, Moritz Neeb, Lisa Hesse and especially Brigitte Hoppe for the laborious and precise text setting, Sandra Schütz for drawing many figures and Springer Verlag for the excellent cooperation.

Darmstadt, February 2017

Rolf Isermann

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