U. Kiencke
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Automotive Control Systems

For Engine, Driveline, and Vehicle

2nd edition

Springer

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Second edition

With 345 figures and 13 tables

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To

Preface to the seco

Since the first edition of this book was published, already
and during this period research on automotive control
the same time, the amount of industrial applications a
prospered. This means that there was a rich flora of pos
selection of material when planning the second edition. In
have been added, important fields have been deepened, a
number of pages down, sections of limited interest have b

In the selection of the new material we have concentr
are both of current interest and importance, but at the s
that also contribute to a better understanding of basic p
The new material includes two completely new chapters: D
and Diagnosis.

In driveline control a new section on Anti-Jerk Control
parts of Vehicle Dynamics and Control have been rewritt
improves the presentation of that material. Further, in t
have hopefully corrected most of the errors in the first
nomenclature, and in order to facilitate to work with this

The level of presentation has been thought trough to b

Preface to the fi

Automotive control has become a driving factor in auton
the last twenty five years. In order to meet the enhanced
fuel consumption, lower exhaust emissions, improved safe
and convenience functions, automotive control had to be a

In any area of technology, control design is an inte
physics, modeling, and design methods. This is also true
and there has been extensive work done in research and d
a number of descriptions, models, and design methodologi

Goal of the book

Our purpose of writing a book on Automotive Control is to
between thermodynamics, basics of engine operation, veh
as parameter estimation and automotive control approach

There are several good books available on the separat
the major references are in German). However, up un
been a text available that explores more deeply the conne

to judge the modeling assumptions. A consequence of
we have selected to treat systems that are close to som
actual vehicles, rather than discussing speculative system
theoretical results.

Intended readers

This book should enable control engineers to understand en
els necessary for controller design and should introduce me
vehicle-specific signal processing and automatic control.

In fact, our inspiration to write the book came from th
bers of the IFAC technical committee on Automotive C
author being the chairman). We met there and also at S
saw the potential value of bridging a gap that was obvious
more important to us is to share some of the fun and exc
the area of Automotive Control Systems and thus give it th

Organization of the book

The outline of the book starts with engines, continues with
deals with the vehicle.

Chapters 2 to 4 treat engines with regard to basics, the
control, and advanced concepts. All the major control sys
are treated. The thermodynamic models in Chapter 2 deal
vary under one cycle and the resolution of interest is typ
degree, whereas the time scales of mean value models ar
several engine cycles, and the variation in variables that a
averaged over one or several cycles. These models form the
ing the complex phenomena that influence the engine op
emissions. They also serve the purpose of describing the
control design and performance in Chapters 3 and 5.

The driveline (engine, clutch, transmission, shafts, ar
fundamental part of a vehicle is the topic in Chapter 7. Sinc
mechanical resonances may occur. The handling of suc
for functionality and driveability, but is also important fo

The basics of these models and some associated control sy
Chapters 8 to 10.

Chapter 11 is the exception from that all the systems
book is close to some of those utilized in actual vehicles. T
and driver modeling is part of simulation design rather t
Nevertheless, it is important to realize that road and driver
parts in the design cycle of automotive systems design du
advanced simulation.

Background and use of the book

The material in this book has been used in courses at the
ruhe, Germany and Linköping, Sweden. It is well suite
(third or fourth year) of the engineering programs at o
("Diploma-engineer", "Master of Science").

The book, to a large extent, covers the basic material
it is advantageous to have a background from basic und
automatic control, signals and systems, mechanics, and ph

The course lay-out includes problem-solving sessions
iments. The laboratory assignments typically include m
models of the type treated in the book, and finally des
simulating them. Here students with more background, f
control, can do more elaborate designs. This is also the
used in an introductory graduate course.

The authors

Dr. Kiencke's experience in this field started in the ea
when developing adaptive lambda control and knock co
Corporation. In the following years more complex appro
elling [2], [22] and controller design [63] were published. A
a team that developed the vehicle communication network
work (CAN)" [67]. Networking allowed to combine former
schemes into an integrated vehicle control system. In the
he joined the University of Karlsruhe in Germany where he

and engine map optimization, Alfred Schutz in engine idl
Leiber in ABS braking control, Dr. Michael Henn in misfir
Daiss in vehicle modelling and identification and Dr. Rajj
driver modelling. It was a great pleasure to cooperate wi
created many friendships. The second author is especiall
Petterssson for joint work in driveline control, and to Lars
in engine modelling and control. Also Lars-Gunnar Hedst
Jan Dellrud deserves special mentioning as research dedicat

Furthermore we both thank Christopher Riegel, Joc
Torkzadeh, and Dr. Tracy Dalton for their tremendous
revise parts of the book, as well as Dr. Dietrich Merkle as

Last but not least we to thank our families and especiall
and Ingrid for tolerating that so much weekend and vacati
to this book.

Being in November 1999 looking forward to the next mill
readers will share some of the excitement that comes al
Control Systems.

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