

Preface

Wheeled off-road vehicles are the vehicles subject to different nonlinear dynamic forces and moments due to nonlinear vehicle dynamics, complex terrain behavior, and irregular traversing surface that the vehicle is engaged with. Off-road vehicles are also considered among the major sources of energy dissipation and pollutant emission owing to their size and rough terrain irregularities they should overcome as well as their operating tasks. The discipline of Terramechanics deals with the development, design, and testing of off-road vehicles and dynamic interaction of the vehicles with their environment in particular tire–ground and wheel–road interactions. As an important subsystem of vehicle, tire has significant effect on the response of driver and road inputs. However, tire performance study is also sophisticated due to tires' composite structure and nonlinear material properties. The role of wheels on vehicle dynamics is considerable given that wheels are the unique elements that connect the vehicle body to the ground and they are subjected to all of the forces and torques applied to the vehicle. The steering, braking, acceleration, traction, handling, and stability are implemented through the wheels. Furthermore, they are a major subsystem of vehicle suspension system. In this manner, those who want to obtain a good understanding of vehicle dynamics have to achieve a good knowledge on wheel dynamics and this requisite is more drastic in the case of off-road vehicles due to the stochastic and nondeterministic wheel–ground interaction condition. Off-road vehicle dynamics is a dynamic system to analyze the traversing behavior of the vehicle over rough irregular terrains. A vehicle is comprised of various components functioning harmoniously and having dynamically interactions. Of these subsystems, propulsion and suspension systems substantially affect the vehicle dynamics. The vehicle performance, handling, and ride comfort are pivotal on aforesaid the important subsystems of the vehicle. However, it is noteworthy that the combination of the components acts as a lumped mass, e.g., in braking process for the reduction of the motion speed.

The classical studies on vehicle dynamics can address those of experimental, analytic, semi-empirical, and numerical approaches. Since the introduction of artificial intelligence, there is an ever-increasing trend toward the application of

different soft computing approaches to be applied in diversity of tasks such as modeling, optimization, and vehicle control strategies. Vehicle dynamics is about the modeling and mathematical description and analysis of vehicle systems based on mechanical concepts and theories. The main goal of this book is to practically overview the dynamics of off-road vehicle systems. The analysis of important mathematical models well agrees with the modeling of vehicle traveling parameters prior to the establishment a first prototype. The tendency to more quick steps toward the development, analysis, and modeling of more efficient vehicles with the optimal performance on rough terrains and the demand of large-sized vehicle designing from the engineers are also the fundamentals of this book that are presented.

This book is intended for students, engineers, and designers who are interested in the scope of off-road vehicle engineering. It provides the essential understanding applied in off-road vehicle dynamics and Terramechanics. This obtained knowledge can potentially serve to develop computer programs for analysis, modeling, and optimization of off-road vehicle dynamics using some state-of-the-art approaches of artificial intelligence. First, the role of Terramechanics and some basic fundamentals and terms are introduced as well as the apparatus for the measuring terrain behavior that is vital for the analysis of any soil-working machinery. Subsequently, tire modeling is presented as a very vital component of vehicle that has a great effect on vehicle dynamics. Different tire parameters are introduced and discussed, and the kinematics and dynamics of wheel are presented at different acceleration and deceleration regimes. While the reader is prepared to the comprehensive models of tire and terrain, the interaction between the wheel and the terrain for the variety of wheel and terrain conditions is covered. The performance of off-road vehicle is then presented through the parameters that influence the performances such as aerodynamic force, rolling resistance, gross traction, and vehicle–obstacle collision. Given this knowledge to the reader, different models of ride comfort from quarter-car, half-car, bicycle-car, and full-car models will be discussed. Stability of motioning and vehicle handling are then covered for different operating conditions. Energetic perspective of off-road vehicle mobility from sources of dissipation to the approaches to harvest/recapture energy from vehicle dynamics is also discussed. Application of different artificial intelligence tools on modeling and optimization is then presented with some case studies and examples with a comparative trend between different approaches and the applicability of such models. Finally, there will be some applied problems in vehicle dynamical systems.

Off-road Vehicle Dynamics

Analysis, Modelling and Optimization

Taghavifar, H.; Mardani, A.

2017, X, 183 p. 118 illus., 86 illus. in color., Hardcover

ISBN: 978-3-319-42519-1