

REGULAR PAPER

Analysis of the traffic conflict situation for speed probability distributions

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Abstract

The increasingly widespread application of drones and the emergence of urban air mobility leads to a challenging question in airspace modernisation: how to create a safe and scalable air traffic management system that can handle the expected density of operations. Increasing the number of vehicles in a given airspace volume and enabling routine operations are essential for these services to be economically viable. However, a higher density of operations increases risks, poses a great challenge for coordination and necessitates the development of a novel solution for traffic management. This paper contributes to the research towards such a strategy and the field of airspace management by calculating and analysing the conflict probability in an en-route, free-flight scenario for autonomous vehicles. Analytical methods are used to determine the directional dependence of conflict probabilities for exponential and normal prescribed speed probability distributions. The notions of geometric and speed conflict are introduced and distinguished throughout the calculations of the paper. The effect of truncating the set of available flight speeds is also investigated. The sensitivity of the calculated results to speed and heading perturbations is studied within the analytical framework and verified by numerical simulations. Results enable a fresh approach to conflict detection and resolution through distribution shaping and are intended to be used in an integrated, stochastic coordination framework.

Nomenclature

a	parameter of the exponential distribution for the ownship [—]
ACAS	airborne collision avoidance system
ADS-B	automatic dependent surveillance-broadcast
ATC	air traffic control
b	parameter of the exponential distribution for the intruder [—]
CA	collision avoidance
CNS	communication, navigation and surveillance
d	distance to be traversed between sensing range and conflict range ^(m)
DAA	detect and avoid
erfc	complementary error function
GC	geometric conflict
l	lower speed limit [Kn]
MDP	Markov decision process
NMAC	near mid-air collision
p	magnitude of normal distribution variables [—]
PAV	personal aerial vehicle
PDF	probability density function
$\Pr(x)$	probability of x

Analysis Of Traffic Conflict Collision

**Hugh W. McGee, National Cooperative
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International Calibration Study of Traffic Conflict Techniques E. Asmussen, 2012-12-06 The concept of traffic conflict was initiated in the United States in the 60s and raised a lot of interest in many countries it was an opening towards the development of a new tool for safety evaluation and the diagnosis of local safety problems The need for such a tool was great because of the many situations where accident data was either scarce unsatisfactory or unavailable Development of Traffic Conflict Techniques TCT started simultaneously in the 70s in several European countries and new studies were also undertaken in the United States Canada and Israel The need for international cooperation was rapidly felt in order to exchange data compare definitions and check progresses An Association for International Cooperation on Traffic Conflict Techniques ICTCT was therefore created grouping researchers and safety administrators with the aim of promoting and organising exchange of information and common practical work Three Traffic Conflict Techniques Workshops were organised in Oslo 1977 Paris 1979 and Leidschendam 1982 A small scale international experiment of calibration of TCTs was also carried out in Rouen France in 1979 and five teams took part in it from France Germany Sweden the United Kingdom and the United States results of this first experiment were used as a basis for the present enterprise To be acknowledged as a safety measuring tool traffic conflict techniques had to be validated in relation to traditional safety indicators such as injury accidents

Measuring Road Safety with Surrogate Events Andrew Tarko, 2019-11-05 Measuring Road Safety Using Surrogate Events provides researchers and practitioners with the tools they need to quickly and effectively measure traffic safety As traditional crash based safety analyses are being undermined by today's growing use of intelligent vehicular and road safety technologies crash surrogates or near misses can be more effectively used to measure the future risk of crashes This book advances the idea of using these near crash techniques to deliver quicker and more adequate measurements of safety It explores the relationships between traffic conflicts and crashes using an extrapolation of observed events rather than post crash data which is significantly slower to obtain Readers will find sound estimation methods based on rigorous scientific principles offering compelling new tools to better equip researchers to understand road safety and its factors

Efficient Transportation and Pavement Systems: Characterization, Mechanisms, Simulation, and Modeling Imad L. Al-Qadi, Tarek Sayed, Naser Alnuaimi, Eyad Masad, 2008-11-01 Internationally significant attention is given to transport sustainability including planning design construction evaluation safety and durability of the road system The 4th International Gulf Conference on Roads Efficient Transportation and Pavement Systems Characterization Mechanisms Simulation and Modeling hosted by the University of

Highway Safety Literature, 1980 **Traffic Engineering Handbook** ITE (Institute of Transportation Engineers), Brian Wolshon, Anurag Pande, 2016-01-26 Get a complete look into modern traffic engineering solutions Traffic Engineering Handbook Seventh Edition is a newly revised text that builds upon the reputation as the go to source of essential traffic engineering solutions that this book has maintained for the past 70

years The updated content reflects changes in key industry standards and shines a spotlight on the needs of all users the design of context sensitive roadways and the development of more sustainable transportation solutions Additionally this resource features a new organizational structure that promotes a more functionally driven multimodal approach to planning designing and implementing transportation solutions A branch of civil engineering traffic engineering concerns the safe and efficient movement of people and goods along roadways Traffic flow road geometry sidewalks crosswalks cycle facilities shared lane markings traffic signs traffic lights and more all of these elements must be considered when designing public and private sector transportation solutions Explore the fundamental concepts of traffic engineering as they relate to operation design and management Access updated content that reflects changes in key industry leading resources such as the Highway Capacity Manual HCM Manual on Uniform Traffic Control Devices MUTCD AASHTO Policy on Geometric Design Highway Safety Manual HSM and Americans with Disabilities Act Understand the current state of the traffic engineering field Leverage revised information that homes in on the key topics most relevant to traffic engineering in today s world such as context sensitive roadways and sustainable transportation solutions Traffic Engineering Handbook Seventh Edition is an essential text for public and private sector transportation practitioners transportation decision makers public officials and even upper level undergraduate and graduate students who are studying transportation engineering

Proceedings of the Sixth International Conference of Transportation Research Group of India Lelitha Devi, Madhu Errampalli, Avijit Maji, Gitakrishnan Ramadurai, 2022-09-28 This book comprises the proceedings of the Sixth International Conference of Transportation Research Group of India CTRG2021 focusing on emerging opportunities and challenges in the field of transportation of people and freight The contents of the volume include characterization of conventional and innovative pavement materials operational effects of road geometry user impact of multimodal transport projects spatial analysis of travel patterns socio economic impacts of transport projects analysis of transportation policy and planning for safety and security technology enabled models of mobility services etc This book will be beneficial to researchers educators practitioners and policy makers alike

Crash Experience Warrant for Traffic Signals Hugh W. McGee, National Cooperative Highway Research Program, 2003

Recent Advancements in Sustainable and Safe Transportation Infrastructure - Vol. 2 Udit Jain,

Accident Risk Forecasting; a Bibliography Lois Flynn, 1977

Safe Mobility Dominique Lord, Simon Washington, 2018-04-18 This book increases the level of knowledge on road safety contexts issues and challenges shares what can currently be done to address the variety of issues and points to what needs to be done to make further gains in road safety

Proceedings of the 7th International Conference of Transportation Research Group of India (CTRG 2023), Volume 3 Prasanta K. Sahu, Amit Agarwal, Ankit Kathuria, Nagendra R. Velaga, 2025-02-26 This book presents select proceedings of the 7th Conference of Transportation Research Group of India 7th CTRG 2023 provides an opportunity for discussion of state of the art research and practice in the developing world for achieving equitable efficient and resilient

infrastructure and opens pathways to sustainable transportation This book covers the solutions related to transportation challenges such as road user safety traffic operation efficiency economic and social development non motorized transport planning environmental impact mitigation energy consumption reduction land use equity freight transport planning multimodal coordination access for the diverse range of mobility needs sustainable pavement construction and emerging vehicle technologies The information and data driven inferences compiled in this book are therefore expected to be useful for practitioners policymakers educators researchers and individual learners interested in sustainable transportation and allied fields

Highway Safety Literature, Annual Cumulation United States. National Highway Safety Bureau, **Symbolic Computation in Software Science** Stephen M. Watt,Tetsuo Ida,2024-08-27 This book constitutes the refereed proceedings of the 10th International Symposium on Symbolic Computation in Software Science SCSS 2024 which took place in Tokyo Japan during August 28 30 2024 The 7 full papers were carefully reviewed and selected from 25 submissions The papers presented emphasize formal analysis and proof of theorems in various applications foundational work on rewrite systems and sound handling of branches of inverse functions

Green Intelligent Transportation Systems Wuhong Wang,Klaus Bengler,Xiaobei Jiang,2017-07-10 These proceedings collect selected papers from the 7th International Conference on Green Intelligent Transportation System and Safety held in Nanjing on July 1 4 2016 The selected works which include state of the art studies are intended to promote the development of green mobility and intelligent transportation technology to achieve interconnectivity resource sharing flexibility and higher efficiency They offer valuable insights for researchers and engineers in the fields of Transportation Technology and Traffic Engineering Automotive and Mechanical Engineering Industrial and System Engineering and Electrical Engineering

Advances in the Collision and Grounding of Ships and Offshore Structures Hervé Le Sourne,Carlos Guedes Soares,2023-09-11 This book offers state of the art developments in the collision and grounding of ship and offshore structures The topics covered by the contributions include dynamics of vessels in collision and grounding collision and grounding in Arctic conditions collision and grounding statistics and measures of the probability of incidents risk assessment of collision and grounding measures for reduction of collision and grounding machine learning methods for the evaluation of probabilistic collision and grounding risk new designs for improvement of structural resistance to collisions analysis of ultimate strength of damaged ship structures design of buffer bows to reduce collision consequences innovative navigation systems for safer sea transportation collision between ships and offshore structures collision between ships and fixed or floating bridges collision and grounding experiments properties of materials under impact loadings residual strength of damaged ships and offshore structures hull girder response of ships under severe dynamic loadings The book is aimed at naval architects marine engineers and scientists The ICCGS conferences aim to present state of the art methods for analysis and design against collision and grounding of ships collisions between ships and icebergs offshore structures bridges submerged tunnels and waterfront structures Previous conferences were held in San Francisco USA in

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The Proceedings of the 11th International Conference on Traffic and Transportation Studies Lingyun Meng, Yongsheng Qian, Yun Bai, Bin Lv, Yuanjie Tang, 2024-11-13 This book reflects the latest research trends methods and experimental results in the field of traffic and transport covering a wealth of state of the art research theories and ideas As a vital field of research highly relevant to current developments in a number of technological areas the topics covered include traffic data analysis transport planning multimodal and integrated transport modelling and analysis of passenger behaviour etc The aim of the proceedings is to provide a major interdisciplinary forum for researchers engineers academics and industry professionals to present the most innovative research and development in the field of traffic and transportation Engineers and researchers from academia industry and government will also explore the solutions that combine ideas from different disciplines in the field The volumes serve as an excellent reference for researchers and graduate students working in the field of traffic and transportation

Intelligent Transportation Related Complex Systems and Sensors Kyandoghere Kyamakya, Jean Chamberlain Chedjou, Fadi Al-Machot, Ahmad Haj Mosa, Antoine Bagula, 2021-09-01 Building around innovative services related to different modes of transport and traffic management intelligent transport systems ITS are being widely adopted worldwide to improve the efficiency and safety of the transportation system They enable users to be better informed and make safer more coordinated and smarter decisions on the use of transport networks Current ITSs are complex systems made up of several components sub systems characterized by time dependent interactions among themselves Some examples of these transportation related complex systems include road traffic sensors autonomous automated cars smart cities smart sensors virtual sensors traffic control systems smart roads logistics systems smart mobility systems and many others that are emerging from niche areas The efficient operation of these complex systems requires efficient solutions to the issues of

sensors actuators used to capture and control the physical parameters of these systems as well as the quality of data collected from these systems ii tackling complexities using simulations and analytical modelling techniques and iii applying optimization techniques to improve the performance of these systems **Transportation Research** Dharamveer

Singh, Avijit Maji, Omkar Karmarkar, Monik Gupta, Nagendra Rao Velaga, Solomon Debbarma, 2023-12-18 This book is a collection of selected research papers from the 14th conference of the Transportation Planning and Implementation Methodologies for Developing Countries TPMDC It covers the broad area of transportation planning and policy pavement design and engineering emerging technologies in transportation traffic management operations and safety and sustainable mobility in transportation The book aims to provide deeper understanding of the transportation issues solutions and learnings from the implemented solutions This book will be of best interest for academicians researchers policy makers and practitioners *Human Factors of Visual and Cognitive Performance in Driving* Candida Castro, 2008-11-21 Written clearly

and concisely using jargon free language that is easily understood this book compresses research from the past few decades into an accessible resource It focuses on the concrete cognitive processes of driving specifically information acquisition and information processing The authors delineate the theory practice and application of human factors knowledge and psychology to explain human errors that occur when acquiring information from the road environment The book provides content on highway engineering new technologies vehicle signage VMS and safety as well as information about the human factors on errors situation awareness workload and fatigue Green, Smart and Connected Transportation Systems

Wuhong Wang, Martin Baumann, Xiaobei Jiang, 2020-03-23 These proceedings gather selected papers from the 9th International Conference on Green Intelligent Transportation Systems and Safety held in Guilin China on July 1 3 2018 They feature cutting edge studies on Green Intelligent Mobility Systems the guiding motto being to achieve green intelligent and safe transportation systems The contributions presented here can help promote the development of green mobility and intelligent transportation technologies to improve interconnectivity resource sharing flexibility and efficiency Given its scope the book will benefit researchers and engineers in the fields of Transportation Technology and Traffic Engineering Automotive and Mechanical Engineering Industrial and System Engineering and Electrical Engineering alike

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