Probabilistic Motion Planning for Automated VehiclesPassivity-Based Model Predictive Control for Mobile Vehicle Motion PlanningEngineering Autonomous Vehicles and RobotsAutonomous Ground VehiclesMPC-BASED AUTONOMOUS DRIVING CONTROL WITH LOCALIZED PATH PLANNING FOR OBSTACLE AVOIDANCE AND NAVIGATING SIGNALIZED INTERSECTIONS

Computing Systems for Autonomous Driving Tremendous industrial and academic progress and investments have been made in autonomous driving, but still many aspects are unknown and to be answered. Section 1 is focused on the trajectory and path planning of autonomous vehicles. An efficient-plan-rewriting algorithm is presented that enables the online replanning of a vehicle's trajectory based on the input of the vehicle's remaining fuel. A key feature of this algorithm is that it is not constrained by the decision of the vehicle's steering angle. A second algorithm, the so-called "progressive" algorithm, is also presented that enables the online replanning of a vehicle's trajectory based on the input of the vehicle's remaining fuel.

Autonomous Vehicle Path Planning With Remote Sensing Data | 7bf17163146b0e26f3b06a16352

Probabilistic Motion Planning for Automated Vehicles

By using physics-based sensor models, which are fed to the controller for data processing and motion planning, obstacle detection and collision avoidance are demonstrated using the trajectory reference to avoid a collision. Model Predictive Control (MPC) is used to implement longitudinal and lateral control of the vehicle. The data from vehicle-to-everything (V2X) systems is used to provide real-time information about the road and surrounding vehicles.

The results of the proposed controller and the scope of the future work conclude the research.

The research delves into improving the autonomy of self-driving vehicles by implementing localized path planning algorithms to introduce motion planning missions in a safe way. Here, three algorithms are developed by taking advantages of SVM formulation, a greedy search algorithm, an A* lattice based planner and a geometrical point, destination, stationary and moving obstacles. These features, combined with smoothness property of the Gaussian kernel used in SVM formulation is proven to be able to solve complex decoupled planning, but the search space in spatiotemporal planning is complex. Support vector machine is used to simplify the search problem to make it more efficient.

A SVM classifies the surrounding obstacles into two classes and efficiently calculate an obstacle free region for the ego vehicle. The formulation achieved by solving SVM, contains information about the initial point, destination point, and moving obstacles. These features, combined with smoothness property of the Gaussian kernel used in SVM formulation is proven to be able to solve complex decision making problems.

The DARPA Urban Challenge Autonomous robot vehicles are vehicles capable of intelligent motion and action without requiring either a guide or teleoperator control. The recent surge of interest in this subject will grow even more further as their potential applications increase. Autonomous vehicles are currently being studied for use as reconnaissance/exploratory vehicles for planetary exploration, undersea, land and air environments, remote repair and maintenance, material handling systems for offices and factories, and even intelligent wheelchairs for the disabled. This reference is the first to deal directly with the unique and fundamental problems and recent progress associated with autonomous vehicles. The editors have assembled and combined significant material from a multitude of sources, and, in effect, now conveniently provide a coherent organization to a previously scattered and ill-defined field.

Frontiers in Guided Waves and Optoelectronics

Computing Systems for Autonomous Driving Tremendous industrial and academic progress and investments have been made in autonomous driving, but still many aspects are unknown and to be answered. The DARPA Grand Challenge and the 2005 DARPA Urban Challenge were major milestones in autonomous driving research, each aiming to advance autonomous vehicle technology in different ways.

The DARPA Grand Challenge focused on steering a vehicle autonomously through a desert terrain, while the 2005 DARPA Urban Challenge aimed to navigate a vehicle through a city at high speeds. These challenges provided a platform for researchers to develop and test autonomous driving technologies.

These events, combined with smoothness property of the Gaussian kernel used in SVM formulation is proven to be able to solve complex decision making problems.

The research conducted in this thesis falls mainly into two parts, the first part investigates decoupled trajectory planning algorithms with a focus on speed planning, and the second section explores different coupled planning algorithms in spatiotemporal environments where pathfinding speed is calculated simultaneously. Additionally, a behavioral approach is carried out to evaluate different tactical maneuvers the autonomous vehicle can have considering the different states of the ego and surrounding vehicles.

Particularly relevant for heavy duty vehicles, the issues addressed in designing a safe speed planner in the first part are road conditions such as banking, friction, road curvature and vehicle characteristics. The vehicle constraints on acceleration, jerk, steering, steer rate limitations and other safety limitations such as rollover are further considerations in speed planning algorithms. For real time purposes, a minimum working roll model is identified using roll angle and lateral acceleration data collected in a heavy duty truck. In the decoupled planners, collision avoidance is treated using a search and optimization based planner. In an autonomous vehicle, the structure of the road network is known to the vehicle through mapping applications. Therefore, this key property can be used in planning algorithms to improve efficiency. The second part of the thesis is focused on handling moving obstacles in a spatiotemporal environment and collision-free planning in complex urban structures. Spatiotemporal planning holds the benefits of exhaustive search and has advantages compared to decoupled planning, but the search space in spatiotemporal planning is complex. Support vector machine is used to simplify the search problem to make it more efficient.

A SVM classifies the surrounding obstacles into two classes and efficiently calculate an obstacle free region for the ego vehicle. The formulation achieved by solving SVM, contains information about the initial point, destination point, and moving obstacles. These features, combined with smoothness property of the Gaussian kernel used in SVM formulation is proven to be able to solve complex decision making problems.

The structure of the road network is included in SVM solution. Inspired by observing significant improvements in calculation time using SVM heuristic and combining the previous approaches for autonomous driving, the data from vehicle-to-everything (V2X) systems is used to provide real-time information about the road and surrounding vehicles.

Algorithms for Autonomous Vehicles

Algorithms for Autonomous Vehicles are designed to enable vehicles to make decisions based on environmental data, such as road conditions, weather, and other vehicles' actions.

These algorithms are essential for autonomous vehicles to navigate safely and efficiently in various situations. They help in obstacle detection, path planning, decision-making, and overall vehicle control.

Algorithms for Autonomous Vehicles are categorized into different types, including perception, prediction, decision-making, and control algorithms.

Perception algorithms help the vehicle understand its environment by processing sensor data such as cameras, lidars, and radar.

Prediction algorithms forecast the future behavior of objects in the environment, including other vehicles, pedestrians, and obstacles.

Decision-making algorithms decide on the appropriate actions the vehicle should take based on the perceived and predicted information.

Control algorithms then implement the decisions made by the decision-making algorithms to control the vehicle's motion.

These algorithms work together to enable autonomous vehicles to navigate complex environments and make safe decisions.

Algorithms for Autonomous Vehicles are continuously evolving, and advancements in these areas promise to bring safer, more efficient, and more widespread autonomous vehicle adoption.
Path Planning of an Autonomous Vehicle Through Regions of Fixed Obstacles Abstract: This report investigates path planning and trajectory generation algorithms for the application in autonomous vehicle avoidance. A literature review of trajectory generation and path planning algorithms that are suitable for autonomous vehicle application. Two path planning approaches are designed in this work. Approach 1 (RRT*-Spline) uses rapidly exploring random trees* (RRT*) path planning algorithm combined with cubic spline trajectory generation algorithm. Approach 2 (A*-Polynomial Curve) plans a feasible path by using A* algorithm and generates a smooth trajectory using 5th order polynomial curve fitting algorithm. The two path planning approaches are compared to the performance of other methods on various types of vehicles. The path planning approaches are validated using Matlab/Simulink. Autonomous vehicles are increasingly important in land-based, marine and aerial operations. Autonomous underwater vehicles may be used for pipeline inspection, marine survey and collection of oceanographic/biological data. Autonomous unmanned aerial systems can be used in a large number of applications such as inspection, monitoring, data collection, surveillance, etc. At present, vehicles operate with limited autonomy and a monitoring gaze. There is a growing interest in more cooperative and autonomous systems. Systems, real-time requirements, and robustness are important factors in the design of autonomous systems and robots. Autonomous navigation of vehicles with high levels of autonomy can be used for special and efficient collection of environmental data, for assimilation of climate and environmental models and to complement global satellite systems. The target audience primarily comprises research engineers in the field of control theory, but the book may also be beneficial for graduate students.

Experimental Robotics Discover the latest research in path planning and robust path tracking control In Autonomous Road Vehicle Path Planning and Tracking Control, a team of distinguished experts present a practical and immediate approach to the challenge of how to control autonomous vehicles. The author offers an exciting overview on the role of designing robust path planning for autonomous vehicles and offers an excellent introduction to the basics for students new to the topic of autonomous vehicles and the innovative, modular-based engineering approach called DragonFly. Engineering Autonomous Vehicles and Robots: The DragonFly Modular-based Approach covers everything that technical professionals need to know about: CAN bus, chassis, sensors, radars, GNSS, complex path planning, motion planning, localization, perception for active perception, control, path planning, and more. The book offers several case studies on the building of an autonomous passenger pod, bus, and vending robot. It features a large amount of supplementary material, including the standard protocol and sample codes for chassis, sonar, and radar. GPSD protocol/NMEA protocol and GPS deployment methods are also provided. Most importantly, readers will learn the philosophy behind the DragonFly approach and gain insight into the authors' own autonomous vehicle projects. Robotics with robots with flexibility and affordability. Offers progressive guidance on building autonomous vehicles and robots Provides detailed steps and coders to create an autonomous machine, at affordable cost, and with a modular approach Written by one of the pioneers in the field building autonomous Vehicles Includes case studies, source code, and state-of-the-art research results Accompanied by a website with supplementary materials. Control and Automation: Vision Calibration methods Engineering Autonomous Vehicles and Robots is an excellent book for students, researchers, and practitioners in the field of autonomous vehicles and robots.

Autonomous Road Vehicle Path Planning and Tracking Control Algorithms are a fundamental component of robotic systems. Robot algorithms process inputs from sensors that provide noisy and partial data, build geometric and physical models of the world, plan high and low-level actions at different time horizons, and execute these actions on actuators with limited precision. The design and analysis of robot algorithms raise a unique combination of questions from many fields, including control theory, computational geometry and topology, geometrical and physical modeling, and sensor data fusion. The Workhorse approach to autonomous vehicle navigation is to provide the robot with as much intelligence and autonomy as possible. The raw data from the robot's sensors is measured, processed, and analyzed to provide a comprehensive understanding of the environment, allowing the robot to plan paths that are optimal with respect to a collection of criteria. The design of the path planning algorithms is a critical aspect of autonomous vehicle navigation. The book offers several case studies on the building of an autonomous passenger pod, bus, and vending robot. It features a large amount of supplementary material, including the standard protocol and sample codes for chassis, sonar, and radar. GPSD protocol/NMEA protocol and GPS deployment methods are also provided. Most importantly, readers will learn the philosophy behind the DragonFly approach and gain insight into the authors' own autonomous vehicle projects.

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2019 IEEE Intelligent Transportation Systems Conference (ITSC) This edited volume, Autonomous Vehicles, is a collection of reviewed and relevant research chapters, offering a comprehensive and methodical view on the current developments and new directions of experimental robotics. The series has traditionally attracted a wide readership in many branches of robotics and automation. The book offers several case studies on the building of an autonomous passenger pod, bus, and vending robot. It features a large amount of supplementary material, including the standard protocol and sample codes for chassis, sonar, and radar. GPSD protocol/NMEA protocol and GPS deployment methods are also provided. Most importantly, readers will learn the philosophy behind the DragonFly approach and gain insight into the authors' own autonomous vehicle projects.
prothetic design; robots in construction and arts, and Evolution, education, legal and social issues of robotics. For the first time in RAAD history, the themes cloud robots, legal and ethical issues of robots, and robots in art as an art form were included in the technical program. The book is a valuable resource for researchers in fields of robotics, engineers who implement robotic solutions in manufacturing, services and healthcare, and master's and Ph.D. students working on robotics projects.

Belief State Planning for Autonomous Driving: Planning with Uncertainty Prediction and Uncertainty Perception The automotive industry appears close to substantial change engendered by “self-driving” technologies. This technology offers the possibility of significant benefits to social welfare—saving lives; reducing crashes, congestion, fuel consumption, and pollution; increasing mobility for the disabled; and ultimately improving land use. This report is intended as a guide for state and federal policymakers on the many issues that this technology raises.

Autonomous Road Vehicle Path Planning and Tracking Control This book on computing systems for autonomous driving takes a comprehensive look at the state-of-the-art computing technologies involved in very demanding frameworks, algorithmic and computational optimizations, systems runtime optimizations, dataset and benchmarking, simulators, hardware platforms, and smart infrastructures. The objectives of level 4 and level 5 autonomous driving require colossal improvement in the computing for this cyber-physical system. Beginning with a definition of computing systems for autonomous driving, this book introduces promising research topics and serves as a useful starting point for those interested in starting in the field. In addition to the current landscape, the authors examine the remaining open challenges to achieve L4/L5 autonomous driving. Computing Systems for Autonomous Driving provides a good introduction for researchers and prospective practitioners in the field. The book can also serve as a useful reference for university courses on autonomous vehicle technologies. This book on computing systems for autonomous driving takes a comprehensive look at the state-of-the-art computing technologies, including computing frameworks, algorithmic and computational optimizations, systems runtime optimizations, dataset and benchmarking, simulators, hardware platforms, and smart infrastructures. The objectives of level 4 and level 5 autonomous driving require colossal improvement in the computing for this cyber-physical system. Beginning with a definition of computing systems for autonomous driving, this book introduces promising research topics and serves as a useful starting point for those interested in starting in the field. In addition to the current landscape, the authors examine the remaining open challenges to achieve L4/L5 autonomous driving. Computing Systems for Autonomous Driving provides a good introduction for researchers and prospective practitioners in the field. The book can also serve as a useful reference for university courses on autonomous vehicle technologies.

Pivot to the Future An invaluable addition to the literature on UAV guidance and cooperative control, Cooperative Path Planning of Unmanned Aerial Vehicles is a dedicated, practical guide to computational path planning for UAVs. One of the key issues facing future development of UAVs is path planning: it is vital that swarm UAVs MAVs can cooperate together in a coordinated manner, obeying a pre-planned course but able to react to their environment by communicating and cooperating. An optimized path is necessary in order to ensure a UAV completes its mission efficiently, safely, and successfully. Focusing on the path planning of multiple UAVs for simultaneous arrival on target, Cooperative Path Planning of Unmanned Aerial Vehicles also offers coverage of path planners that are applicable to land, sea, or space-borne vehicles. Cooperative Path Planning of Unmanned Aerial Vehicles is authored by leading researchers from Cranfield University and provides an authoritative resource for researchers, academics and engineers working in the area of cooperative systems, cooperative control and optimization in the aerospace industry.

Robot Operating System (ROS) Autonomous vehicles, despite their relatively short history, have already found practical application in many areas of human activity. Such vehicles are usually replacing people in performing tasks that require long operating time and are held in inaccessible or hazardous environments. Nevertheless, autonomous robotics is probably the area that is being developed the most because of the great demand for such devices in different areas of our lives. This book is a collection of experiences shared by scientists from different parts of the world doing researches and daily exploiting autonomous systems. Giving this book in the hands of the reader, we hope that it will be a treasure trove of knowledge and inspiration for further research on autonomous vehicles.

Creating Autonomous Vehicular Systems As the editor, I feel extremely happy to present to the readers such a rich collection of chapters authored/co-authored by a large number of experts from around the world covering the broad field of guided wave optics and optoelectronics. Most of the chapters are state-of-the-art on respective topics or areas that are emerging. Several authors narrated technological challenges in a lucid manner, which was possible because of individual expertise of the authors in their own subject specialties. I have no doubt that this book will be useful to graduate students, teachers, researchers, and practicing engineers and technologists and that they would love to have in their book shelves for ready reference at any time.

Path Planning for an Autonomous Vehicle By Scott Douglas McKeever
Path Planning for Autonomous Vehicles in Difficult Unstructured Environments
Contributions to Path Planning Algorithms for Autonomous Vehicles Discover the latest research in path planning and robust path tracking control In Autonomous Road Vehicle Path Planning and Tracking Control, a team of distinguished researchers delivers a practical and insightful exploration of how to design robust path tracking control. The authors include easy to understand concepts and equations applicable to the very demanding applications in control engineering. In this thesis, we have chosen two algorithms for comparison on various metrics. The first implementation is a graph based technique, A*, algorithm, to allow a collision free path from source to destination and using b-splines, an interpolating technique to smooth this obtained path. The second implementation is state dependent robes that explores the whole environment in a path-in-turn are used by a robot to plan a path. These algorithms are compared using two techniques are compared on various performance metrics such as execution time, optimality, arc length, path cost, ability to find path in narrow spaces and feasibility of the generated path. The execution time of the state lattice planner is less than A* based splines planner. However, the drawback of this approach is that if does not create a shortest path and that the path cost and arc length are greater than that of A* based splines approach.

Simulating the most likely future scenarios allows to find an optimal policy online that enables non-conservative planning under uncertainty. Sensing and Control for Autonomous Driving Cooperative Path Planning of Unmanned Aerial Vehicles (ADAS) This work presents a behavior planning algorithm for automated driving in urban environments with an uncertain and dynamic nature. The algorithm allows to consider the prediction uncertainty (e.g. different intentions), perception uncertainty (e.g. occlusions) as well as the uncertain interactive behavior of the other agents explicitly. Simulating the most likely future scenarios allows to find an optimal policy online that enables non-conservative planning under uncertainty.

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Computing Vision in Vehicle Technology

Comparison of Path Planning Approaches of Autonomous Vehicles for Obstacle Avoidance Application Passivity-based Model Predictive Control for Mobile Vehicle Navigation represents a comprehensive comparison and a critical assessment of the adoption of passivity-based model predictive control (MPC) for autonomous vehicles in both indoor and outdoor environments. The book introduces the arc length function that describes the arc length of the shortest path that goes from a starting point to a goal point. This formula is used to determine the length of the path, which is useful in robotics and computer science applications. The length function is given by:

\[ L = \int_{0}^{t} \sqrt{\dot{x}^2 + \dot{y}^2 + \dot{z}^2} \, dt \]

where \( L \) is the arc length, \( x, y, \) and \( z \) are the coordinates of the path, and \( t \) is the time. The book also discusses the limitations of traditional optimization techniques and the advantages of using a passivity-based approach for path planning.

\[ \dot{z}^2 \]
COMPARISON BETWEEN A* BASED SPLINES AND STATE LATTICE PATH PLANNING FOR AUTONOMOUS VEHICLES

The 2019 annual flagship conference of the IEEE Intelligent Transportation Systems Society will be held in Auckland, New Zealand. This conference welcomes papers and presentations in the field of Intelligent Transportation Systems, dealing with new developments in theory, analysis, simulation and modeling, experimentation, demonstration, case studies, field operational tests and deployments. ITSC 2019 particularly invites and encourages prospective authors to share their work, findings, perspectives and developments as related to implementation and deployment of advanced ITS applications.

Path Planning for Autonomous Vehicle Path Planning (PP) is one of the prerequisites in ensuring safe navigation and manoeuvrability control for driverless vehicles. Due to the dynamic nature of the real world, PP needs to address changing environments and how autonomous vehicles respond to them. This book explores PP in the context of road vehicles, robots, off-road scenarios, multi-robot motion, and unmanned aerial vehicles (UAVs).

Autonomous Driving

This is one of the first technical overviews of autonomous vehicles written for a general computing and engineering audience. Students will find a comprehensive overview of the entire autonomous technology stack and practitioners will find many practical techniques. Throughout the book, the authors share their practical experiences designing autonomous vehicle systems. These systems are complex, consisting of three major subsystems: (1) algorithms for localization, perception, and planning and control; (2) client systems, such as the robotics operating system and hardware platform; and (3) the cloud platform, which includes data storage, simulation, high-definition (HD) mapping, and deep learning model training. The algorithm subsystem extracts meaningful information from sensor raw data to understand its environment and make decisions as to its future actions. The client subsystem integrates these algorithms to meet real-time and reliability requirements. The cloud platform provides offline computing and storage capabilities for autonomous vehicles. Using the cloud platform, new algorithms can be tested so as to update the HD map in addition to training better recognition, tracking, and decision models. Since the first edition of this book was released, many universities have adopted it in their autonomous driving classes, and the authors received many helpful comments and feedback from readers. Based on this, the second edition was improved by extending and rewriting multiple chapters and adding two commercial test case studies. In addition, a new section entitled “Teaching and Learning from this Book” was added to help instructors better utilize this book in their classes. The second edition captures the latest advances in autonomous driving and that it also presents usable real-world case studies to help readers better understand how to utilize their lessons in commercial autonomous driving projects.