

# Lane Departure Analysis: Bibliometric Methods and Trends

Vidya Sagar SD\*, Prabhakar CJ

Department of PG Studies and Research in Computer Science, Kuvempu University, Shivamogga, Karnataka, India \*Corresponding Author's Email: vidyasagarsd@gmail.com

## Abstract

The present study employs the VOS Viewer software to conduct a bibliometric analysis on lane departure research. 1424 articles from the Scopus core database spanning 1968 to 2023 were analyzed. This study aims to comprehensively examine the progression, trends, and key contributors in lane departure research. The methodology employed in this study encompasses a meticulous process of article selection and data collection. The VOS Viewer software is used to visualize bibliometric networks. The analysis presents descriptive statistics of the dataset and visualizes bibliometric networks. The findings of this study encompass significant research articles, authors who have produced a substantial body of work, and journals that have received a high number of citations. Additionally, this study identifies emerging methodologies and research trends. This study is constrained by its reliance on the Scopus core database and proposes that future research should consider broadening the scope. In summary, this study makes a scholarly contribution to lane departure research by conducting a thorough bibliometric analysis utilizing VOS Viewer.

**Keywords:** Lane departure, Bibliometric analysis, VOS viewer software, Methodologies, Trends.

## Introduction

Lane departure, defined as the inadvertent deviation of a motor vehicle from its assigned lane, represents a pivotal element in traffic collisions and presents a substantial peril to the overall security of roadways (1). Over the course of several years, a significant amount of research has been undertaken to create lane departure detection and prevention systems that are highly efficient. Given the field's rapid evolution, it is imperative to gain a comprehensive understanding of the methodologies utilized and the emerging trends in lane departure research (2). Bibliometric analysis, a quantitative methodology for examining scientific literature, is valuable for investigating the research landscape within a specific academic domain. Bibliometric analysis facilitates the identification of influential articles, prolific authors, and emerging research trends by examining publication patterns, citation networks, and co-citation relationships (3). These insights offer a robust basis for comprehending the present condition of the field and directing future research endeavor's. The significance of bibliometric analysis in lane departure research cannot be overemphasized (4). This enables researchers to

obtain a comprehensive perspective on the advancements achieved in the respective field, recognize areas where knowledge is lacking, and explore potential opportunities for collaboration. Bibliometric analysis offers empirically grounded insights into the development, influence, and patterns within the field of lane departure through a systematic examination of the literature and quantitative analysis of research outputs (5). This research paper has two primary objectives. Our primary aim is to undertake an extensive bibliometric analysis of lane departure research, encompassing various studies published between 1968 and 2023. In this study, we will analyze the publication patterns, authorship characteristics, and citation networks within the field by utilizing the extensive dataset available in the Scopus core database. Additionally, this paper aims to identify and analyze the methodologies used in studies on lane departure, with a particular emphasis on emerging trends and advancements. The research questions that drive this study are as follows:

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## **RQ1: What are the critical methodologies employed in lane departure research, and how have they evolved?**

Through exploring these research inquiries, our objective is to offer a thorough comprehension of the methodologies and patterns employed in lane departure research. This will facilitate the dissemination of knowledge, foster collaboration, and promote further advancements in this crucial field of road safety. In the subsequent sections, we will elucidate the methodology utilized for the bibliometric analysis, present the analysis and outcomes, deliberate upon the implications of our findings, and ultimately conclude with recommendations for future research about lane departure analysis.

## **Methodology**

The present study utilizes bibliometric analysis as a methodological approach to examine the various critical methodologies employed in lane departure research and their temporal progression (6, 7). The methodology encompasses the execution of a thorough search utilizing the Scopus core database, applying filters to ensure the pertinence of the retrieved information, and using the VOS Viewer software to analyze and visualize the collected data (8, 9). The research investigation is centered on the extraction of metadata and citation information from a total of 1,424 scholarly papers. The VOS Viewer software can produce visual representations, such as co-citation networks, which can be utilized to discern influential articles, prolific authors, and emerging research trends within a particular academic discipline (10, 11). The methodology offers a comprehensive framework for investigating the research landscape of lane departure and acquiring a deeper understanding of the methodologies utilized in lane departure research.

## **Overview of the collected dataset**

The dataset comprises a total of 1424 research findings acquired through the search query "TITLE-ABS-KEY (lane departure) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (SUBJAREA, "ENGI") OR LIMIT-TO (SUBJAREA, "COMP") OR LIMIT-TO (SUBJAREA, "MATH") OR

LIMIT-TO (SUBJAREA, "DECI"))". The dataset encompasses open access availability, publication year, author names, subject areas, document types, types, and language. The dataset presented in this study offers a comprehensive collection of scholarly research on lane departure, covering a wide range of subject areas, including engineering, computer science, mathematics, and decision science.

## **Result**

### **Publication year distribution**

Figure 1 depicts the distribution of scholarly publications on lane departure research over various years, offering valuable insights into the temporal patterns and level of research engagement in this field. The dataset exhibits a persistent upward trend in publications from the late 1990s to the present, suggesting a burgeoning interest in the lane departure research area. The publication counts during 2019, 2022, and 2021 exhibited notable peaks, indicating periods characterized by significant research activity. The current increase in published works can be ascribed to the progress made in driver assistance systems. There was a lower volume of publications in previous years, which underscores the growing prominence that lane departure research has garnered over the last two decades. The existence of scholarly journals dating back to the early 2000s signifies the enduring significance and progression of the discipline.

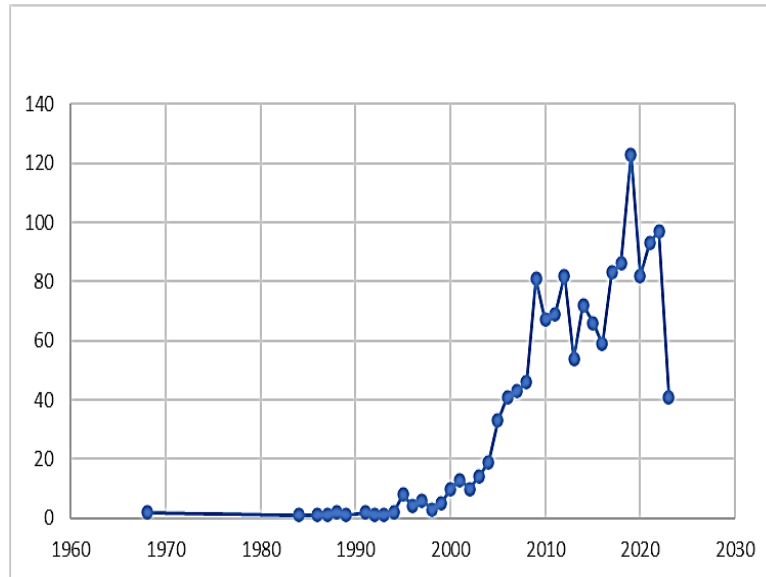
### **Publication count**

The dataset offers a comprehensive representation of the quantity and variety of scholarly literature on lane departure. Figure 2 illustrates the distribution of publication types, emphasizing the predominance of conference papers (756) and articles (570) as the primary means of disseminating research findings. Including book chapters, totaling 37, significantly enhances the comprehensiveness of scholarly works. Conversely, other forms of literature, such as reviews, surveys, and letters, exhibit comparatively lower frequencies. The distribution of scholarly output indicates a substantial academic contribution, wherein conferences play a prominent role in facilitating

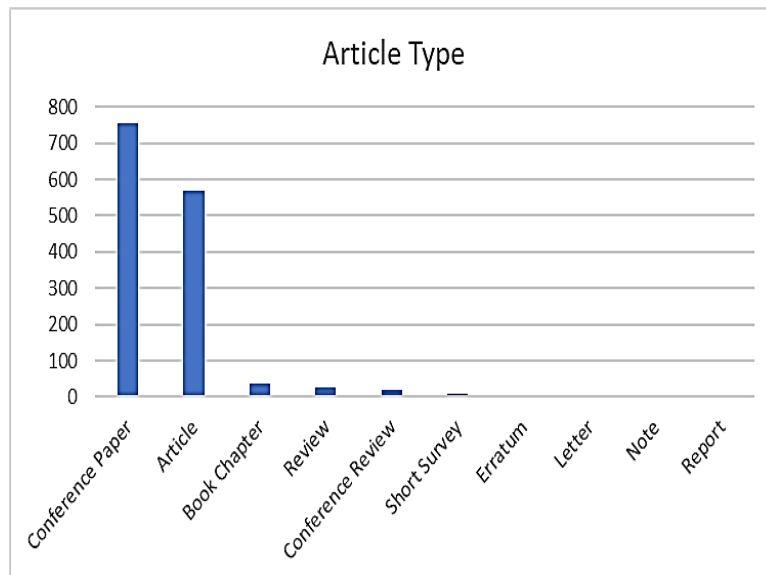
the dissemination of knowledge. Articles undergo a rigorous process of peer review, which serves as an indication of the presence of substantial original research. The results illustrate the diverse manifestations of scholarly output in lane departure research.

### Authorship characteristics

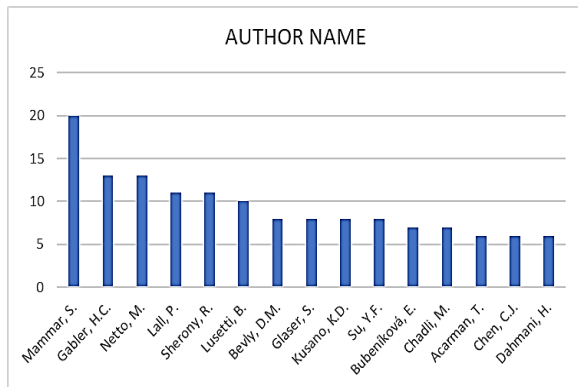
Descriptive statistics related to authorship include the total number of unique authors, the distribution of publications per author, and measures of author productivity. These statistics shed light on the collaboration patterns and productivity of researchers in the field. Figure 3 illustrates the distribution of publications by author name in lane departure research. The bar chart presents the



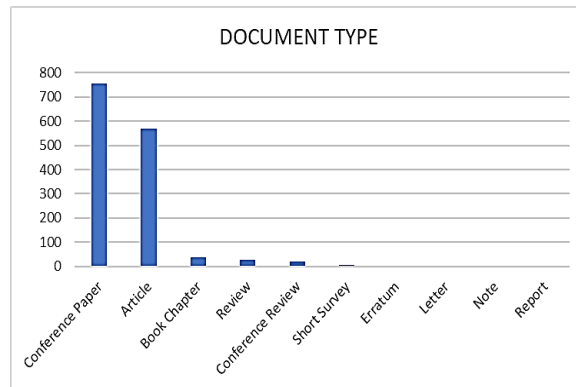
**Figure 1:** Distribution of lane departure research publications by year (1968- 2023)



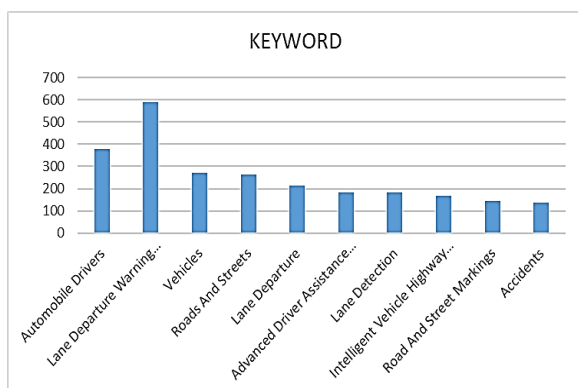
**Figure 2:** Distribution of publication types in lane departure research



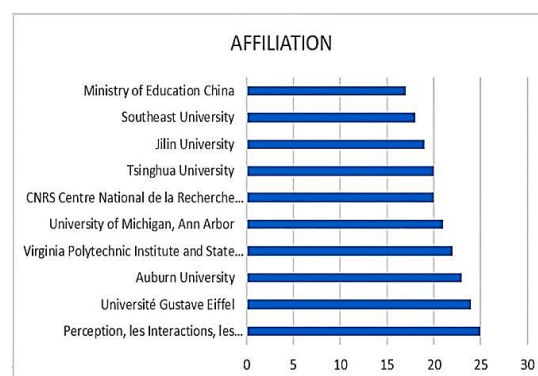
**Figure 3:** Distribution of publications by author name



**figure 4:** Distribution of document types in lane departure research



**Figure 5:** Most used keywords



**Figure 6:** Most affiliations working on lane departure

number of publications attributed to each author, emphasizing the contributions of authors with more publications. The dataset comprises authors' names and their respective publication counts in lane departure research. Several authors have achieved notable publication counts, including Mammam S, Gabler HC, Netto M, Lall P and Sherony R. The authors mentioned above have made noteworthy contributions to their respective fields of study. The observed distribution exhibits a cooperative characteristic, demonstrating that numerous authors possess comparable publications. The visual representation depicted in the figure highlights the distribution of publications among authors, with a particular emphasis on those authors who have a higher count of publications.

**Journal/Conference distribution**

As shown in Figure 4, examining the distribution of publications across different journals or conferences provides an understanding of the venues where lane departure research is h- index. These statistics reflect the impact and

published. It helps identify the most prominent publishing outlets and potential research networks. The results reveal the distribution of document types in lane departure research. Conference papers and articles are the most prevalent publication types, with 756 and 570 counts, respectively. This suggests that conferences and scholarly journals are the primary platforms for sharing research findings. Book chapters and conference reviews have relatively lower counts, indicating their lesser prominence in the field. Short surveys, errata, letters, notes, and reports comprise a smaller portion of the publications, indicating their specialized purposes. The results highlight the diverse forms of scholarly output within lane departure research.

**Citation counts**

As shown in Table 1, descriptive statistics related to citation counts include the total number of citations received by the papers in the dataset and measures such as average citations per paper and influence of the research within the field. The top

10 most cited articles in lane departure research reveal significant contributions. A highly influential paper from 2006 discusses video-based lane estimation and tracking for driver assistance, while a 2018 article introduces an instance segmentation approach for end-to-end lane detection. Other notable works cover slip angle estimation, adaptive cruise control, trajectory planning, shared steering control, bicycle infrastructure, and lane detection algorithms. These highly cited articles reflect the importance of driver assistance systems, vehicle control, behavior analysis, and advanced detection techniques in lane departure research. Their citation counts highlight their impact and influence on the field's development.

### Keyword frequencies

Analyzing the frequency of keywords used in the titles or abstracts of the research papers provides insights into the prominent themes and research topics in lane departure research. As shown in Figure 5. The analysis of the most used keywords in lane departure research highlights the focused areas within the field. "Lane Departure Warning System" emerges as the most prominent keyword, indicating the significant attention given to developing systems that warn drivers when they deviate from their lanes. Other essential keywords include "Automobile Drivers," "Vehicles," and "Roads and Streets," emphasizing the relevance of understanding driver behavior and the road environment in lane departure studies. The

presence of key- words like "Advanced Driver Assistance Systems," "Intelligent Vehicle Highway Systems," and "Intelligent Systems" reflects the integration of intelligent technologies and automation in lane departure research. Additionally, keywords such as "Lane Detection," "Road and Street Markings," and "Accidents" suggest a focus on detection algorithms, road infrastructure, and accident prevention. Overall, these keywords provide insights into the major concepts and areas of investigation within lane departure research.

### Affiliation analysis

As shown in Figure 6, affiliation in research and academia is a crucial aspect that fosters collaboration, innovation, and knowledge exchange. Researchers, institutions, and organizations can work together towards common goals. The list of affiliations mentioned represents diverse entities, including universities such as Université Gustave Eiffel, Auburn University, Virginia Polytechnic Institute and State University. It also includes renowned research institutions like CNRS Centre National de la Recherche Scientifique and industrial players such as Ford Motor Company and General Motors. These affiliations highlight the interconnectedness of global research networks and the importance of collaboration in advancing various fields of study, including perception, interactions, behaviors, and simulation of road users.

**Table 1:** Most cited articles

Year	Document Title	Authors	Citation
2006	Video-based lane estimation and tracking for driver assistance: Survey, system, and evaluation (12)	McCall JC, Trivedi MM.	890
2018	Towards End-to-End Lane Detection: An Instance Segmentation Approach (13)	Neven D, De Brabandere B, Georgoulis S, Proesmans M, Van Gool L.	409
2009	Development and experimental evaluation of a slip angle estimator for vehicle stability control (14)	Piyabongkarn D, Rajamani R, Grogg JA, Lew JY.	276
2004	Behavioral Adaptation to adaptive cruise control (ACC): Implications for preventive strategies (15)	Rudin-Brown CM, Parker HA.	246
2010	An optimal-control-based framework for trajectory planning, threat assessment, and semi-autonomous control of passenger vehicles in hazard avoidance	Anderson SJ, Peters SC, Pilutti TE, Iagnemma K.	217

	Scenarios (16)		
2013	Shared steering control between a driver and an automation: Stability in the presence of driver behaviour uncertainty (17)	Saleh L, Chevrel P, Claveau F, Lafay JF, Mars F.	200
2009	Influence of individual perceptions and bicycle infrastructure on decision to bike (18)	Akar G, Clifton KJ.	198
2010	A novel lane detection based on geometrical model and Gabor filter (19)	Zhou S, Jiang Y, Xi J, Gong J, Xiong G, Chen H.	186
2015	Real-time illumination invariant lane detection for lane departure warning system (20)	Son J, Yoo H, Kim S, Sohn K.	177
2018	A review of recent advances in lane detection and departure warning system (21)	Narote SP, Bhujbal PN, Narote AS.	176

### Visualization of keyword network

As shown in Figure 7, the keyword network analysis used 8,728 keywords with a threshold of 15 occurrences. From this set, 184 keywords were selected for further discussion. These keywords represent various aspects of lane departure research, including automobile drivers, lane departure warnings, vehicle technology, road infrastructure, advanced driver assistance systems, and intelligent vehicle highway systems.

Some of the most frequently used keywords include "automobile drivers" (378 occurrences), "lane departure warning" (305 occurrences), and "lane-departure-warning systems" (285 occurrences). On the other hand, some of the least used keywords include "convolutional neural networks" (16 occurrences), "errors" (16 occurrences), and "lighting" (16 occurrences). The distribution of these keywords provides insights into the critical areas of focus and the diversity of topics within the field of lane departure research.

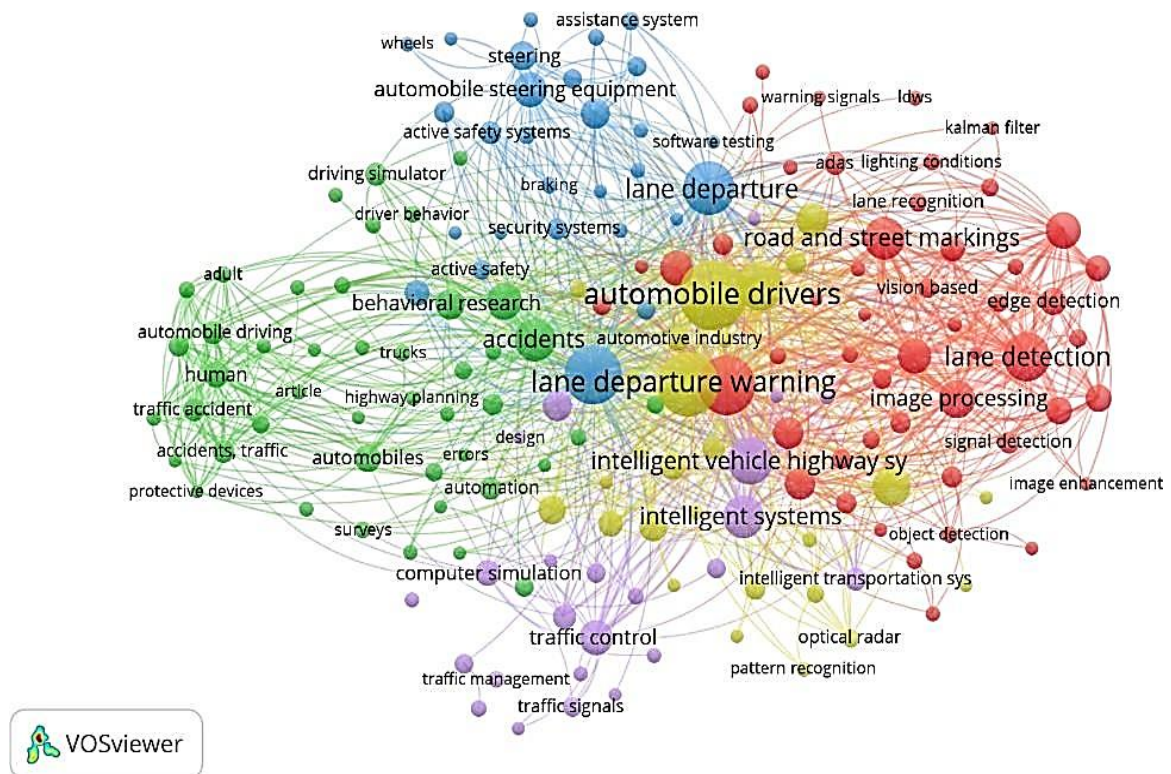
The keyword association strength provides insights into the analyzed data's relationships and co-occurrence patterns between keywords. A higher association strength indicates a more robust connection or frequency of occurrence between two keywords. Here are some interpretations of the provided keyword association strengths: "Lane detection" (0.019667525) and "Lane departure warning" (0.015687193) have the highest association strengths, suggesting a close relationship between these keywords in the analyzed context. This implies that lane detection and lane departure

warnings are frequently mentioned or share common themes. "ADAS" (Advanced Driver Assistance Systems) has a relatively high association strength of 0.009833763, indicating its strong association with other keywords. ADAS is commonly discussed alongside other concepts in the analyzed data. "Hough transforms" (0.009365488) and "Lane departure" (0.008428939) also demonstrate notable association strengths, suggesting their frequent co-occurrence or relevance within the analyzed context. "Image processing" (0.006087567) and "Computer vision" (0.003980332) have moderate association strengths, indicating their connections to other keywords but to a lesser extent compared to the top keywords. Keywords with lower association strengths, such as "Deep learning" (0.00163896) and "Intelligent transportation systems" (0.001404823), have weaker connections or occur less frequently in relation to other keywords.

The results provided include the link strength and link count for each keyword in the network: "Lane detection" has the highest link strength of 16.8, indicating solid connections to other keywords in the network. Additionally, it has a relatively high link count of 84, suggesting that it is frequently linked to other concepts or discussed extensively in the analyzed context. "Lane departure warning" has a link strength of 11.16666667 and a link count of 67, indicating its significant association with other keywords in the network. It is frequently linked to and discussed alongside other concepts. "ADAS" (Advanced Driver Assistance Systems) has a link strength of 8.4 and a link count of 42, suggesting its relevance and connection to other

keywords in the network. ADAS is a prominent topic in the analyzed data. "Lane departure warning system" has a link strength of 7 and a link count of 28, indicating its moderate association with other keywords. It is mentioned and linked to other concepts, but to a lesser extent than the top keywords. "Hough transform" and "LDWS" have link strengths of 6.666666667 and 6, respectively,

and relatively high link counts. These keywords are essential in the network and are frequently connected to other concepts. "Autonomous driving," "Hough Transform," and "Driver assistance" have moderate link strengths and lower link counts, indicating their relevance but lesser prominence compared to the top keywords.



**Figure 7:** Keywords network

### Visualization of keywords transition

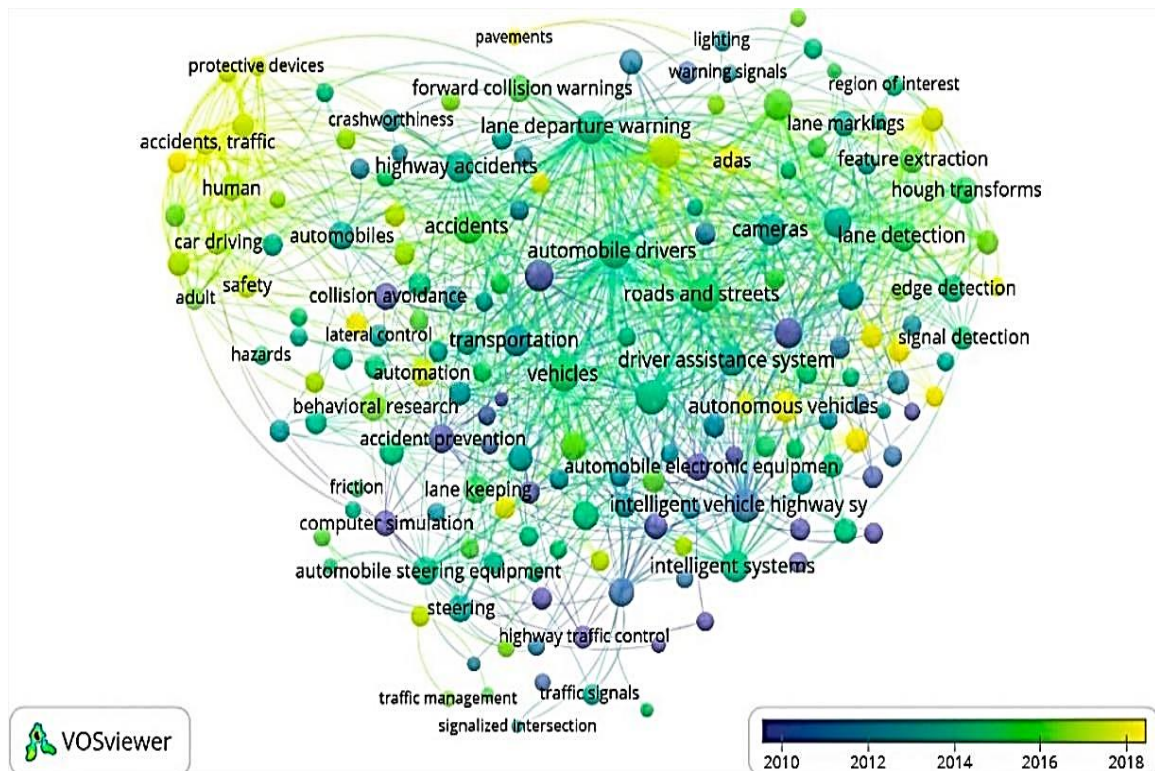
As shown in Figure 8 these transitions illustrate the evolving landscape and emerging research areas within the Lane Departure domain. The keyword transition is illustrated in the network figure showing yellow-colored markers for the keywords discussed in the past few years after 2018. The paper section discusses the keywords transition in 2022 and 2023 as recent years' transition in lane departure research areas. In 2023, the keyword transitions reflect the shifting focus and emerging trends within the analyzed context. Initially, there was a transition from keywords related to vehicle-human interaction and electromagnetic fields to those associated with run-off road incidents, cell phone use, roadway departure, and distractions. This suggests a growing emphasis on road safety and driver

behavior. Subsequently, the discussion shifted to fast model predictive control, lane-keeping, autonomous driving, and robust control systems, indicating an increasing interest in advanced control technologies. Additionally, the transitions from position errors and GNSS to collision prevention, steering control, and automated driving highlight the focus on improving navigation and safety in automated vehicles. The changes involving cybersecurity terms and mixed traffic flow with connected and automated vehicles indicate the growing importance of security and Optimization in the context of emerging technologies.

The keyword transitions in the provided dataset reveal several prominent themes in autonomous driving and advanced driver assistance systems (ADAS) in 2022 (22, 23). These themes include

lane reservation problem optimization and time-dependent travel time, Hough transform, dSPACE, SIL, ADAS, and lane marking detection. Other significant topics include retroreflection, ADAS, lane support systems, visibility, and technology acceptance model about human factors and driver behavior. Signal preemption, traffic scheduling, emergency vehicle path planning, state-dependent

rate, traffic lights, and traffic flow are relevant to research areas. Additionally, trajectory prediction, risk assessment, lane-keeping assist, and driver trust are essential considerations in automated driving. Lane departure warning systems, advanced driver assistance systems, and lane detection technologies are vital in promoting driving safety.



**Figure 8:** Keywords transition by years

### Analysis of citation patterns and co-citation networks

As shown in Figure 9 and 10, the network Analyzing citation patterns and co-citation networks provides valuable insights into the scholarly impact of a set of documents. With an h-index of 66, it indicates that of the 1424 documents considered, 66 have been cited at least 66 times, showcasing a significant level of recognition and influence within the research community. This suggests the cited documents' strong presence and contribution to the relevant field and high engagement and recognition from other researchers. The co-citation networks associated with these documents can further reveal influential clusters and connections, aiding in

understanding the intellectual landscape and knowledge dissemination within the field.

### Identification of methodologies and trends in lane detection research

As shown in Table 2, methods and algorithms play a crucial role in lane departure research. These methodologies and computational techniques enable the development and implementation of lane departure warning systems, lane detection algorithms, and advanced driver assistance systems. Some commonly mentioned methods include Lane Departure Warning, Lane Detection, Hough Transforms, Computer Vision, and Convolutional Neural Networks. These methods utilize various techniques such as image processing, feature extraction, and

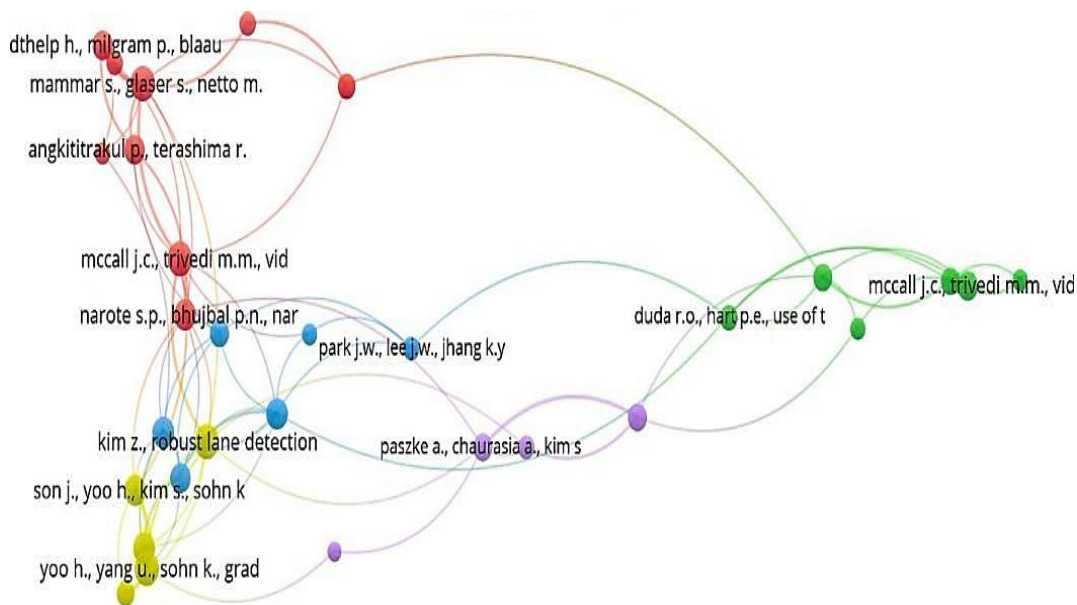


pattern recognition to analyze road and lane markings, detect lane departures, and provide timely warnings to drivers. These methods enhance driver safety, prevent accidents, and improve road transportation systems.

**RQ1: What are the key methodologies employed in lane departure research, and how have they evolved?**

Various methodologies have been utilized in lane departure research throughout the years. One of the most unique systems is the Lane Departure Warning system, which notifies drivers when they inadvertently deviate from their designated lane. Additionally, Lane-departure-warning Systems can actively detect and avert lane departure occurrences. Lane detection, which encompasses algorithms for express lane marking identification

and image processing techniques that leverage visual information for detecting lane departures, has played pivotal roles. The application of Computer Vision techniques has been utilized for the interpretation of graphic data, particularly in the context of lane departure research, where the development and implementation of algorithms have played a crucial role. The application of Hough Transforms in lane detection has been substantial. Technological advancements have enhanced the methodologies which have integrated machine learning, deep learning, and artificial intelligence. The growing emphasis on real-time systems, mathematical modelling, and simulation indicates the need to implement advanced methodologies to conduct thorough research on lane departure.



**Figure 9:** Co-citation author network

**Table 2:** Methods and algorithms

<b>Category</b>	
Driver and Vehicle	Automobile Drivers [378], Vehicles [270] Automobiles [57], Motor Transportation [49], Car Driving [37], Automobile Driving [39], Trucks [24], Commercial Vehicles [19], Field Programmable Gate Arrays (FPGA) [22], Ground Vehicles [22], Off-Road Vehicles [19], Wheels[19], Buses [19], United States [18]
Lane Departure Warning	Lane Departure Warning [305], Lane-departure- warning Systems [285], Lane Departure [213], Lane Departure Warning System [48], Lane Departure Avoidance [31], LDWS [18], Advanced Driver Assistance System [18]
Driver Assistance Systems	Advanced Driver Assistance Systems [184], Driver Assistance System [87], ADAS [42], Assistance System [27], Driving Assistance Systems [38], Driver Assistance [23], Driving Assistance [23]
Roads and Streets	Roads And Streets [262], Road And Street Markings [144], Road Departures [35], Lane Markings [53], Highway Markings [25], Highways [19], Highway Traffic Control [32], Traffic Congestion [32], Traffic Signals [32], Curves (road) [27], Highway Engineering [19], Highway Planning [19]
Accidents and Safety	Accidents (136), Highway Accidents [105], Safety Engineering [52], Traffic Accident [41], Collision Avoidance [35], Active Safety Systems [40], Safety [29], Traffic Safety [17], Crashworthiness [21], Crash Avoidance [19], Protective Devices [17], Protective Equipment [17]
Image Processing	Cameras [117], Image Processing [111], Hough Transforms [103], Image Segmentation [61], Edge Detection [61], Feature Extraction [60], Hough Transform [52], Signal Detection [37], Vision-Based [32], Signal Processing [26], Object Detection [24], Convolutional Neural Network [19], Convolutional Neural Networks [16], Image Enhancement [17]
Intelligent Systems	Intelligent Vehicle Highway Systems [169], Intelligent Systems [136], Intelligent Transportation Systems [43], Intelligent Systems [136], Automation [44], Artificial Intelligence [17], Learning Systems [18]

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Control and Algorithms	Algorithms [81], Adaptive Control Systems [60], Controllers [30], Control System Synthesis [27], Kalman Filters [25], Mathematical Models [31], Real-Time Systems [31], Optimization [19], Linear Matrix Inequalities [19], Learning Systems [18], Kalman Filter [16]
Behavior and Perception	Behavioral Research [72], Humans [49], Human [52], Driver Behavior [23], Lane Keeping [70], Adaptive Cruise Control [66], Decision Making [32]
Traffic Management	Traffic Control [95], Traffic Management [21], Traffic Signs [27], Traffic Signals [32], Traffic Congestion [32], Traffic Safety [17]
Simulation and Modeling	Mathematical Models [31], simulation [20], Forecasting [32], Virtual Reality [20]

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Lane departure research has utilized various methodologies throughout its evolution, including Lane Departure Warning systems, Lane-departure-warning Systems, Lane Detection, and Image Processing. Nevertheless, notwithstanding these advancements, certain research areas still require further attention and investigation. One concern is the precision and dependability of lane detection algorithms, particularly when confronted with difficult circumstances like inadequate illumination or deteriorated lane markings. Furthermore, it is imperative to conduct further research into alternative sensor technologies, such as radar or LiDAR, to augment lane departure detection's effectiveness and enhance its resilience. Furthermore, the integration of lane departure research with other advanced driver assistance systems and autonomous driving technologies remains an area that requires further exploration (24-28). While significant progress has been made, addressing these research gaps will contribute to the continuous evolution of methodologies in lane departure research.

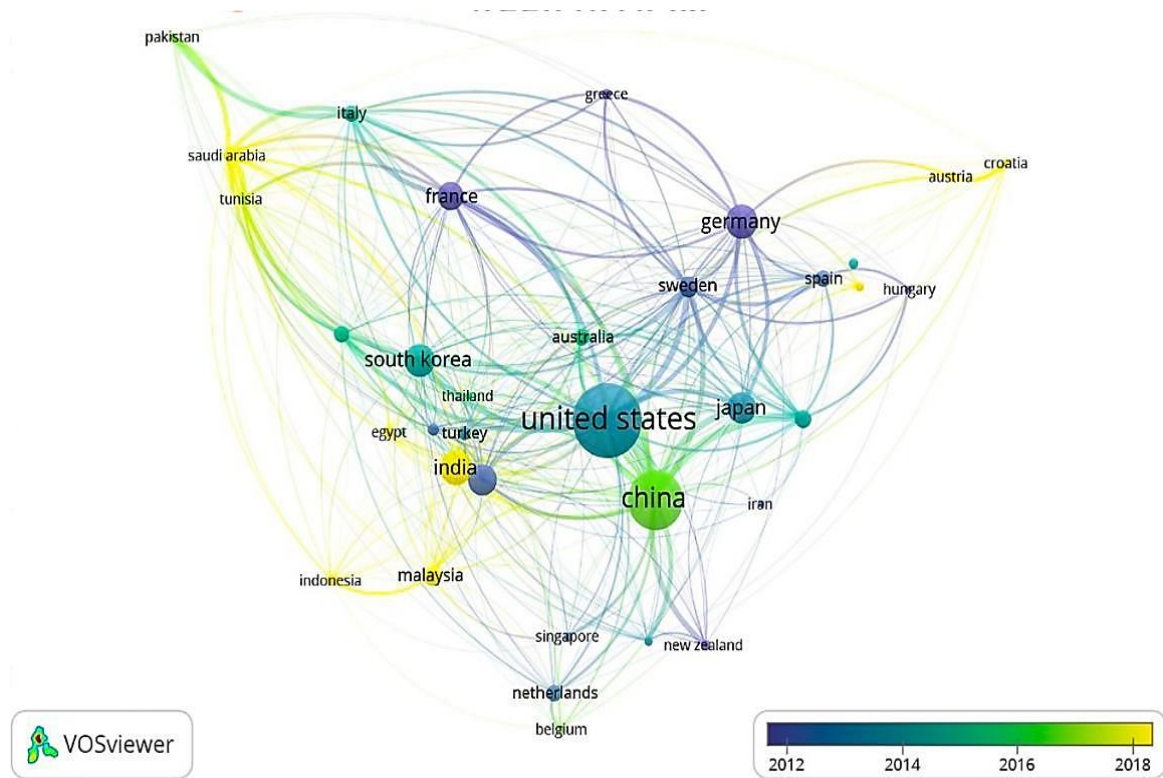
## Discussion

This study presents a comprehensive bibliometric analysis of lane departure research, examining publication patterns, authorship characteristics, citation networks,

and keyword frequencies. The analysis reveals a growing interest in the field, with increased publications over time. Conference papers and articles are the dominant publication types, indicating the primary dissemination modes. Prolific authors and collaboration among researchers are observed, highlighting the collaborative nature of the field. Prominent publishing outlets in lane departure research are identified through journal/conference distribution analysis. Highly influential articles that have significantly impacted the field are identified through citation counts. Keyword analysis provides insights into critical themes and areas of investigation. The findings of this study contribute to the existing literature by providing a holistic view of lane departure research. By comparing with previous studies, the consistency or divergence of findings can be identified, and emerging trends can be recognized. The recognized methodologies and trends have implications for researchers. They can guide researchers in selecting appropriate methods, inform resource allocation, and contribute to developing effective lane departure detection and prevention systems. The study has some limitations, including reliance on a specific database that may not include all relevant publications and potential biases due to inaccuracies or incompleteness of metadata. It focuses on English language

publications, limiting the representation of non-English research. Future research can delve into specific subdomain methodologies, conduct longitudinal studies, explore regional differences, and promote interdisciplinary collaborations. This study provides valuable

insights into lane departure research methodologies, trends, and characteristics, highlighting its growth and collaborative nature. The findings have implications for both academic and practical aspects of the field while suggesting directions for future research.



**Figure 10:** Bibliometric coupling between countries

The bibliometric analysis conducted in this study provides valuable insights into lane departure research. The findings comprehensively understand the methodologies employed, emerging trends, and key contributors within the domain. The research has shed light on the evolution of lane departure research over time, with a consistent increase in publications from the late 1990s to the present, indicating a growing interest in the field. The analysis of publication types reveals the prevalence of conference papers and articles as primary dissemination modes, emphasizing the importance of conferences and scholarly journals in sharing research findings. The analysis of authorship characteristics serves to identify prominent authors who have made substantial contributions to the field, thereby promoting collaboration and the dissemination of knowledge. The citation analysis presents a comprehensive overview of the highly cited articles, thereby highlighting their significant impact and influence on the advancement of lane departure research. The works mentioned earlier, which have received essential citations, encompass a range of topics, including video-based lane estimation, instance segmentation for lane detection, slip angle estimation, and adaptive cruise control. The analysis of keywords offers valuable insights into the prevailing themes and areas of study in lane departure research, encompassing lane departure warning systems, drivers of automobiles, vehicle technology, and road infrastructure. As mentioned earlier, the keywords indicate the incorporation of intelligent technologies and automation within the domain (24-28).

## Conclusion

This bibliometric analysis enhances lane departure research by comprehensively examining methodologies, trends, influential articles, and prominent authors. The results of this study have the potential to provide valuable guidance for researchers, practitioners, and policymakers in comprehending the present condition of the field, recognizing areas where knowledge is lacking, and investigating possible opportunities for collaboration. The analytical

methodology utilized in this study has the potential to be extrapolated to various other research fields, enabling the acquisition of quantitative observations and promoting the use of evidence-based decision-making.

## Abbreviation

ADAS, VOS Viewer.

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## Author's contributions

Conceptualization, Vidya Sagar S D and Prabhakar C J; Understanding the Methodologies, Vidya Sagar S D and Prabhakar C J; Formal analysis, Prabhakar C J and Vidya Sagar S D ; Writing— Original draft preparation, Vidya Sagar S D and Prabhakar C J; Supervision, Prabhakar C J; The bibliometric analysis conducted in this study provides valuable insights into lane departure research. The authors have read and agreed to the published version of the manuscript.

## Conflict of interest

The authors do not have any conflict of interest with other entities, organization, researchers or Individuals.

## Ethics approval

Not applicable.

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