Academic Journal of Science and Technology
ISSN: 2771-3032 | Vol. 8, No. 1, 2023

Research on the Application of Target Detection Algorithm in Autonomous Driving at Home and Abroad

-- The Visual Analysis based on the CiteSpace

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Abstract: Autonomous driving is an important global research hotspot and a strategic direction of the development of the automobile industry. The autonomous driving module is inseparable from the support of the target detection technology. Its application in the field of autonomous driving is of great research significance. So with China network and Web of Science as a data source, with the help of CiteSpace visual analysis software for 2014-2021 international and domestic target detection algorithm application in the field of autonomous driving literature, in post trend analysis, keywords co-occurrence map, keyword clustering map, Timezone View, analysis, on the basis of the time distribution, research institutions, research hotspot, future trend prediction from several aspects of the statistics, comparison and analysis.

Keywords: Autonomous driving; Target detection algorithm; CiteSpace; Visual analysis.

1. Introduction

Transportation is a very important basic industry for the sustainable development of national economy. With the improvement of people's living standard, cars have become an important means of transportation for people's daily travel. According to statistics from the Ministry of Public Security, China's car ownership will reach 302 million [1] in 2022. But while cars provide convenience, the number of traffic accidents across the country remains high, and an estimated 90% of car accidents are [2] caused by human error. At present, with the change of Volkswagen's demand for autonomous vehicles and the rapid development of artificial intelligence, autonomous driving has become one of the research hotspots in the automotive field.

In the case of autonomous driving, the accuracy of obstacle detection determines whether the driving is safe. In order to make the car in the autonomous driving scene operate safely, efficiently and stably on the road, the autonomous vehicles need to make real-time and accurate detection and judgment. Accurate detection, identification and judgment of real-time targets are the basis and core [3] to ensure its operation.

However, at present, there are not many references for the scope and depth of the application of target detection algorithm in autonomous driving, which is not conducive to researchers' intuitive understanding of the current situation of the field [4]. In order to solve this problem, this paper selects CiteSpace, the current mainstream bibliometric software, in visual data analysis, focusing on the application of target detection algorithm in the field of autonomous driving.

2. Research Design

2.1. Data Sources

In this paper, CNKI (CNKI) is used as the source of Chinese literature data and Web of Science (WoS) as the source of foreign literature data. Based on the target detection algorithm from deep learning period in 2014, after 2014, the traditional target detection algorithm is rarely used in this situation, to "automatic driving" and "target detection algorithm" as the theme, in 2014-2021 for the time span on CNKI, retrieved 242 literature, and then by manually eliminate meetings, newspapers, filling enlightenment, information bulletin, and irrelevant to the research topic of this paper, select 231 literature as Chinese data source. As the world's largest comprehensive academic information resource platform covering the largest number of disciplines, WoS includes various core academic journals [5] of 8850 (SCI) + 3200 (SSCI) + 1700 (AHCI) in the top fields of various research fields, including biomedicine, engineering and natural science. With the same English subject words and time span as the search conditions, 838 documents were retrieved in the WoS core database. After eliminating the conference and irrelevant documents, the weight removal operation was performed in CiteSpace, and 299 documents were finally selected as foreign language data sources.

2.2. Research Tool

This paper uses a mainstream visual bibliometric software CiteSpace for data analysis. CiteSpace is a free Java application developed by Professor Chaomei Chen from Redsell University, USA. It is a software [6] applied in the scientific literature to identify and show new trends and new trends in scientific development. Through visual operation, the relationship between the articles is clearly displayed to the researchers in the way of scientific knowledge graph, which helps to clarify the past research process, and also helps to grasp the future development direction.

2.3. Research Method

This paper mainly uses the functions of keyword co-occurrence, keyword clustering, Timezone View and so on of CiteSpace software, and uses bibliometry and common word analysis method to compare analyze the current situation and

hot spots of target detection algorithm application in the field of unmanned driving at home and abroad. Bibliometry is to use the methods of mathematics, statistics and other disciplines to study the quantitative relationship, law change and distribution structure of literature, and to further study some characteristics, structure and laws of science and technology. Common word analysis is to judge the relationship between the keywords in the represented field [7] according to the frequency of recurrent words or phrases in the literature.

3. Data Processing and Visualization and Analysis

3.1. Comparison of the Trend of the Number of Publications

Compared with the international and domestic publication trend chart from 2014 to 2021, we can see that the applied research of target detection algorithm in the field of automatic driving is generally on the rise. From 2014 to 2018, the number of domestic and foreign papers published was relatively small and the growth is slow, and the domestic publication volume was slightly lower than the international level; after 2018, the number of domestic and foreign publications increased significantly, and the total number of publications in 2019 was the sum of the previous five years, and reached the international level in 2020. On the whole, the gap between domestic and international publications is gradually narrowing. The side reflects the steady improvement of the domestic research level in recent years. See the trend chart of international and domestic(Figure 1) and (Figure 2).

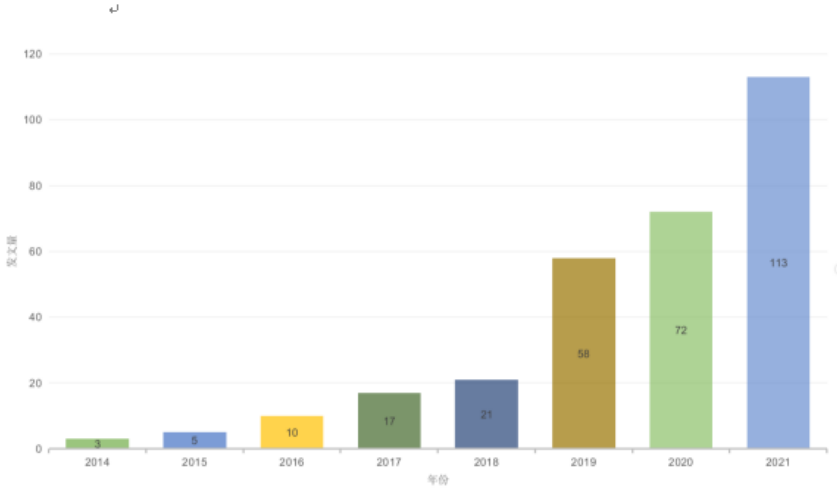

Figure 1. Trend chart of international publications

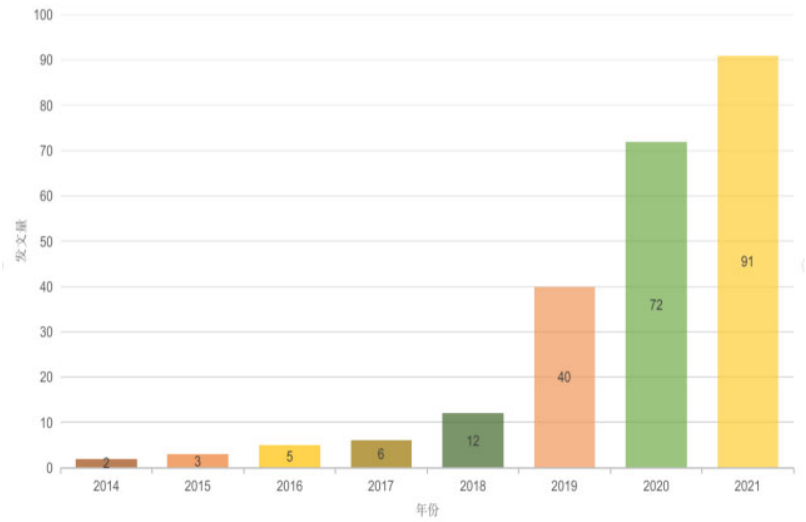

Figure 2. Trend chart of domestic publications

3.2. Keyword Map Analysis

Keywords can summarize the core content of an article, through the analysis of the keywords of the article can better grasp the theme of the article. The association of keywords in the literature can be expressed by the frequency of co-occurrence. When multiple keywords appear more frequently in the same literature, the closer the relationship is. Common word analysis uses the frequency of simultaneous words or phrases in the literature set to infer the relationship between research hotspots in the field [8]. Count the frequency of keywords in an article in the sample literature. The higher the co-occurrence frequency of keywords, the larger the node cross, the more important the node is in this study.

Distribution of international keywords

The Node Type was set to Keyword, and the analysis yielded 171 nodes, 443 lines with a network density of 0.0305 (Figure 3) and cluster map (Figure 4).

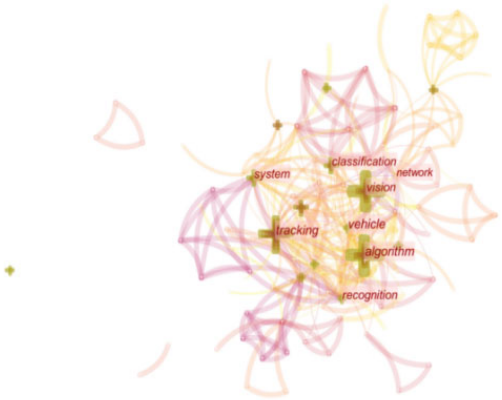

Figure 3. International keyword co-occurrence map

Figure 4. International keyword cluster map

It can be seen that algorithm, vision, tracking, classification, vehicle, recognition have high frequency, and are the hot issues in algorithm research in autonomous driving scenarios in the world. The six clusters of curb, scene understanding, learning strategy, integrity, range resolution, and two-stage sampling are concentrated, indicating a close relationship and high coincidence degree, which represent the international research focus in this field.

Domestic keyword distribution

The number of visual nodes of the domestic knowledge map is 146, the number of connections is 319, and the network density is 0.0301. After screening, 24 high-frequency keywords (Figure 5) and 9 clusters (Figure 6) were selected for analysis. It can be seen from the figure that the target recognition algorithm has developed into deep learning algorithm since 2014. The two mainstream series of single-stage regression target detection algorithm- -YOLO and SSD series are highly popular in the field of autonomous driving in China. Data enhancement optimization and the improvement of small target detection technology have promoted the development of autonomous driving research in China [9]. Single-stage target detection algorithm and small target and lidar detection algorithm without anchor box are hot research hotspots in China [10], and algorithm optimization mainly focuses on feature fusion and environment perception. Occlusion treatment has also received great attention as a separate cluster.

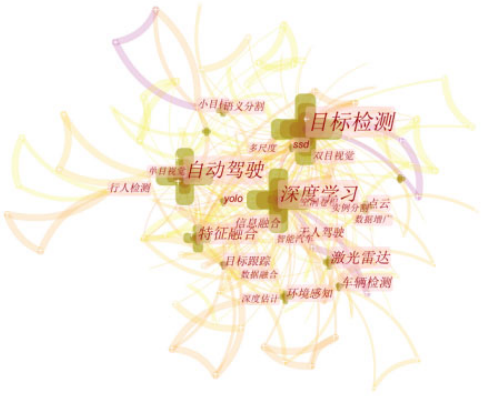

Figure 5. Domestic keyword co-occurrence map

Figure 6. International keyword cluster map

3.3. Timezone View

Timezone View, as one of the classic view of Citespace software, shows the appearance order of each keyword by matching the time axis with the first year of keywords, and intuitively reflects the application and development process of domestic and foreign target detection technology in the field of unmanned driving in the way of time line.

International development process

The time zone distribution of the international target detection algorithm in the field of driverless driving is shown as (Figure 7). It can be seen that high-frequency words mainly appeared in 2014, with the largest number of new words appeared in 2015, and a certain number of new words appeared in 2016. Therefore, the main international research directions in this field were first proposed in 2014-2016, and appeared frequently in the whole time span, and were strongly associated with the subsequent years. After 2016, they are mainly studied in the related fields of these high-frequency words. It is worth noting that algorithm first appeared in 2018 and has a high clustering degree, while most other years are derived articles from related fields with low clustering degree.

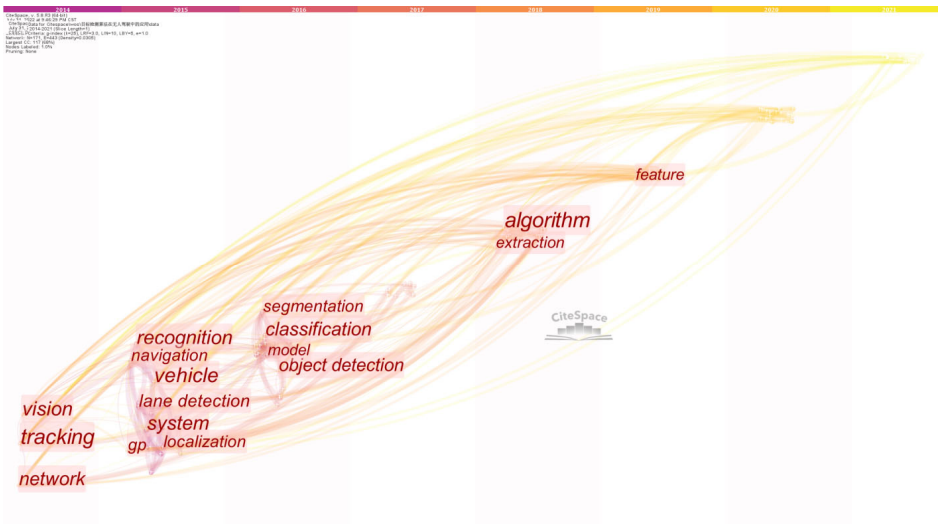

Figure 7. Time-zone view of the international development process

Domestic development process

The application time zone distribution of the domestic target detection algorithm in the field of driverless driving is shown in (Figure 8). By comparing with Figure 5, it can be found that the domestic research situation is completely different from the international research form. Compared with the international peak of keywords first appeared in 2014-2016, domestic keywords first appeared time generally lag, mostly concentrated in the 2018-2020 range, which also reflects that the domestic research on autonomous driving target detection algorithm lags behind the international several years.

Since the emergence of high-clustering keywords such as deep learning, target detection and autonomous driving in 2014 to 2017, the target detection technology in the field of unmanned driving in China has not been too hot. Until 2018, a lot of research has been done on the optimization of target detection algorithm in China, especially in YOLO and SSD series algorithms, on the detection optimization of common obstacles in the driving process, such as pedestrians and vehicles. The latest keywords emerging in 2020 are lightweight, feature extraction, and data expansion.

Figure 8. Time-zone view of the domestic development history

3.4. Analysis of Issuing Institutions

Through the visualization operation of the publishing institutions of the data source, it intuitively shows which institutions are studying in this aspect. On the one hand, the high-yielding institution of papers in this field provides guidance for China to introduce high-end talents and find academic leaders [10]; on the other hand, it also helps to quickly determine the active units of international research, and provides support [11] for the research cooperation and international comparison in the field of autonomous driving in China.

International document organization

Among the internationally published articles, Chinese Acad Sci, Univ Chinese Acad Sci, Natl Univ Def Technol, Shanghai Jiao Tong Univ, Univ Michigan, and Southeast Univ published many articles and had relevance, indicating that there is a cooperative relationship and they are the main publishing organization. Seoul Natl Univ It also has a high amount of publications, but it has a low correlation with other major publishing agencies and is relatively independent. The

above institutions constitute the main research on target detection algorithms for autonomous driving. As shown in (Figure 9):

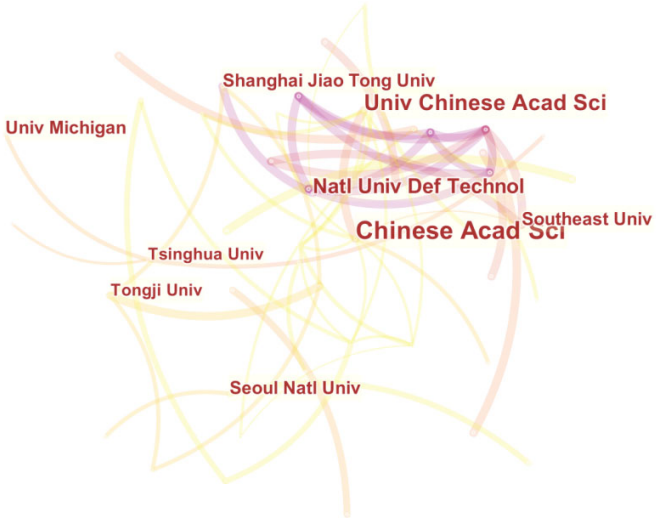

Figure 9. Foreign publishing agencies jointly present the map

Domestic document organization

The collected data were analyzed, and the institutions with more than 8 publishing articles were screened. The co-occurrence map of the domestic publishing institutions is shown in (Figure 10). Compared with international publishing institutions, domestic publishing institutions are more dispersed. Among the institutions with a large number of publications, the main cooperative relations are Naval Aerospace University and Yantai Institute of Technology, and the main publishing institutions are Wuhan University, Key Laboratory of Yunnan Minzu University and Guangxi Normal University.

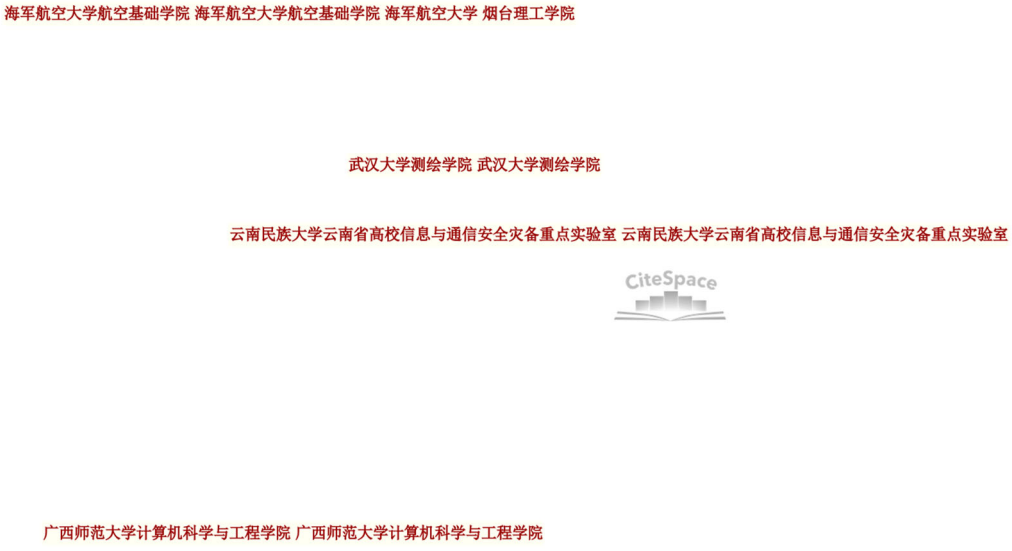

Figure 10. Domestic publishing agencies jointly present the map

3.5. Future Trend Analysis

By studying the keyword mutation situation in related fields, we can clearly see the development process of the research in this field and predict the research hotspot trend and future research trend in this field [12]. Summarize the heat trend of the top 9 international and domestic key keywords, It is found that the international (Figure 11) tracking heat in 2014 is high; Both models and robust started in 2016 and disappeared in 2017 and 2018; Both environment and obstacle detection only briefly emerged in 2018; The last four keywords all hit in 2019, Only feature and extraction heat continued until 2021, Therefore, it is predicted that the international research hotspot in this field should be in feature and extraction.

The research popularity in China (Figure 12) has been relatively stable. It is worth noting that only YOLO will continue from 2020 to 2021, which is likely to become the main application research direction of target detection algorithm in the field of autonomous driving in the future.

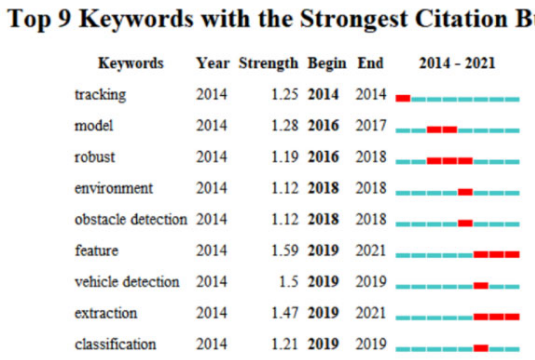

Figure 11. International keyword mutation

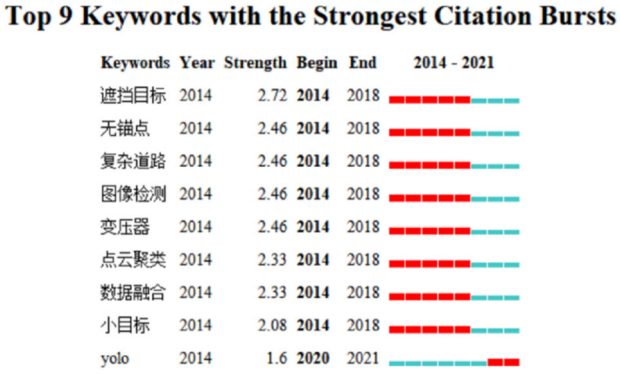

Figure 12. Domestic keyword mutation

4. Conclusion and Outlook

In this paper, the analysis of the application of target detection algorithm in the field of autonomous driving, and then the following four conclusions are obtained:

(1) The general direction of international and domestic research is basically the same, both focusing on algorithm optimization, vision and deep learning. However, the emphasis is different. The international side refers to the optimization of two-stage target detection technology, while the domestic side refers to single-stage target detection algorithms such as YOLO and SSD.

(2) The international and domestic research progress is inconsistent, the international research in this field developed rapidly in the following two years in 2014, with less new development; the target detection algorithm developed in 2014, and began in 2018. With the increasing popularity of automatic driving system in domestic automobile, a large number of research branches appeared, with a wide range and large quantity, and is expected to become the global leader in target detection technology research in the field of automated driving.

(3) Domestic publishing institutions have less relevance, which is too dispersed compared with the international ones; international publishing institutions have close ties, so they should enhance communication and academic discussion among domestic research institutions, strengthen cooperation, and jointly produce better research results.

(4) The future trend of international and domestic research is different, the international popularity of feature and extraction will continue, and the domestic may be more inclined to the single-stage research of detection algorithm for small targets such as YOLO.

Through analyzing the application of target detection algorithm in the field of autonomous driving at home and abroad, it can provide reference and support for researchers in this field to correctly understand the research differences at home and abroad and grasp the frontier direction of the research field. This paper analyzes the data at home and abroad from many aspects, hoping to be helpful to the relevant research scholars in the selection of research directions in this field. The sample size based on the current database is not very sufficient and may have some impact on the study accuracy [13]. In the future, the research sample size will be increased and a systematic analysis of the application of the target detection algorithm in the field of autonomous driving will be conducted in more aspects.

Acknowledgment

None.

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