A Preliminary Analysis of Research Hotspots and Evolution Trends of YOLO Object Detection Algorithm Based on Bibliometrics

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Abstract

Publications related to YOLO have increased rapidly year by year, reflecting a robust development momentum of this research field. Based on reference co-citation and keyword co-occurrence analyses, YOLO research inherits the traditional theoretical framework of object detection and has formed a complete research system covering theoretical exploration, algorithm iteration, performance optimization and practical application. Current research hotspots mainly include network lightweight design, small object detection, feature fusion and attention mechanism optimization, which are widely applied in industrial inspection, remote sensing, agriculture and other fields. This paper briefly sorts out the research context in this field, which can provide a reference for the subsequent optimization and application research of the YOLO algorithm.

Keywords

YOLO algorithm; object detection; bibliometric analysis; research hotspot; lightweight network.

1. INTRODUCTION

The YOLO (You Only Look Once) algorithm, proposed by Redmon et al., is one of the representative object detection algorithms. YOLO completes bounding box regression and class prediction through a single forward inference. With the continuous iteration and upgrading of the algorithm, its detection speed, detection accuracy, generalization ability and deployment performance have been significantly optimized and improved. It has now been widely applied in many fields such as traffic monitoring, medical image analysis, industrial quality inspection, and agricultural pest detection[1]. Especially in the past decade, research on the YOLO algorithm has shown explosive growth. Based on the authoritative Web of Science (WOS) database and the VOSviewer tool, this paper adopts a bibliometric visualization analysis method to sort out the literature related to the YOLO algorithm, and briefly analyzes the research hotspots and frontier trends of its application.

2. DATA SOURCES

The literature data of this study were obtained from the Science Citation Index and Social Sciences Citation Index in the Web of Science Core Collection[2]. The retrieval formula was set as TS=(YOLO OR "YOLOv*") AND TS=("object detection" OR "object recognition"). The document types were limited to journal articles and proceedings papers, and the subject categories were selected as Computer Science, Engineering, Imaging Science & Photographic Technology, and Telecommunications. The retrieval time span was from January 1, 2019 to August 8, 2026. The statistical curve of publication volume is shown in Figure 1, which presents the annual publication volume and cumulative publication volume statistics in the field of YOLO algorithm application. The blue bars represent the annual number of newly published literatures, and the red bars represent the total cumulative literatures[3]. The red dashed line is the 4th-order polynomial fitting curve of cumulative publications, reflecting that the total literature volume of this field shows a sustained and rapid growth trend. The blue dashed line is the 2-period moving average curve of annual publications, which smooths the fluctuation of annual publications. It can be seen that the annual publication volume maintains an overall upward trend. The growth trend is calculated as follows:

$$y = -7.2093x^4 + 117.62x^3 - 542.21x^2 + 1034.4x - 620.3 \quad (1)$$

In this 4th-order polynomial equation, 99.69% (\(R^2=0.9969\)) of the variation in cumulative publication volume data can be explained, indicating an extremely high degree of fitting.

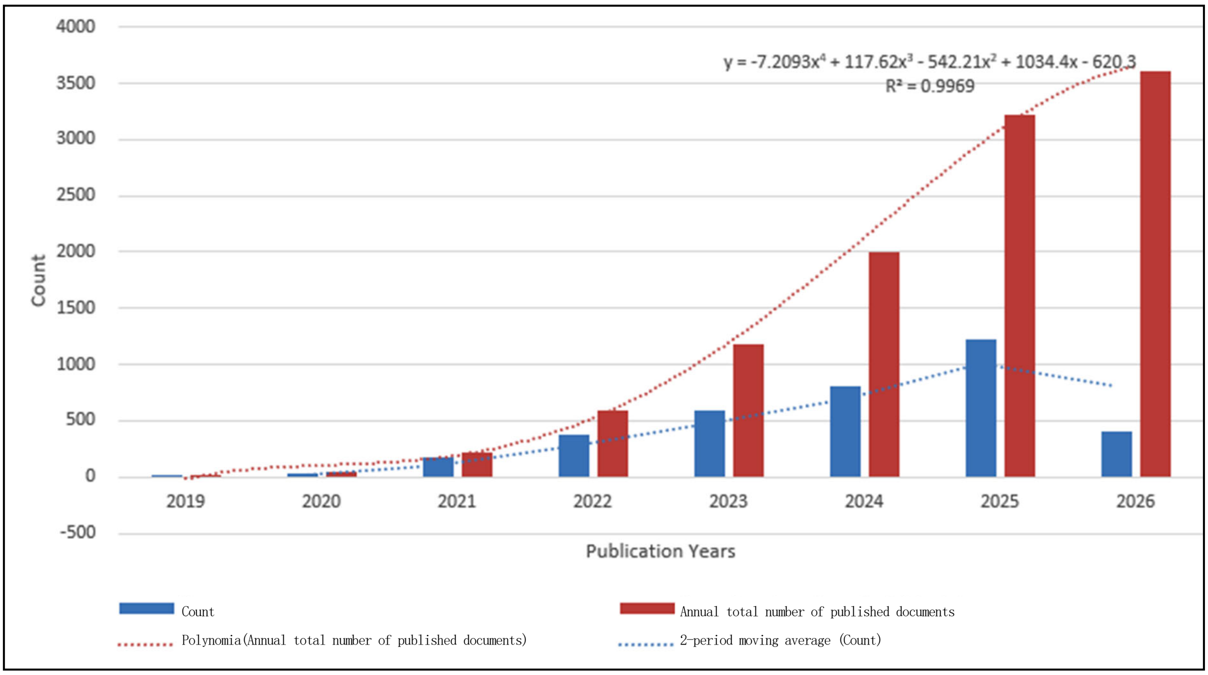

Figure 1. Statistics of the number of publications

Figure 1 indicates that the application directions of the YOLO algorithm have continuously attracted academic attention, and relevant research outputs have increased year by year. In terms of growth characteristics, the publication growth rate kept rising from 2019 to 2025, suggesting that this field is in a stage of vigorous development.

To ensure the smooth implementation of the subsequent co-citation analysis, as shown in Table 1, literatures with complete references were screened and retained among publications from high-output years, while discipline-irrelevant literatures were excluded. Finally, a literature dataset for visualization analysis was constructed. After retrieval, duplicate and irrelevant literatures were manually removed, and a total of 3570 records in plain text format were exported for subsequent analysis. Figure 2 shows a partial display of the dataset.

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Table 1. Description of data sources

Category	Specific Standard Requirements
Research database	Web of Science core collection
Citation indexes	SCIE
Searching period	January 2021 to August 2026
Language	English
Searching keywords	("YOLO" OR "You Only Look Once") AND ("object detection" OR "target detection")
Subject categories	"Computer Science" or "Engineering" or "Imaging Science Photographic Technology" or "Telecommunications"
Document types	"Articles" OR "Early Access" OR "Review"
Data extraction	Export with full records and cited references in plain text format
Sample size	3570

Year	The citation frequency of the WOS core collection	Title	Author Keywords	Additional Keywords	Journal	Author's abbreviation	Organizati	Country or Region	Full author's name	The category of WOS	Research direction	The number of uses in the past 180 days	The number of uses in the past 180 days	The number of uses in the past 180 days	The number of uses in the past 180 days	The number of references cited
2023	2	S2F-Yolo:	Improved	Neural-Netw	Journal C	Wang, F;Zhen	Southern	Peoples R C	Wang, Feng;Zheng	Computer Scien	Computer S	2	24	2	24	35
2024	5	Yolo-Dyna	Spaceborn	Classificat	Sensors	Zhang, Hy;Li	Changchun	Peoples R C	Zhang, Haiying;I	Chemistry, Ana	Chemistry;I	0	37	6	37	43
2024	8	Yolo-Mfd:	Object De	缺失字段	Cmc-Compu	Zhang, Zy;Zh	Hunan Uni	Peoples R C	Zhang, Zhongyuan	Computer Scien	Computer S	0	44	8	44	31
2021	56	Robust De	Cnn;Dense	Object Dete	Journal C	Dewi, C;Chen	Univ Muns	Taiwan;Indo	Dewi, Christine;	Computer Scien	Computer S	5	112	60	112	74
2022	12	A Study C	Objection	Convolution	Sensors	Woo, J;Baek,	Univ Sung	South Korea	Woo, Joo;Baek,	Chemistry, Ana	Chemistry;I	0	46	14	46	23
2022	8	Efficient	Autonomou	缺失字段	Sensors	Yun, H;Park,	Kyungpook	South Korea	Yun, Heuijee;Par	Chemistry, Ana	Chemistry;I	2	13	8	13	34
2025	10	An Optimi	Artificia	缺失字段	Scientifi	Gupta, C;Gil	Islamic U	Saudi Arabi	Gupta, Chhaya;Gi	Multidisciplin	Science & T	5	10	11	10	52
2025	12	Yolo-Srm	Unmanned	缺失字段	Remote Se	Weng, Sm;Wan	Northeast	Peoples R C	Weng, Shimin;War	Environmental	Environmen	9	20	15	20	47
2023	17	Dynamic A	Real-Time	Recognition	Sensors	Ye, Yq;Ma, X	Zhejiang	Japan;Peopl	Ye, Yangqing;Ma,	Chemistry, Ana	Chemistry;I	1	52	19	52	51
2021	64	Sea Surfa	Yolo V4;S	Ship Detect	Journal C	Liu, T;Pang,	708Th Res	Peoples R C	Liu, Tao;Pang, F	Engineering, M	Engineering	2	193	75	193	43
2024	9	Walnut Re	Low-Altit	Identificat	Agricultu	Wu, Mj;Yun,	Engn Res	Peoples R C	Wu, Mingjie;Yun,	Agronomy	Agriculture	6	46	10	46	49
2025	4	Yolo-Arm:	Convoluti	缺失字段	Alexandri	Wang, Fz;Son	Xihua Uni	Peoples R C	Wang, Fuzhi;Song	Engineering, M	Engineering	2	13	4	13	34
2025	5	Ls-Yolo:	Accuracy;	Object Dete	Ieee Acce	Ju, C;Chang,	Yanan Uni	Peoples R C	Ju, Cheng;Chang,	Computer Scien	Computer S	20	77	7	77	36
2024	8	Stereoyol	Object De	Classificat	Journal C	Shang, Yf;Yu	Jimei Uni	Peoples R C	Shang, Yifan;Yu,	Engineering, M	Engineering	8	54	9	54	35
2024	12	Lida-Yolo	Computer	Image-Enhan	Iet Image	Xiao, Y;Liao	Sichuan W	Peoples R C	Xiao, Yun;Liao,	Computer Scien	Computer S	2	58	12	58	46
2025	7	Technical	Smart Log	缺失字段	Sensors	Dilmi, W;El	King Fahd	Saudi Arabi	Dilmi, Wissem;El	Chemistry, Ana	Chemistry;I	6	23	8	23	44
2025	32	Sema-Yolo	Small Ob	缺失字段	Remote Se	Wu, Zc;Zhen,	Wuhan Uni	Peoples R C	Wu, Zhenchuan;Zh	Environmental	Environmen	26	97	32	97	66
2023	42	Yolo-Lwne	Road Dama	Crack Detec	Sensors	Wu, Cg;Ye, M	Changan U	Peoples R C	Wu, Chenguang;Ye	Chemistry, Ana	Chemistry;I	9	289	49	289	77
2023	11	Ba-Yolo F	Satellite	缺失字段	Applied S	Wang, Kl;Liu	Jilin Uni	Peoples R C	Wang, Kuilin;Liu	Chemistry, Mul	Chemistry;I	0	84	13	84	41
2025	6	Small Obj	Yolo-V8;I	缺失字段	Plants-Ba	Tang, Rp;Jun	Shenzhen	Malaysia;En	Tang, Ruipeng;Ju	Plant Sciences	Plant Scien	18	38	7	38	31

Figure 2. Partial Display of the Dataset

3. RESEARCH METHODS

3.1. Reference Co-citation Analysis

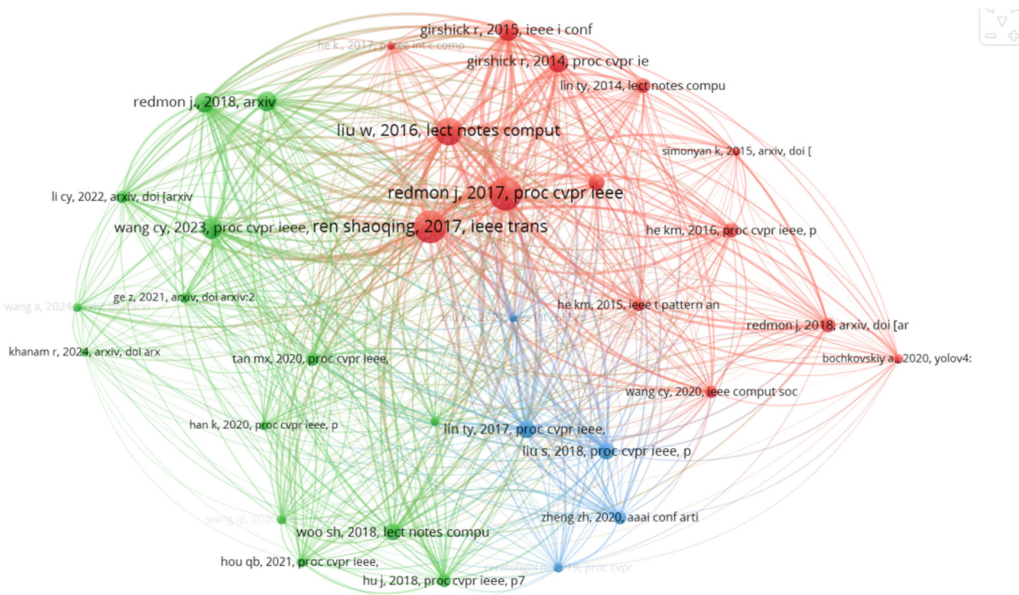

Figure 3. Reference Co-citation Map

VOSviewer was adopted in this study to construct the reference co-citation map. The minimum citation threshold of cited references was set to 180, and 33 highly cited papers were screened from 79,867 references. As shown in Figure 3, each node in the map represents a

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reference; the larger the node, the higher the citation frequency of the literature. The links between nodes represent co-citation relationships, and the thickness of links indicates co-citation strength. Different colors correspond to different clusters. The red cluster consists of foundational papers on two-stage object detection such as R-CNN and Faster R-CNN, which constitute the early basic theories in the field of object detection. The green cluster is dominated by core YOLO papers authored by Redmon, Bochkovskiy and other researchers, serving as the direct theoretical foundation of the YOLO algorithm.

A large number of intersecting links between clusters demonstrate that YOLO-related research has close knowledge connections with two-stage detection methods. Numerous YOLO papers cite both categories of literature simultaneously. Researchers draw on ideas including detection frameworks, loss functions and region proposals of R-CNN and Faster R-CNN when designing YOLO algorithms. Thick links within the same cluster imply higher co-citation strength among internal documents. Multiple classic papers within one branch are frequently cited together, forming stable knowledge communities.

The blue cluster focuses on classic achievements of YOLO improvement directions such as feature fusion and small object detection. Many links exist between this cluster and the main green YOLO cluster, revealing that subsequent improved YOLO studies are largely based on the original YOLO framework, with optimizations carried out by combining multi-scale features, small-object enhancement and other technologies. This map clearly presents the composition of the knowledge base and literature correlations in the YOLO research field, reflecting the knowledge evolution: YOLO research inherits the traditional two-stage detection theories and continuously extends toward lightweight networks, small object detection and other directions.

3.2. Keyword Co-occurrence Analysis

Keywords were extracted from WOS database. A total of 8639 keywords were obtained from 3570 pieces of literature. The minimum occurrence threshold of keywords was set to 60, and 29 high-frequency keywords were finally screened to construct the keyword co-occurrence network map.

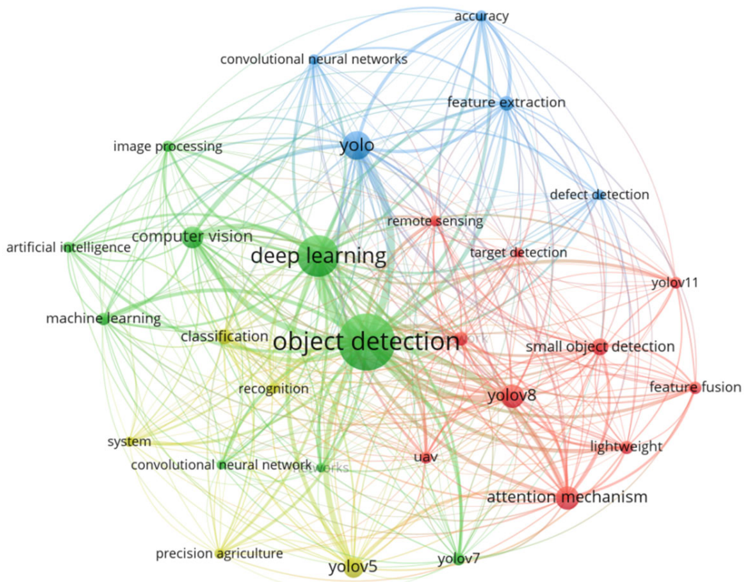

Figure 4. Keyword Co-occurrence Map

As shown in the figure 4, keyword clusters are divided into four regions. The green cluster includes deep learning, computer vision, convolutional neural networks, which form the

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theoretical basis of YOLO research. The yellow cluster covers multiple YOLO versions such as YOLOv5, YOLOv7, YOLOv8 and YOLOv11, reflecting the continuous iteration characteristics of the algorithm. The red cluster focuses on algorithm improvements, including small object detection, lightweight network, attention mechanism and feature fusion. The blue cluster represents practical application scenarios such as defect detection, remote sensing, UAV and precision agriculture. Dense connections between nodes indicate strong correlations among research topics. Theories of deep learning support the iteration of YOLO models, and optimization strategies like attention mechanism and feature fusion are widely adopted in remote sensing and industrial detection tasks. In general, YOLO research shows the development feature of "supported by basic theories, continuous algorithm iteration and scenario-oriented optimization". Small object detection and lightweight networks are current research hotspots.

3.3. Author Cooperation Analysis

In this study, the minimum number of publications per author was set to 6 and the minimum citation count was set to 2. A total of 63 authors were screened, and the largest connected subgraph was selected for visual analysis. After optimizing clustering parameters, the author cooperation network was constructed based on association strength, which was divided into four major clusters. Among them, the cluster centered on Wang Wei includes 7 authors and represents the largest research team with close internal co-authorship. The cluster led by Chen Yan and Wang Jun consists of 8 authors, forming another important research group. On the whole, several relatively stable research teams have been formed in this field. Researchers cooperate closely within each team, while cross-team cooperation is relatively limited, showing a cooperation pattern of “close intra-team collaboration and loose inter-team links”. As the core hub of the network, Wang Wei maintains cooperative connections with multiple research teams and acts as a bridge for academic communication in this field.

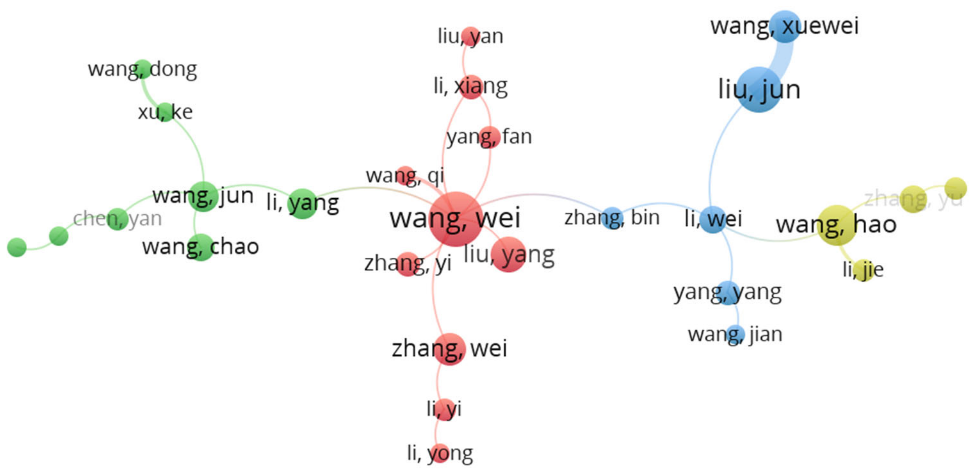

Figure 5. Author Cooperation Network Map

3.4. Reference co-citation Analysis

This study used VOSviewer to construct the reference co-citation map. The minimum citation threshold for cited references was set to 50, and 166 highly cited references were screened from the reference set corresponding to 3550 source documents. It can be observed from the map that Diwan (2023) and Wang (2023) are the two core papers with the highest citation frequencies in this field, forming an important knowledge foundation for research on the YOLO algorithm. The blue cluster where Wang (2023) is located centers on the improvement and optimization of the YOLO algorithm, focusing on algorithm innovations including lightweight

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networks, feature fusion and model performance enhancement. The pink cluster of Diwan (2023) concentrates on the practical application of YOLO models in real-world scenarios such as industrial defect detection and remote sensing image recognition. As a critical bridging node, Yan (2021) connects multiple clusters, which reflects extensive knowledge intersection and theoretical references among diverse research directions. With the threshold set to 50, more moderately cited papers are incorporated into the map, and subdivided research branches are visualized. The overall network consists of several relatively independent yet interconnected knowledge clusters, demonstrating that YOLO-related research has established a complete knowledge system covering theoretical foundation, algorithm iteration and scenario-based applications.In thiFigure 3 Reference co-citation map.

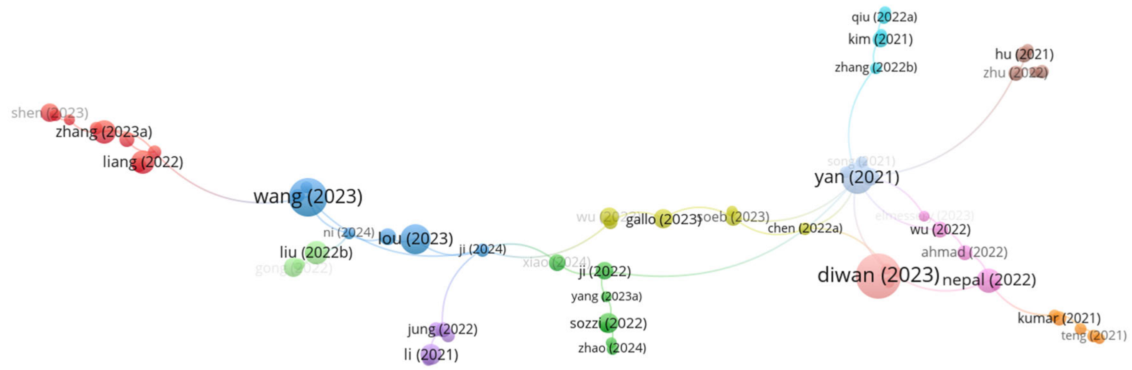

Figure 6. Reference co-citation Map

4. CONCLUSION

By sorting out the reference co-citation relationships, knowledge framework, scientific research cooperation status and frontier development trends in the YOLO field, this study concludes that YOLO algorithm research has formed a systematic and hierarchical knowledge system through continuous knowledge inheritance and integration. Based on the reference co-citation analysis with a citation threshold of 50, a total of 166 highly cited core literatures shape the theoretical foundation of current YOLO research, which mainly consists of two dominant knowledge clusters: algorithm optimization innovation represented by lightweight network and feature fusion, and practical application exploration oriented to industrial detection and remote sensing scenarios. Interconnections among different clusters indicate that interdisciplinary knowledge integration and technical mutual learning have become important driving forces for field development. On this basis, YOLO research has established a mature and complete research system of "theoretical inheritance support, continuous algorithm iteration and scenario-oriented optimization". Network lightweighting and small object detection will remain the core research directions in this field in the future, which can continuously promote the engineering implementation and popular application of YOLO models in complex industrial and agricultural scenarios. This study provides effective reference and theoretical support for subsequent algorithm improvement, performance optimization and innovative application research.

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