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## Abstract Object detection has always been a fundamental research topic in the computer vision community, focusing on predicting the category and location of all objects in the scene. In recent years, progressing from the rapid development of deep learning, the speed and accuracy of general object detection methods have also achieved significant breakthroughs. This paper aims to report the latest research progress in the field of object detection based on deep learning to inspire and promote subsequent research. Specifically, this paper systematically introduces the research progress of predecessors from four aspects: dual-stage, single-stage, Transformer-based and key point, including the design ideas and basic processes of representative algorithms. In addition, this paper also quantitatively compares the performance of different methods on common data sets to further distinguish the benefits and disadvantages of different categories of methods. Finally, this paper summarizes the challenges that still exist in the field of object detection and looks forward to future development directions.

## Introduction With the fast development and the wide application of artificial intelligence technology, autonomous vehicles are becoming an important part of future transportation in our daily lives. Autonomous driving technology tries to achieve autonomous navigation and control of vehicles by computer vision, sensor technology and deep learning algorithms. In recent years, the research of autonomous driving has made major breakthroughs, which not only promote the transformation and upgrading of the automotive industry, but also bring new opportunities for the development of modern cities and intelligent transportation.

In the process of the realization of autonomous driving technology, environmental perception is a vital link, which is related to the safety directly and reliability of autonomous vehicles. The core task of an environmental awareness system is to accurately detect and identify all kinds of aims on the road, including pedestrians, vehicles, traffic signs, road obstacles and so on. Among them, Object Detection, as the basic link of environment perception, plays a key role. The accuracy and real-time performance of object detection directly affect the decision-making and control ability of automatic driving systems. There is still lots development space and research value in the future technology. To popularize the public's doubts about object detection technology in autonomous driving, this article will show the development process of the technology, analyze the shortcomings, discuss the social significance, and propose current challenges and future directions.

Based on a review of the general and specialized approaches to object detection task modeling in automated driving, we classify the main approaches into four categories according to the evolution route and development time of the model: two-stage, single-stage, key point-based and transformer-based approaches. Through analyzing the representative models of various methods and the pros and cons of existing technologies, we divided the main features of this generation of methods and the improvement of the next generation of methods over the previous generation. At the end of this paper, the current problems and challenges of object detection technology are discussed. With the continuous progress of autonomous driving technology, object detection algorithms still need to be continuously innovative in the face of complex environments and diverse scenarios. Multi-domain object detection, multi-mode fusion, small object detection, lightweight network architecture, video detection, weak supervision and small sample detection will become the focus of future research.

\*\*Table 1. Accuracy (mAP) comparison between different representative methods\*\*  
| Method | Category | VOC2007 | COCO |  
|:------------|:-------------------|--------:|------:|  
| Fast RCNN | Two-stage method | 70.0 | 19.7 |  
| Faster RCNN | | 73.2 | 21.9 |  
| SSD | Single-stage method | 81.6 | 26.8 |  
| YOLOv4 | | 81.8 | 43.5 |  
| Retina-Net | | 79.5 | 36.2 |  
| RefineDet | | 79.2 | 39.1 |  
| CornerNet | Key point-based | 79.5 | 42.5 |  
| CenterNet | | 78.0 | 41.8 |  
| FCOS | | 78.8 | 44.7 |  
| Deformable DETR | Transformer-based | 79.5 | 52.3 |  
| Swin Transformer | | 81.0 | 57.7 |

Breakthroughs in these directions will further promote the intelligence and safety of autonomous driving systems, and promote their faster application to reality.