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A Concise Analysis of the Object Detection and Tracking Process

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Abstract : In the context of Computer Vision Systems (CVS), identifying and tracking moving objects is an essential yet challenging problem. Surveillance, autonomous robot navigation, and vehicle navigation are just a few of the many fields that might benefit from modern advances in object recognition and tracking made possible by the ever-increasing availability of computing power and vast public databases. These corporations may benefit from these changes. When used to image analysis, the object tracking technique seeks to segment the region of interest, monitor its translations and rotations, and pinpoint any blobs present in the image. An object detection technique must be utilized either in every frame or at the moment in the video sequence when an item is noticed for the first time in order to carry out tracking. With the widespread availability of powerful central processing units and cheap, high-quality video cameras, automated object tracking in video sequences has become more important in recent years.The focus of computer vision studies has shifted in recent years to the detection and tracking of many items in a dynamic setting.In this research, we provide a number of methods for tracking objects and their whereabouts.

IndexTerms - Vehicle Detection, Image Processing, Vehicle Tracking, Deep Learning, Object Tracking.

I. INTRODUCTION

Research into automated video analysis for object identification is experiencing a true boom due to the ever-increasing emphasis on safety and security. Recognition and tracking technologies have emerged in response to the explosion in the number of accessible hardware facilities like picture processing equipment and mobile phones. An active field of domain in CVS, "object recognition and tracking" aims to recognize and track objects over several frames and to provide an explanation for how they behave. Streets, parks, shopping centers, subway stops, campuses, and homes are all under the watchful eye of various surveillance systems. This encompasses the vast bulk of people's everyday surroundings. A important tool in the fight against terrorist activity, illicit activity, and for safeguarding the public is the ability to identify and track objects. Object recognition and tracking is employed for accurate medical diagnosis and is essential for the effective management of traffic."Object detection" [1] is the initial stage of the video analysis process. Each frame is analyzed independently, or the video frame in which an item is initially detected is used for object detection [2].It may be challenging to distinguish between separate items when images are taken simultaneously under a wide range of lighting and environmental conditions. The reliability of a discovery is directly related to the quality of the image processing.To address issues related to the degradation of image quality during imaging, including low resolution, noise, and blur, we build a video dataset that accounts for these factors [3].After important data has been gleaned from a video, the next step is to classify the objects shown in it. The objects in a video frame may be classified using a method called object classification, which can be used for both categorization and prediction. Individuals, wildlife, creatures, cars, and other moving things are some of the items that may be categorized. [4] To finally, we get to object tracking, which is defined as "the procedure of linking successive video frames to a common set of target objects" [5]. In order to determine the motions of moving objects in a video, object tracking must first appropriately recognize those items. In other words, the mission is to follow moving objects. Researchers now devote their time and energy to studying the identification and monitoring of automated items as a result of technological progress.

I. RELATEDWORKS

In order to find and track objects that are moving within video footage, a number of researchers have presented various approaches. The latest findings from deep learning (DL)-based approaches have been encouraging, but few strategies actually use such methods to analyse images. Only a small percentage of algorithms use some aspect of picture processing. In this research, we provide many methods for finding and following things.

1.1 The Detection and Tracking of Objects Utilizing Different Methods of Image Processing

There are three main steps in image processing: object detection, categorization, and tracking.

The technique developed by the author in [6] uses background subtraction to compare two video frames and identify the item that has changed the most visually between them.If there are several models in the background, it will crash. Author [7] does not maintain a backdrop estimate buffer and instead uses each incoming frame to repeatedly refine the same background model. The background picture in [8] was generated using a sliding window approach based on the time-varying values of each pixel in the buffer containing L Video frames. The author proposed a method of clustering images based on the characteristics of visual flow dispersion of the images themselves [9]. To do so, it is necessary to make an estimate of the image's optical flow field. It is clear from the foregoing that object recognition makes use of frame difference, optical flow, and background reduction.

Classifying the items being tracked is the next stage in object tracking. This method may be used to detect and track a wide variety of moving objects in a video, including humans, animals, birds, automobiles, and more. While the author's proposed motion-based categorization avoids using a set of predefined patterns, it has problems telling the difference between moving and stationary objects [10]. Motion-based classification has an average degree of accuracy. Using the alignment with a gradient that occurs in particular portions of the image, the author of [11] proposes a technique for texture-based image classification that produces better quality results at the price of additional processing time. A simple implementation of pattern-matching techniques that may be utilized with graph-matching methods is the shape-based classification approach proposed in [12]. Y. Railkar et al. [13] presented color-based object identification, which uses brightness and chromatic distortion to identify moving objects and their shadows in order to extract objects for further usage.

The last step is to locate the target. It's a method for keeping tabs on moving targets in a scenario. The author provides an in-depth analysis of object tracking methods in [14]. There are three main categories of object trackers: point trackers, kernel trackers, and silhouette trackers. Point tracking uses focus points to depict moving objects. Inaccurate object identification and occlusion make point tracking a significant challenge. Calculating the motion of non-stationary objects from one frame to the next using basic object regions is the key of kernel-based tracking. The purpose of the silhouette tracking technique is to find the area of each picture where an item is present using an object model obtained from a previous model.Figure 1 above depicts the intricate framework for object identification and tracking.

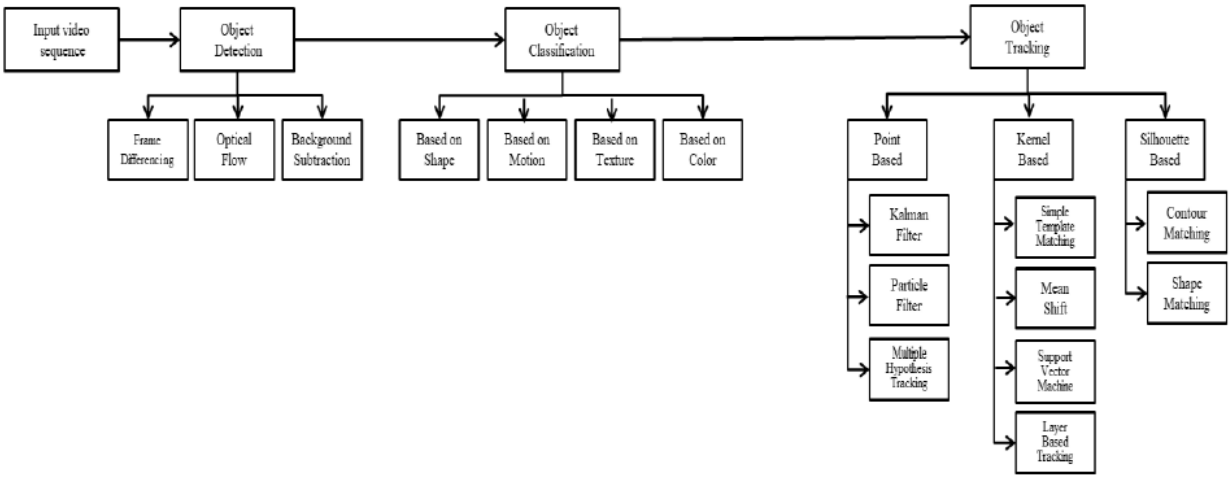

Fig.1 The overarching procedure for locating and following objects

1.2 Detecting and following objects using deep learning

Recent advances in computer vision research have focused particularly on deep learning-based approaches to object recognition and tracking, which had previously received less attention.In this article, we discuss many techniques for finding and following objects. There are two primary methods: (i) single-stage detectors and (ii) dual-stage detectors. Comparing one stage and two stage detectors, the former are more precise while the latter are quicker. Some examples of two-stage detectors include region convolutional neural networks (RCNNs), mask RCNNs, fast R-CNNs, granulated CNNs, and granulated RCNNs.Some examples of single-stage detectors are the YOLO family, SSD, and M2Det[15].Figure 2 depicts a number of single-stage and two-stage methods for detecting objects.

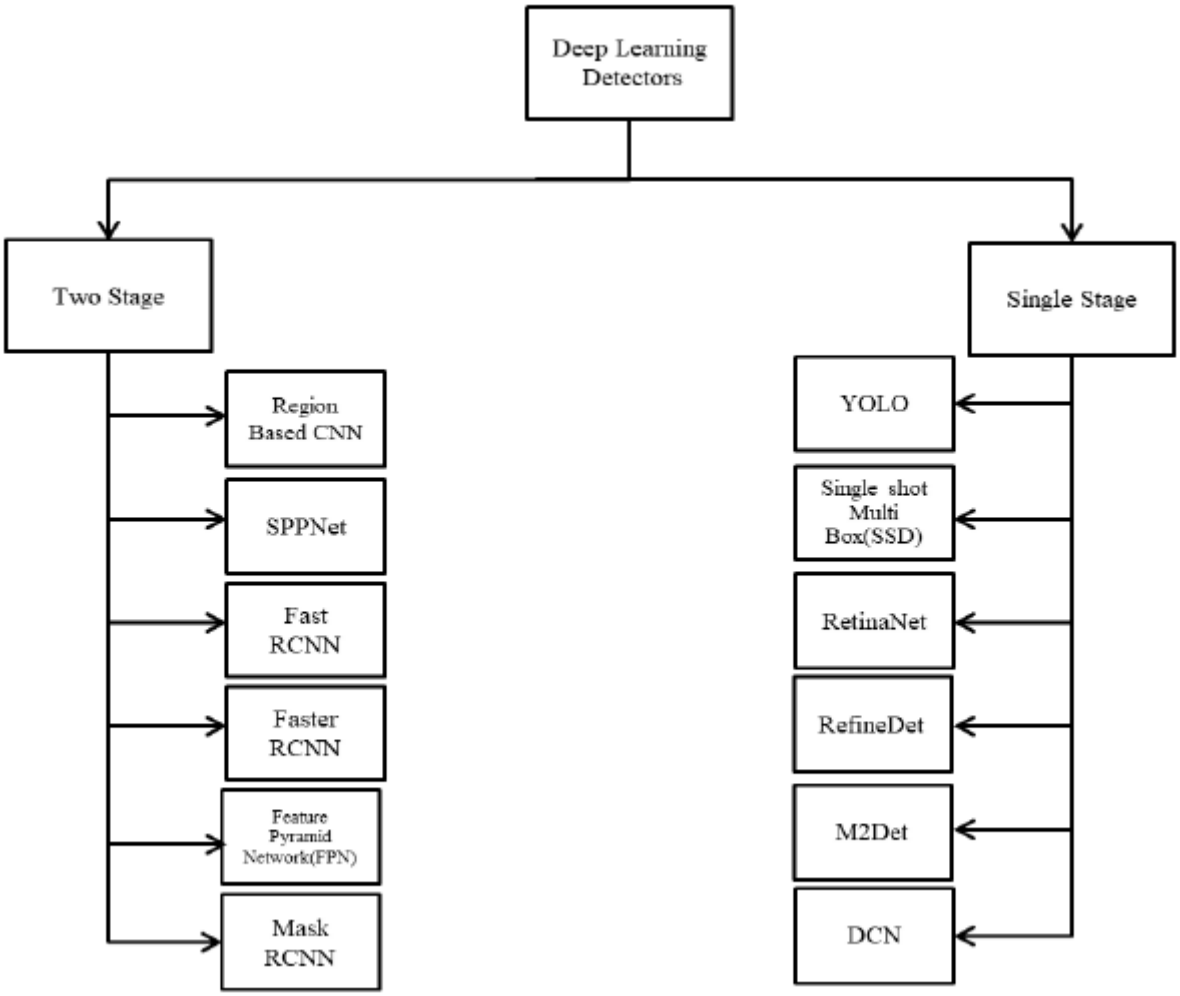

Fig.2 For object identification, single- and two-stage deep learning algorithms

One of the most extensively used algorithms, Deep SORT is a prominent object tracking system. The Simple Online Real-Time Tracking (SORT) method was suggested by A. M. Qureshi et al. [16]. By assigning a unique id to each bounding box, SORT is able to keep tabs on all detections. When an item is no longer visible, the tracking software creates a new identifier for it and moves on to monitoring newly detected things. K mean approach is presented for object recognition and tracking by the author in [17], and "good feature to track" algorithm is utilized in order to isolate the key features of each picture. Using an evolution of the traditional competitive neural network methodology, M. Safaldin et al. [18] came up with the Growing competitive neural network (GCNN) method to help with video surveillance object tracking. Humans are the primary target of the tracking approach suggested by A. Sahay et al. [19]. CNNs are used to learn spatial and temporal characteristics during offline training. The reviews in [20, 21] are some of the most comprehensive on object recognition and tracking using deep learning.

II. Flowchart of Operations for Deep Network-Based Object Detection and Tracking

When used with computer vision programs There is a close relationship between object detection and object tracking. item detection is the process of determining the identity of an item or pinpointing its location among a pool of potentially relevant images. When an item is tracked, its motion over time is analyzed in order to establish a trajectory or route. Below, Figure 3 depicts the block diagram for all-object recognition and tracking. The dataset is split in half so that items may be identified inside the frame. Only 20% of photos are utilized in actual testing, whereas 80% are used in the actual training process. Objects in a picture may be located using deep learning methods. A box is drawn to encompass the thing. The neural network is given the observed bounding box to use as a reference while following. Bounding boxes may be followed over numerous images using object tracking.

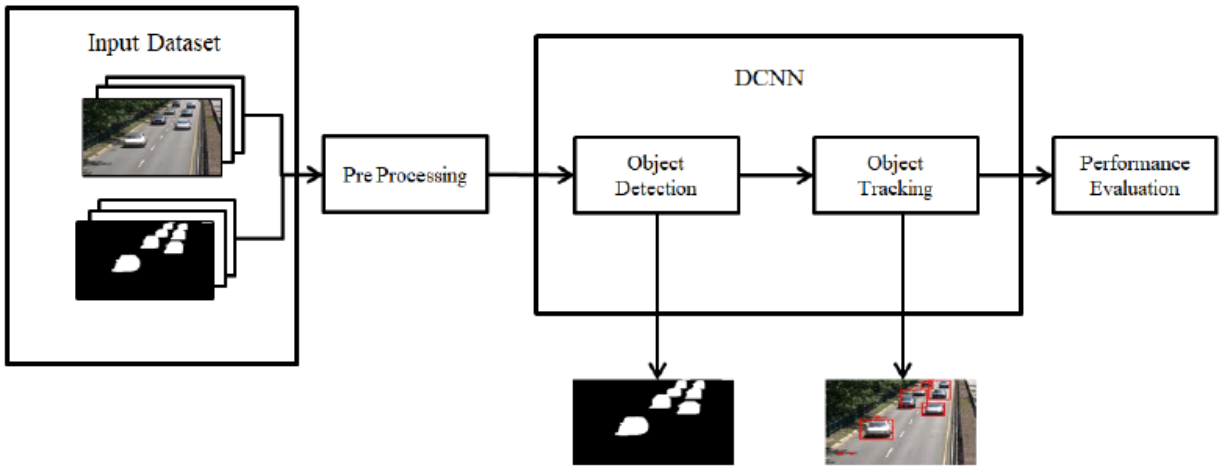

Fig.3 Detecting and following objects using deep neural networks: a high-level block diagram

III. ANALYSIS

Here, we provide a brief overview of popular detection and tracking methods that have been published by various authors.Accuracy of 85%, Precision of 95%, and Recall of 94.4% were achieved by Akansha Bathija et al.[22] using SORT tracker and YOLO detector on 6 video sequences. With a range of 30-100 meters, the point-level assessment accuracy of the LiDAR detection and tracking technique presented by Tianya Zhang et al. [23] is 94.74%, the precision is 976.90%, and the recall is 70.08%. In a study of multi-object identification and tracking methods, authors [15] used the MOT2015 dataset and concluded that Faster R-CNN combined with Deep SORT outperformed other methods in terms of monitoring assessment. Using the KITTI 3D object identification validation set, authors of [24] detected an automobile with an accuracy of 93.28%, an AMOTA of 45.43 percent, and an AMOTP of 77.41 percent.

IV. FUTURE SCOPE AND CONCLUSION

In this study, we provide a concise overview of object recognition and tracking methods based on deep learning and image processing. Explained in depth how object detectors work, with a focus on both one- and two-stage systems. Important insights are gained by thinking about the two processes of object identification and tracking together. Several authors' findings indicate that the best results for feature extraction may be achieved by combining two-stage detectors with Deep SORT tracking. Several authors used several datasets to prove the efficacy of the network design and evaluate it against the state-of-the-art methods: MOT2015, KITTI 3D object identification benchmark data set, COCO dataset, and INRIA Person Dataset. Regular upgrades to high-powered computer infrastructure may explain the meteoric rise of DL-based object detection and tracking. The most important feature of tracking is the quality of object recognition throughout a video frame, since object detection occurs before tracking.

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