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A Survey on Object Recognition Methods

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***Abstract*—The Recognition of Objects is considered as difficult one in Image Processing. Object recognition is an important part of computer vision because it is closely related to the success of many computer vision applications. A number of object recognition algorithms and systems have been proposed for a long time in order to address this problem. This paper presents a survey of different techniques in the field of computer vision and object recognition. Mainly this paper is to review and study of the different methods of object detection. In this survey we discuss background subtraction, optical flow, point detector, frame differencing to detect objects. We also compared accuracy and limitations of these methods. The research paper includes various approaches that have been used by different researchers for object detection.**

***Keywords*— Object detection, object classification, Background subtraction.**

I. Introduction

Category recognition and detection are 2 parts of object recognition. The objective of category recognition is to classify an object into one of several predefined categories. The goal of detection is to distinguish objects from the background. There are various object recognition challenges. Typically, objects have to be detected against cluttered, noisy backgrounds and other objects under different illumination and contrast environments. Proper feature representation is a crucial step in an object recognition system as it improves performance by discriminating the object from the background or other objects in different lightings and scenarios. Object recognition features are categorized into two groups - sparse and dense representations. For sparse feature representations, interest-point detectors are used to identify structures such as corners and blobs on the object. A feature Object detection is a challenging field in computer visualization and pattern analysis research area. There are many techniques which have been proposed and developed. In this paper we present different approaches of detecting objects using different methods such as frame differencing, optical flow, point detectors, background subtraction, temporal differencing. We have also evaluated the accuracy rate of these methods and identified the advantages and disadvantage of each method. We have also discussed the categorization methods and the feature types of different methods of object detection such as edge based feature type, patch based feature type etc. We try to find out the comparison among the object classifying methods and study the accuracy rate and advantages among this methods. The future of this research area is very promising. The possible prospective of discovering new methods of object detection, object classification is very high.

Rest of this paper is organized as follows. Section II elucidates various difficulties in object recognition under varied circumstances. Section III presents various object recognition techniques. In Section IV applications for object recognition are discussed and finally, we conclude in Section V.

II. Difficulties In Object Recognition Under Varied Circumstances

1. Lightning: The lightning conditions may differ during the course of the day. Also the weather conditions may affect the lighting in an image. In-door and outdoor images for same object can have varying lightning condition. Shadows in the image can affect the image light. Whatever the lightning may be the system must be able to recognize the object in any of the image.
2. Positioning: Position in the image of the object can be changed. If template matching is used, the system must handle such images uniformly.
3. Rotation: The image can be in rotated form. The system must be capable to handle such difficulty. As shown in fig.2, the character ‘’A’’ can appear in any of the form. But the orientation of the letter or image must not affect the recognition of character “A” or any image of object.
4. Mirroring: The mirrored image of any object must be recognized by the object recognition system.
5. Occlusion: The condition when object in an image is not completely visible is referred as occlusion. The system of object recognition must handle such type of
6. Scale: Change in the size of the object must not affect the correctness of the object recognition system. Above stated are some of the difficulties that may arise during object recognition. An efficient and robust object detection system can be developed by conquering the above stated difficulties.

III. Object Detection

Object detection and tracking are playing an important role in many computer vision and pattern recognition applications such as video classification, vehicle navigation, surveillance and autonomous robot routing. Object detection includes detecting objects and recognizing patterns in the frame of a video sequence. An object detection mechanism is needed in any tracking method either in each frame or when the object first appears in the video. Using information in single frame is the most familiar method for object detection. Although some of the object detection methods use the temporal information computed from analysing a sequence of frames in order to reduce the number of fake detections and increase accuracy

rate[2]. Few methods of object detection are described as follows.

1. *Frame differencing*

The presence of moving objects in a frame is found out by calculating the difference between two successive images. Frame differencing method has a strong adaptability for a range of dynamic environments, but it also shows errors in obtaining complete outline of moving object, which is responsible for the empty phenomenon, as a result accuracy level of detection of moving object is very low[4].

2. *Optical Flow*

Optical flow method [3] involves calculating the image optical flow field and doing clustering processing according to the optical flow distribution characteristics of image. This method can get the complete movement information of an object and it is useful for detecting the moving object from the background with the 85% accuracy, but this method has a few disadvantages including large quantity of calculations, sensitivity to noise, poor anti-noise performance, which make it not appropriate for real-time object detection and tracking.

3. *Temporal Differencing*

Temporal differencing method uses pixel- wise difference between two or three successive frames in a video imagery to extract moving regions from the background[7]. It is a high adaptability with dynamic scene changes al- though it cannot always extract all relevant pixels of a foreground object mostly when the object moves slowly or has uniform texture [5,6]. When a foreground object stops moving, temporal differencing method cannot detect a change between successive frames and results in loss of the object. Let In(x) represent the gray-level intensity value at pixel position x and at time instance n of video image sequence I, which is in the range [0, 255]. T is the threshold initially set to a pre-determined value. Lipton et al [5]. Developed two-frame temporal differencing scheme suggests that a pixel is moving if it satisfies the following [5]

$$|I\ n(x)\ I\ n1(x)| > T \quad [5]$$

4. *Point detectors*

Point detectors are used in finding some useful points in images which have an expressive texture in their respective localities [9]. A useful interest point is one which is in-variant to changes in illumination and camera viewpoint. Some commonly used interest point detectors include Moravecs detector, Harris detector, KLT detector, SIFT detector [8].

5. *Background Subtraction*

One consistent method of object detection involves building a representation of the scene known as the background model and finding deviations from the model for each incoming frame in the video images. Any significant change in an image region from the background model is noted down as a moving object. The pixels in the regions of the undergoing change are marked as moving objects and reserved for further processing. This process is referred to as the background subtraction. There are various methods of background sub- traction as discussed in the survey [10] are Frame differencing Region-based (or) spatial information, Hidden Markov models (HMM) and Eigen space decomposition[9].

Background subtraction has mainly two approaches:

- Recursive Algorithm: Recursive techniques for background sub- traction [11] [12] do not maintain a buffer for background estimation. This method re- cursively updates a single background model based on each input frame. In this situation, input frames from distant past could have an effect on the current background model being analyzed. Recursive techniques require a smaller amount of storage as compared with non-recursive techniques, but any error in the background model can have a significant effect for a much longer period of time. This technique includes various methods such as approximate median, adaptive background, Gaussian of mixture [1].
- Non Recursive Algorithm: A non-recursive technique [11] [12] uses a sliding-window approach for estimating changes in the background. The process includes storing a buffer of the previous L video frames and estimating the background image based on the temporal variation of each pixel within the buffer. Nonrecursive techniques have high adaptability as they do not depend on the history beyond those frames stored in the buffer as in recursive algorithms. On the other hand, the storage requirement can be very vast if a large buffer is needed to manage the slow-moving data traffic [1]. Simple Background Subtraction[9]:In simple background subtraction an absolute difference is taken between every present image It(x; y) and the reference background image B(x; y) to find out the motion detection mask D(x;y). The reference background image is generally the first frame of a video, without containing foreground object.

Where is a threshold, which decides whether the pixel is foreground or background. If the absolute difference is greater than or equal to, the pixel is classified as foreground; otherwise the pixel is classified as background. The problem with background subtraction [14], [13] is to automatically update the back- ground from the incoming video frame and it should be able to overcome the following problems:

- Motion in the background
- Illumination changes
- Memory
- Shadows ·
- Camouflage
- Bootstrapping

IV. Feature Types

Most of the object detection methods can be categorized based on two different feature types edge based feature type and patch based feature type. Recent researches show that a different feature type can be achieved by combined the edge based and patch based feature type [16-20].

A grouping of these two features which includes all the advantages of both the feature types and removes the disadvantages is more useful than using any one of this individual feature for object detection. A good system needs to be developed along with the advances in computational systems to make it possible to use both feature types efficiently and in real time manner

1. Edge-based features

Edge-based feature type methods [18] ex- tract the edge map of an object in the image being analysed and identify the features of the object in terms of edges. Some examples include [16, 17] Using edges as features is advantageous over other features due to various reasons [21]. Edges are extremely invariant to changes in illumination conditions and variations in objects colours and textures. The object boundaries are represented well and the data is analysed efficiently in the large spatial extent of the images.

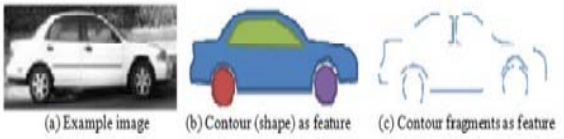

Fig. 1. Edge-based feature types for an example image

1)

2) Patch-based features

The other prevalent feature type besides edge based features type is the patch based feature type, which uses appearance as markers. This feature is being used for more than two decades [18], Edge-based features are relatively new in comparison to patch based feature types. This feature type was invented by Moravec who looked for local maxima of minimum intensity gradients, which he called corners and selected a patch around these corners. His work was improved by Harris, who improved the method by making the new detector less sensitive to noise, edges, and anisotropic nature of the corners proposed in. There are two main variations in patch based feature type:

a. Patches of rectangular shapes containing the characteristic boundaries which describes the features of the objects [16]. These features are generally referred to as the local features.
b. Irregular patches in which each patch is homogeneous or similar in terms of intensity or texture. The changes in these features are determined by the boundary of the patches. These features are generally called the region-based features. A better approach is to use features that may be small or big in order to appropriately cover the size of the local feature such that the features are more robust across various images. In this less storage space is required [18].

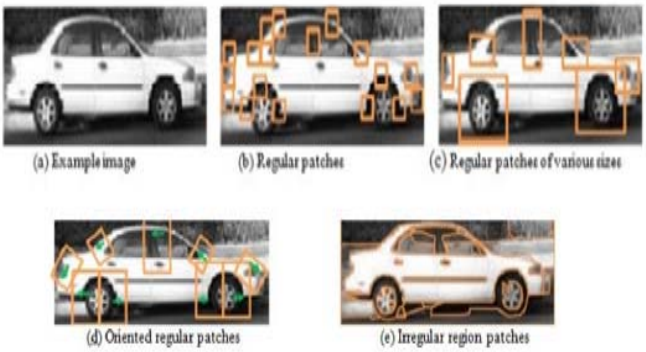

Fig. 2. Patch-based feature types for an ex- ample image. Feature types shown in (b)-(d) are called local features, while the feature type shown in (e) is called region-based features

V. Comparative Study Of Object Recognition Methods

Methods		Accuracy	Time Efficiency	Feedbacks	Uses rate
Background subtraction	Gaussian of mixture	Moderate	Moderate	+Don't need huge memory	40%
				- It does not cope with multimodal Background	
	Approximate Median	Low to moderate	Moderate	+ It does not require sub sampling of frames for creating an adequate background model.	
				- It computation requires a buffer with the recent pixel values	
Optical Flow		Moderate	High	+It can produce the complete movement information	20%
				- Require Large amount of calculation	
Frame Differencing		High	Low to moderate	+ Easiest Method. Perform well for static background.	30%
				- It requires a background without moving objects	
Temporal differencing		Moderate	High	+ This method is computationally less complex and adaptive to dynamic changes	10%
				- Temporal difference may left holes in foreground objects, and is more sensitive to the threshold	

VI. Application Of Object Recognition

1. Biometric recognition: Biometric technology uses human physical or behavioural traits to recognize any individual for security and authentication [19]. Biometrics is the identification of an individual based on distinguished biological features such as finger prints, hand geometry, retina and iris patterns, DNA, etc. For biometric analysis, object recognition techniques such as template matching can be used.
2. Surveillance: Objects can be recognized and tracked for various video surveillance systems. Object recognition is required so that the suspected person or vehicle for example be tracked.

3. Industrial inspection: Parts of machinery can be recognized using object recognition and can be monitored for malfunctioning or damage.
4. Content-based image retrieval (CBIR): When the retrieval is based on the image content it is referred as CBIR. A supervised learning system, called OntoPic, which provides an automated keyword annotation for images and content–based image retrieval is presented in [20].
5. Robotic: The research of autonomous robots is one of the most important issues in recent years. The humanoid robot soccer competition is very popular. The robot soccer players rely on their vision systems very heavily when they are in the unpredictable and dynamic environments. The vision system can help the robot to collect various environment information as the terminal data to finish the functions of robot localization, robot tactic, barrier avoiding, etc. It can decrease the computing efforts, to recognize the critical objects in the contest field by object features which can be obtained easily by object recognition techniques [21].
6. Medical analysis: Tumour detection in MRI images, skin cancer detection can be some examples of medical imaging for object recognition.
7. Optical character/digit/document recognition: Characters in scanned documents can be recognized by recognition techniques.
8. Human computer interaction: Human gestures can be stored in the system, which can be used for recognition in the real-time environment by computer to do interaction with humans. The system can be any application on mobile phone, interactive games, etc.
9. Intelligent vehicle systems: Intelligent vehicle systems are needed for traffic sign detection and recognition, especially for vehicle detection and tracking. In [18], such a system is developed. In detection phase, a color-based segmentation method is used to scan the scene in order to quickly establish regions of interest (ROI). Sign candidates within ROIs are detected by a set of Haar wavelet features obtained from AdaBoost training. Then, the Speeded up Robust Features (SURF) is applied for the sign recognition. SURF finds local invariant features in a candidate sign and matches these features to the features of template images that exist in data set. The recognition is performed by finding out the template image that gives the maximum number of matches.

VII. Conclusion

In this survey paper all the main terminology of object detection have been addressed. These include object detection methods, feature selection and object classification. Most commonly used and well recognized methods for these phases have been explained in details. Different methods for object detection are like frame difference, optical flow and background subtraction. Most commonly used method is back- ground subtraction. The advance forward feature of methods behind the object detection can be achieved by two main feature types like edge-based feature type and patch based feature type. This theory is already proven so yet no practical implementation done without this theory. Classification of objects is one of the most important parts of an object detection system. Among the many methods of object classification most of the researchers prefer texture based and color based object classification. Advance study may open the paths to find efficient algorithms to reduce computational cost and to decrease the time required for detecting the object for variety of videos containing different characteristics and to increase accuracy rate.

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