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Object Recognition Algorithms for Computer Vision System: A Survey

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***Abstract*—This paper presents a study of standard efficient algorithms for object recognition. Object recognition is a challenging problem in real-world scenario since objects can vary. In recent years, recognition in computer vision has contributed to great advances in object recognition systems. This paper presents a survey of the object recognition in computer vision. We start by introducing the concepts behind object recognition in computer vision—the use of object recognition, how an object is been recognized using matched patterns, how an input object image is been featured, and the major components of an object recognition systems. Long-term robot operations have results with that changing appearance and rotation of image as a significant factor in object recognition failure. Therefore, here we discuss how object recognition can be successful for a visible change in the environment. Finally, we close with a discussion on the real time object recognition systems in embedded environment.**

***Index Terms*— Object recognition, SIFT, SURF, ORB.**

1. INTRODUCTION

OBJECT recognition is a task which is still a challenge in computer vision system. Our aim in writing this survey article is to provide a survey of object recognition research that is relevant to computer vision system. This paper contains successful object recognition algorithms. Object recognition is a process for identifying a specific
objects in a digital image or a video. Object recognition algorithms merrily rely on matching, pattern recognition or learning algorithms using a feature based technique or appearance based technique. Object recognition is a technology in the field of computer vision.

In this paper, we are going to review few techniques that have been used for object recognition. Although various object recognition algorithms are introduced in recent days, the chosen algorithms SIFT, ASIFT, SURF, ORB techniques which are more distinct in terms of performance accuracy, speed. In these algorithms ORB more suitable for embedded environment.
These algorithms are widely used in many applications of robotics, industries, military, home serve applications etc. Recent researches are mostly based on these object recognition algorithms.

2. CONCEPT OF OBJECT RECOGNITION IN COMPUTER VISION

The task of automatic object searching or recognition is achieved by computer vision technique in which objects in an image or video sequence can be identified and recognized. Computer vision includes methods for acquiring, processing, analyzing and understanding images and gives numerical or symbolic information its output.

There are several overlapping between computer vision, machine vision and image processing. The goal of image processing is to enhance or compress image / video information. It eases pixel-wise operations such as transforming one image to another. Hence, there is no extraction of meaningful information from the pixel-wise operations. The goal of computer vision is mainly to extract very meaningful information from the input images or videos. The information are such as presence or absent of objects. The computer vision is not limited to pixel-wise operations but in the other hand it can be more complex than image processing. These complex operations can be summarized into a feature detectors which an provide rich meaningful information about the controls of images or video sequence.

The machine vision comes under the large umbrella of computer vision. The machine vision has focused more on the use of image or videos in industrial settings where light, motion and position are controlled and where the objects to be identified are already known and all the events observed are predictable. Computer vision has expanded its ambitions to vision that are uncontrolled, often unpredictable and where objects and their activities are much unknown.

The relationship between computer vision, machine vision and image processing are quite complex. These fields overlap considerable but they are different.

In other words, computer vision can be explained as a method where it uses an image processing for feature extraction and machine learning which uses these features to build a model.

3. SHIFT : SCALE INVARIANT FEATURE TRANSFORMS ALGORITHM

The SIFT algorithm [1] is an algorithm in computer vision which is to detect and describe local features in images. It describes the distinctive features that have properties which help for matching different images of an object and these distinctive features are invariant to various transformations of images.

3.1 Flow of SIFT Algorithm

In SIFT Algorithm there are four major stages of computation which are used to generate the set of image features which are briefed as follows.

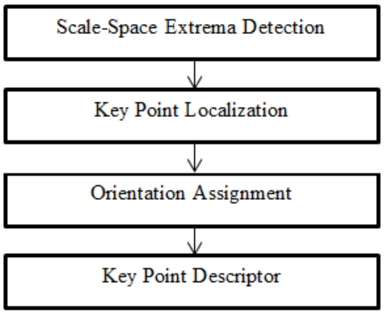

Fig 1 :The Flow of SHIFT Algorithm

The first step is scale-space extreme detection. In this step the algorithm searches key points over all scales and image locations. It has been implemented by using Difference of Gaussian (DOG) function to identify potential point of interest that are invariant to image scale and orientation.

The second step is key point localization. In this step the key points are filtered so that only stable key points are retained. At each candidate location, a detailed model should determine location and scale. Hence, the key points are selected depending on the measurement of stability. Unstable key points with low contrast will be rejected.

The third step is orientation assignment. In this stage each key point is assigned an orientation to make the description invariant to rotation. Here key point locations are found at particular scales and orientations are assigned to them. So, this step has ensured invariance to te image location, scale and rotation.

The fourth step is called keypoint descriptor. This step involves the computation of descriptor vector for each keypoints obtained so that the descriptor will be invariant to the descriptor. This step is performed on the scale of image which is close to scale of the key points.

This key point descriptor use and orientation histograms on 4x4 grid. Each of the orientation histogram has 8 orientation bins which are created over a 4x4 pixels window. Therefore the feature vectors will have totally 128 elements which is computed from 16x16 pixels window. Hence in this algorithm object recognition will be done by matching the descriptor elements of input image and reference image which will be obtained as the result of this algorithm.

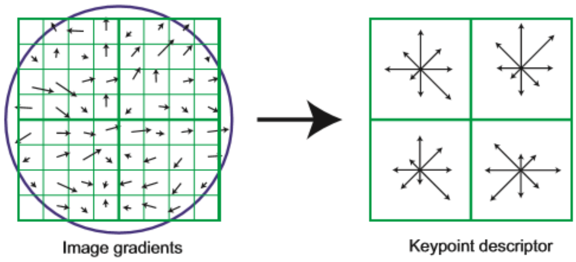

Fig 2 : Local Image Descriptor From [1]

Fig 3:Image representing keypoints that are displayed as vectors indicating scale, orientation and rotation from [11]

4. SURF: SPEED UP ROBUST FEATURES ALGORITHM

In computer vision, SURF algorithm from [3] is a local feature detector and descriptor. It has been partly inspired by the scale-invariant feature transform (SIFT) descriptor, but the SURF key point detector is a better algorithm compared to SIFT in its speed. The SURF algorithm is efficient at rotation and other transformations of image.

4.1 Flow Of SURF Algorithm

In SURF algorithm there are four major stages of computation to generate the image features which are briefed as follows.

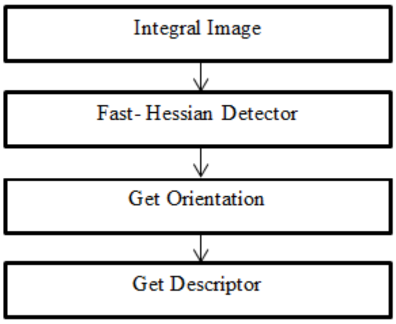

Figure 4: The Flow of SURF algorithm

The first step is integral image creation. An input image is obtained and an integral image is created with respect to the input image. The determines which are to be extracted in the following steps are to be obtained from this integral image.

The second step is called as Fast-Hessian detector. Here the determines are extracted from DOG (Difference of Gaussian) in the First-Hessian detector stage. When this determines are greater than the threshold, then it is designated as keypoint candidate. Then a key point candidate will be selected as a key point, if the determine is greater than 18 neighboring determines of up-scale and down-scale, and also greater than 8 neighboring determines of same scale. This step extracts key points in each size of box filter in the following pattern, 9x9, 15x15, 21x21 and 27x27. Hence the processing speed is slow.

The third step is called as the get orientation stage. This step is to decide a major direction for which a partial image with size of 6 scale based on each keypoint is made. This step gets Haar response using Haar Wavelet and accumulates response included in 0~60 degrees. Then this process is repeated for 72 times as 5 degree for each unit. The major direction is decided by the largest vector and the Cos and Sin values of major direction calculated and interpolated for the partial image with size of 20* scale based on each key point.

The fourth step is the get descriptor stage. In this step the size of the descriptor is obtained. The window formulated in the previous step is divided into 4x4 of 16 areas, in which each pixel is computer by Haar Wavelet better for each of the 16 areas 4 descriptors are created, so totally 16x4, i.e. 64 descriptors are created in this step.

As the result, the matching patterns are found by comparing the descriptors obtained from different images.

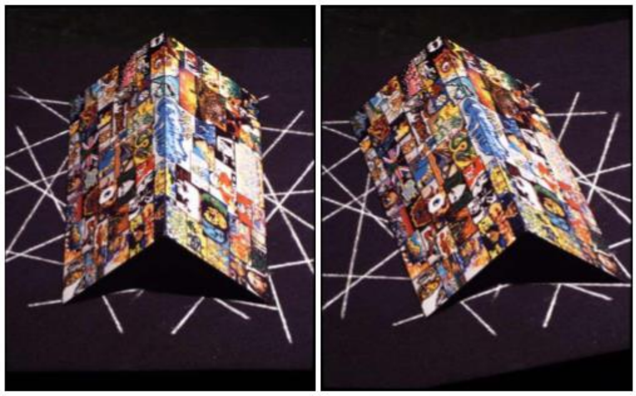

Figure 5: Input images representing a good scene choice for the comparison of different types of interest point detectors. The components are simple geometric elements from[2]

Figure 6 : An example image from the reference set(left) and the test set (right).Images representing the difference in viewpoint and colors from [2]

5. ORB: ORIENTED FAST AND ROTATED BRIEF ALGORITHM

The ORB algorithm from [3] in computer vision is an efficient alternative to SIFT or SURF. The ORB is very strong in object recognition at image rotation condition. The ORB overcomes the drawbacks faced by the SIFT and SURF algorithm.

5.1 Flow Of ORB Algorithm

In ORB algorithm there are four major stages of computation which are briefed as follows.

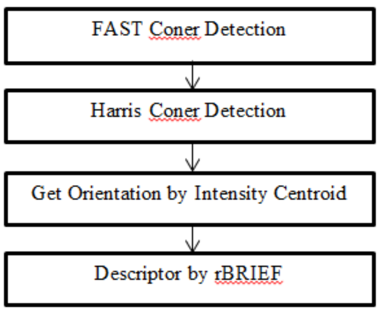

Fig 6: The Flow of ORB algorithm

The first step is called FAST Conner detection. The Fast coner detection is been used to find the key point in the input image. Moreover, number of corners is likely to become key point by this Fast corner detection. It also uses image pyramid to produce multiscale features. But, Fast does not computer orientation.

The second step is called Harris corner detection. Once the key points are obtained, this step is implemented to find the top N points among the obtained key points of the input image. ORB extracts key points in each scale using FAST and Harris corner detection by orientation and rotation invariance are not computed in this step.

The third step is to get orientation by intensity centroid. In this step or intensity weighted centroid of patch with located corner at center is keen computed. Hence, the direction of the vector from this corner point to centroid forms the orientation. For obtaining the rotation invariance, the moments are computed within a circular region of defined radius on which radius will be defined by the size of the patch.

The fourth step is to get descriptor by rBRIEF (rotation BRIEF) where BRIEF in Binary Robust Independent Elementary Features. In this algorithm rBRIEF is called since BRIEF is weak at rotation. The rBRIEF determines a test point what is strong at rotational changes. This step runs a greed search among all binary tests to find the ones that have high rotational invariance and mean close to 0.5, where rBRIEF enumerates binary test for 31x3 pixel patch and sub-window 5x5 based on keypoints taken from many images. rBRIEF compares all test points and if the point is larger than threshold it is removed. These procedures are repeated until 256 tests are created. The result is called rBRIEF. The final result will be obtained by descriptor matching where object is recognized from the image. ORB is faster that SIFT & SURF and ORB descriptor work better than SURF.

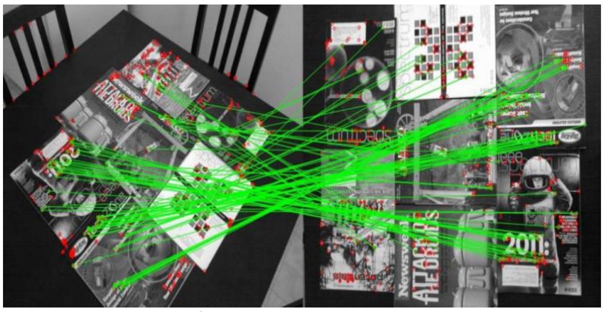

Fig 7: Results screen for ORB on real world images with key point change from [3]

6. RESULT AND DISCUSSIONS

The SIFT algorithm results to produce the correct match for a keypoint that is selected from a huge database of other keypoints. This distinctive feature has been achieved by assembling a high dimensional vector representing the image gradients within a local region of the image.

The` SURF algorithm presents a fast and performs ant scale and rotation invariant interest point detector and descriptor. SURF uses square-shaped filters where the SIFT approach uses cascaded filters to detect scale-invariant characteristic points. Hence, SURF gives much faster matching but, it takes lot of time to determine the direction and create descriptor since more calculation is required. The ORB algorithm uses different approach to obtain descriptor which makes this algorithm to work better in terms of cost, matching performance and applications.

7. CONCLUSION

Object recognition has made great advances in recent years, but we are still a long way from a universal recognition system. Object recognition is benefitting from research in other fields, particularly the great strides being achieved in computer vision. The experience gained in this survey may have valuable applications, both in other robotic tasks such as object recognition and in other areas including remote sensing, environ-mental monitoring, and other tasks that require recognition and identification in uncontrolled environments.

The SIFT keypoints described in this paper are specifically advantageous due to their distinctive features and the keypoints have been shown to be invariant to image rotation and scale and robust across a substantial range of affine distortion, addition of noise, and change in illumination. The SURF algorithm will be an extension of SIFT algorithm where this is more efficient than the SIFT algorithm in case of robustness. The important speed gain is due to the use of integral images. Object recognition has highlighted SIFT and SURF algorithms potential in a wide range of computer vision application. In spite of these, SIFT and SURF are too slow to recognize objects in embedded environment. Hence an ORB algorithm is been introduced which efficiently replaced SIFT and SURF algorithms and it is very much faster and evidentially suitable for object recognition in an embedded environment. We can make ORB algorithm real time to further increase the speed and enhance by integrating with other algorithm for moving tracking or multiple object detection.

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