Journal of Advances in Science and Technology
Vol. 15, Issue No. 2, September-2018, ISSN 2230-9659

A Method for Object Detection in Colored Images using Improved Point Feature Matching

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Abstract – For some of application which involve detection of any object though a digital image, image matching is an essential trait. For detecting a particular object within an image, detection using point feature method is much effective technique. The Point feature matching within an image is done by comparing various correspondence points of object and analyzing the points between cluttered scene image to find a required object of interest in image. In this paper, a modified approach of Point feature matching with novel SURF algorithm is used for extracting the information from image, describing the points, matching object and detecting of object of interest in colored images. The algorithm works on finding correspondence points between a target and reference images and detecting a particular object. Speeded-up robust features (SURF) algorithm is used in this study which can detect objects for unique feature matches with non-repeating patterns. This approach of detection can vigorously find specified objects of interest within an colored image even with cluttered objects in image and provide constriction to other achieving near real time performance. The algorithm can be used for real time detection of object for military weapons guidance.

Keywords — Object of Interest, SURF, Object Recognition, Objects Capture, Matching Technique.

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I. INTRODUCTION

The detection of objects is basically an engineering domain that constitutes the laptop vision of objects present in pictures and videos that are digital in nature. The pedestrian and face detection are one of the most well researched fields of object detection.[1] Laptop vision, recovery of the image, in police video investigation etc. are some of the prominent applications of object detection. Object detection involves technique that is capable of discovering illustrations of objects that are real world in nature and also that are analogous to the objects present in the image or video that can be buildings, faces, etc. In order to recognize the object instances we use the algorithm for extracting and learning the options that is typically employed in object detection [1]. Detection of objects in the sequence of pictures and videos is the main job. We humans can easily detect or acknowledge the object varying in any size in the picture without any effort, even when the image is translated, turned or rotated in many read points [2]. The objects can be recognized by using different kinds of models which include the algorithmic rule of Viola-Jones, SURF and MSER admiring models [3], template matching, algorithms based on boosted learning and image segmentation. Vision is one of the strongest senses of humans and most of the knowledge that the human brain acknowledges from the environment is with the vision itself [4]. A human vision understands and perceive different objects, recognize distinct faces encircling in the surroundings with the least effort. It is possible to split the human vision in two main phases: the first one being the low level and the second is high level vision. It is very crucial to recognize the boundary that exist between these two phases of human vision. The retina collects the data being visualized in the low level phase at the rate of bits per second which is the first step. Now in the next step it is very important to extract the information regarding the knowledge perceived in the previous step where it is further transmitted to the high level phase to continue its operations. Basically, the gathering and extraction of the knowledge is done in this step. Practically in the high level vision phase the image contents are acknowledged meaning matching the illustrative scene points with the objects containing information that is very well memorized [5]. The human vision can recognize the huge number of objects in less time though there is large amount of visual data processing which is combinational in nature. Only the human brain neurons have this extraordinary capability of recognizing such vast degree of data in such a

response rate and that is why the human vision system exhibits high effectiveness due to the human brain performance. Visual attention is the very first preprocessing step that allows the access of the data [6]. After detecting the important elements in the visible object, the computer vision owing to its high level tasks ponders on the particular locations.

II. SPEEDED-UP ROBUST FEATURE (SURF)

SURF algorithm also works on same principles like scale invariant feature transform (SIFT) but details in each step are different in SURF [7]. SIFT uses parallel filters and lower approximated Gaussian laplace with difference of Gaussian to detect a particular object while SURF approximates laplacian of Gaussian with box filter. The advantage of using box filter in SURF is convolution with box filters can be easy calculated also it can work parallely for different scales. Figure shows difference in SIFT and SURF [8]. SURF algorithm performs fast computation of operators using box filters. This enables the algorithms to be used for real time applications like object recognition and tracking [9]. SURF algorithm works in three steps namely, feature detection, feature description and feature matching. Figure 1 shows the difference between SIFT and SURF. In the feature detection process, local maxima in the image which is determined by determinant of hessian are used to select interest point candidates. If the response is above a provided threshold value these candidates are validated and using quadratic fitting both location and scale of these candidates are redefined. For a megapixel image, few hundred interest points are detected [10]. In the feature description step, description is built of neighborhood of each interest point which is invariant to changes in view point [11] . Haar wavelets that is local gradient orientation distribution is used to achieve rotation invariance. Based on haar wavelet coefficients 64 dimensional descriptor is built in this step. For image indexation, object detection or image registration, while considering image matching process[12], local descriptors which were done in second step are matched. By computing the Euclidean distance between all matching paris exhaustive comparison is performed. To reduce mismatching combined with optional RANSAC based method nearest neighbor distance ratio matching is done.

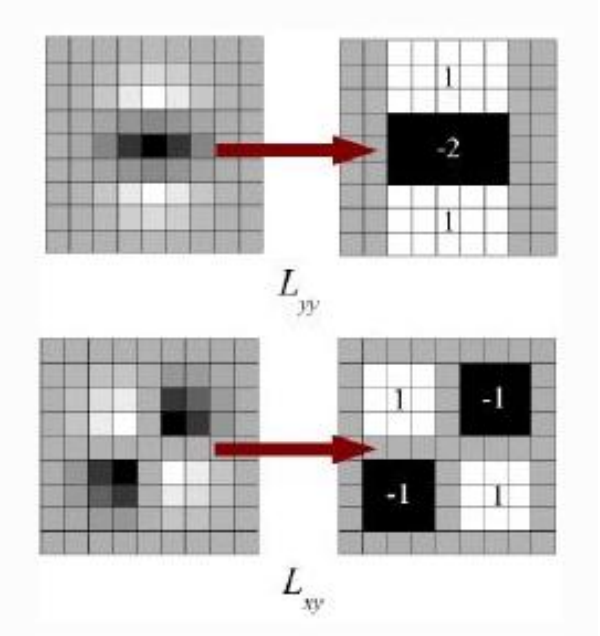

Fig 1. SIFT and SURF approach

Filtering images with a square and sum of image using integral image gives faster result, the formula is given as

$$S(x,y) = \left(\sum_{i=0}^{x}\sum_{j=0}^{y} I(i,j)\right) \quad (1)$$

SURF algorithm uses hessian matrix blob detector to detect object of interest. For a given point p=(x,y) in an image I, the hessian matrix H(p,σ) can be rewritten as

$$H(p,\sigma) = \begin{pmatrix} L_x(p,\sigma) & L_{xy}(p,\sigma) \\ L_{yx}(p,\sigma) & L_{yy}(p,\sigma) \end{pmatrix} \quad (2)$$

Where p is point in image and σ is scale.

$L_{xx}(p,\sigma)$ is convolution of second order derivative of Gaussian with the image I(x,y) at point x.

$$L_{xx}(X,\sigma) = I(X) * \frac{\partial^2}{\partial x^2}\, g(\sigma)$$

$$L_{xy}(X,\sigma) = I(X) * \frac{\partial^2}{\partial xy}\, g(\sigma) \quad (3)$$

$L_{xx}(x, \sigma)$ is convolution of image with second order derivative of the Gaussian. SURF detection works on non-maximal suppression of the determinant of hessian matrix.

III. RELATED WORK FOR OBJECT DETECTION

The following steps are included:

Object representation: In the beginning of object detection the first step is to interpret or visually

explain the object of interest. Object may be marked or painted with its appearance and form. Several methods are discussed for marking.

Points- Object of interest in image is marked by a degree i.e collection of points or center of mass. If the trailing objects occupy tiny space in the image then this method of representation is appropriate [13].

Primitive geometric forms- In this representation method, object of interest is marked by conic, parallelogram etc. This method is appropriate when the objects are straightforward or rigid.

Skeletal form models- Medial axis remodel is used to extract object skeleton. Model is used as form illustration for representation of objects. [14-15]

Articulated form- In this representation, two or more sections that are connected by some flexible joints like legs, hands etc that are connected by joints are marked by integral element victimization ellipse or cylinder. Kinematic motion models are used to define the relationship between the joint angles etc [16-17].

Object tracking: The objects of interest are marked using any method discussed above. For Object tracking the various techniques are shown in fig 1.

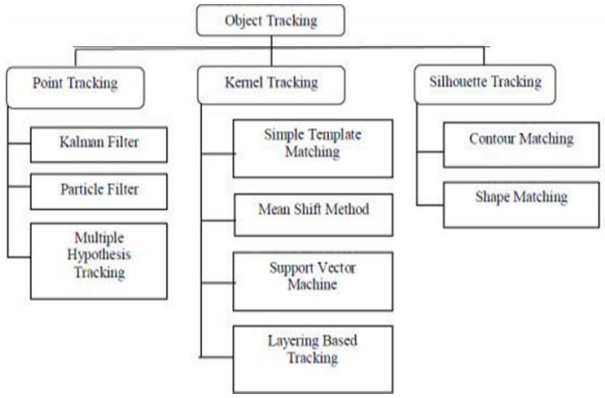

Fig 2. Object Tracking

Point Tracking- The object of interest is tracked by feature points. Kalman filters, Multiple hypothesis tracking are used to detect and track the object of interest in frame [18].

Kernel Tracking- Kernel tracking is used to track object of interest in moving frames as well. It computes the motion of object of interest frame to border [19].

Silhouette Tracking- This technique is also used to detect object in moving frame. It generates the model of object supported to previous frame.

IV. FEATURE DETECTION

Feature detection use comparing each pixel before and after sum of squared difference

$$E(u,v) = \sum_{(x,y)\in W}[I(x+u, y+v) - I(x,y)]^2 \qquad (4)$$

$$\approx \sum_{(x,y)\in W}\left[I(x,y) + [I_x \quad I_y]\begin{bmatrix}u\\v\end{bmatrix} - I(x,y)\right]^2 \qquad (5)$$

This can be rewritten as

$$\approx \sum_{(x,y)\in W}\left[[I_x \quad I_y]\begin{bmatrix}u\\v\end{bmatrix}\right]^2 \qquad (6)$$

Where E(u,v) is Error by SSD

V. ALGORITHM

The figure 2 shows steps involved for implementation of proposed algorithm. Firstly, the object of interest i.e reference image which is colored image is read. Then the cluttered image is read which is colored and having many objects in scene. Both images are converted into grayscale so that SURF algorithm can be implemented. Then feature extraction is done by SURF algorithm which works in three steps detection, description and matching. In first step detection, the unique features are automatically identified. It approximates Gaussian kernel and its spatial derivatives by uniform kernels and the local maxima in rectangular of hessian distribution are used to select interest points. In description, each interest point is uniquely described which does not depend on rotation and scale. In matching, the convolutions of second order derivatives are matched. 150 strongest feature points were taken for reference image and 350 strongest feature points were taken in cluttered images. Then matching of these strongest feature points is done and firstly putatively matched features were displayed then matching point pairing is done with removal of outlines. The calculation of Geometric Transform and the transformation relating the matched points was done, while eliminating outliers. Finally locating the object in scene is done using matched points. Another reference image is analyzed using same algorithm. The approach was implemented for colored images and gave satisfied results.

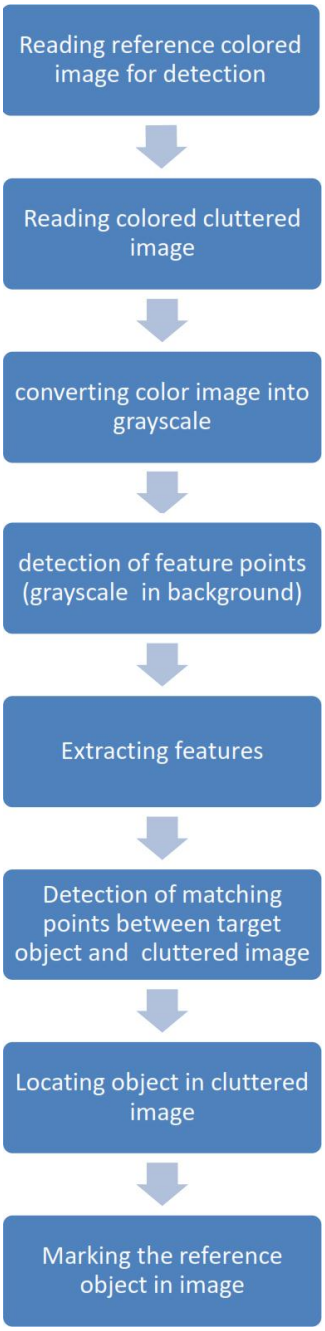

Fig 3.Steps for proposed SURF algorithm

VI. RESULTS

Fig 4. Object of interest.

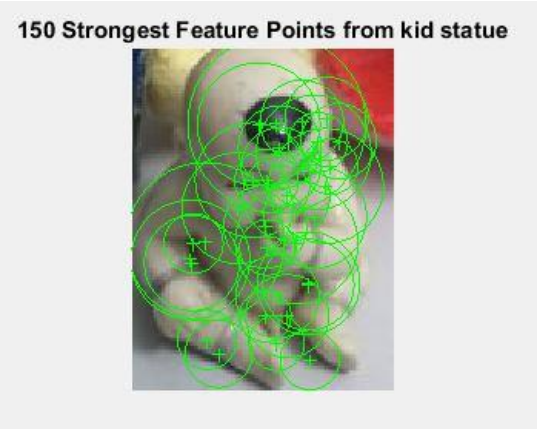

Fig 5. Feature extraction of reference image

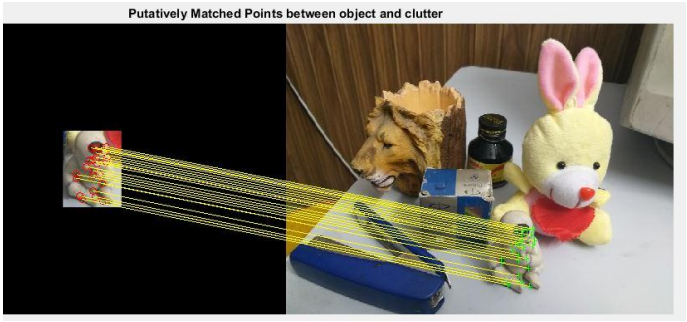

Fig 6. Putatively matched points

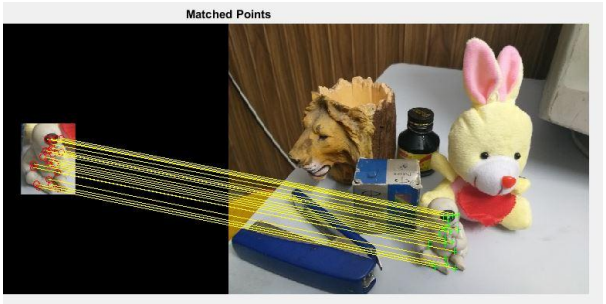

Fig 7. Matched points between reference and cluttered image

Fig 8. Detected object in cluttered image

VII. CONCLUSION

In this article, we have implemented point feature matching technique for object recognition in colored image using SURF approach. SURF algorithm achieves fast and comparable to other algorithms for image matching. The article presents basic notations and mathematical concepts for extracting features and detecting object of interest. The algorithm is modeled and simulated for finding a specific object in cluttered image for example a particular object in many objects image. The related work has been done on grayscale images, for detection the object of interest the images taken were in grayscale. The proposed work is capable for detecting the object in colored image. The approach works well for uniformly colored objects and objects containing regular patterns. The fast computation and enables this technique for real time applications such as object detection and tracking for military applications. Algorithm can also be used for fingerprint matching.

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