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FEATURE EXTRACTION USING SURF ALGORITHM FOR OBJECT RECOGNITION

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***Abstract*—Video surveillance is active research topic in computer vision research area for humans & vehicles, so it is used over a great extent. Multiple images generated using a fixed camera contains various objects, which are taken under different variations, illumination changes after that the object's identity and orientation are provided to the user. This scheme is used to represent individual images as well as various objects classes in a single, scale and rotation invariant model.The objective is to improve object recognition accuracy for surveillance purposes & to detect multiple objects with sufficient level of scale invariance.Multiple objects detection& recognition is important in the analysis of video data and higher level security system. This method can efficiently detect the objects from query images as well as videos by extracting frames one by one. When given a query image at runtime, by generating the set of query features and it will find best match it to other sets within the database. Using SURF algorithm find the database object with the best feature matching, then object is present in the query image.**

Keywords— Image recognition, Query image, Local feature, Surveillance system, SURF algorithm.

I. INTRODUCTION

An object recognition system finds objects in the real world from an image of the world, using object models which are known a priori. This task is surprisingly difficult. Humans perform object recognition effortlessly and instantaneously. Algorithmic description of this task for implementation on machines has been very difficult. The problem of recognizing multiple object classes in natural images has proven to be a difficult challenge for computer vision. The object recognition problem can be defined as a labelling problem based on models of known objects. Formally, given an image containing one or more objects of interest (and background) and a set of labels corresponding to a set of models known to the system, the system should assign correct labels to regions, or a set of regions, in the image.

The object recognition problem is closely tied to the segmentation problem i.e. without at least a partial recognition of objects, segmentation cannot be done, and without segmentation, object recognition is not possible.

In order to recognize the objects from the database, following steps are carried out:

The images in the test set are compared to all images in the reference set by matching their respective interest points. The object shown on the reference image with the highest number of matches with respect to the test image is chosen as the recognized object.

The matching is carried out as follows: An interest point in the test image is compared to an interest point in the reference image by calculating the Euclidean distance between their descriptor vectors. A matching pair is detected, if its distance is closer than 0.7 times the distance of the second nearest neighbour. The geometric constraints reduce the impact of false positive matches, yet this can be done on top of any matcher. For matching and recognition as well as to many other applications, local features are used as they are robust to blockage, background noise and other changes. The challenge is to obtain invariance to viewing conditions. It can first detect features and then compute a set of descriptors for these features. In the case of significant transformations, feature detection has to be adapted to the transformation, as at least a subset of the features must be present in both images in order to allow for correspondences. Features which have proved to be particularly appropriate are interest points.

ORGANIZATION OF THE PAPER

This paper organizes as follows, section II covers the methodology of this scheme & using SURF algorithm which extracts the features. Section III covers the result of proposed methodology which is to be carried out in MATLAB and Section IV is summarizes this project work in terms of conclusion.

II. METHODOLOGY

First, for each image in the training set, select a set of interest points and construct their local feature descriptors using SURF[3] (Speeded Up Robust Features).Then, by using statistical analysis, select representative points from the Interest points. Representative points of an object are interest points that deliver rich and distinguishing information about the object for recognition. All interest patch pairs and selected the patches are similar score was higher than some threshold as representative patches. If an interest point has an enough number of similar interest points in terms of the SURF descriptor, consider the interest point to be a representative point. Based on the representative points of the objects, calculate a threshold for each object type from the training set.

Speeded-Up Robust Features (SURF) [3] is a newly-developed framework, which is very likely to becoming the next fact feature detector in the industry. To improve performance of object recognition system, there is need to address two issues: first, there is need to emphasize the importance of the number of feature pairs when object recognition is done. Since this number is already present in the recognition score, one potential improvement would be to raise its value to a larger power. Using this algorithm, it can generate a set of feature pairs between the query image and each individual database image. For object recognition task,[4] SURF algorithm is used because of its powerful attributes, including scale invariance, translation invariance, lighting invariance, contrast invariance, and rotation invariance & it can detect objects in images taken under different extrinsic and intrinsic settings.

Algorithm consists of four main parts:
1) Integral image generation,
2) Fast-Hessian detector (interest point detection),
3) Descriptor orientation assignment (optional),

4) Descriptor generation.

Fig.1. Flow of SURF algorithm

Integral image is used by all subsequent parts of algorithm to significantly accelerate their speed. Eq. (1) shows integral image. When using integral image, it is necessary to always read only four pixel values to calculate surface integral of any size from original image.

$$I\Sigma(x,y) = \sum_{i=0}^{x}\sum_{j=0}^{y} I(i,j) \qquad \text{........Eq.1}$$

This fact is widely used when calculating Gaussian and Haar wavelet filter responses.

$$\mathcal{H}(x,y) = \det\begin{pmatrix} \frac{\partial^2 f}{\partial x^2} & \frac{\partial^2 f}{\partial x \partial y} \\ \frac{\partial^2 f}{\partial x \partial y} & \frac{\partial^2 f}{\partial y^2} \end{pmatrix}$$

$$\mathcal{H}(\bar{x}) = D_{xx}(\bar{x})\, D_{yy}(\bar{x}) - (0.9\, D_{xy}(\bar{x}))^2$$

$$\bar{x} = (x,y,s) \qquad \text{............Eq. 2}$$

SURF uses determinants of Hessian matrices to locate image's significant points. Equation (2) shows original definition of this determinant for general two dimensional function.
Fast-Hessian detector modifies this equation in two significant ways: 1) Second order partial derivatives are replaced by convolutions of image with approximated Gaussian kernels second order derivatives. Approximation is done by box filters with coefficients 1,-1,2,-2^2. Coefficient0:9 in eq. (3) is used to compensate this approximation.2) Gaussian kernels are not parameterized only by positionin image, but also by their size.

$$\mathcal{H}(x) = \mathcal{H} + \frac{\partial \mathcal{H}^T}{\partial x}\boldsymbol{x} + \frac{1}{2}\boldsymbol{x}^T\frac{\partial^2 \mathcal{H}}{\partial x^2}\boldsymbol{x}$$

$$\hat{x} = \frac{\partial^2 \mathcal{H}^{-1}}{\partial x^2}\frac{\partial \mathcal{H}}{\partial x} \qquad \text{....Eq.3}$$

Scaling is represented by third parameter s in eq. 3, this parameter creates the three dimensional space of determinant results, usually referred to as "scale space". Scale differs (and is quantized) according to octaves and intervals.
If SURF algorithm is used [4], all the representative points are treated with same weight. This can be accounted for by assigning dynamic weights to the representative points. Intuitively, true representative points will appear in images in the training set, and false representative points will appear rarely.

Based on this intuition, the weight of each representative point can be defined as follows:

$$Wp = \frac{\text{No. of detected images w.r.t. point p}}{\text{No. of training images in object}}$$

III. EXPERIMENTATION

The simulation is done in MATLAB R2013a. As shown in the fig.2. below, the query image with multiple objects in it is given as input. The objects to be detected from that query image are first taken as input training images such as clock.jpg,vicks.jpg,pen.jpg.

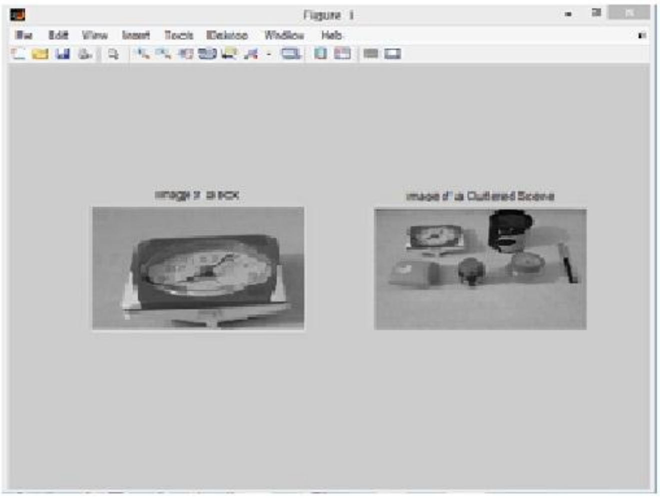

Fig.2. Training object and query image

Extract features of that training object & query image. Then calculate interest points of both the images and based on that matching is done.

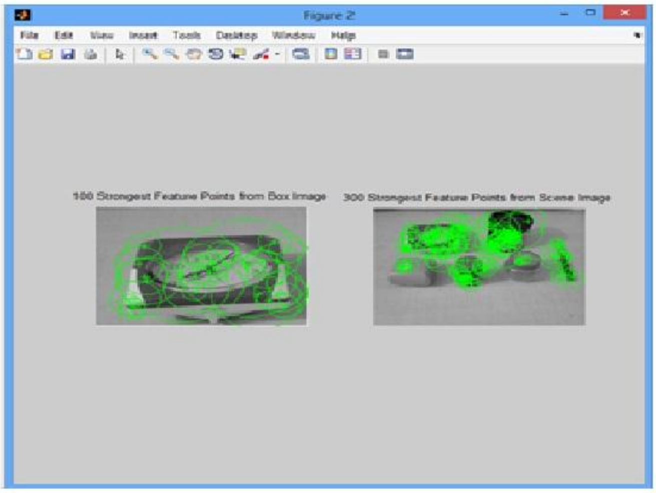

Fig.3. Representative Points of training object 1 & Interest Points of query image.

Now in some cases, there are matched points among the two images which are not actually belong to the object are called as outlier points and hence they should be excluded and only Inlier points are considered.

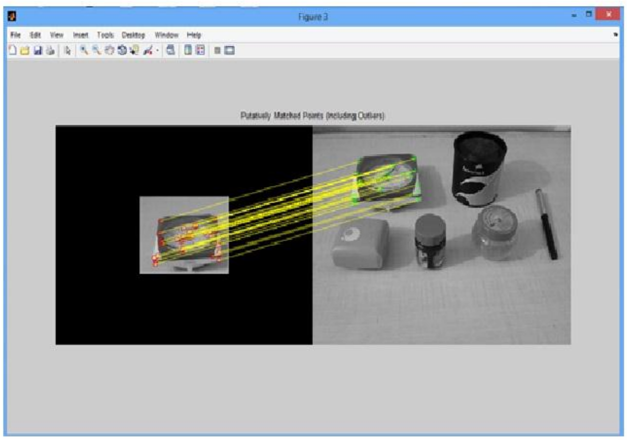

Fig.4.Representation of matched points among Training object and query image

At final stage by comparing all features of that object from image, it is detected in image. This process will go on in iterative manner till all objects are identified in image.

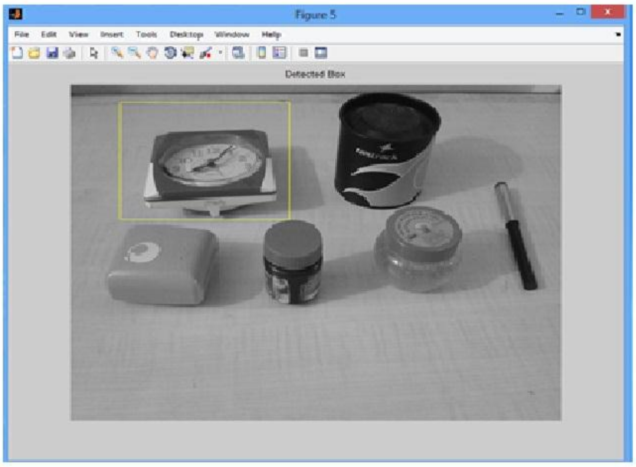

Fig.5. Identifying the detected object in query image.

As shown in fig.5. Object is detected in query image, as it is highlighted in yellow box.

IV. CONCLUSION

A proposed object recognition scheme is implemented to evaluate the performance of the scheme. The SURF algorithm is used in this scheme for recognizing multiple objects, calculation of thresholds and measuring the object recognition accuracy under variable conditions of scale, orientation & illumination.

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