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A Study on SURF Algorithm and Real-Time Tracking Objects Using Optical Flow

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Abstract. This paper presents SURF (Speed-Up Robust Features) algorithm and real-time tracking objects using optical flow algorithm. SURF is the fastest algorithm to find features of an object image in real-time and then by using this algorithm we will compare object image features with our real-time object image features. After that match object image features and real-time features. Next, we will apply optical flow algorithm to track the object location. It tracks the object exactly in real-time when object appear in camera's view. In this paper, we use LK (Lucas-Kanade) optical flow which can operate reduction by choosing an area. We can track object quickly and exactly in real-time.

Keywords: SURF, Optical flow, Matching, Feature detection

1 Introduction

In recent years terrorism is increasing all around the world, the demand of security related services and software's have become higher importance. For example, if we want to track a person or object in any public places or shopping malls with the help of CCTV footage video we can track and find the person and also like black box in missing planes and ships, using black box to check mechanical problem in airplane and ship and so on. Various techniques are developed based on different approaches, applications. Here, we use SURF and optical flow algorithms to find and track objects.

SURF is robust local feature detector, first presented by Herbert Bay et al. in 2006, that can be used in computer vision tasks like object recognition. It is partly inspired by the SIFT (Scale Invariant Feature Transform) descriptor. The standard version of SURF is several times faster than SIFT. SURF is based on sums of 2D Haar wavelet responses and makes an efficient use of integral images. It uses an integer approximation to the determinant of Hessian blob detector, which can be computed extremely quickly with an integral image (3 integer operations). For features, it uses the sum of the Haar wavelet response around the point of interest. Again, these can be computed with the aid of the integral image.

Optical flow is the pattern of apparent motion of image objects between two consecutive frames caused by the movement of object or camera. It is 2D vector field where each vector is a displacement vector showing the movement of points from first frame to second.

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2 Related Theory

2.1 SURF Algorithm

The SURF algorithm is composed of three consecutive steps [1][2]. The first step is interest point detection and second step is building the descriptor associated with each interest points. The last step is descriptor matching. Similarly to the SIFT method, the first two steps rely on a scale-space representation, and on first and second order differential operators. The originality of the SURF method is that these operations are speeded-up by the use of an integral image and box filters techniques. While the scale space is obtained by convolution of the initial images with Gaussians, the discrete box-space is obtained similarly by convolving the original image with box filters at several different discrete sizes. In the detection step, the local maxima of a Hessian-like operator, the box Hessian operator, applied to the box-space are computed to select interest point candidates. These candidates are then validated if the response is above a given threshold. Both box size and location of these candidates are then refined using an iterated procedure fitting locally a quadratic function. Typically, a few hundreds interest points are detected in a digital image of one megapixel. The purpose of the second step described is to build a descriptor that is invariant to view-point changes of the local neighborhood of the point of interest. The location of this point in the box-space provides invariance to scale and provides scale and translation invariance. To achieve rotation invariance, a dominant orientation is defined by considering the local gradient orientation distribution, estimated with Haar wavelets. Making use of a spatial localization grid, a 64-dimensional descriptor is then built, corresponding to a local histogram of the Haar wavelet responses. Classically, the third step matches the descriptors of both compared images. Exhaustive comparison is performed by computing the Euclidean distance between all potential matching pairs.

2.2 Optical Flow Algorithm

We usually use optical flow algorithm when tracking of an object [3]. This algorithm divides two types. One is dense optical flow and the other is sparse optical flow. First, dense optical flow case, it is not easy to calculate. For example, after choosing object, compare with previous frame and present frame and find that object color values are same. Only the edges may change, and even then only those perpendicular to the direction of motion. The result is the dense methods must have some methods of interpolating between points that are more easily tracked so as solve those points.

This leads to alterative option sparse optical flow [4]. Algorithms of this nature rely on some means of specifying beforehand the subset of points that are to be tracked. This method uses LK (Lucas-Kanade) algorithm with pyramid image. When we use LK algorithm, we assume three points. One is brightness constancy. The pixel from the image of an object in the scene does not change in appearance as it moves from frame to frame. Second is temporal persistence. The image motion of the surface

patch changes slowly in time. Third is spatial coherence. Neighboring points belong to same surface, similar motion and project to nearby points.

3 Proposed Algorithm

We proposed this algorithm using a SURF algorithm with optical flow. SURF algorithm can find an object in real-time and optical flow algorithm can be possible to track an object in real-time. In fig.1, we can see our proposed algorithm. First, through the SURF feature detector, we get a feature in real-time and this feature is compared with image SURF features. After detector, a descriptor and interest point's process can be possible to detect an object. If an object gets matched, then image features should match with in real-time image feature which have same points more than fifty.

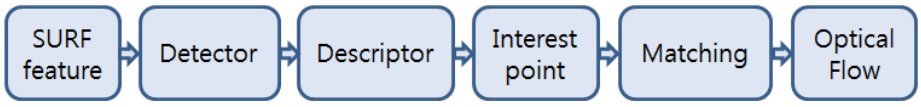


Fig. 1. The diagram of proposed system algorithm.

(a) (b) (c) (d)

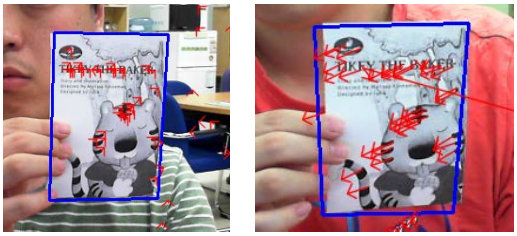
Fig. 2. The result of matching based on SURF. (a) shows 5th frame (d) shows 15th frame object moved from left to right.

(a) (b) (c) (d)

Fig. 3. The results of applying optical flow. (a) is optical flow in real-time; (b) to (c) show object moving; (d) shows pixel moved.

The fig. 2 indicated SURF and matching result. We can see the object moving and change in coordinates. After matching we record time and coordinates. It could be possible to compare with first image and last image. It helps to calculate location and direction. At the same time optical flow also calculates. To see the optical flow calculation, we draw the line like in fig. 3. Where, (a) shows optical flow in real-time;

(b) is previous image and (c) is present image; (d) shows what pixels are moved. The fig.4 presents final result. Each figure, we can see the object directions which are present using allows. When we focus on the object, we know that almost allows exist near the object area and background area has a little arrow amount. It means the background is fixed when we see the camera's view. It makes to get object direction. This result means if we use SURF algorithm and optical flow algorithm we can track object fast and exactly.



(a) (b)

Fig. 4. The final result of proposed method. (a) presents the object move from south to east; (b) presents object move from south to west.

4 Conclusion and future Research

In this paper, we proposed our algorithm using SURF algorithm and optical flow algorithm in real-time. In real-time experience, we can get an object location and direction fast and exact. In this experiment, when we track object using a webcam, background is same all times and it can track an object. In the future, we can track objects while the camera is moving so that it can track its background along with an object.

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