A Study on Moving Object Tracking Algorithm Using SURF Algorithm and Depth Information

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Abstract: This paper is a study on real-time object tracking algorithm using depth information of the Kinect and fast speeded up robust feature(SURF) algorithm. Depth information of the Kinect is used to overcome the disadvantage which continuously adaptive meanshift(Camshift) and Meanshift have of illumination and noise. Because processing time of SURF algorithm is faster than that of scale invariant feature transform(SIFT), Interest point detection of SURF algorithm is used for real-time processing. In this paper, depth information using background modeling and SURF algorithm generates interest point detection, interest point detection can create search window and we present object tracking method using Camshift and interest point detection.The experimental results show that the proposed method using depth information and SURF algorithm is more effective than conventional methods at processing time and accuracy.

*Key-Words:*Camshift,depth information, interest point detection, Kinect, object tracking, SURF

1 Introduction

Recently health care, science and education as well as games field have been studied using the Kinect.The Kinect doesn't only print out color image and object's distance easily is measured using depth information of the Kinect.Image processing was made possible by various processing and application using depth information and real time object tracking was also made possible by various methods[1].

After the object is separated from the background, using the interest point is a way to accurately trace the moving object.The ways to extract interest point always have been studied for expression of the object.A method using interest point is apply to Face Recognition, estimated position, etc.[2], the typical algorithms which extract interest point of object are scale invariant feature transform(SIFT)[3] and speeded up robust feature(SURF)[4].

SIFT and SURF algorithms have a goal to search interest point but the main difference between the two is performance.SURF algorithm using Hessian matrix of detector is faster than SIFT algorithm but SURF algorithm has low ability of extraction beside SIFT algorithm. In this paper, SURF algorithm is used for real-time processing between SIFT algorithm and SURF algorithm. This paper proposes a way to enhance the operation speed and not to be sensitive to light using depth information.

2 Problem Formulation

2.1 Camshift

Camshift which is the abbreviation of continuously adaptive Meanshiftalgorithm is built on Meanshift.Meanshift algorithm which is based on the characteristics of the distribution of all kinds as well as the color information searches center point of the object.But it doesn't update the size of search window and prone to converge to local maximum.Camshift algorithm is corrected by thisdemerits[5, 6].

The following is a process of Camshift algorithm.
Step 1 :Set the size of search window. When Camshift only is used, user personally sets the size. So it needs other algorithm for the size.
Step 2 :Set the center point of search window set the size in step 1.
Step 3 :RepeatMeanshift algorithm. This step using second momentsets up width and length of window scale and angle of rotation.
Step 4 :After obtaining center point from step3, change the size and position of window.
Step 5 :Untilthere is no change in the center point of search window, repeat step2~step4.

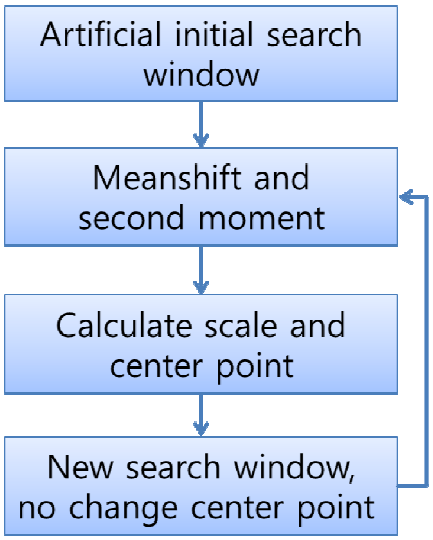


Fig.1. Block diagram of Camshift algorithm.

Figure 1 is block diagram of Camshift algorithm. Itincludes Meanshift algorithm.

2.2 SURF algorithm

SURF algorithm which is faster than SIFT algorithm is proposed by Herbert Bay[4]. It uses simple detector and descriptor for speed and uses the integral image.

Figure 2 is the entire structure and this is divided between Interest point detection and Interest point description.

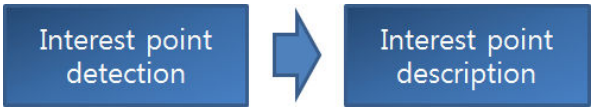


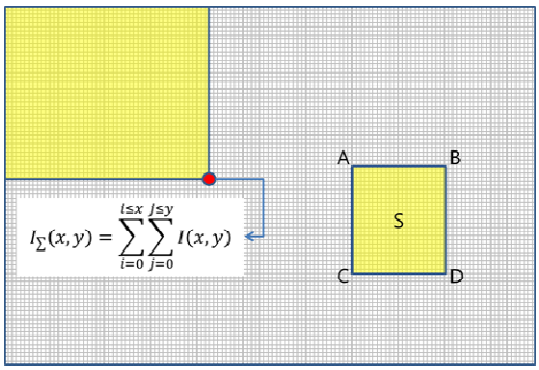
Fig.2. SURF algorithm.

2.2.1 Interest point detection

First step for interest point detection generates the integral image from the original image.The integral image is generated by using equation (1)[7].

(1)

Equation (1) is the sum of all pixel values within a rectangular region from starting point to a pixel location.A point of x, y indicates a pixel location. is sum to the location. The typical method is calculated from many pixels in original image for the sum of the rectangular region but this method using integral imageonly needsfour points. Figure 3 indicates this method.



$$S = I_{\sum}(D) - I_{\sum}(B) - I_{\sum}(C) + I_{\sum}(A)$$

Fig.3. A way of calculating area in theintegral image.

Second step extracts interest point using equation (2) of Hessian matrix.The approximate second order Gaussian simplified Gaussian filter is used in order to simplify calculations. Figure 4shows the filters of approximated Hessian matrix.These indicate D in equation (2).

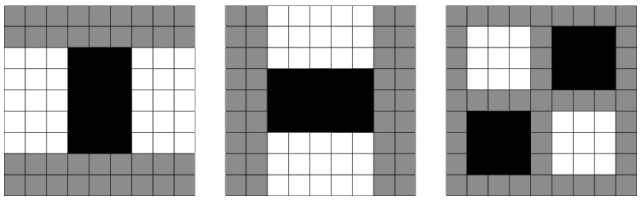


Fig.4. Filters of approximated Hessian matrix(Dxx, Dyy, Dxy).

The interest points of various scales are extracted by changing the size of the filter using the simplified Gaussian filter and integral image fixed. This eventually will have invariant features at the size. Figure 5 indicates many different sizes of filter.

Fig.5. Changing size of Hessian matrix filter.

2.2.2 Interest point description

A window around interest point is divided into 4x4 for interest point description and the size of angle and orientation are calculated by a divided window using haar wavelet filter. The direction is decided by the most orientation vector of haar wavelet features.Each 64, 128 dimensional interest point description are calculated by the calculated features of four, eight.Figure 6 indicates the result of interest point detection and description using SURF algorithm.

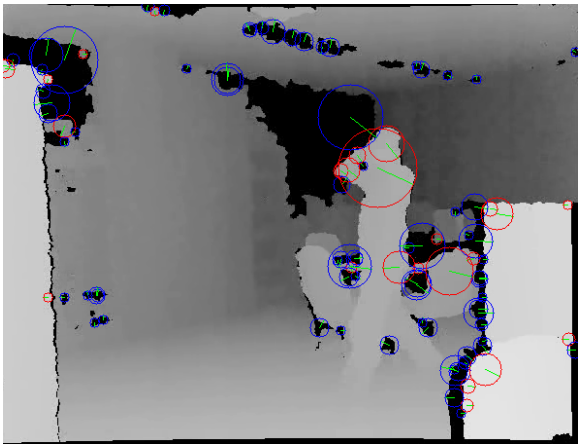


Fig.6. Interest points detection and description using SURF algorithm.

3 Problem Solution

Using Meanshift and Camshift in color image causesunsuccess of object tracking because of the noise such as illumination.This drawback can be solved by using depth information of Kinect.Because the Kinect measures infrared light reflected, it can ignore illumination.But the Kinect doesn't measure all infrared light reflected because of the limit of sensor technology and this errors are the noise. So the errors are indicated in input image. If the nearest things are displayed by white, the noises are displayed by black.

After input image is divided between object and background by Gaussian mixture model(GMM), this processed image is removed by morphological filter. Figure7 indicates GMM processing.Because of the noises, white points are generated. And figure8 is noise processing of morphological filter. The noises easily are removed by this.

The range of the divided object is set into Region of Interest(ROI) and interest point detection is extracted by SURF algorithm.This paper uses only interest point detection for processing speed.A rectangle using the outer points among interest point detections extracted is made and Camshift using this rectangle traces the object.

Fig.7. Separation using GMM of background image.

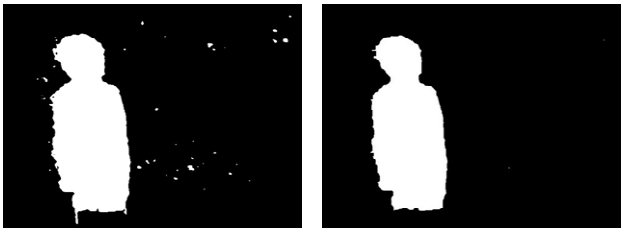


Fig.8.Noise processing using Morphological filter.

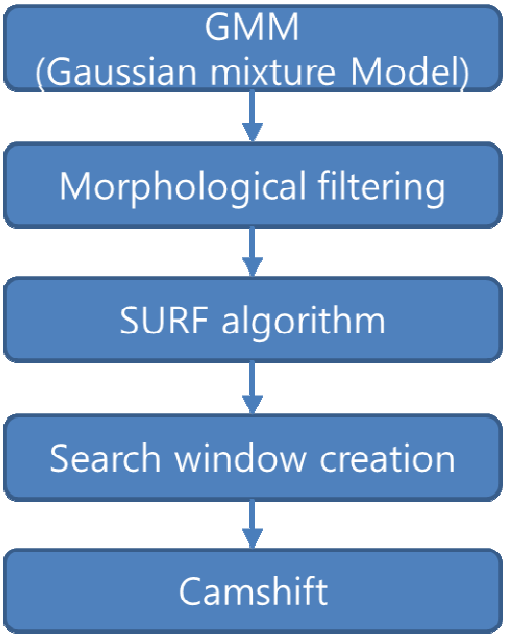


Fig.9. The proposed object tracking algorithm.

Figure 9 is a block diagram which is proposed by this paper.

4 Conclusions

Images of 640x480 are recorded by Kinect indoors because of measuring range of Kinect .

The following is a computer spec:

-Intel(R) Core(TM)2 2.5 GHZ, 4GB RAM

-MS Windows 7 Enterprise with Service Pack 1

-Microsoft Visual C++ 2008 Service Pack 1.

ISBN: 978-1-61804-115-9

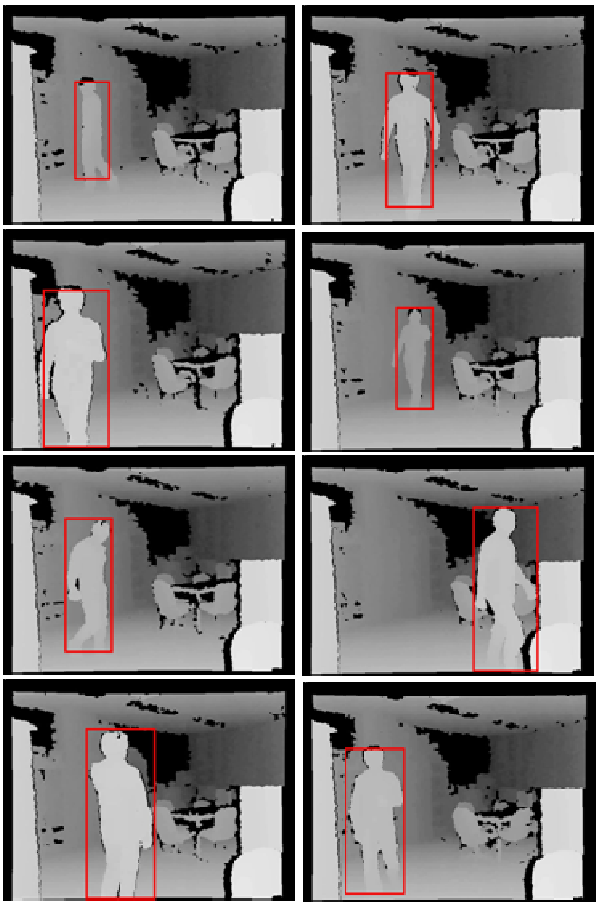


Fig.10. The result images of object tracking with the proposed method.

Table 1.Performance comparison with various algorithms.

	Image-size (pixels)	640x480
	Total frames	2540
Average execution time (sec/frame)	CamShift	0.0408
	SIFT	9.53
	SURF	3.14
	The proposed method	0.0652

Figure 10 is the result images using a proposing method in this paper.Because a problem has using only Camshift of object tracking in color image and using only SURF algorithm which is difficult to apply to real-time processing, this algorithm is proposed in this paper.While first object is generated, this algorithm has another problem because the number of frames per second is decreased by SURF algorithm.After SURF algorithm operation, object tracking using Camshift is efficient.

Table 1 indicates the performance of the other algorithm and proposing algorithm. First experimentresultonly using Camshift is the fastest but search window of Camshift algorithm artificially is set in this experiment. Next experiment result only using SURF algorithm is very slow because this method uses both interest point detection and interest point description. SIFT and SURF algorithmsaredifficult for using real-time processing. Interest point detection of SURF algorithm and Camshift algorithm are used by proposing algorithm in this paper for real-time processing.

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