IMPROVED FEATURE EXTRACTION USING BOX FILTER COMBINATION IN IMAGE DATA

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Abstract— A feature of the image is the point that can represent better the characteristic of the image other than points. Therefore, a feature of the image data must be detected regardless of the change of scale, rotate and viewpoint, etc. For feature extraction of existing research, feature point is extracted compare to normal image and abnormal image, otherwise method has been developed to extract edge points. In particular, SIFT(Scale Invariant Feature Transform) applies the filter and uses DoG(Difference of Gaussian)to extract the edge points. In this case, Gaussian filter is used. The reason is known that the best filter to extract the feature of image is Gaussian filter. However, Gaussian filter blur objects in image. So, using Gaussian filter prevents to extraction exact feature point. Therefore, the purpose of this study is to solve the problem by developing a filter with linear combination of box filters. The proposed filter extracts feature that located the boundary between the object in image more sensitive. In addition, through experiments,the proposed filter is confirmed to be better than Gaussian filter in specific image.

Keywords— Gaussian filter,box filter, SIFT,Combination of box filters.

I. INTRODUCTION

Interesting point is widely used in computer vision field and image processing.It is a feature point which can represent a character of the image so, it means a set of points or point that best explain the characteristics of the image regardless of changes in the scale of images, rotation, distortion, etc. The most common method when recognizing the objects in the image or matching between images is to compare the important key points. For example, we extract the interesting points of the two images. Extracted points are used in a wide range of tasks, such as object recognition, motion tracking, determining the identity of the image.

Until now, various studies have been conducted to find the feature points of the image. Typical method of finding the corner points and feature points in the image is the Harris corner detector published in 1988. Features of Harris corner detection method is invariant to translation, rotation. Also, it has a strong character to lighting changes. However, There are disadvantages that the sensitivity to changes in image's scale. To solve this problem,Harris – Laplacian method is studied in 2001. After extracting the Harris corner points from multiple imaging scale, the maximum points of Laplacian are selected for the scale change. Shi – Tomasi feature point extraction method has an advantage to select the feature points by considering affine change. SIFTis the well-known interesting point extraction method. In order to solve the problem Harris corner is sensitive about scale change of image, SIFT considers the maximum feature points in the scale axis, as well as in image based on DoG. SIFT has been successfully used in a variety of image processing. SIFT applies the convolution to find feature points. In general, a Gaussian filter is applied. The reason for applying the filter to the algorithm is that it reduce the noise in the image and find discrimination at interesting points. In application process, filter has the advantage to reduce the noise. However, there is a disadvantage to make blurred boundary between objects of image. Fig. 1 is an illustration of a comparison of the image applied to the original image with a Gaussian filter($\sigma^2 = 2$). We can check that the roof's outline is misty, this is because Gaussian filter reduce or erase a large changes portion in the pixel. Therefore, the use of a Gaussian filter interferes to extract distinct interesting point. Thus, this paper aims to develop a new filter to replace the Gaussian filter.

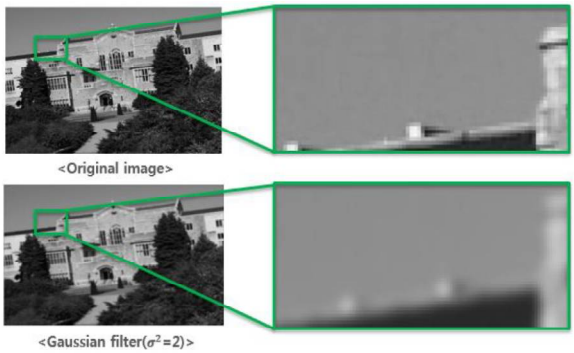

Fig.1. Comparison between Two Images

II. DETAILS EXPERIMENTAL

2.1. Convolution

SIFT applies the convolution to find feature points. In equation (1), $I(x, y)$ is an image, and

$$L(x, y; \sigma) = g(x, y; \sigma) * I(x, y) \quad (1)$$

$$g(x, y; \sigma) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

$g(x, y; \sigma)$ is a Gaussian filter. * means convolution. Oneof the functions reverse and shift and then

integrating the result of multiplied by another function. Through the convolution of the Gaussian filter and image, we reduce noise and extract discriminative interesting points. In Fig. 2, it is an example of an image convolution with filter of size 3 × 3. Using equation (2), to derive a new value of L(x,y), the surrounding pixels of $I(x, y)$ and filter are used to obtain a weighted average.

L(x,y)=a·I(x-1,y-1)+b·I(x,y-1)+c·I(x+1,y-1)+ d·I(x-1,y)+e·I(x,y)+f·I(x+1,y)+g·I(x-1,y+1)+h·I(x,y+1)+i·I(x+1,y+1)(2)

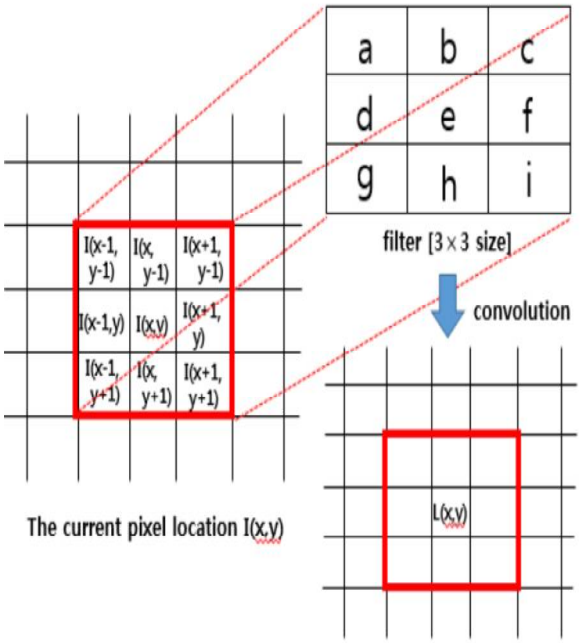

Fig.2. Example of Convolution

2.2. SIFT(Scale Invariant Feature Transform)

SIFT has been known to announce David Lowe's research in 2004. SIFT has an advantage that it extract scale invariant feature, even robust rotation. Also, in order to extract a feature point, SIFT Algorithm make the scale space in the process. Scale space is made of a different size to adjust images. Because it considers both big image and small size image, it is possible to obtain scale invariant feature points. SIFT determine size and location of the feature using Scale-space extrema detection. At this time, Gaussian filter with variety of variance and image are conducted convolution.

$$D(x, y; \sigma) = \big(g(x, y; k\sigma) - g(x, y; \sigma)\big) * I(x, y) = L(x, y; k\sigma) - L(x, y; \sigma) \quad (3)$$

In equation (3), it computes a difference between neighbor images using DoG. As shown in Fig.3, SIFT select the local extrema using DoG to compare 3 × 3 × 3 size of matrixes. SIFT has the reason for using DoG.

In order to extract local maximum points, SIFT used

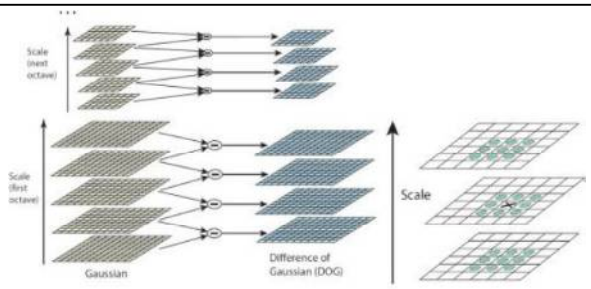

Fig.3.DoG(Difference of Gaussian)

LoG(Laplacian of Gaussian). This means that SIFT uses the second derivative in order to detect local maximum points of the edge and corner. However, with the convenience of calculation, SIFT generally uses DoG. It is proved that DoG approximateLoGusing equation (4).

$$\mathrm{LoG} \approx \frac{g(x, y; k\sigma) - g(x, y; \sigma)}{k\sigma - \sigma} \quad (4)$$

2.3. Gaussian Filter and Box Filter

The Gaussian filter is a Gaussian distribution that used in image processing. As shown left figure in Fig. 4, it has the rotationally symmetric shape and single peak. Gaussian filterreduces weight between pixel at the center and neighbor pixels in the distance. So, it has a characteristic to replace a weighted average of the neighbor. Box filter has shape like right figure of Fig. 4. It adds the value of the surrounding pixels and averages the result. For existing SIFT, it uses Gaussian filter to extract interesting points in image data. However, when Gaussian filter is applied at image, left figure in Fig. 5 shows that the window's outline is misty. This show that the use of Gaussian filter erases detailed information of the image. Also, it leaves only the information of overall outline.So,

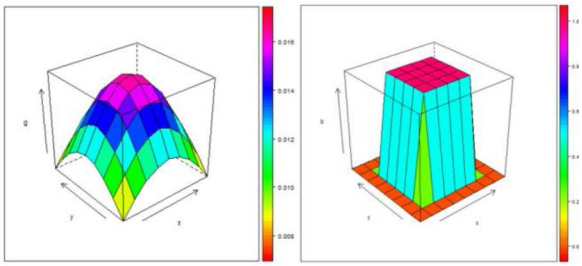

Fig.4. Gaussian Filter and Box Filter

When Gaussian filter is applied to SIFT's feature extraction, it has a problem to reduce discrimination. When applying the box filter for feature extraction, right figure in Fig. 5 shows box filter leave the details of the image more than Gaussian filter. However, the performance of the feature points with box filter alone is less than when Gaussian filter is used. Therefore, while keeping thedetails of the image, it is necessary to develop a filter that has performance such as Gaussian filter.

2.4. Combination of Box Filters

In order to extract a sensible feature, this study

proposes a new type of filter. Through linear combination of box filters, it makes the intermediate filter of the box filter and Gaussian filter. X isbox filter to

$$\hat{\beta} = \text{argmin}(\text{y} - X\beta)^2(\text{y is Gaussian ilter}) \quad (5)$$
$$X\beta = \beta_1 X_1 + \beta_2 X_2 + \cdots \beta_n X_n\,, \qquad \text{n} = 1, 2, 3 \ldots$$

convert column vector, we approximate Gaussian filter with the different size of n box filters. This has the advantage that while utilizing Gaussian filter, and leaving the details of the image. So, sensible feature points is extracted when using proposed filter. We choose MARS(Multivariate Adaptive Regression Splines) as regression model. This is because MARS has variable selection function. It means that we reduces the box filters which is not required. In Fig. 6, this is finally created filter. Compare with Fig. 4, it has intermediate shape of the Gaussian filter and box filter.

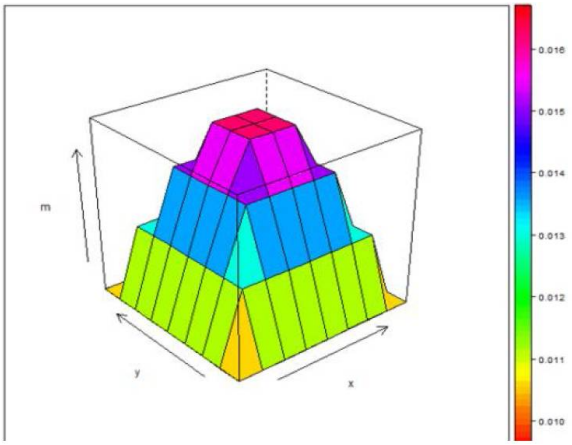

Fig.6. Combination of Box filters

III. RESULTS AND DISCUSSION

3.1. Experimental Results

The experiment uses two image for performance evaluation. Fig.7 isimage used for the test. The left image that pixels are mild change and right image that pixels are severe change. We compare the performance of Gaussian filter and proposed filter. Compare Fig.8 and Fig.9 using Gaussian filter toFig.10 and Fig.11 with the proposed filter, the proposed filter is more sensitive to change of pixel. Also, to evaluate the performance of the selected feature points, Repeatability score is used.



Fig.7.Two Test Images



Fig.8. Bikes Image with Gaussian Filter



Fig.9. Graffiti Image with Gaussian Filter

$$\text{R} = \frac{number\ of\ correspondences}{minimum\ number\ of\ points\ detected} \qquad (6)$$

In equation (6), R isRepeatability score that comparing the feature points of two image. Against the reference image, it is a measure to confirm that the feature points are extracted in the same place by comparing the feature point of the rotated image. For experiment, we match each 20,30,40,50 and 60 rotated image with reference image and calculate the Repeatability score. In Figure 12 and 13, when proposed filter is used in bikes image, Repeatability score is greater than Graffiti image. On the other hand, Gaussian filter show better performance when it is used Graffiti image. This is because proposed filter extract too many feature. So, Repeatability score is lowered.



Fig.10. Bikes Image with Proposed Filter



Fig.11. Graffiti Image with Proposed Filter

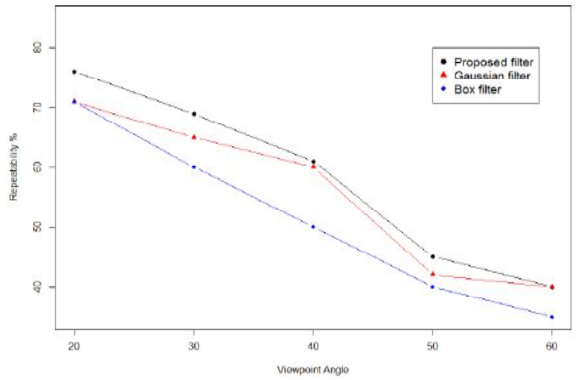

Fig.12.Repeatability Score of Bikes Image

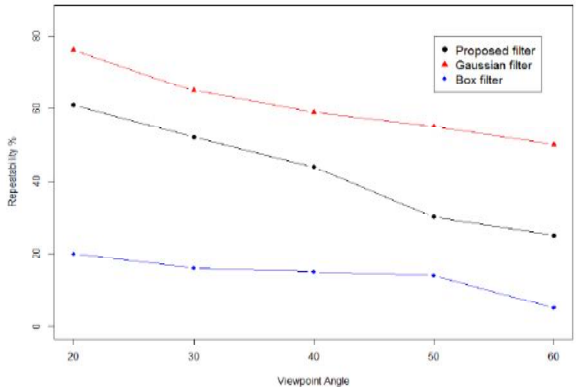

Fig.13.Repeatability Score of Graffiti Image

CONCLUSIONS

We studied how to extract feature in image data. In particular, Gaussian filter is not always good to extract feature. Also, through experiment, when specific condition, proposed filter shows better performance. For the further study, we need optimal parameter to gain feature with proposed filter. Also, the performance of proposed filter is evaluated with other images.

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