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Image Duplication and Rotation Algorithms for Storage Utilization: A Review

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Abstract: Nowadays there exists high-end server for data storage utilization. However, it is expensive and it is not lean. The proposed solutions are implemented with enhancement to remove the waste and cost concern. Usually images in storage server are duplicate, multi-scale, transition and rotated. SIFT and V-J algorithms are selected for the enhancement. Both algorithms have been widely applied in real world, but limited speed performance and rotation respectively. Experiments data validations with other researchers' methods were compared. Result show better compare with previous researchers' methods.

Key words: Pattern detection · Face detection · Image duplication

INTRODUCTION

Data storages were growing drastically with 42% for midsize company from 2004 to 2008 due to user need to work with them independently by duplicate the files [1]. This rapidly growing could be the image files because the image files are usually huge compared to text file. Although some image files are resourceful to company, it could be inappropriate or duplicate. There are some methods to overcome the problems, which are increasing the hardware storage size and deduplication methods. Unfortunately, hardware implementation is not recommended because failure of hardware could pose a threat to business. Besides that, it is expensive because redundant components are needed if single point of hardware failure [2]. Furthermore, it is not necessary company to invest such waste and it is against companies rule due to inappropriate image files. In order to follow the company policy, it is ridiculous for administrator to detect the inappropriate or duplicate images as well, as image files could be in scale, rotation, occlusion and transition conditions. Besides that, deduplication method also impossible for the cases above. Fortunately, there are some computer vision algorithms could be used to detect object in condition with scale, rotation and transition in images such as SIFT, Harris Laplace, Laplacian of Gaussian, MSER, FAST, SURF and V-J face detector. SIFT and V-J face detectors were selected for controlling the storage utilization. Both algorithms were selected due to it's famous in research. Additional, SIFT is able to detect object near-duplication so called occlusion. V-J face detector is selected because of real-time face detection. Face detection could be used for detecting inappropriate image such as adult image and personal image. However, V-J face detector not able to detect rotated face. Therefore, enhancement of V-J face detector also was proposed.

Gaussian Theory: Gaussian function has been applied to digital image processing long time ago. D. Marr [3] showed filter that localization in both spatial and frequency domain is the equation [4]. Gaussian smoothing or Gaussian blur was used for removing noise. The equation of 1D Gaussian function is

$$G(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{\frac{-x^2}{2\sigma^2}} \quad (1)$$

2D Gaussian Function is:

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

Gaussian has been applied in features detection, such as edge detection, corner and blob. Edge detection algorithms can be classified into derivative types, template matching, Gaussian derivatives and Pattern fit approach [5]. There are 2 types of derivate methods. First

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derivative or first order edge detection algorithms are Sobel, Prewitt, Robert and etc. Second derivate or second order algorithm is Laplacian. The advantage of the second derivative is rotation invariant [5]. However, the disadvantage is sensitive to noise compared to first order. Marr-Hildrith [3] proposed Gaussian function is used for smoothing before Laplacian operator to be performed. It was named as Laplacian of Gaussian. The equation can be written as

$$LoG = \frac{d^2}{dx^2}G(x,y,\sigma) + \frac{d^2}{dy^2}G(x,y,\sigma)$$

$$LoG = \frac{x^2+y^2-2\sigma^2}{\sigma^4}e^{\frac{-(x^2+y^2)}{2\sigma^2}} \quad (2)$$

Besides that, Moravec corner [6] was one of the first corner detection. It was improved by Harris to remove the noise. Harris [7] applied Gaussian to autocorrelation matrix for corner detection. Moreover, edge detection could be used to become blob detection. Although LoG is edge detection, it can be turned into blob. It was depend on the sigma or standard deviation. T. Lindeberg [8] showed that the Laplacian response is decay when the standard deviation or scale getting bigger. Superposition of two ripples result the maximum response become the blob-like. To keep the Laplacian response is same across the scale, second order of Gaussian must multiply by σ^2. D. G. Lowe [9] proposed to use Difference of Gaussian (DoG), which is approximate for LoG. Optimization is improved by using DoG. The equation can be described as

$$D(x,y,\sigma) = \big(G(x,y,k\sigma) - G(x,y,\sigma)\big) * I(x,y) \quad (8)$$

Harris [6] corner detection is rotation invariant but scale variant. Scale space theory was introduced, there are 2 important steps. Feature detection and finding maxima and minima extrema. T. Lindeberg [8] introduce automatic scale selection. There are many blob detection based on LoG or DoG in scale space. For instance, Determinant of Hessian (DoH), SIFT [9], Harris Laplacian [10], Hessian Laplacian [8] and Harris Affine Region [11].

$$DoH(x,y,t) = t^2(L_{xx}L_{yy} - 0.9L^2{}_{xy}) \quad (6)$$

where,

$$L_{xx} = (x^2 - \sigma^2)e^{\frac{-(x^2+y^2)}{2\sigma^2}}$$

$$L_{yy} = (y^2 - \sigma^2)e^{\frac{-(x^2+y^2)}{2\sigma^2}}$$

$$L_{xy} = xye^{\frac{-(x^2+y^2)}{2\sigma^2}}$$

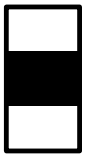
$$L^2{}_{xy} = \left(xye^{\frac{-(x^2+y^2)}{2\sigma^2}}\right)^2$$

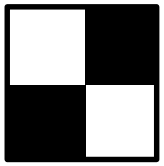
The LoG could be representing in Haar wavelet. SURF [12] measure the LoG as below.

$$LoG = \frac{d^2}{dx^2}G(x,y,\sigma) + \frac{d^2}{dy^2}G(x,y,\sigma)$$

where,

$\frac{d^2}{dx^2}G(x,y,\sigma) =$ 

$\frac{d^2}{dy^2}G(x,y,\sigma) =$ 

$\frac{d}{dxy}G(x,y,\sigma) =$ 

Computation of Haar wavelet can be done by using Integral Image method. This method has speed up the process. Viola Jones implemented Haar wavelet based on area of sum table also known as Integral image combination with variance normalization due to illumination problem. Variance normalization is written as

$$\sigma^2 = m^2 - \frac{1}{N}\sum x^2 \quad (11)$$

where, m = mean, σ = standard deviation, x = pixel value

Related Work: There are also various types of near-duplicate image detection. Feature detection is blob detection – Different of Gaussian (DOG) and Harris. Scale detection based on pyramid or Laplacian. Rotation challenge can be resolved by DAISY and RIFF. Other challenge like illumination also can be solved by GA-SIFT. Affine challenge was resolved by ASIFT. Besides that, noise challenge was resolved by PCA. SIFT detection is slow. However, it was overcome by SURF, parallel ASIFT

and FSIFT although there are many speed techniques which are well performed but the algorithms are complex. This paper focus on simplify the slow detection process issue.

Over the past few years, face detection has been studied by many researchers and there are many different techniques have been proposed such as appearance method, template method, knowledge based method and feature invariant [13]. Based on appearance method, statistical analysis and machine learning are used. Example of feature representation is statistical analysis and feature selection is machine learning. Details example of feature representation techniques are Haar feature, skin color and shape. Most feature selection techniques are based on machine learning such as Adaboost, neural-network and SVM. Techniques that help to improve the training time during performing Adaboost is Cascaded method [14]. Alternatively, preliminary process dimension reductions can also be used to improve training speed – skin color [15] and PCA. However, skin color based method has skin color like background challenge. Recently, this challenge was resolved by using skin modelling coefficient matrix techniques [16]. Illumination is also another challenge; however it can be resolved by using Local Binary Pattern techniques [17, 18], enhancement of variance normalization. In addition, low pass filter, median filter, Super Resolution and adaptive median filter can be used to eliminate noise challenge [19]. Occlusion challenge can be resolved by using structure model, Fast Weighted PCA and Super Resolution. Rotation can be classified to in-plane or off-plane rotation. In-plane rotation techniques are rotated Haar feature, rotated image and Local Binary Pattern. This paper is based on the theory of Viola Jones face detection framework and extends it by detecting rotated face region. The theory of feature representation of Viola Jones's method is Haar feature and integral image and the feature selection is the Adaboost. The feature selection is used to classify face region or non-face region. It was improved with cascaded method, which make it high accuracy detection and real-time. Although there are still a lot challenge such as rotation variant, noise, illumination and occlusion. Therefore, this paper will just focus on rotation variant. Many detectors have performed well rotated face region in certain level, but the algorithms are complex. The proposed face detection is to simplify the process for rotated face detection. However, this paper based on SIFT due to SIFT based on DoG in scale space. It was proposed because it provides another angle of view for speed up by combination of Robert edge with DoG. Viola Jones face detection also was selected due to the feature of Integral image. However, it is rotation variant. This paper also proposed the rotation invariant for the Haar feature.

Methodology

Action Research Phase:

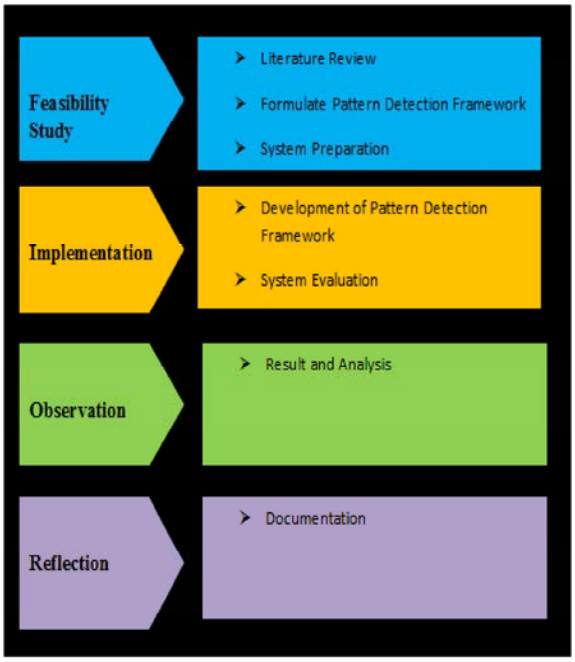


Fig. 1: Research Phase

Research Design:

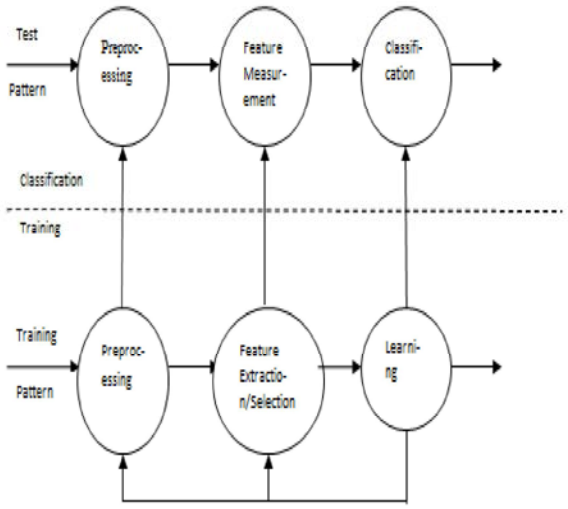


Fig. 2: Research Design of Pattern Detection

This paper follows research design of pattern recognition [20]. In this research, it involves the study of the enhancement of SIFT for object detection and Haar feature detection for face detection. Both detection methods are part of the pattern detection methods. Before running SIFT, Binary Cross Robert edge detection is performed as preprocessing. The conventional SIFT consists of a process of Gaussian Smooth image, scale space extrema detection, accurate keypoint localization, assigns magnitude and orientation to the keypoint and finally the matching part. Feature extraction for SIFT – represent feature detection or interest point by exploiting orientation histogram. Before Haar feature detection phase, image is rotated in optimal angle. The Haar feature detection process so called integral region in the image. Feature selection for V-J rotated face detection – reduce dimension of feature detection or interest point by exploiting Adaboost.

Limitations of Selected Algorithms: Many researchers have done successfully the real-time face detection. One of the methods that famous and successful is Viola and Jones's [14] framework. It is also called as V-J face detection. Basically, the algorithm include integral image, which speed up the computation. Another part is the cascade Adaboost, which also increase the speed for face detection. Adaboost is machine learning use for calssifying the face or non-face image. Bi Li [21] proposed to rotate the image in +15° and -15° before perform V-J face detection. The proposed solution shows high positive result compare to original viola jones's method. However, this method could be further enhanced by optimizing the rotation 15° within 360°. Besides that, another method that could use as generic for object detection, which is SIFT. The method is famous [9] with its scale invariant. The basic steps of the SIFT algorithm is as below:

Step 1: Gaussian Smoonth Image.
Step 2: Scale Space Extrema Detection.
Step 3: Accurate Keypoint Localization by removing contrast and eliminating edge.
Step 4: Assign magnitude and orientation to keypoint.

The slowness of the SIFT algorithm could be further enhanced by integrating the binary Robert edge detection.

Proposed Solutions of Selected Algorithms: The idea of the researcher proposed that [21], image is rotated by optimal angle in 0°, +15° and -15° prior to processing Adaboot algorithm could show better accuracy. To overcome the limitation of Viola Jones's method on detecting the rotated face, image is rotated with 15° till 360° with 24 steps are proposed to perform before V-J method. Another proposal for increasing the speed performance of the SIFT is to reduce the dimension as pre-processing before SIFT. Edge detection could be used for dimension reduction. There are many types of edge detection such as, Prewitt, Sobel, Canny and Robert Cross. The reason Robert Cross was selected was the method is the fastest edge detection.

CONCLUSION

The comparison result of speed performance of SIFT by using binary Robert Cross edge detection and enhancement of rotated Adaboost (Viola Jones's face detection method) by rotating 0°-360° with added 15° for each step shows outperformed as expected. With the intelligent method, it could be helpful to resolve ethic issue, cost effectiveness and capacity of storage and reduce the workload of users and administration. Indirectly, it could cope with the challenges to manage digital images in storage such as inappropriate image and redundant image. Therefore, it is suitable to apply to real world problems. For future works, there are few points to consider such as illumination invariant for object detection and face detection, to detect occluded face, to optimize storage, to test on other platform. The proposed enhancement of rotation invariant face detection could be further enhanced by other feature detection methods. Although the details of the image might lose if binary edge detection was applied before SIFT, future could utilize a novel method to prevent loss of the details of the image.

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