Image Duplication and Rotation Algorithms for Storage Utilization

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***Abstract*—In this era, there is high end storage with high storage capacity. However, due to ethic issues, this development has rapidly increased the cost of hardware every year. In order to prevent the rapid increase of the hardware cost, pattern detection methods are introduced to optimize the storage utilization by detecting image duplication and inappropriate image. Pattern detection is usually applied before pattern recognition. The accuracy of pattern detection can give impact to pattern recognition. Therefore, it plays an important role on a digital image. This paper is based on scale invariant feature transform (SIFT) for image near-duplication detection and V-J face detection. V-J method refers to Viola Jones's method. Both methods have been successfully applied to the real world problem. Since the V-J face detection method is not trained with rotated features, it has limitiation to rotation invariant, whereas the SIFT method detects many feature keypoints, affecting the speed performance. In order to overcome the issues above, this paper proposed a new method by enhancing the SIFT with speed performance and V-J face detection with high rotation invariant. The comparison result of the experiment shows that the proposed solutions produce better performance.**

***Index Terms*— SIFT, V-J Face Detection, Pattern Detection**

I. INTRODUCTION

Ethic issue is associated with language, action, and digital documents and it is becoming serious nowadays. One of the ethical issues in digital document is to store inappropriate digital image in the company. Nowadays, network storage has the capability to provide features quickly and execute information management efficiently leading to easy accessibility to data, survivability and control costs (Jepsen, 2004). However, the computer technologies today could lead to ethic issue. For instance, the ability of computer network storage to provide a service that allows other computers to access and share data across the network can be misused by some people who utilize the company's network storage to store inappropriate images, such as adult images and personal image.

This research also considers the issue of managing digital image. Although computer network storage technologies provide the advantages of flexibility, they lack of intelligent feature to manage big data. In this respect, high-end enterprise storage systems have been deployed in the production environments to ensure that there is no single point of failure since a failure can be expensive due to customized hardware and multiple redundant components (K. Rao et. at., 2011). Further, improper managing digital image could lead to waste of company resources, especially the high-end storage with feature of data protection and backup. For instance, computer network storage allows users to manipulate data directly as the flexibility allows the images to be easily manipulated directly by duplicating it in network storage. However, the unnecessary redundancy images could lead to insufficient storage capacity which indirectly increases the cost of storage every year.

There are many methods to govern the digital image issue in the company. One of the proposed methods is by using pattern detection techniques to manage it. It is vital for developing an intelligent system that can manage digital images in storage, which can classify inappropriate images and the duplication image in network storage.

II. RELATED WORK

There are many approaches have been proposed in the literature. The researchers (Wu et al., 2013) made a comparative study of SIFT and its variants such as PCA-SIFT, GSIFT, CSFIT, SURF, and ASIFT on time consumption in 4 situations. The result showed that SIFT and CSIFT performed better in scale & rotation situations, while GSIFT performed better in blur or illumination image and ASIFT performed better in affine image. The fastest speed performance was SURF. The studies showed that SIFT & its variants had its own benefits to solve real-time problems based on situations. Liao et al. (2013) proposed an improvement SIFT descriptor for image matching, which contains steps normalizing elliptical neighboring region, transforming to affine scale-space, improving SIFT descriptor with polar histogram orientation bin, and integrating the mirror reflection invariant. The result showed better differences than the original SIFT, MIFT, PCA-SIFT, GLOH, SIFT Gabor, and ZM phase. Other researchers (Tong et al. 2013) proposed multicore and NVIDIA's Compute Unified Device Architecture (CUDA) GPU-based affine scale invariant feature transformation (parallel ASIFT) that improves speed performance of ASIFT. Based on the principle of parallel implementation, multi-core CPU is suitable for task level parallel computing, whereas ASIFT algorithm is suitable for data-level parallel computing. The result showed that there is a

speed improvement and the same precision with the serial ASIFT algorithm. Li et al. (2014) proposed GA-SIFT for multispectral images. It followed the existing SIFT with new proposed methods to support multispectral image due to inability of the original SIFT algorithm to extract features from multispectral images. The reason was that the original SIFT must be converted the image to gray scale image as pre-processing image. Comparisons were done between feature extraction from multispectral and pseudo color images. The multispectral method result showed that the correct-positive from the image reduced luminance from images scaled with 50% higher than other pseudo color method such as (standard SIFT, Hue-SIFT, OpponentSIFT, C-SIFT, and RGB-SIFT). This was the new SIFT method for multispectral image, called GA-SIFT method.

Over the past few years, face detection has been studied by many researchers, and there are many different techniques have been proposed (Mekami et al., 2010) such as appearance method, template method, knowledge based method, and feature invariant method (Jalil et al., 2015). Based on appearance method, statistical analysis and machine learning are used. Statistical analysis is used for feature representation and machine learning is used for feature selection. 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. (Park et. al., 2014) proposed improved Haar-like feature so called Haar Contrast Feature, which efficiently for object detection under various illumination. For the experiments, the proposed solution was compared with Haar-like feature with and without variance normalization, and local binary pattern (LBP) descriptor in trained face classifier, pedestrian classifier, and vehicle classifier. Images from the Extended Yale Database were captured under various illumination conditions and vehicle images were captured under relatively uniform illumination conditions. Result showed that the proposed solution outperformed the descriptor above. Ban et al. (2014) proposed a cascaded classifier based on Adaboost combined with Local Binary Pattern (LBP) and skin color emphasis instead of skin color segmentation or any parametric fitting or morphological operation. YCbCr space was used for skin color emphasis. Result showed that the proposed solution had better tolerance to face pose variation and complex background compared to traditional booting-based classifier. However, it does not solve the occlusion problem. Guo et al. (2013) proposed improved DAISY for forgery detection. Adaptive non-maximal suppression (ANMS) was adopted to extract evenly distributed keypoints in this algorithm to cater insufficient or none keypoints problems. New DAISY was proposed due to DAISY method variant to rotation. The proposed solution above was evaluated on the Uncompressed Colour Image Database (UCID). The result showed the method outperformed other researchers such as Huang et. al.'s and Jing et al's methods, which used SIFT method for forgery detection, in terms of accuracy and speed performance. Takacs et al. (2013) proposed the rotation invariant fast features (RIFF) for large recognition and real-time tracking. The proposed solution was faster 15 times than SURF and retrieval results were comparable to SIFT. The researcher claimed that FAST corner detector was low complexity, but it does not provide scale or orientation. CensurE method is not efficient as FAST detector. Although it lacks of orientation, it is good in localizing features in scale-space. However, the accurate tracker result showed that Kanade Lucas Tomasi (KLT) was the best method, followed by RIFF then NCC. The reason that the proposed methods were faster is due to the interest point detector had low complexity, proper anti-aliased and subsampled scale-space, and no pixel interpolation. Huang, Member and Ai (2007) proposed rotation invariant for multi view face detection. The contribution are Width-First-Search (WFS) tree structure, the Vector Boosting algorithm which are the enhancement from Adaboost.MH and Adaboost.MR, the sparse features in granular space, and the weak learner based on the heuristic search method. For RIP, it covers 360 degree with 90, 180, and 270 degree, whereas yaw and composite pitch varies from -90 to 90 and -30 to 30 degree respectively. Mohammad, Anvar, Star and Star (2013) proposed in-plane angle estimation for face images from multi-poses. SIFT was applied to 2 reference points, which are the midpoint of eyes and nose. The appearance descriptors consists of SIFT descriptors such as location, scale, orientation of reference points. 2 hypotheses were used to determine face or non-face via Bayesian classifier. The proposed result outperformed the Viola Jones's method in term of low false face detection rate, low in-plane rotation error and speed performance. Oh and Kwak (2012) proposed recognition driver's gaze for vehicle headlamp control, which deals with the rotation of a driver's face. The author used V-J algorithm to train frontal face images and left half profile image for face detection. Right half profile by mirroring the entire image was used when neither both are detected. The linear discriminant analysis was used to extract salient features and the purpose for dimension reduction. Then, the driver's gaze was detected in 7 directions with every direction 20 degree. The author claimed that gaze recognition focus on detecting and movement of eye and irises required high computation using high-resolution images. The results showed that the proposed method performed better under the various rotation angles of a driver's head. Han et al. (2014) constructs a strong classifier by using the robustness of Haar-like Local Binary Pattern feature to illuminate change. The researchers also proposed a new method, called feature transformation to detect rotated face. The method can speed up the Adaboost training time for multi-view face detection.

III. Pattern Detection Method

A. Pattern Detection Method

All the problems can be formulated into one method called pattern detection method. Unger (1959) defined that pattern detection "consists of examining an arbitrary set of figures and selecting those having some specified form" and pattern recognition "consists of identifying a given figure which is known to belong to one of a finite set of classes". Sung and Poggio (1998) proposed to use the pattern detection technique to find human faces, which consider face detection as part of the pattern detection method. Face recognition is part of the pattern recognition, which also refers to finding human faces in the library of known faces. There are pattern variations for face detection such as facial appearance, present objects, and lighting changes on images. The purposes of

deduplication or near-duplication detection are common to overcome storage burden due to data redundant. The idea of pattern detection method discussed in this paper consists of face detection and near-duplication detections. The methods are utilized to cope with inappropriate image and near-duplication image problems.

B. Inappropriate Image Detection by V-J Face Detection

Harnessing and countering inappropriate image store in network storage and generating awareness of potential illegal are considers as threats. In order to prevent the problems, a method from pattern detection is chosen, which is face detection method. Most of the inappropriate image contains human faces such as adult image and personal image that are not related to work. The proposed method does not require people to manually guard it, but rather it is guarded automatically by a system. Face detection applications are widely applied nowadays in real world problems such as face recognition.

C. Near-Duplication Image Detection by SIFT Detection

Near-duplication image in network storage can happened easily by utilizing powerful software editor. Users can resize, rotate, composition and keep it in new version by generating similar but not identical copies. This practice may result in a rapid increase of the capacity of network storage. Therefore, near-duplication detection technique, which is object detection, is exploited to reduce the significant capacity consumption. The proposed method is exploited to detect an unknown object in images. Later, the proposed method can be applied by other researchers to other applications such as counter check legal image, forgeries, and other security applications.

D. Challenge in Developing Pattern Detection Method

Nowadays, it is easy to do text or numerical data processing such as data arithmetic and data comparison. However, it is challenging to do the digital image processing. To do text comparison, a user needs to use operator logic "==" to compare the text, whereas for special algorithms user need to compare objects in 2 different image files. The algorithm to detect objects in an image is much more complicated compared to human recognition. Human can recognize multi-object in image with less afford although the object has varied angles or scale. Angles or scale must be considered when implementing the algorithm.

IV. ENHANCEMENT OF ROTATED FACE DETECTION

In the earlier works in face detection, there are many researchers had developed real-time face detection. One of the famous and successful methods was the Viola and Jones's (Viola et al., 2004) face detection framework. The basic of Viola and Jones's method was based on Haar feature. In order to speed up the process, Viola proposed to use integral image method. Adaboost was one of the machine learning. Viola utilizes it to classify face or non-face image. Bi Li (2010) proposed the rotated face detection based on Viola Jones's face detection. Rotated sub-windows +15º and -15º were performed and the result showed high positive result compared to original Viola Jones's method. This achieves the objective of speed performance and invariant properties such as transition, scaling, and rotation. To achieve rotation invariant rotated sub-window, 15º was added to each step from 0º to 360º . Figure 1 shows the 5 basic Haar features. They are represented in two-rectangle features, three-rectangle features, and four-rectangle features. The value of the rectangle feature was the sum of the differences between black region and white region. Figure 2 shows the integral region by calculating area D. Formula to get the area D = (X4,Y4)+(X1,Y1)-(X2,Y2)-(X3,Y3). The Haar features are shown in Figure 1. The speed up process of the intensity measurement of Haar features based on the formula above is shown in Figure 2 . Figure 3(a) shows the proposed algorithm method by Li et al. (2010), while 3(b) shows the enhancement of rotated face detection from figure 3(a). Figure 4 shows the detected rotated face by utilized the new proposed method. Figure 5 shows the accuracy of rotation faces detected by manual visualization of the image. If rotated face in any angle is detected correctly, the image is considered as an inappropriate image.

Figure 1: Haar Features

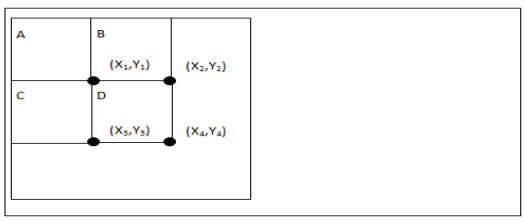

Figure 2: Integral Region of Image

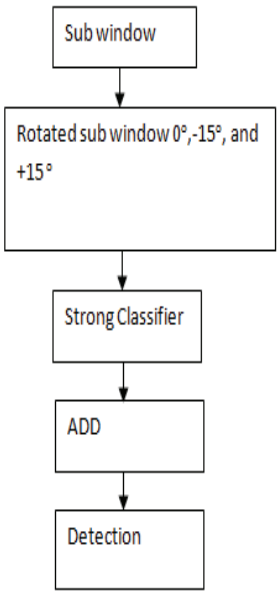

Figure 3(a): Existing Rotated Face Detection Algorithm

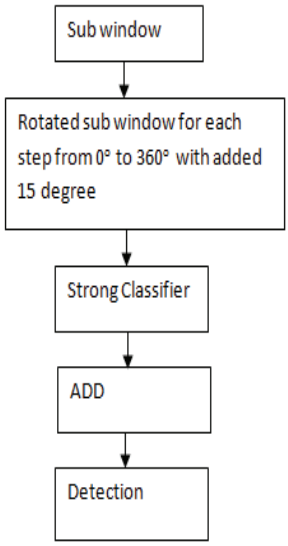

Figure 3(b): Proposed Rotated Face Detection Algorithm

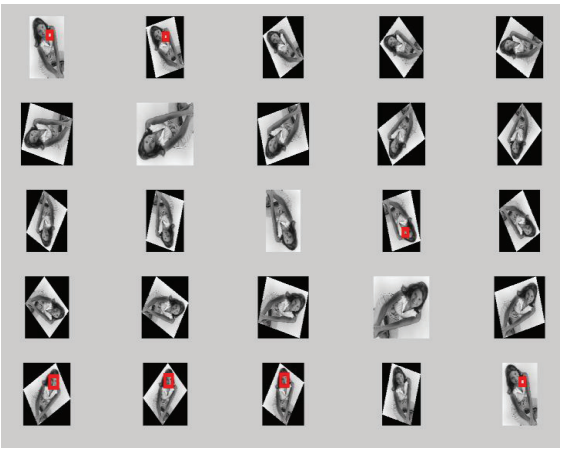

Figure 4: Rotated Face Detection

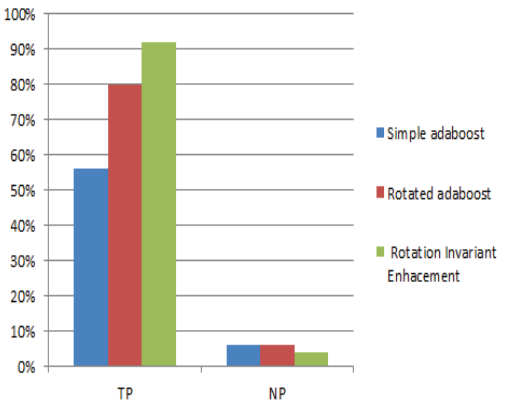

Figure 5: Accuracy of Rotated Face Detection

V. ENHANCEMENT OF SIFT FOR NEAR-DUPLICATION DETECTION

In the earlier works in object detection, many researchers had developed object detection. One of the famous and successful methods was the Scale invariant feature transform (SIFT) (Lowe, 2004). The basic of the SIFT descriptors is based on 4 steps below:

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

Although SIFT supported the invariant properties such as transition, scaling, and rotation, its speed performance is not good. In order to get better speed performance, a novel method is proposed. Pre-processing Binary Robert Cross edge

detection is applied before SIFT. Binary Robert Cross edge detection is calculated based on the gradient image in x direction and y direction. Figure 6(a) shows the proposed binary Sobel edge SIFT, while Figure 6(b) shows the binary Robert Cross algorithm. Both algorithms were tested with the speed performance in Figure 10. Figure 7 shows the keypoints detected by conventional SIFT and Figure 8 shows the keypoints detected by binary Sobel edge SIFT. Figure 9 shows the keypoints detected by binary Robert Cross edge SIFT. The purpose of the keypoints is used for feature matching purpose, the less keypoints detected the less feature matching required. Indirectly, it improves the speed performance for image matching for the application of near-duplication purposes. Figure 10 shows the comparisons of speed performances of conventional SIFT, binary Sobel edge SIFT, and binary Robert Cross edge SIFT across 6 images. The processing time taken of binary Robert Cross edge SIFT is shorter than other methods across each image as shown in Figure 10.

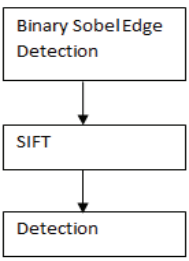

Figure 6(a): Binary Sobel Edge SIFT Algorithm

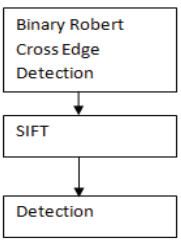

Figure 6(b): Binary Robert Cross Edge SIFT Algorithm

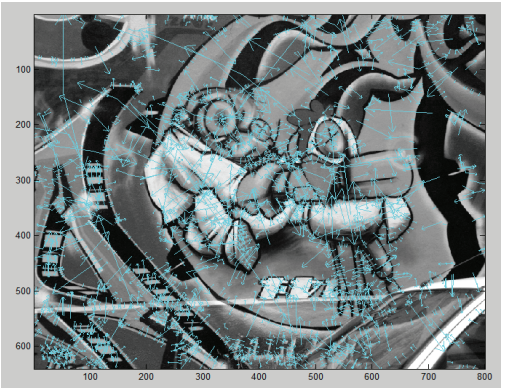

Figure 7: Keypoints of Conventional SIFT

Figure 8: Keypoints of Binary Sobel Edge SIFT

Figure 9: Keypoints of Binary Robert Cross Edge SIFT

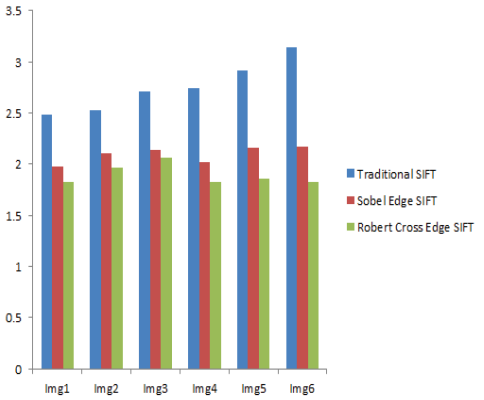

Figure 10: Speed Performance of SIFT with Other SIFT

VI. CONCLUSIONS & FUTURE WORKS

Improved rotated Adaboost V-J Face Detection by rotating 0º-360º with an addition of 15º for each step shows a better performance than expected. The comparison result (Figure 10) of the speed performance of SIFT by using conventional SIFT (Figure 7), binary Sobel edge SIFT (Figure 8), and binary Robert Cross edge SIFT (Figure 9) was detected. The time taken for binary Robert Cross edge SIFT is faster. With the intelligent methods above, it is suitable to apply to real world problems such as inappropriate image and image near-duplication. Another contribution is the adapted pattern detection in the taxonomy of image processing. For future works, the proposed enhancement of rotation invariant face detection can be further enhanced by the speed performance. Besides that, the details of the image may lose if binary edge detection is applied before SIFT. Therefore, there must be a novel method to prevent the loss of details of the image.

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