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Face Searching and Matching Using Gray Scale Diagonal Square Matrix

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-----ABSTRACT-----
This paper presents a novel approach in face digital image searching and matching. The given key image is converted into gray scale image and after that a matrix is computed with gray scale values of the key image. Then we are collecting the diagonal key elements for diagonal searching key sequence. Using Pair wise sequence alignment we are trying to match the key with available images in the large data base of collection of faces. Initially we discussed various techniques used in digital image searching and matching in this paper. This new algorithm Diagonal matrix is a new algorithm for all face images searching and matching. Face recognition is very essential in the field of criminology. Face Image searching and matching are very difficult task in image processing; there are several algorithms for face image matching. But still needs more optimization for image matching. Using this new approach we can match criminal photo from a large database. Face Image recognition, feature extraction and pattern matching needs improvements in Image processing. There are several methods for Face image searching and matching, but we need new optimized technique for image searching and matching. This new Diagonal matrix approach is tried to give optimized solution in Face digital image matching.

Key words : Image retrieval, edge detection and matching, face recognition, affine invariant, image searching and matching, diagonal searching and pair wise alignment.

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I. INTRODUCTION

The birth of digital computer has introduced to the society a machine that is more powerful than human beings in numerical computation. The pertinent question then was whether the human capability of processing non numerical information received from the environment as well as society, of reasoning and decision making based on non-numerical data could be incorporated in the machine with equal or more efficiency. This led to evolution of a new subject called artificial intelligence [29], which has a large area of common interest and motivation with another subject known as pattern recognition [34]. A major portion of information received by a human from the environment is visual. Hence the visual information by computer has been drawing a very significant attention of thee researchers over the last few decades. The process of receiving and analyzing visual information by a human species is referred to as sight, perception or understanding. Similarly, the process of receiving and analyzing visual information by digital computer is called digital image processing and scene analysis. The term image rather than 'picture' is used here, because the computer stores and process numerical image of a scene. Although 'pattern recognition' [6][10] and 'image processing' [23][24] have a lot in common, yet they are developed as a separate disciplines [25]. Two broad classes of techniques, viz., processing and analysis have evolved in the field of digital image processing and analysis. Processing of an image includes improvement in its appearance and efficient representation. So the field consists of not only feature extraction, analysis and recognition of images, but also coding, filtering, enhancement and restoration.

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II. PREVIOUS WORK

There are several methods available to search and match images like edge detection and matching, geometrical image matching, template matching, content based image matching, face recognition and robust affine invariant feature extraction

A. EDGE DETECTION AND MATCHING

The edge detection and matching is the one of the popular matching technique in image processing. Figure 1 is a sketch of a continuous domain, one-dimensional ramp edge modeled as a ramp increase in image amplitude from a low to a high level, or vice versa. The edge is characterized by its height, slope angle, and horizontal coordinate of the slope mid point [30]. An edge exists if the edge height is greater than a specified value. An ideal edge detector should produce an edge indication localized to a single pixel located at the midpoint of the slope. If the slope angle of Figure 1.a is 90°, the resultant edge is called a step edge, as shown in Figure 1.b. In a digital imaging system, step edges usually exist only for artificially generated images such as test patterns and bi-level graphics data. Digital images, resulting from digitization of optical images of real scenes, generally do not possess step edges because the anti aliasing low-pass filtering prior to digitization reduces the edge slope in the digital image caused by any sudden luminance change in the scene. The one-dimensional profile of a line is shown in Figure 1.c. In the limit, as the line width w approaches zero, the resultant amplitude discontinuity is called a roof edge.

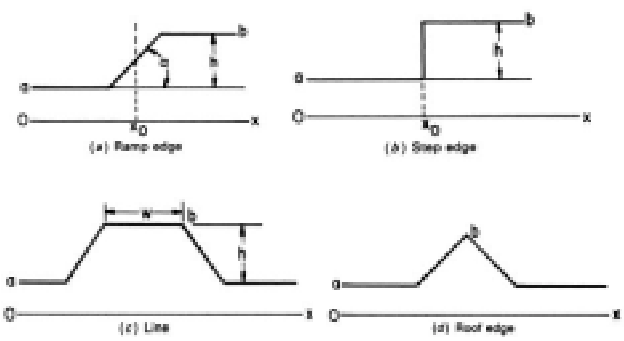


Figure 1 One-dimensional, continuous domain edge and line models.

B. GEOMETRICAL IMAGE MATCHING

One of the most common image processing operations is geometrical modification in which an image is spatially translated, scaled, rotated, nonlinearly warped, or viewed from a different perspective [21].

Translation, minification, magnification, and rotation

Image translation, scaling, and rotation can be analyzed from a unified standpoint. Let $G(j, k)$ for $1 \leq j \leq J$ and $1 \leq k \leq K$ denote a discrete output image that is created by geometrical modification of a discrete input image F(p,q) for $1 \leq p \leq P$ and $1 \leq q \leq Q$. In this derivation, the input and output images may be different in size. Geometrical image transformations are usually based on a Cartesian coordinate system representation in which the origin (0,0) is the lower left corner of an image, while for a discrete image, typically, the upper left corner unit dimension pixel at indices (1, 1) serves as the address origin. The relationships between the Cartesian coordinate representations and the discrete image arrays of the input and output images are illustrated in Figure 2. The output image array indices are related to their Cartesian coordinates by

$$x_k = k - \tfrac{1}{2} \qquad y_k = J + \tfrac{1}{2} - j \tag{2.1}$$

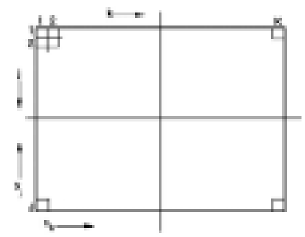


Figure 2 Relationship between discrete image array and Cartesian coordinate representation.

Similarly, the input array relationship is given by

$$u_q = q - \tfrac{1}{2} \qquad v_p = P + \tfrac{1}{2} - p \tag{2.2}$$

Translation: Translation of F(p,q) with respect to its Cartesian origin to produce G(j,k) involves the computation of the relative offset addresses of the two images. The translation address relationships are

$$x_k = u_q + t_x \qquad y_j = v_p + t_y \tag{2.3}$$

Where $\mathbf{t_x}$ and $\mathbf{t_y}$ are are translation offset constants[21]. There are two approaches to this computation for discrete images: forward and reverse address computation. In the forward approach, $\mathbf{u_q}$ and $\mathbf{v_p}$ are computed for each input pixel (p,q) and substituted into Eq. 2.3 to get $\mathbf{x_k}$ and $\mathbf{y_j}$ Next, the output array addresses (j,k) are computed by inverting Eq. 2.1. The composite computation reduces to

$$j' = p - (P - J) - t_y \qquad k' = q + t_x \tag{2.4}$$

where the prime superscripts denote that **j'** and k' are not integers unless $\mathbf{t_x}$ and $\mathbf{t_y}$ are integers. If **j'** and **k'** are rounded to their nearest integer values, data voids can occur in the output image. The reverse computation approach involves calculation of the input image addresses for integer output image addresses. The composite address computation becomes

$$p' = j + (P - J) + t_y \; q' = k - t_x \tag{2.5}$$

where again, the prime superscripts indicate that p' and q' are not necessarily integers. If they are not integers, it becomes necessary to interpolate pixel amplitudes of F(p,q) to generate a re sampled pixel estimate F˜(p,q), which is transferred to G(j,k).

Scaling: Spatial size scaling of an image can be obtained by modifying the Cartesian coordinates of the input image according to the relations

$$x_k = s_x u_q \qquad (2.6)$$

Where $\mathbf{s_x}$ and $\mathbf{s_y}$ are positive-valued scaling constants, but not necessarily integer valued. If $\mathbf{s_x}$ and $\mathbf{s_y}$ are each greater than unity, the address computation of Eq. 2.6 will lead to magnification. Conversely, if $\mathbf{s_x}$ and $\mathbf{s_y}$ are each less than unity, minification results. The reverse address relations for the input image address are found to be

$$p' = (1/s_y)(j + J - \tfrac{1}{2}) + P + \tfrac{1}{2}$$
$$q' = (1/s_x)(k - \tfrac{1}{2}) + \tfrac{1}{2} \qquad (2.7)$$

As with generalized translation, it is necessary to interpolate F(p,q) to obtain G(j,k).

Rotation: Rotation of an input image about its Cartesian[21] origin can be accomplished by the address computation

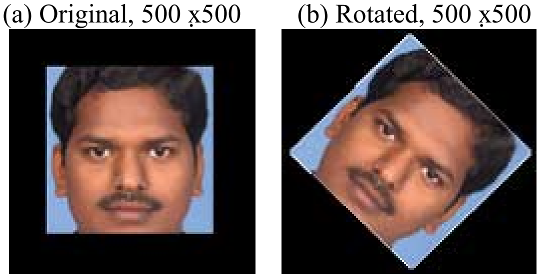
$$x_k = u_q \cos\theta - v_p \sin\theta$$
$$y_j = u_q \sin\theta + v_p \cos\theta \qquad (2.8)$$

Where θ is the counterclockwise angle of rotation with respect to the horizontal axis of the input image. Again, interpolation is required to obtain G(j,k). Rotation of an input image about an arbitrary pivot point can be accomplished by translating the origin of the image to the pivot point, performing the rotation, and then translating back by the first translation offset. Equation 2.8 must be inverted and substitutions made for the Cartesian coordinates in terms of the array indices in order to obtain the reverse address indices (p',q'). This task is straightforward but results in a messy expression.

Affine Transformation

The geometrical operations of translation, size scaling, and rotation are special cases of a geometrical operator called an *affine transformation* [1]. It is defined by Eq. 2.14 in which the constants *ci* and *di* are general weighting factors. The affine transformation is not only useful as a generalization of translation, scaling, and rotation. It provides a means of image shearing in which the rows or columns are successively uniformly translated with respect to one another. Image matching is easy loss less image transformation, but image matching is very difficult in lossy image transformation. Figure 3.c and 3.d are easy to match, but Figure 3.a and 3.b are very difficult to match.

(a) Original, 500 x500 (b) Rotated, 500 x500



(c) Original, 708 x708 (d) Rotated, 708 x708

Figure 3 Rotation by 45° on the Face image about its center.

C. FACE RECOGNITION USING LINE EDGE MAP

A novel concept, 'faces can be recognized using line edge map'[26], is proposed here. A compact face feature, Line Edge Map (LEM), is extracted for face coding and recognition. A feasibility investigation and evaluation for face recognition based solely on face LEM is conducted which covers all conditions of human face recognition, i.e., face recognition under controlled/ideal condition, varying lighting condition, varying facial expression, and varying pose. The system performances are compared with the eigenface method, one of the best face recognition techniques, and reported experimental results of other methods. This research demonstrates that LEM together with the proposed generic Line Segment Hausdorff Distance measure provide a new way for face recognition [24][27].

Figure 4 An illustration of a face LEM.

D. ELASTIC GRAPH MATCHING

The elastic graph matching (EGM) [24] was introduced to alleviate the problems caused by misalignment between test faces and their corresponding references. Lade *et al.* [1] applied the Gabor wavelet transformation (GWT) to extract local features and proposed a cost function for graph-based matching between a probe face and its reference. Wiskott *et al.* proposed a facial graph structure based on fiducial point and bunch concept, where the bunch concept is effective for reducing computational complexity[25].

For calculating the similarity (or distance) between images of eformable objects like human faces, elastic graph matching (EGM) is more effective than rigid matching strategies. As shown in Figure5, in the EGM for face recognition, a graph representing a face consists of three sets:

1) $\{\mathbf{z}_i = (x_i, y_i)\}_{i=1}^{i=N}$ containing the information about the positions of nodes in the region of interest
2) $\{e_{ij}\}$ describing the relationship or joint properties between neighboring nodes
3) $\{\mathbf{j}(\mathbf{z}_i)\}_{i=1}^{i=N}$ representing the set of *jets* characterizing each node,

Where the jet at a node is a feature vector describing the image patch where the node is located.

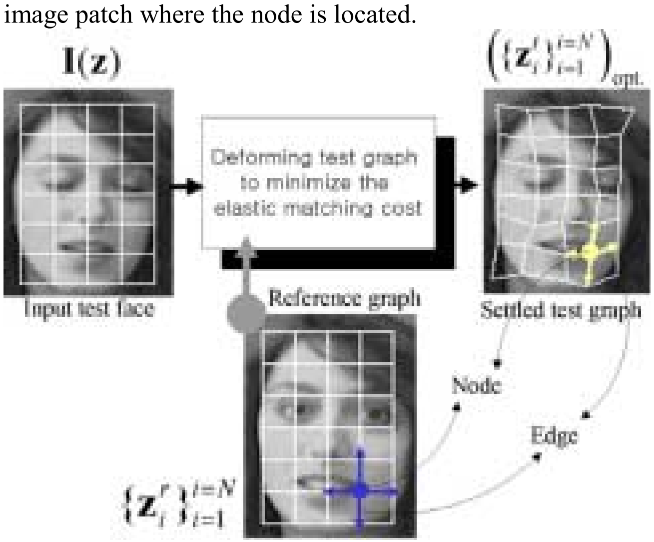


Figure 5. Elastic Graph Matching. In our approach, graph of lattice grid is used, but the fiducial-point-based graph also can be used.

E. HIERARCHICAL-COMPOSITIONAL MODEL OF HUMAN FACES,

A hierarchical-compositional model of human faces, as a three-layer AND-OR graph to account for the structural variabilities over multiple resolutions. In the AND-OR graph, an AND-node represents a decomposition of certain graphical structure, which expands to a set of OR-nodes with associated relations; an OR-node serves as a switch variable pointing to alternative AND-nodes. Faces are then represented hierarchically as shown in figure7 [18][19]: The first layer treats each face as a whole, the second layer refines the local facial parts jointly as a set of individual templates, and the third layer further divides the face into 15 zones and models detail facial features such as eye corners, marks, or wrinkles. Transitions between the layers are realized by measuring the minimum description length (MDL) given the complexity of an input face image. Diverse face representations are formed by drawing from dictionaries of global faces, parts, and skin detail features.

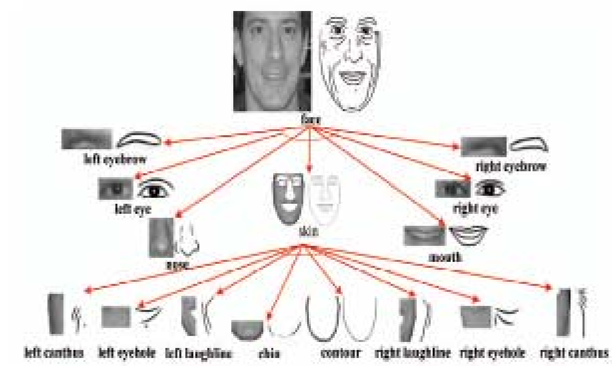


Figure 7 A Hierarchical Compositional Model For Face Representation

F. HUMAN FACE IMAGE SEARCHING SYSTEM USING SKETCHES

A two-phase method, namely, sketch to mug-shot matching and human face image searching using relevance feedback is designed as shown in the figure 8.

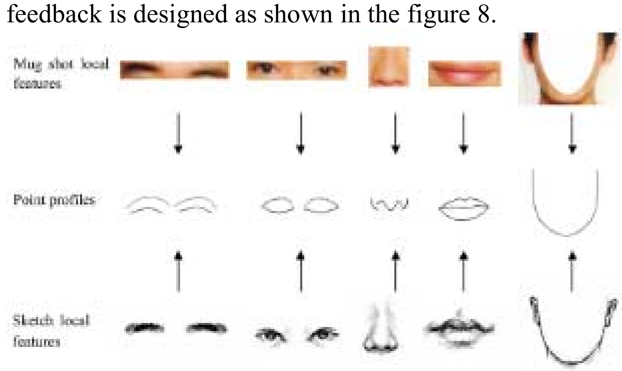


Figure 8 Facial feature matching.

In the sketch to mug-shot matching phase, the facial feature matching algorithm using local and global features. A point distribution model is employed to represent local facial features while the global feature consists of a set of the geometrical relationship between facial features. It is found that the performance of the sketch-to-mug-shot matching is good if the sketch image looks like the mug shot image in the database.

III. RESULTS AND DISCUSSION

There are several techniques for face image searching and matching. Each technique is good for some purpose and not good for some purpose. In this paper, how each method is working and various faces matching technique are discussed clearly. From the following table we can easily predict which technique can be suitable from small database to large database.

Matching Technique	Small DB	Large DB
Edge detection and Matching	Good	Good
Geometrical image matching	Good	Good
LEM	Good	Medium
Face template	Good	Good
Hieararchical composition	Good	Medium
Face sketching	Good	Medium

IV. NEW APPROACH

Diagonal matrix is a newly proposed algorithm for face searching and matching. It is specific for face searching and matching like face or finger print matching. This is a general algorithm for image searching and matching. This algorithm is very useful in matching a key image with images available in large databases.

Algorithm Steps:

1. Start.
2. Get the key image (Assumption is square image).
3. Convert to gray scale image.
4. Compute square matrix (2 dimensional array) with gray scale values (0-7).
5. Collect the diagonal elements (1 dimensional array) from the computed matrix.
6. Take image from database. Convert to gray scale image then matrix with gray scale values.
7. Try to match the key sequence in newly computed matrix. There are 8 possible search directions. For this matching backtracking and maze solutions are used.
8. Put some gap penalty one for one element adjustment in a sequence.
9. Repeat the steps 6, 7 and 8 for all images available in the database.
10. Less penalty matching will give optimum solution.
11. Stop.

The algorithm steps are explained in the figure 15. This Diagonal matrix will give many matching. But we can choose optimum solution with minimum gap penalty. For easy computation we are going for a matrix with gray scale values from 0 to 7. Here negative color is taken for easy computation purpose. Bioinformatics sequence matching is used because of the search space is very vast.

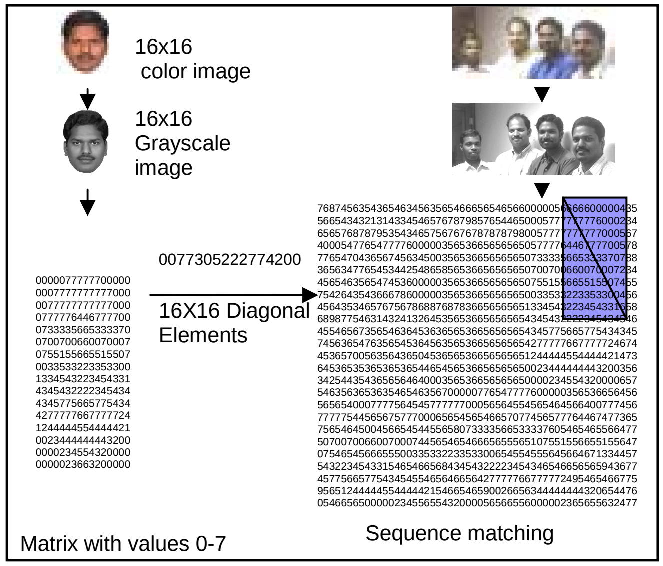


Figure 9. Steps in Diagonal matrix image matching algorithm

TRIAL TEST

Key Diagonal sequence: 0077305222774200
Matching sequence 1: 00_77_30_52_22_77_42_00
Matching sequence 2: 0077_3052_2277_4200
Matching sequence 3: 00773052_22774200
Note: _ indicates non related elements
Gap penalty for sequence 1 is 7
Gap penalty for sequence 2 is 3
Gap penalty for sequence 3 is 1

So sequence 3 will be considered as an optimal solution. If there are extra elements in matching sequence then we should add Positive gap penalty. If some elements are missing then we have to add some negative gap penalty.

V. CONCLUTION

There are several techniques used for image searching and matching. Each technique is good for some purpose. For example face recognition by line edge map is best for criminals face matching. Each method has its own advantages and disadvantages. So we need a unique technique for all kind of image searching and matching. This Diagonal matrix Image matching is developed to produce optimum solution in image searching and matching.

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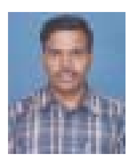

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