IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Personal Authentication using Hand Geometry Features

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Abstract: A simple and smart system to verify a person's identity using hand geometry as a biometrical identity is proposed. Biometrics security systems are pattern recognition systems using components and methods common to those in machine vision systems (cameras, A/D, edge detection, thresholding, etc.) to compare features of a person's biological or behavioral characteristics to stored features in a database in order to confirm their identity. It involves the measurement and analysis of the shape of one's hand. The aim of the study is to build a low cost, reliable personal verification system based on the hands geometry.

***Keywords* - Image, Edge detection, biometrics, sobel, canny.**

I. INTRODUCTION

Biometric recognition, or simply biometrics, is the science of establishing the identity of a person based on physical or behavioral attributes. It is a rapidly evolving field with applications ranging from securely accessing one's computer to gaining entry into a country. While the deployment of large-scale biometric systems in both commercial and government applications and has increased the public awareness of this technology [1].

The history of Biometrics originated back in 1981 to identify criminal's fingerprints to be analyzed and stored[7]. Biometric measurements now have evolved not only from only fingerprint but also from different parts of our body such as palm vein[8], iris scan[9], voice recognition[10], facial recognition[11], brain waves[12], ECG signals[13], DNA identification[14], and behaviour biometrics.[15]

Breaking the barriers of use in only for criminal identification, biometrics has now evolved to personal security level and reached to cloud computing as well[16]. Biometrics help us change our lives reforming manual tasks into automation and providing that extra layer of security. It is not only affecting our lives only as an individual but also as a community, and even as a species in the environment.

Biometrics has been widely used in forensics also[17]. A biometric system is essentially a pattern recognition system which makes a personal identification by determining the authenticity of a specific physiological or behavioral characteristic possessed by the user [2]. In the current work the geometry features of hands are used for personal identification.

II. IMPLEMENTATION

In hand geometry system as shown in the Fig1 the hand image is taken initially with digital camera and image is stored in a data base. Before capturing the image we must ensure that the surface or background on which the hand is placed is uniform and in a single color, so we have chosen a white background. After the image is stored in the database we perform the remaining operations such as grayscale conversion, image segmentation and feature extraction. Segmentation is performed by sobel and canny edge detection. Feature extraction includes extracting geometrical features which represents hand shape. By using those features, one can define hand shape [2] that will be used in authentication or identification system that is being built.

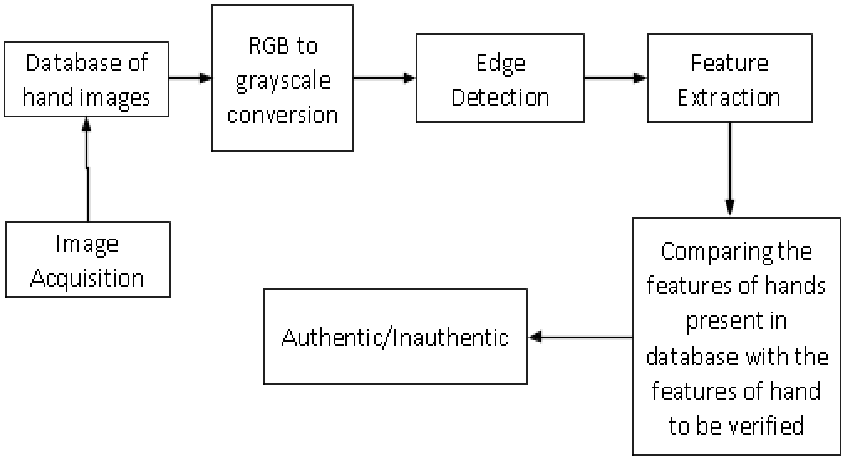


Fig.1 Block diagram of hand geometry identification system

III. IMAGE SEGMENTATION

Image segmentation is an essential step in image analysis. Segmentation separates an image into its component parts or objects. The level to which the separation is carried depends on the problem being solved. When the objects of interest in an application have been inaccessible the segmentation must stop. In this project we achieved segmentation by edge detection using the octave in built function edge(). The syntax is:
edge(grayscale image, 'edge detection operator');
here for the edge detection operator we specify it as sobel for sobel edge detecion and canny for canny edge detection.

Segmentation algorithms for images generally based on the discontinuity and similarity of image intensity values. Discontinuity approach is to partition an image based on abrupt changes in intensity and similarity is based on partitioning an image into regions that are similar according to a set of predefined criteria. Thus the choice of image segmentation technique is depends on the problem being considered. Edge detection is a part of image segmentation [3].

IV. EDGE DETECTION

Edge Detection is simply a case of trying to find the regions in an image where we have a sharp change in intensity or a sharp change in color, a high value indicates a steep change and a low value indicates a shallow change.
The pixel's gray-level which value is similar to other around pixel's gray-level, there is probably not an edge at that point. However, if a pixel has neighbors with widely varying gray levels, it may represent an edge point. Many of the edge detection operators are implemented with convolution masks [4].

4.1 Sobel Edge Detection

When using Sobel Edge Detection, the image is processed in the X and Y directions separately first, and then combined together to form a new image which represents the sum of the X and Y edges of the image. When using a Sobel Edge Detector, it is first best to convert the image from an RGB scale to a Grayscale image.
The Sobel edge detector use two masks with 3x3 sizes, one estimating the gradient in the x-direction and the other estimating the gradient in the y-direction. The mask is slid over the image, manipulating a square of pixels at a time. The algorithm calculates the gradient of the image intensity at each point, and then gives the direction to increase the image intensity at each point from light to dark. Edges areas represent strong intensity contrasts which are darker or brighter [4]. Sobel algorithms work using a mathematical procedure called convolution and commonly analyze derivatives or second derivatives of the digital numbers over space.
We implement the Sobel method for edges detection, which is based on a 3 by 3 array that is moved over the main image. This array is given by [4]:

-1	0	+1
-2	0	+2
-1	0	+1

Gx

+1	+2	+1
0	0	0
-1	-2	-1

Gy

Fig.2 Sobel convolution kernels

The Sobel kernels are moved over a particular pixel in the grayscale image. Then we calculate a new value. The sobel convolution kernels are designed to respond to edges vertically and horizontally. These masks are each convolved with the image. We calculate horizontal and vertical gradient (G*x* and G*y*), then we combined together to find the absolute magnitude of the gradient at each point and the orientation of that gradient. We use these numbers to compute the edge magnitude which given by [4]:

$$|G| = \sqrt{Gx2 + Gy2}$$

4.2 Gaussian Smoothing

The Gaussian smoothing operator is a 2-D convolution operator that is used to `blur' images and remove detail and noise. In this sense it is similar to the mean filter, but it uses a different kernel that represents the shape of a Gaussian (`bell-shaped') hump [5].

The Gaussian distribution in 1-D has the form:

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

where σ is the standard deviation of the distribution. We have also assumed that the distribution has a mean of zero (*i.e.* it is centered on the line *x*=0). The distribution is illustrated in Figure 3.

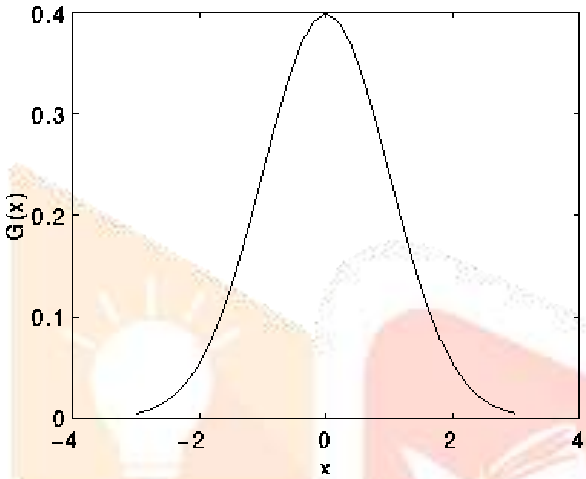


Fig.3 1-D Gaussian distribution with mean 0 and σ=1

In 2-D, an isotropic (*i.e.* circularly symmetric) Gaussian has the form:

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

This distribution is shown in Figure 4.

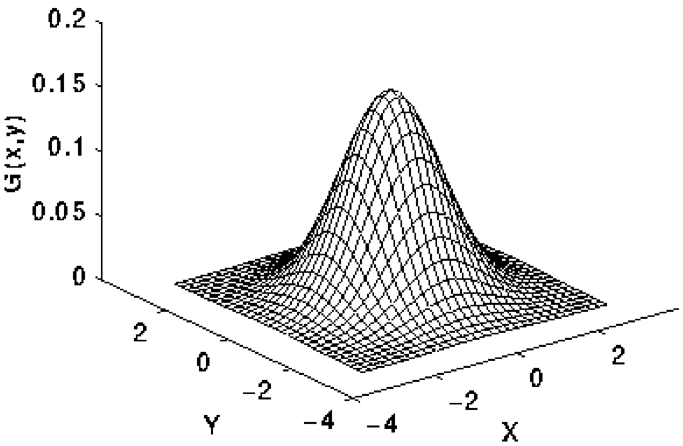


Fig.4 2-D Gaussian distribution with mean (0,0) and σ=1

4.3 Canny Edge Detection

The Canny operator works in a multi-stage process. First of all the image is smoothed by Gaussian Convolution. Then a simple 2-D first derivative operator is applied to the smoothed image to highlight regions of the image with high first spatial derivatives. Edges give rise to ridges in the gradient magnitude image. The algorithm then tracks along the top of these ridges and sets to zero all pixels that are not actually on the ridge top so as to give a thin line in the output, a process known as non - maximal suppression. The tracking process exhibits hysteresis controlled by two thresholds: T1 and T2, with T1 > T2. Tracking can only begin at a point on a ridge higher than T1. Tracking then continues in both directions out from that point until the height of the ridge falls below T2. This hysteresis helps to ensure that noisy edges are not broken up into multiple edge fragments [5].

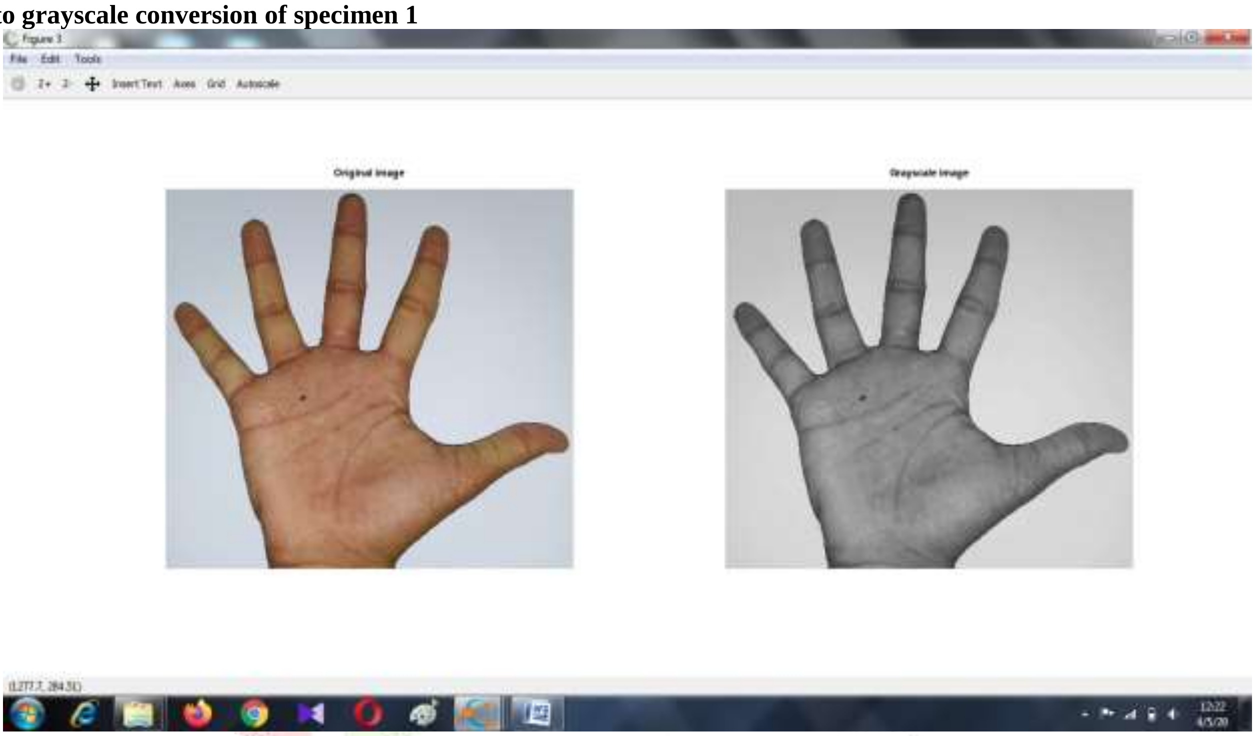
The effect of the Canny operator is determined by three parameters --- the width of the Gaussian kernel used in the smoothing phase, and the upper and lower thresholds used by the tracker. Increasing the width of the Gaussian kernel reduces the detector's sensitivity to noise, at the expense of losing some of the finer detail in the image. The localization error in the detected edges also increases slightly as the Gaussian width is increased [5].

V. REGION PROPERTIES

The closed areas of an Image are considered as region. All regions have some properties like Area, Perimeter, Centroid etc. So, basically the Region Properties are refers to the mathematical features of a particular region of image. Regions can either describe boundary-based properties of an object or they can describe region based properties. It measures a set of properties for each labeled region L. L can be a label matrix or a multidimensional array. When L is a label matrix, positive integer elements of L correspond to different regions [6].

VI. RESULTS AND DISCUSSION

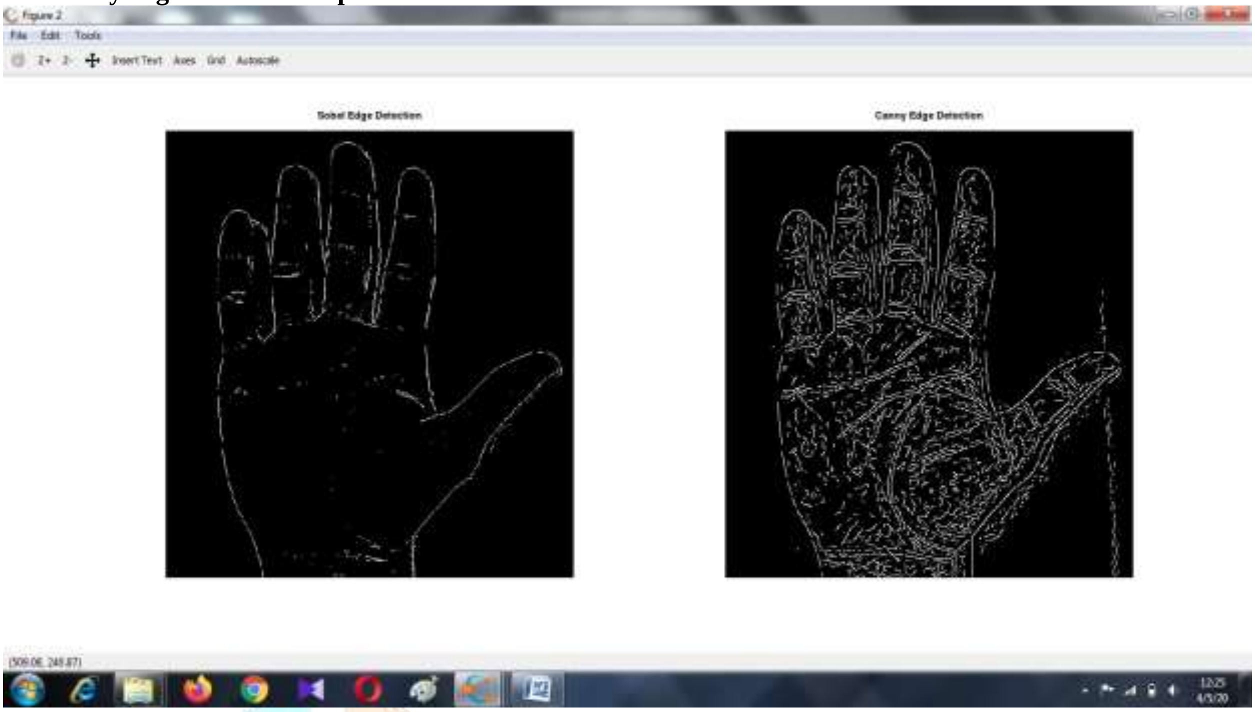
6.1 RGB to grayscale conversion of specimen 1



6.2 RGB to grayscale conversion of specimen 2

6.3 Sobel and Canny edge detection of specimen 1

6.4 Sobel and Canny edge detection of specimen 2



6.5 Feature Extraction

Table 6.1 Extracted features

Specimen 1	Specimen 2
Sobel area = 14547.75000	Sobel area = 4129.5
Canny area = 136139.75000	Canny area = 20839.62500
Centroid = 640.50 595.50	Centroid = 265.00 290.00
WeightedCentroid = 654.52 592.64	WeightedCentroid = 266.69 271.86
Eccentricity = 0.36835	Eccentricity = 0.40651
EquivDiameter = 1392.6	EquivDiameter = 624.49
MajorAxisLength = 1478.0	MajorAxisLength = 668.57
MinorAxisLength = 1374.1	MinorAxisLength = 610.84
Perimeter = 4836.9	Perimeter = 2167.4

6.6 Output

Inauthentic

6.7 Conclusion

As there is a lot of variation or mismatch in the features of both the specimens hence, the output is shown as inauthentic, else if the features were found to match the output would be shown as authentic.

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