Implementation of Daugman's Algorithm and Adaptive Noise Filtering Technique for Digital Recognition of Identical Twin using MATLAB

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Abstract

This paper presents the implementation of Daugman algorithm and adaptive noise filtering technique for digital recognition of identical twin. The main aim of this work is to present a novel epistemology that will differentiate identical twin using the integro- differential operator model of John Daugman.

However, the challenge of this algorithm is (background impurity) white noise from the eye sclera, this work employs the best filtering technique called adaptive noise filtering process together with other image processing techniques for this work. Also the research paper presents another global application of Daugman algorithm for identical twin recognition which has not been solved till date even by face recognition systems. This work will highly improve investigation, eliminate impersonation, and stop mistake identity arrest of suspect to mention a few among other benefits. The work will be demonstrated using the matlab development tool.

Keywords: *face recognition, identical twin, investigation, impersonation*

I. INTRODUCTION

Today the need to maintain the security of information or physical property is becoming both increasingly important and challenging. Overtime in our daily times, national news and social media,we hear about the crimes of credit card fraud, impersonation, computer breaking's by hackers, security breaches in a company or government building. In most of these cases, the criminals took advantage of detected flaw in the conventional access control systems which do not grant access by "who we are", but rather by "what we have", such as ID cards, keys, passwords, username, PIN numbers, or mother's maiden name, however none of these means really define us. In other words if someone steals, duplicates, or acquires this identity, means he or she will be able to access our data or our personal property any time they want.

Recently, technology became available to allow recognition and verification of "true" individual identity through Biometric systems. This system refers to technologies that analyze and measure human body characteristics features for securityapplications. These features include fingerprints, palm, DNA, voice patterns, irises, hand measurements and facial patterns.

In this modern era, when internet has reached its peak and forms the basis for all modern banking and business systems [1], the accurate verification for accessing accounts is also becoming a necessity. A demand for a superior technology compared to passwords, secret questions and other access protecting technologies led to the increased research and development of biometrics systems[2].

The major problem yet to be solved despite series of biometric research work has been to differentiate identical twin with face.There have been many attempts to solve this problem. The earlyapproaches are aimed for gray level images only, view-based detectors are popular in this category, includingRowley's neural networks classifier [3], Sung and Poggio's correlation templates matchingscheme based on image invariants [4] and Eigen-face decomposition [5]. Model baseddetection is another category of face detectors [6] but they all ended up solving the problem of detection and not recognition. [7] and [8] came close with their research on face recognition, but their work cannot differentiate twins. This provoked the researcher to consider other research field that concentrates on specific facial features (eyes). According to [9], no video images of one or both of the irises of an individual's eyes, whose complex patterns are unique. Although small (11 mm) and sometimes problematic to image, the iris has the great mathematical advantage that its pattern variability among different persons is enormous being part of the human face. Daugmandemonstrated this effect using the integro-differential operator algorithm.However, the application of this great revelation was limited to authentication only in manyfields (banks, server rooms, control rooms to mention a few, that is using the iris features to authenticate user.This research work provides a new applicable dimension to this trend to differentiate and recognize two similar faces or different persons using Mathlab as the implementation tool.

II. OBJECTIVES OF THE RESEARCH

i. To develop a system that employs Daugman's algorithm to differentiate similar faces
ii. To process image using adaptive noise filter and other image processing techniques
iii. To develop a system that employs machine learning for training and classification of extracted features.
iv. To improve on the existing system

III. REVIEW

To solve this problem the image acquisition tools, processing tools and machine learning tools will be employed: this will help us implement the following techniques below:

Image capture:this process involves capturing the facial image using a HD image acquisition device (quality of image is important), Daugman proposed (70 pixels). It is implemented using the image acquisition tool in mathlab.

Iris Localization:this process involves the accurate detection of the iris and pupil features using the integro-differential operator as follows [10]:

$$Max(r;x0;y0)\,(G\sigma(r) * \frac{\partial}{\partial \mathbf{r}} \oint_{r,xo,yo} \frac{I(x,y)}{2\pi r}\mathbf{ds}) \text{.........................equation (1)}$$

I(x, y) is the intensity of the pixel at coordinates (x, y) in the query iris image.rrepresents the radius of various circular regions with the center coordinates at (x0, y0).σis the standard deviation of the Gaussian distribution.Gσ(r) represents a Gaussian filter of scale sigma (σ).(x0, y0) is the assumed centre coordinates of the iris and s is the contour of the circle given by the parameters (r, x0, y0).this process blurred the iris image at a scale set by **σ**, which searches iteratively for a maximum contour integral derivative with increasing radius at successively finer scales of analysis through the three parameter space of center coordinates and radius (x0; y0; r) defining a path of contour integration [2].

1. Image Binarization

this process converts the iris into a bi-level in preparation for processing in preparation for preprocessing.

2. Histogram equalization

this technique is employed to enhance the image and eliminate background noise. This is the first processing step.

3. 2D Adaptive noise filtering:

The weiner technique is specially considered as the best filtration technique for this research work based on the fact that the noise associated with the binarize eye image is a constant power additive noise (white background noise from eye sclera).This approach preserves edges,high frequency part of an image and employs a pixelwise adaptive method [12] based on statistical estimation (local mean and variance) from local neighbor of each image pixel. The technique filters the 2D image (I)using the local neighborhood of [m,n] to estimate the local image standard deviation (see equation iii) and image mean (see equation ii) as shown below:

$$\mu = \frac{1}{nm}\sum_{x1\,x2\,En} j(x1,x2) \text{...equation ii}$$

$$\sigma 2 = \frac{1}{nm}\sum_{x1\,x2\,En} j^2(x1,x2) - \mu^2 \text{.......................................equation iii}$$

Where x is the n-by-m local neighborhood of each pixel in the image

Wiener2 then creates a pixelwise Wiener filter using these estimates

$$I\;(x1,\;x2) = \mu + \frac{\mu^2 - v2}{\mu^2}(j(x1,\;x2) - \mu) \text{.......................................equation iii}$$

Where v^2 is the noise variance. If the noise variance is not given, wiener2 uses the average of all the local estimated variances

4. Feature extraction

This is the final step of the image processing step. This involves is a statistical method of dimensionality reduction that represents the discriminative part of the image in a compact feature vector, this is implemented with mathlab using the histogram of oriented gradient technique to extract the training and label features.

5. Training and Classification

For the training and classification of the statistical extracted features, we employ a supervised machine learning technique called the k-nearest neighbor classifiers.

It is a simple algorithm and a non parametric method that classifies data based on similarity measures such as distance metrics which are defined by the standard Euclidean distance and Euclidean distance.

Given an *mx*-by-*n* data matrix X, which is treated as *mx* (1-by-*n*) row vectors $x_1, x_2, \ldots, x_{mx}$, and *my*-by-*n*data matrix Y, which is treated as *my* (1-by-*n*) row vectors $y_1, y_2, \ldots, y_{my}$, the various distances between the vector x_s and y_t are defined as follows [13]:

Euclidean distance: d^2_{st} =(xs−yt)(xs−yt)′……….………………..….equation (iv)

Standardized Euclidean distance: d^2_{st} = (xs−yt)V−1(xs−yt)…………………………………equation (v)

Where V is the m-by-*n* diagonal matrix whose *j*the diagonal element is $S(j)^2$, where S is the vector containing the inverse weights.

6. Prediction of Label (Result)

For the prediction of the classified label: the mathematics function below is employed [13]

$$q = \arg\min_{q=1,,,,,k} \sum_{k=1}^{k} T\left(\frac{k}{x}\right) C\left(\frac{q}{k}\right),$$ ……………………………………equation (vi)

Where

q is the predicted classification.

k is the number of classes.

$T\left(\frac{k}{x}\right)$is the posterior probability of class *k* for observation *x*.

$C\left(\frac{q}{k}\right)$ is the cost of classifying an observation as *y* when its true class is *k*

Implementing the function given a set *x* of *n* points and a distance in equation (iv) and (v) respectively, k nearestneighbor (K-NN) search finds the (k) closest points in *x* to a query point or set of points y (see figure 1).

Given a number of columns of x to be less than 10 the equidistance is calculated and the label is predicted as shown in equation (vi). The clustering diagram below further explains the classification model and label prediction.However, if the number of x is more than 10, the ExhaustiveSearcher model is employed, this model considers the either the hammering distance, angles, correlation, spearman, jaccard, seuclidean, mehalanobis or custom distance function for classification.

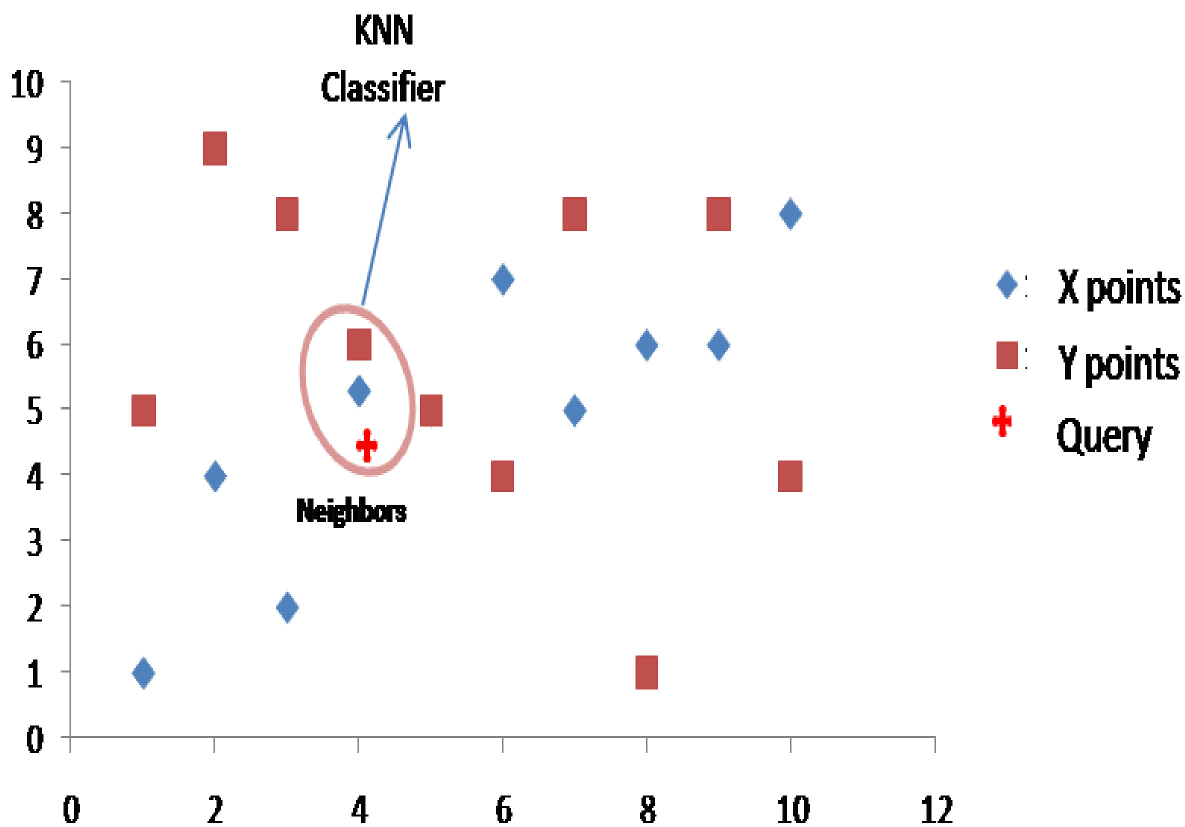

Figure 1: KNN classification model

IV. SYSTEM FLOW CHART

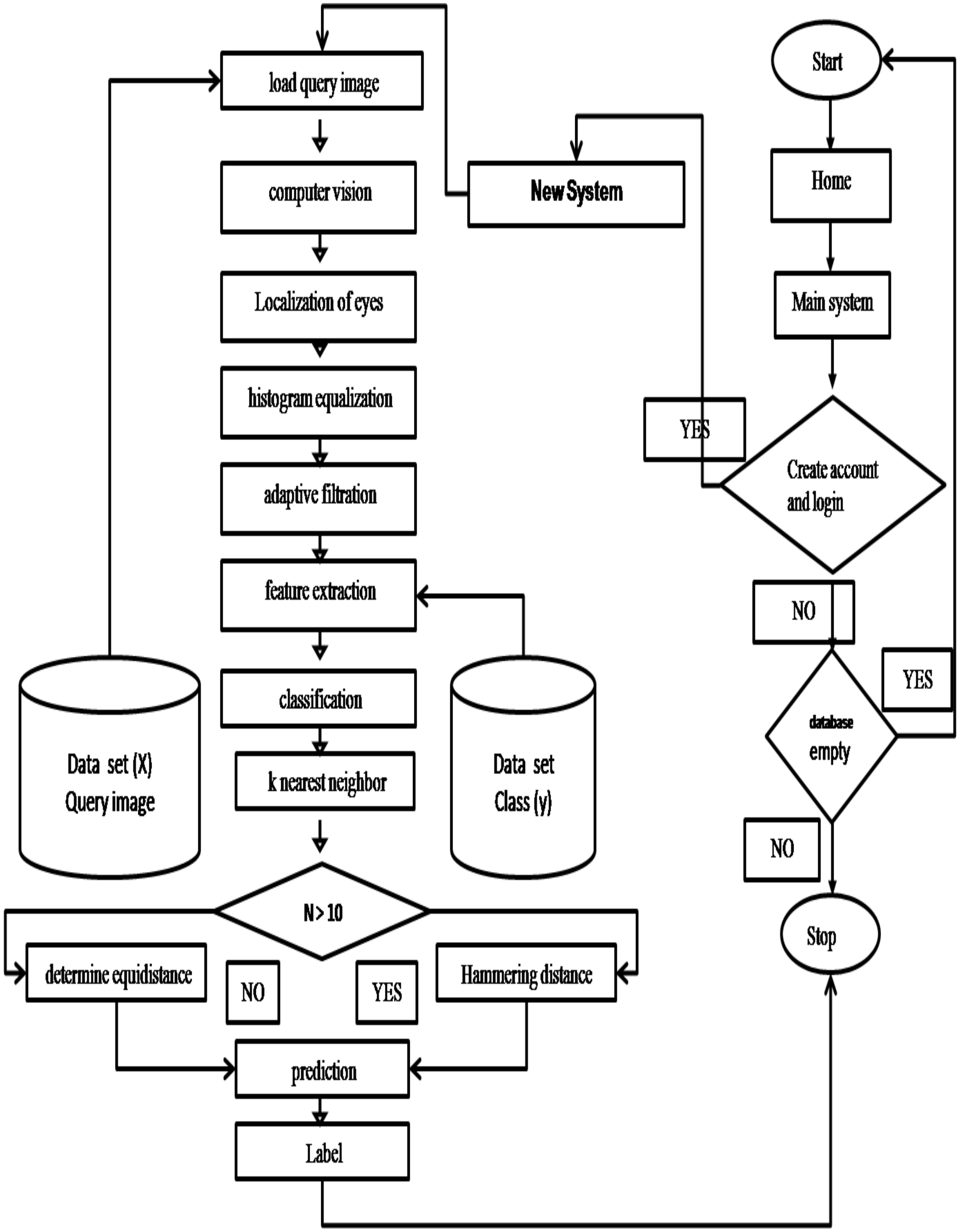

Figure 2: system flow chart

V. PROCESS FLOW DIAGRAM

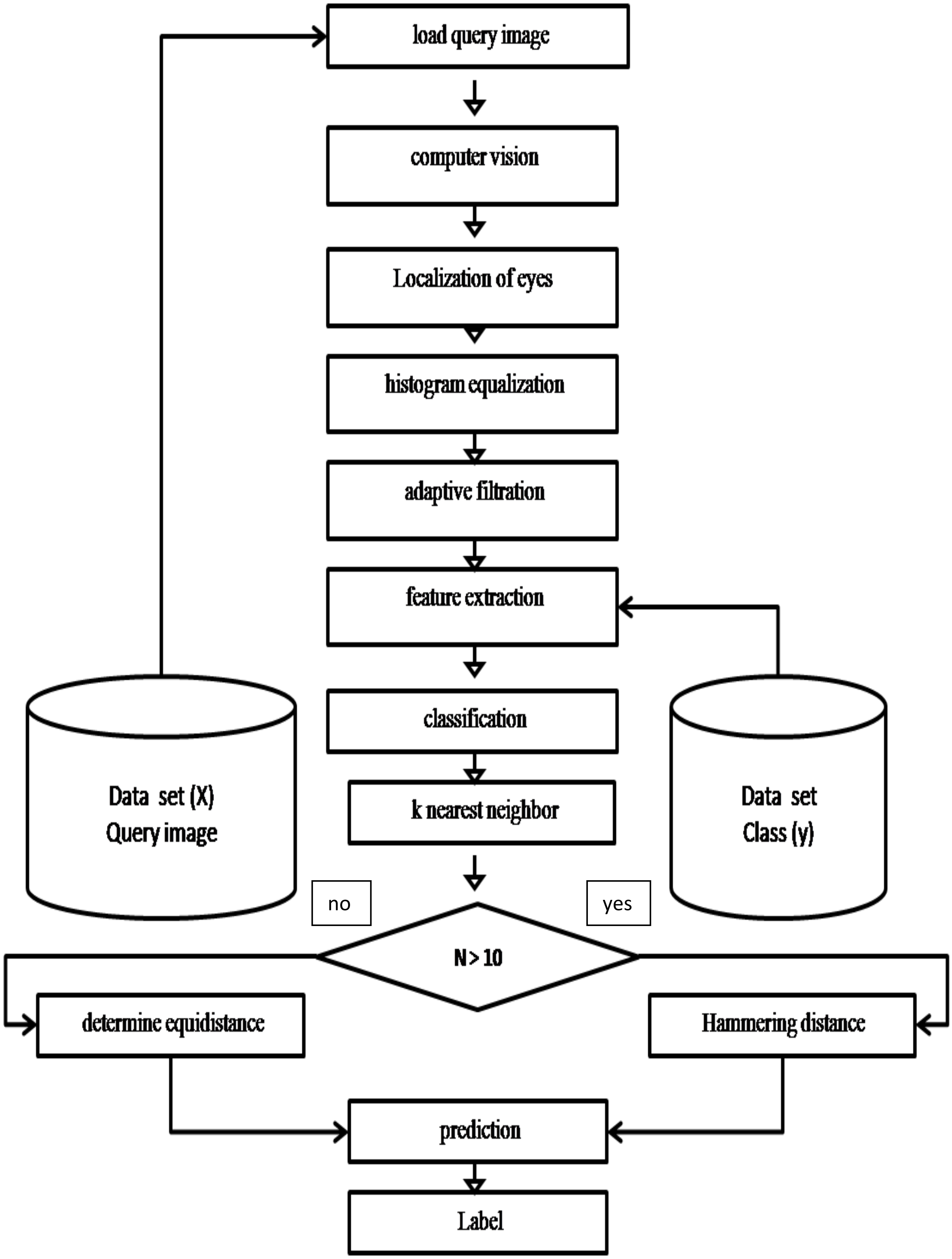

Figure 3: process flow chart

VI. IMPLEMENTATION RESULTS

This research work will be developed using matlab, employing various image processing tools which are modeled by the figures below.Figure 4 shows the evidence of two identical twins which will be added to training dataset. (See figure 6) strictly for research purpose. One of the figure 5a: image will be used for search as the query image (Figure 5b): the database montage is presented in figure 6: highlighting the two identical images to e searched among other images in the dataset. Figure 7: provides the preliminary filtration model while figure8: demonstrate the adaptive noise filter process. The feature extraction and transformation curve is showed in figure 9 respectively. Finally the recognition result is displayed in figure 10.

Figure 4: Sample of two identical faces to be added to dataset

Figure 5a: source of query images

figure 5b: query image

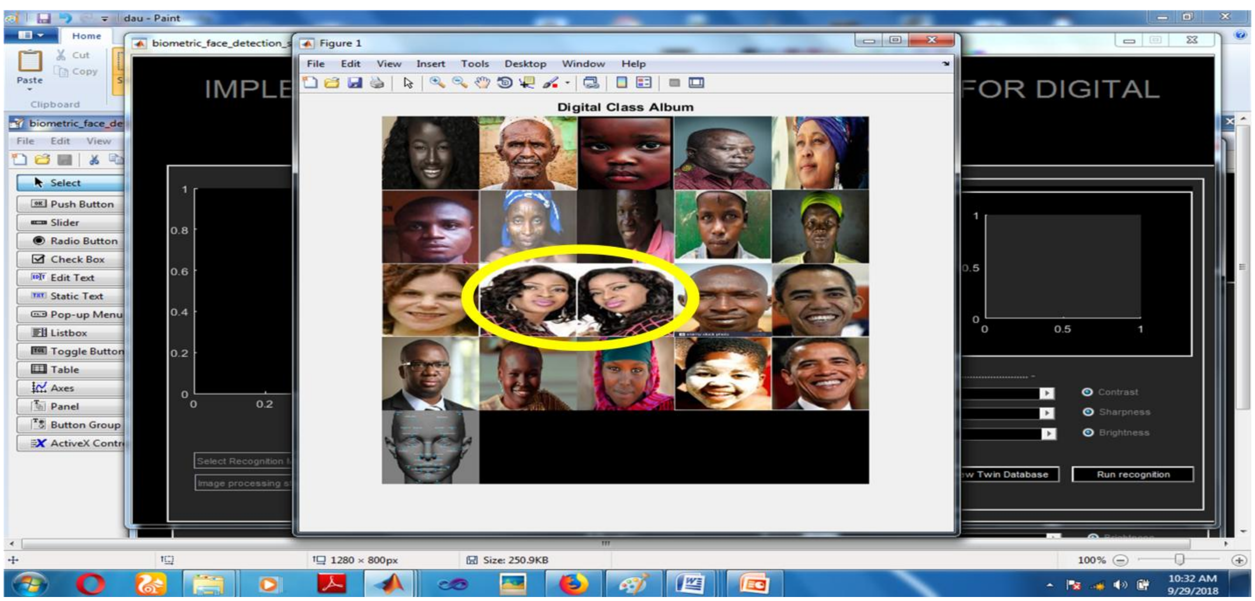

Figure 6: implementation result showing montage of database images

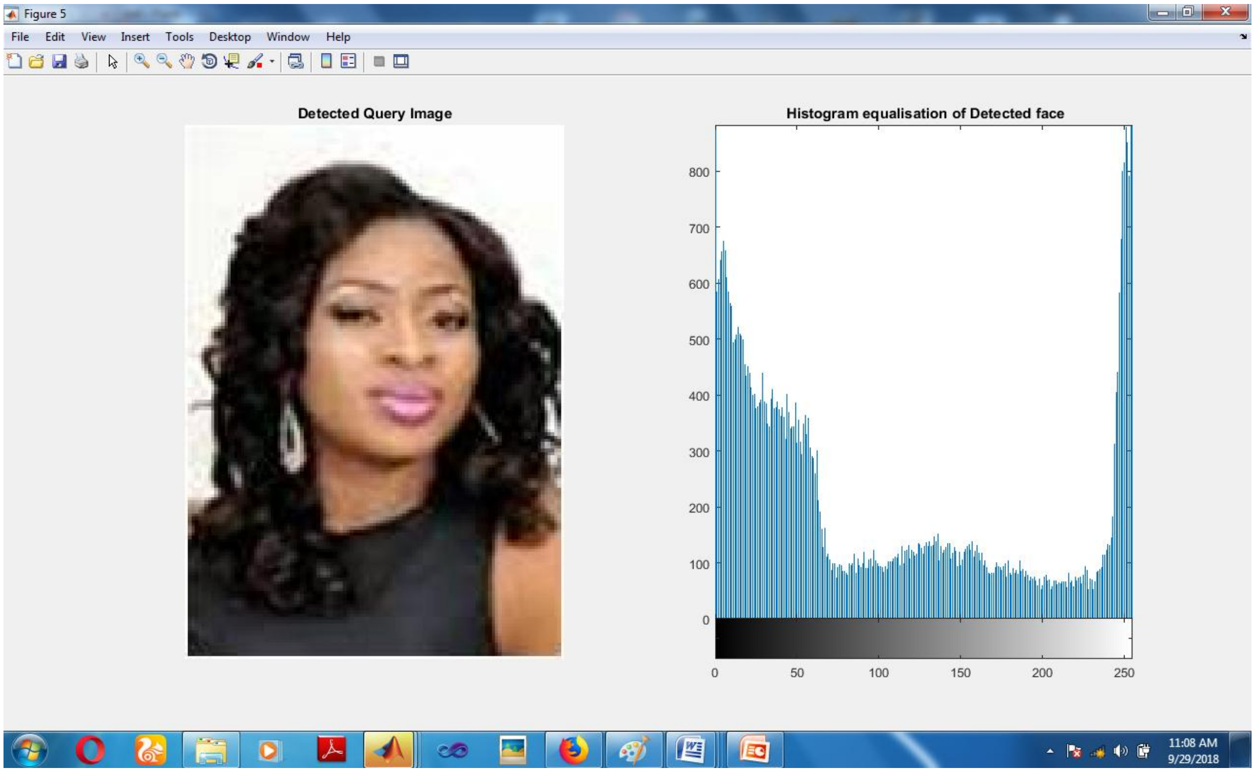

Figure 7: histogram equalization process

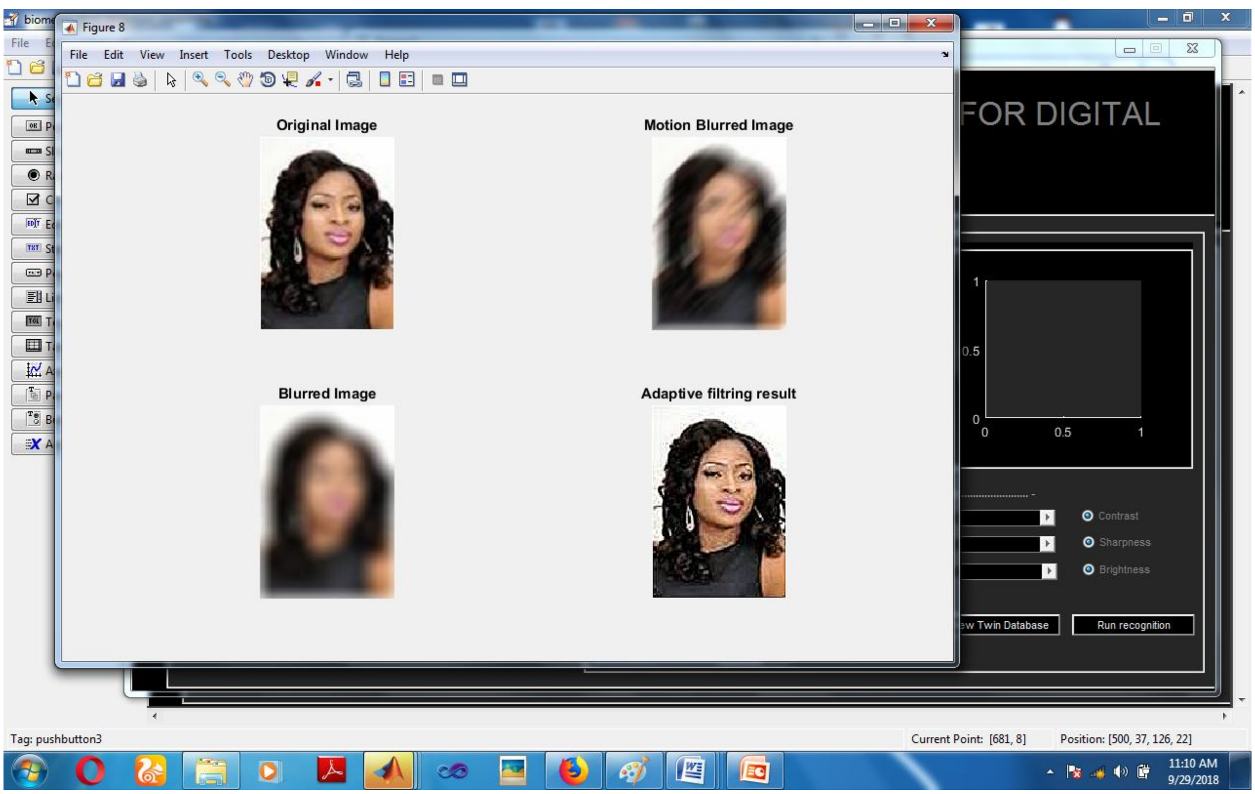

Figure 8: Adaptive noise filtering process

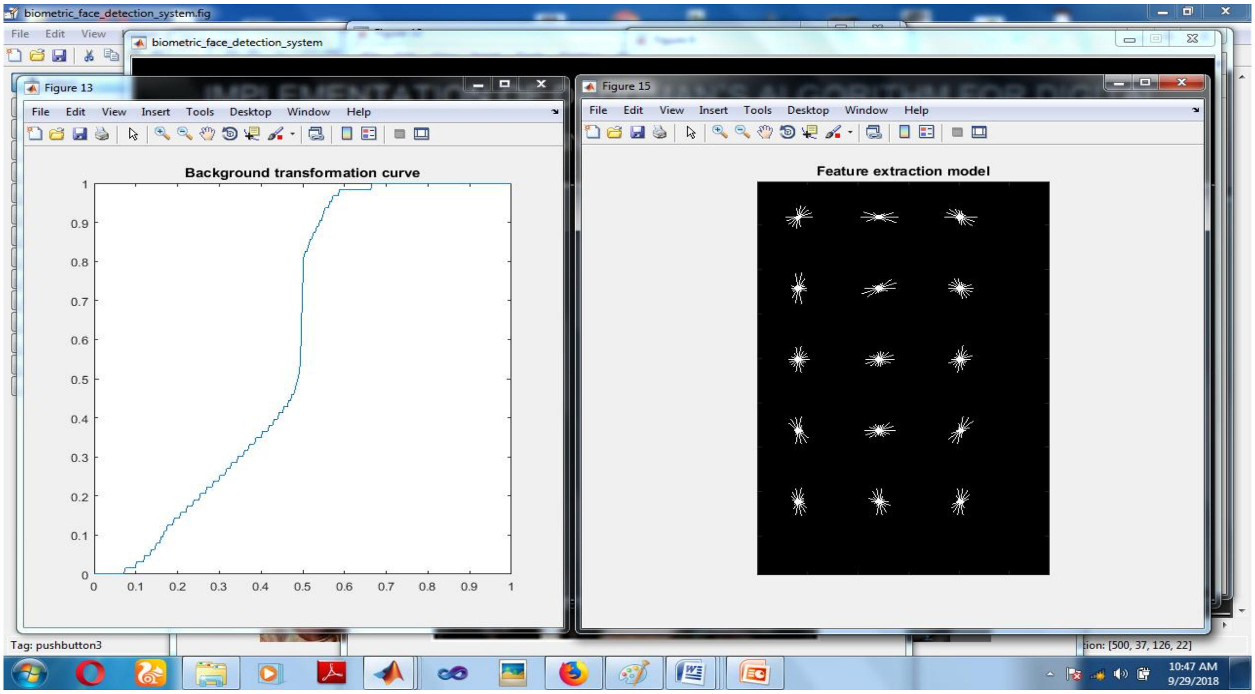

Figure 9: background transformation and feature extraction model

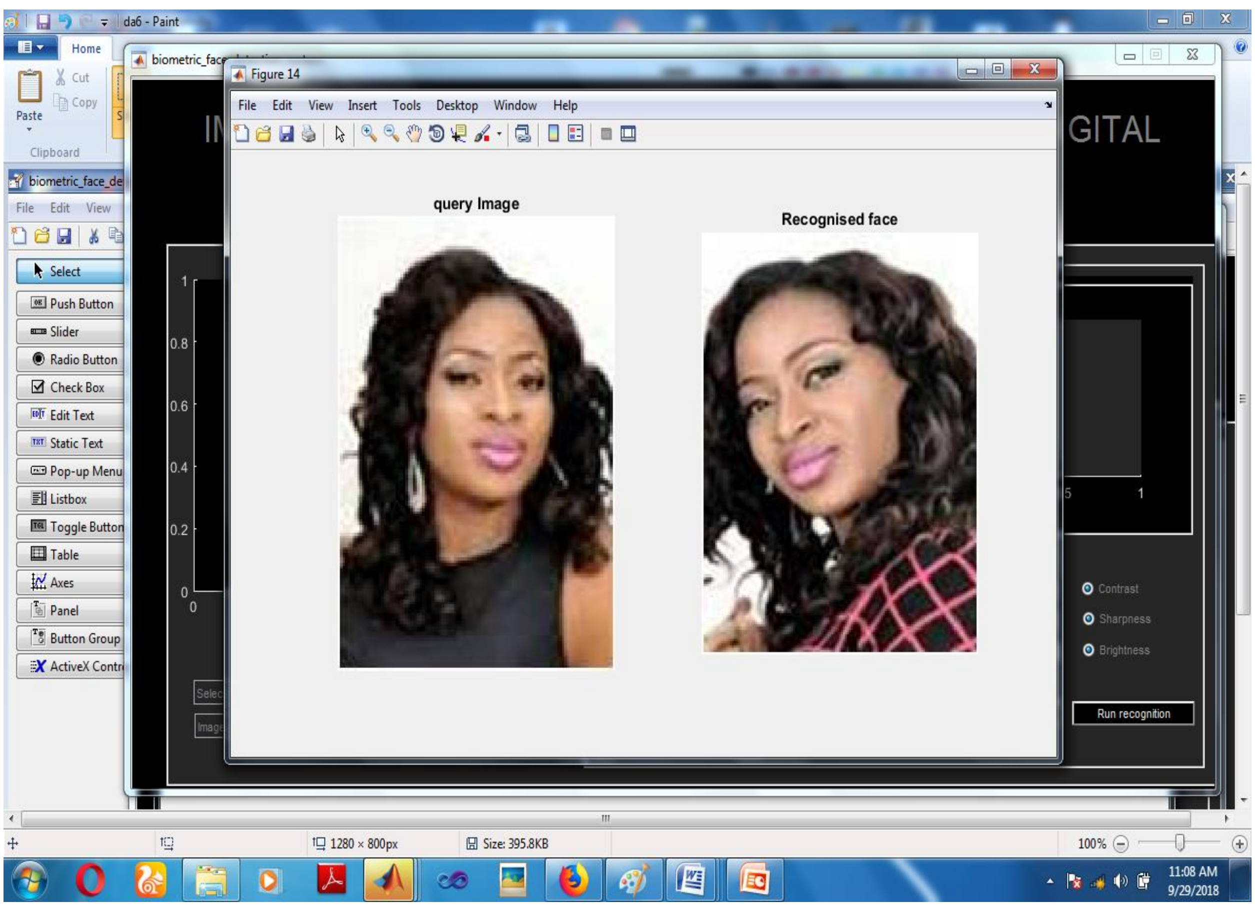

Figure 10: Recognition result

V. CONCLUSION

This work has successfully provided a new direction for the application of Daugman's algorithm. Secondly, a perfect image processing technique which was designed to filter constant power adaptive noise (white noise from the eye sclera), has been applied as the best filtration process for iris image.A machine learning algorithm (K-NN classifier) is employed to train and classifies the extracted features from both the query (x) and class images (Y) using the Euclidean model. The result is a classified group of K nearest neighbors which the label is predicted as result. The work can further improved using neural network instead of support vector machine which was employed for this research due to the limited number of images dataset used as training set.

REFERENCE

[1] Robert H Zakon .Hobbes' Internet Timeline. Significant dates in the history of the Internet. 2010

[2] Oad Percy and Ahmad Waqas, Iris localization using Daugman's algorithm, 2010

[3] H.Rowley, S. Baluja, and T. Kanade.Neural network-based face detection. In Proc. IEEE Conf.on Computer Visioin and Pattern Recognition, pages 203-207, San Francisco, CA, 1996

[4] Kah-Kay Sung and TomasoPoggio. Example-based learning for view-based human face detection.A.I. Memo 1521, CBCL Paper 112, MIT, December 1994

[5] B.Moghaddam and A. Pentland.Probabilistic visual learning for object representation.In S.K.Nayar and T. Poggio, editors, Early Visual Learning, pages 99--130. Oxford Univ. Press,1996.

[6] O.Jesorsky, K. J. Kirchberg, R.W. Frischholz. Robust Face Detection Using the HausdorffDistance.In Proc. Third International Conference on Audio- and Video-based BiometricPerson Authentication, Halmstad, Sweden, 2001

[7] Vimal, VirenderKadyan, Implementation and Performance Analysis of Face Recognition Using MATLAB. Dept. of Computer Science and Engineering, RNCET, Panipat, Haryana,.IJCST Vol. 6, Issue 2, April - June 2015 ISSN : 0976-8491 (Online) | ISSN : 2229-4333.

[8] NawafHazimBarnouti. Face Recognition Using Eigen-Face Implemented On DSP Processor. International Journal of Engineering Research and General Science Volume 4, Issue 2, March-April, 2016, ISSN 2091-2730

[9] Wikipedia project 2017.

[10] Daugman J. "How iris recognition works." IEEE Trans. CSVT, vol. 14, no. 1. 2004.

[11] Mark S. Nixon and Alberto S. Aguado. Feature extraction and image processing. AcademicPress, 2008

[12] Lim, Jae S., Two-Dimensional Signal and Image Processing, Englewood Cliffs, NJ, Prentice Hall, 1990, p. 548, equations 9.26, 9.27, and 9.29

[13] Mathworks documentation 2017a.