BIOMETRIC SYSTEMS -SWE1015
IRIS Segmentation

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by

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Introduction:

Broadly eye detection is the process of tracking the location of human eye in a face image. Previous approaches use complex techniques like neural network, Radial Basis Function networks, Multi-Layer Perceptrons etc. In the developed project human eye is modeled as a circle (iris; the black circular region of eye) enclosed inside an ellipse (eye-lashes). Due to the sudden intensity variations in the iris with respect the inner region of eye-lashes the probability of false acceptance is very less. Since the image taken is a face image the probability of false acceptance further reduces. Hough transform is used for circle (iris) and ellipse (eye-lash) detection. Hough transform was the obvious choice because of its resistance towards the holes in the boundary and noise present in the image. Image smoothing is done to reduce the presence of noise in the image further it makes the image better for further processing like edge detection (Prewitt method). Compared to the aforementioned models the proposed model is simple and efficient. The proposed model can further be improved by including various features like orientation angle of eye-lashes (which is assumed constant in the proposed model), and by making the parameters adaptive

Literature Review:

Nianfeng Liu et.al suggested a code-level plan in heterogeneous iris recognition. The non-linear connection betwixt binary elements codes of heterogeneous iris images was demonstrated via an adapted Markov network. Additionally, a weight map on the dependability of binary codes in the iris template can be gotten from the model. Broad exploratory results of matching cross sensor, high-resolution versus low-resolution and, clear versus obscured iris images exhibited that the code-level approach can accomplish the most noteworthy accuracy in contrasted with the current pixel-level, feature level besides score-level solutions.
Sheng-Hsun Hsieh et.al recommended a new hardwaresoftware hybrid strategy to build the stand-off distance in an iris recognition framework. When designing the framework hardware, they utilized an improved wavefront coding procedure to expand the field depth. To recompense for the image obscuring caused by wavefront coding, on the software side, the presented framework utilized a local patch centered super-resolution strategy to reestablish the obscured image to its clear variant. The presented framework can expand the catch volume of a regular iris recognition framework by three times and keep up the framework's high recognition rate. But still, attributable to the hardware implementation, the planned model has the downside of high-cost.
Chun-Wei Tan et.al researched a promising iris encoding accompanied by a matching system for the noisy iris images obtained at a distance in the company of under less compelled conditions utilizing visible accompanied by NIR imaging. The approach exhibited in their work concurrently exploited the iris features

computed from both the computed and worldwide feature portrayals. The supremacy of the projected iris encoding along with coordinating methodology has been decided by furnishing examination with numerous contending iris encoding together with corresponding algorithms on this three freely accessible databases: UBIRIS.v2, CASIA.v4- distance, FRGC, which recommend upgrades of 36.3%, 32.7% and29.6% in equal error rates(EER), individually, as contrasted with a quite few contending approaches. The restriction of their work is, they don't consider the multimodal procedure. Chun-Wei Tan et.al [9] planned a nonlinear way to simultaneously represent both local consistency of iris bit moreover the general qualities of the weight map to stabilize /weight the encoded iris bits. Their approach hence more successfully penalizes the delicate bits while simultaneously remunerating more steady bits in an attempt to attain more stable elements of local iris features, a Zernike moment centered phase encoding of iris features was suggested. A joint methodology was embraced to simultaneously extract and consolidate the global accompanied by the localized iris features. Their experimental results recommended that suggested technique can accomplish huge advancement in iris matching accuracy over those contending approaches i.e., an average advancement of 54.3%, 32.7%, along with 42.6% in EER, individually, aimed at UBIRIS.v2, FRGC, along with CASIA.v4-distance. Jianxu Chen et.al [10] implemented an iris recognition technique intended for identifying corresponding iris crypts International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 10 (2018) pp. 8728-8735 © Research India Publications. http://www.ripublication.com 8730 consequently. The proposed matching plan was intended to manage potential topological alterations in the spotting of a similar crypt in various images. Their approach beats the eminent visible-feature centered iris recognition strategy predicated on three distinctive datasets. In particular, their approach accomplished in excess of 22% higher rank one hit rate in the identification, and more than 51% lower EER in verification. Likewise, the benefits of their approach on multienlistment was tentatively illustrated. Still substantial occlusion along with terrible illumination have a more extreme effect on their approach than the customary iris code. Poor illumination may bring about low contrast so fewer features can be spotted than under normal illumination.

Zhiyong Peng et.al has given an enhanced Daugman iris recognition algorithm that incorporates in two aspects: Improvement intended for iris confinement as well as The improvement intended for iris encoding along with matching algorithms. In Step 1, the localization and shape of the pupil were generally decided in iris image. In Step 2, the conceivable noise from residual eyelashes was additionally separated by choosing a “pure” iris part as a reference and making an approval judgment pixel-wise. The suggested algorithm has an undeniable improvement in boosting the speed accompanied by lessening the dismissal rate.

Imran Naseem et.al introduced the class-specific dictionaries concept aimed at iris recognition. Substantially, a linear combination of training images from every class was the depiction of the query image. The well-conditioned inverse issue was solved utilizing least squares regression in addition the decision was ruled supporting the class which has the utmost accurate estimation. An augmented modular approach was further suggested to oppose noise because of imperfect segmentation of the iris region. The suggested algorithm was contrasted with the newfangled Representation Classification with Bayesian fusion aimed at multiple sectors. the suggested algorithm’s complexity analysis demonstrated the decisive excellence of the recommended approach.

Existing systems:

Integrodifferential operator:

- This approach is regarded as one of the most cited approach in the survey of iris recognition. Daugman uses an integrodifferential operator for segmenting the iris. It finds both inner and the outer boundaries of the iris region.
- The outer as well as the inner boundaries are referred to as limbic and pupil boundaries.
- The parameters such as the center and radius of the circular boundaries are being searched in the three-dimensional parametric space in order to maximize the evaluation functions involved in the model.
- This algorithm achieves high performance in iris recognition. It is having a drawback that, it suffers from heavy computation.

Masek Method:

- Masek introduced an open iris recognition system for the verification of human iris uniqueness and also its performance as the biometrics.
- The iris recognition system consists of an automated segmentation system, which localise the iris region from an eye image and also isolate the eyelid, eyelash as well as the reflection regions.
- This Automatic segmentation was achieved through the utilization of the circular Hough transform in order to localise the iris as well as the pupil regions, and the linear Hough transform has been used for localising the eyelid occlusion.

- Thresholding has been employed for isolating the eyelashes as well as the reflections. Now, the segmented iris region has got normalized in order to eliminate the dimensional inconsistencies between the iris regions.
- This was achieved by applying a version of Daugman’s rubber sheet model, in which the iris is modeled as a flexible rubber sheet, which is unpacked into a rectangular block with constant polar dimensions.
- Ultimately, the iris features were encoded by convolving the normalized iris region with the 1D Log-Gabor filters and phase quantizing the output to produce a bit-wise biometric template. For metric matching, the Hamming distance has been chosen, which provides a measure of number of disagreed bits between two templates.
- The drawback of has been recovered in this paper i.e., the localisation of the circular iris as well as the pupil region, occlusion of eyelids as well as the eyelashes, and also the reflection occurs. The drawback of this approach is that the iris segmentation is not that much accurate and also the speed of the system is low.

Proposed System:

Hough transform:

Hough transform can be applied to many computer vision problems as most images contain feature boundaries which can be described by regular curves. The main advantage of the Hough transform technique is that it is tolerant of gaps in feature boundary descriptions and is relatively unaffected by image noise, unlike edge detectors. One important difference between the Hough transform and other approaches is resistance of the former to noise in the image and its tolerance towards holes in the boundary line. Hough transform can also be used for detection of circles and other parametrizable geometric figures.

Algorithm:

- In our Project we have modeled the human as a circle circumscribed in an ellipse as discussed earlier, where the circle represents the iris of the human eye and the elliptical part represents the eye lashes, and then the Hough transform if used to detect this modeled eye from a given image and then final pair of eye is given by considering the geometry of the human eye. The Image of interest contains many features and noise that are completely not of interest, so to remove or avoid them smoothing of the image is done.

- As we know that the color of the eye inside eye-lash is white, which makes the eyes significant and prominent as the face color is quite dull in comparison to the pure white color. Due to the prominent color of eye the image smoothing using Gaussian operator has no significant effect on the edges and on the iris of the human eye. Edge detection is performed to further avoid the features and details that are not of interest.

- A log-linear transform can also be performed for the aforementioned operation. Edge detected where there is a sudden intensity change based on a pre-specified threshold used in the edge-detection by Prewitt operator. The area of almost constant intensity is left white, while the edges are marked black. This processed image then undergoes Hough transform where circles and ellipses are detected.

- It is possible that this algorithm may detect circles other the iris of the human eye and ellipses very different from the eye lashes. So, final detection is done based on geometrical considerations of human eye. Like ratio of iris diameter to the eye-lash major axis is constant and ratio of iris diameter to the distance between the centers of the two iris is constant etc.

Steps to perform process:

- Take input the image of which eye detection has to be performed.
- Convert color image into grayscale image.
- Smoothen the image to remove noise present in the image and to avoid any feature
- Detect the edges of the image using the Prewitt operator.
- Detect the iris (black circular region in eye) using Hough transform for circle detection.
- Store the center and radii of the circles thus detected from the previous step.
- Detect the presence of the ellipses surrounding the circle again using the Hough transform.
- Geometrically match each of the detected circle enclosed in an ellipse

- Rule out the pair of eyes based on geometrical considerations from the above step.

Advantages of proposed method

- A method for object recognition
- Robust to partial deformation in shape
- Tolerant to noise
- Can detect multiple occurrences of a shape in the same pass
- Among the three methods the hough transform is the most effective way because this technique provides the exact output for the given image even if it has noise and any defaults.
- It first detects the eye line and then it identifies the iris part of the eye .and also it is accurate.

Implementation Code:

```
clear all;
close all;
clc;
msk = [0 1/32 1/16 1/32 0;
    1/32 1/32 1/16 1/32 1/32;
    1/16 1/16 1/8 1/16 1/16;
    1/32 1/32 1/16 1/32 1/32;
    0 1/32 1/16 1/32 0];
%msk = ones(5,5); %msk = msk.*(1/25);
img_prt = double(zeros(5,5));
pic_tot = 0;
%x = imread('1.jpg');
x = rgb2gray(imread('1.jpg'));
x2 = x;
%x = rgb2gray(imread('1.jpg'));
%x = rgb2gray(x);
[m,n] = size(x);
I1 = edge(x,'prewitt');
imshow(I1);
y2 = x;
for k = 1:1:5
    for i=1:1:(m-4)
        for j = 1:1:(n-4)
            img_prt = double(y2(i:i+4,j:j+4));
            img_prt = img_prt.*msk;
            pic_tot = uint8(round(sum(img_prt(:))));
```

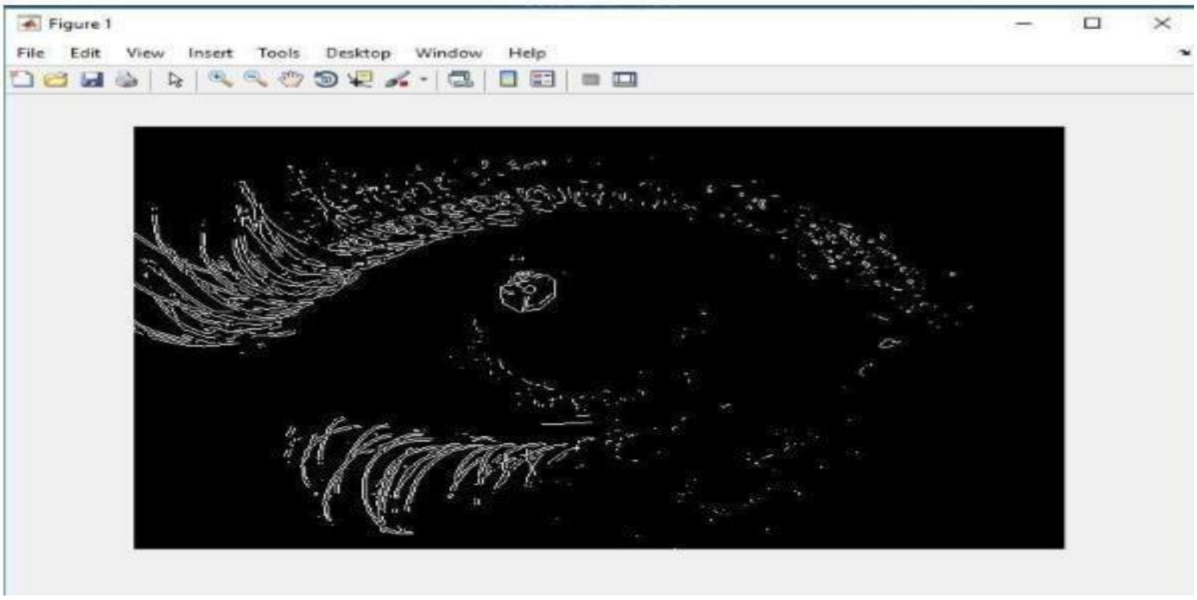
```
            y(i,j) = pic_tot;
        end
    end
    [m n] = size(y);
    y2 = y;
end
imshow(y);
y1 = edge(y,'prewitt');
figure;
imshow(y1);
%I = rgb2gray(imread('1.jpg'));
I = rgb2gray(imread('1.jpg'));
%I = edge(I,'roberts');
I =im2bw(I);
[y,x]=find(I);
[sy,sx]=size(I);
imshow(I);
totalpix = length(x);
cntdn = 0;
HM = zeros(sy,sx,50);
%R = 1:50; %R2 = R.^2;
a1 = 101:150; a2 = a1.^2;
b1 = 51:100; b2 = b1.^2;
sz = sy*sx;
for cnt = 1:totalpix
    for cntR = 1:50
        k = 1:sy;
%a = (round(x(cnt) - sqrt(R2(cntR) - (y(cnt) - [1:sy]).^2)));
h = (round(x(cnt) - a2(cntR).*sqrt(1 - ((y(cnt)-(1:sy))./b2(cntR)).^2)));
k = k(imag(h)==0 & h>0);
h = h(imag(h)==0 & h>0);
ind = sub2ind([sy,sx],k,h);
HM(sz*(cntR-1)+ind) = HM(sz*(cntR-1)+ind) + 1;
    end
    cntdn = cntdn + 1;
end
for cnt = 1:50
    H(cnt) = max(max(HM(:,:,cnt)));
end
plot(H,'*-');
[maxval, maxind] = max(H);
[B,A] = find(HM(:,:,maxind)==maxval);
figure; imshow(I);
hold on;
```

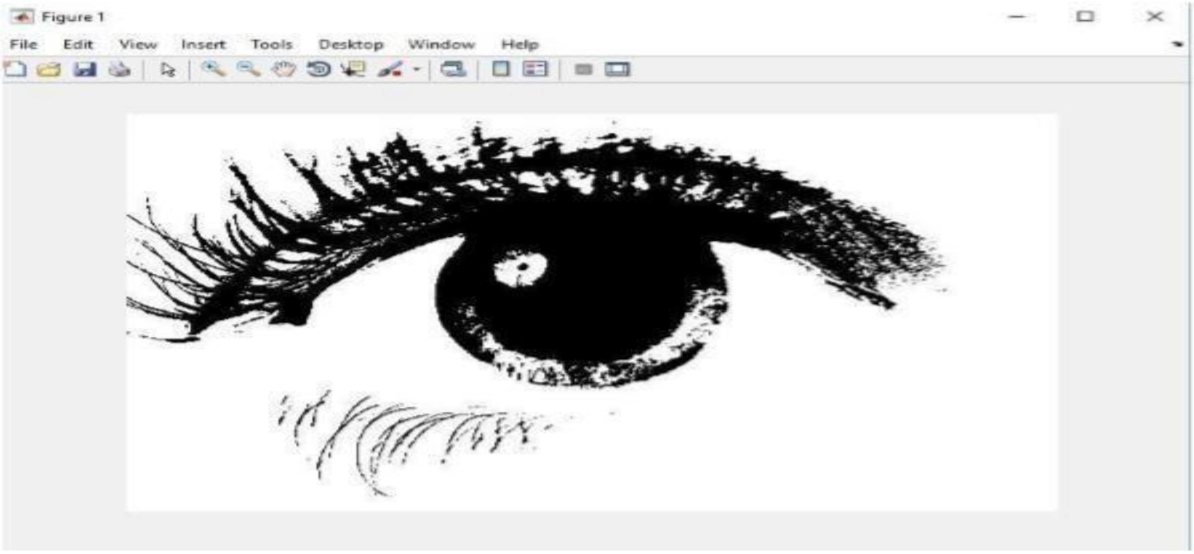
```
plot(mean(A),mean(B),'xr')
%text(mean(A),mean(B),num2str(maxind),'color','green')
text(mean(A),mean(B),num2str(maxind),'color','green')
```

Results and Discussions:

Table is the comparison of segmentation value of the iris image based on their circle iris and circle iris and circle pupil between the two techniques.

Database	Hough Transform						Integro-Differential Operaror					
	Circle Pupil			Circle Iris			Circle Pupil			Circle Iris		
ID1	118	156	57	115	158	110	120	148	52	120	128	88
ID2	132	160	50	133	160	113	132	172	44	124	192	84
ID3	142	130	55	140	130	108	140	140	52	140	160	84





Conclusion:

In this we discussed about the pre- processing required, which includes RGB to grey level conversion, image smoothing and edge detection. Finally the Hough transform is applied for detection of circles and ellipses and pair of detected eyes are ruled out by geometrical considerations. The type of approach discussed here cannot be applied for realtime eye detection scheme; however it has been found that this technique efficiently detects eyes in still images and can be used for off-line eye detection system. The results of the discussed algorithm have been found satisfactory. Hough transform has been used because of its robustness for noise and resistance towards discontinuity in standard geometrical structures

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