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Extracting The Important Features From Iris To Aid The Biometric Key Generation

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Abstract
The Ever-Increasing Threats And Security Lapses In The Computer World Has Envisaged Many New Novel Techniques To Be Adapted To Secure And Safe Guard The Consumer / User Data. Bio-Metric Is One Of The Most Reliable Security And Popular Method Mainly Due To Its Outstanding Ability To Verify Individuals With Distinct Characteristics And It Is Highly Impossible To Forge And Crack The Security Formed By The Bio-Metric System. This Paper Deals With The Extraction Of The Most Important Features From The Iris Biometric Entity.
Keywords: *Bio-Metric, Image Capture, Cryptosystem*

Introduction

Usually The Cryptosystem Or The Cryptography Comprises Of Two Processes Named Encryption And Decryption Where Keys Generated By Computations And Mathematical Equations Are Used. This Key Is Generated In Varying Lengths Depending Upon The Nature Of The Security And The Data Being Secured, If The Data Is Of Highly Confidential Then The Key Used Will Be Of Bigger Length And Make It Quite Difficult For The Intruders And Hackers To Break Through The Security System And Breach The Data.

The Uniqueness Present In The Iris Images Largely Imbues Many Research Scholars Across The Globe To Carry Out Their Research Based On Iris Patterns. The Security Systems Designed With The Iris Patterns Has Shown Promising Accuracy And High Security When Dealt With Confidential Data And Privacy Of The Users And Organizations. The Captured Iris Image Should Be Carefully Pre-Processed To Remove The Unwanted Portions Present, Enhance The Iris Image, Detect The Region Of Interest, Segment The Iris And Then Extract The Important Features Present To Be Employed In Various Applications Like Security System, Network, Cyber-Key Generation, Identification Of Individuals, Surveillance, And Forensic Analysis.

Iris Bio-Metric – An Overview

The Security Based On Iris Is Overwhelmingly Used In Various Organizations And Plethora Of Individuals Uses It As A Trustworthy Security Authentication System Because Of Its Unique Textures, Stability, And Cheap Image Capturing Devices Available In The Market. The Human Iris Is An Important Portion Of The Human Eye Which Is Situated Between The Pupil And The Sclera As Shown In The Figure 1 [1] [2]. Like Any Other Bio-Metric Means The Iris Comprises Of Large Number Of Features Namely, Coronas, Stripes, Freckle, Crypts, Furrows, Pupil, And Collarets, That Are Very Distinct And No Two Human Will Have The Same Features And Every Eye In This World Is Unique In Its Own Term [3].The Main Purpose Of The Iris Is Its Knack To Constrict And Dilate The Sphincter Muscles To Regulate The Light That Enters The Eye Through The Pupil. The Iris Is Made Up Of Very Complex Fibrous Tissues Which Make It The Most Unique And Varies From Person To Person.

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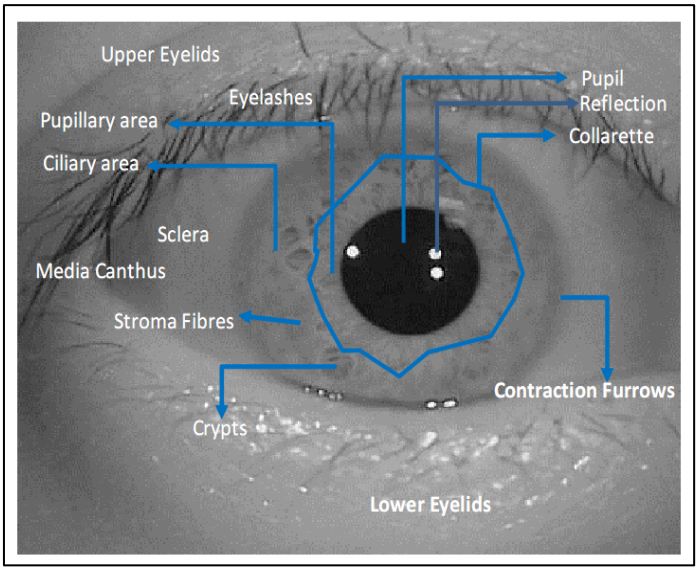

Figure 1: Human Iris

The Iris Pattern Is Initially Formed At The Gestation Stage Of The Conception (I.E.) As Early As During The First Three Months And The Entire Iris Is Formed By The Eighth Month Of The Development Of The Child [4]. The Iris Structure Formed Will Be Constant And Never Changes During The Entire Life Span Of A Human But The Pigmentation And The Color Will Be Formed After The Birth Of The Child And Will Continue To Change For At Least One Year. This Stability Of The Iris Textures Is The Main Reason And The Motive For The Research Fraternity To Use The Iris More Often And Trust The Security Of This Bio-Metric More Than Any Other Bio-Metric. The Iris Texture Will Change Only In Case Of Accident Or Damage To The Eye And It Will Remain Perpetually Static And Stable Throughout The Life Of The Individuals.

Features Of The Iris

Medial Canthus: This Is The Vital Portion Situated Between The Upper And Lower Eyelids Near The Midpoint Of The Human Face.

Sclera: This Is The Whitish Portion Present In An Eye Image Usually Surrounding The Iris Region.

Pupil: This Is The Dark Middle Portion Of An Eye Image Usually Surrounded By The Iris Region.

Pupillary Area: This Is The Innermost Portion Of The Iris Whose Edges Segregate The Outline Of The Pupil From The Iris Region And In This Portion The Sphincter Muscles That Enclose The Pupil Resides.

Ciliary Area: This Iris Region Is Present From The Pupillary Area To The Ciliary Body. In This Portion The Dilator Muscles That Regulates The Dilation And Constriction Of The Pupil Is Located And This Controls The Amount Of Light To Enter The Eye.

Stroma Fibres: This Is The Most Important Feature Of The Iris Comprises Of Pigmented Fibrous Tissues That Builds Most Of The Visible Iris Patterns Present In The Human Eye And It Will Be Extensively Distinct.

Crypts And Furrows: These Are The Two Types Of Irregularities And Anomalies That Are Normally Found In The Entire Distribution Of Stroma Fibre Present In The Iris Portion.

Collarette: This Is The Portion That Splits The Pupillary Area From The Ciliary Area.

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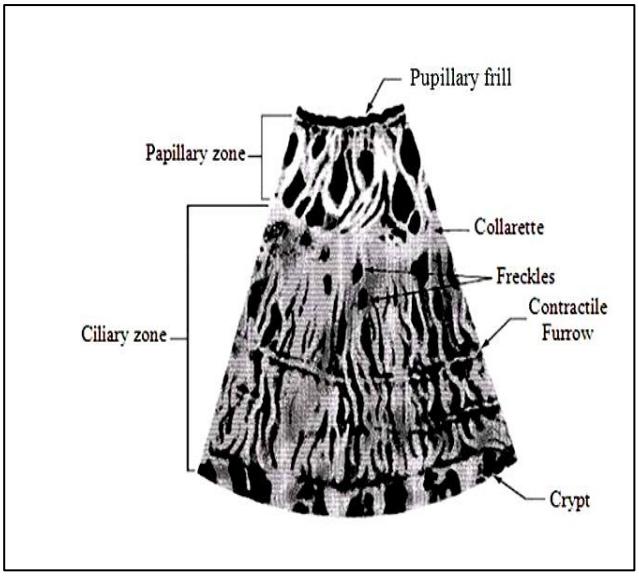

Figure 2: Important Features In Human Iris

The Feature Extraction Process Comprises Of Two Important Tasks Namely Preprocessing And Segmentation. The Preprocessing Starts With The Acquiring Of The Iris Image And The Acquired Iris Image Is Enhanced And Converted Into A High Resolution Image To Ensure Smooth Operations Related To Feature Extractions. The Enhancement Of The Iris Image Comprises Of Many Process Like Detecting The Occlusions By Eyelid, Occlusions By Eyelashes, Low Lighting Image, Reflection Due To The Light Of The Capturing Device, Off-Gaze, Blurred Iris Image, Defocused Iris Image Due To Head Shake Or Device Shake [5]. All These Flaws Are To Be Detected And Cleared To Ensure Accurate Feature Extraction Present In The Iris Image.

Iris Image Preprocessing

The Initial Process Carried Out In The Preprocessing Is Dealing With The Blurred Iris And Defocused Iris Images Which Are Usually Caused By The Eyeball Movement, Head Shakes And Capturing Image Shake. This Problem Has To Be Sorted Out And The Iris Image Has To Be De-Blurred And The Noise Present In The Image Has To Be Eliminated.

To Ensure That The Image Is Sharp And Not Blurred The Following Equation Is Applied And Checked. Initially The Portion Of The Iris Image Which Is Important Is Discovered, And Neighborhood Pixel Comparing Technique Is Employed To Find The Sharpness Of The Pixel And Calculate The Mean Sharpness Of The Portion We Intend To Use.

$$Ps = \frac{\sum_{i=1}^{MxN} \sum_{j=1}^{8} \left| \frac{Id}{x} \right|}{M \times N} \quad \text{------- Equation 1}$$

Where Ps Is The Sharpness Of The Pixel Point, Id Is The Derivative Intensity Of The Pixel, *X* Is The Pixel Distance Between Two Adjacent Pixels, And M,N Are The Width And The Height Of The Iris Image We Intend To Use. In The Equation 1, Eight Pixels Surrounding A Particular Pixel Is Considered As Shown In The Figure 3,

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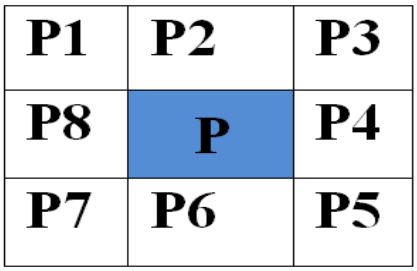

Figure 3: Neighborhood Pixel Sharpness Comparison

The P Is The Main Pixel And P1, P2, P3…. P8 Are The Neighborhood Pixels Whose Sharpness Values Are Calculated And The Mean Sharpness Is Calculated To Get The Average Sharpness Value Of The Portion. If The Acquired Image Is Clear And Has Acute Surface, Then The Value Of The Sharpness Calculated Is Also High And A Minimum Threshold Sharpness Value Is Provided To Consider Whether The Iris Image Is Considered To Be Sharp And Smooth. If The Image Is Below Par Then Filtering Methods Are Utilized To Increase The Sharpness Of The Iris Image. Simple Weiner Filtering Technique Is Employed To Increase And Enhance The Quality Of The Iris Image And Make Sure That The Selected Iris Image Is Optimum To Extract The Important Features From It To Be Employed In The Key Generation And Fusing.

Eyelid And Eyelash Occlusion

The Human Eye Has An Excellent Protection From The Dust And Minute Particles Without Harming The Eye In The Form Of Eyelids And Eyelashes But When Eye Is Processed As A Bio-Metric Entity Then These Obstructions Pose A Huge Threat To The Accuracy And In Fact Hides The Important Features Of The Iris And Makes It Hard For The System To Identify The Uniqueness Present In The Iris Textures. So This Obstructions And Obstacles Have To Removed And Eliminated To Ensure That The Iris Features Are Not Hidden. The Pseudo Code To Estimate The Eyelids And Eyelashes Is Shown In The Figure 4. The Most Important Obstacle Which Is Present In The Eye Is The Eyelids And Eyelashes And This Obstruction Will Impede And Hamper The Texture Extraction Of The Iris And Will Severely Degrade The Performance Of The Security If It Is Used For Authentication And In This Research These Two Obstruction Will Degrade The Extraction Of The Minutiae Points Present In The Eye.

Procedure Estimateocclusion(Input Image I)
Input: Iris Image I
Output: Cleaned Iris Without Occlusion
Begin:
Load The Input Image
Compute The Number Of Pixels In Input Image →Nop_{iris}
Set Threshold Gray Value For Eyelid →T_{eyelid}
Set Threshold Gray Value For Lash →T_{lash}
For Each Pixel P In Nop_{iris} Do
If[P Islowerthant$_{lash}$ Then
P→Lash Remove The Lash Pixel From The Image I
If[P Islowerthant$_{eyelid}$ Then
P→Eyelid Remove The Eyelid Pixel From The Image I
Close If

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```
Close If
Close For
Use Equation 2 To Find The Iris Free Of Occlusion
End Procedure
```

Figure 4: Pseudo Code Of The Estimateocclusionprocedure

$$N(x, y) = \begin{cases} 1, T_{lash} \le I(x, y) \le T_{eyelid} \\ 0, I(x, y) > T_{eyelid} \text{ (or) } I(x, y) < T_{lash} \end{cases}$$

Equation 2: Estimation Of Occlusion

The Estimation Of The Eyelid And Lash Pixel Is Carried Out Using The Above Equation 2 And This Will Completely Eliminate The Unwanted Hindrances From The Iris Portion And Ensures A Smooth Retrieval Of The Crucial Unique Features From The Iris During The Key Generation Phase.

Removal Of Reflection

The Reflection Present In The Eyes Will Hinder The Extraction Of The Features Present In The Iris Largely And This Reflection Has To Be Removed To Ensure Clean Extraction. The Pseudo Code To Remove The Reflection Is Shown In The Figure 5

```
Procedure Eliminatereflection(Input Image I)
Input: Input Image I
Output: Clean Image Without Reflection
Load The Iris Image
Compute The Average Intensity For Iris Portion
→ Ai
Set Constant Threshold Value →Ctv
For Each Pixel P In I Do
Calculate The Intensity Pi Of P
If[ Pi > (Ai + Ctv) ] Then
Consider This Pixel As Reflection
Remove This Pixel
Close If
Close For
Use Equation 2 To Find The Iris Free Of
Occlusion
End Procedure
```

Figure 5: Pseudo Code Of Eliminatereflection Procedure

The Reflection Removal Is Carried Out Using The Intensity Of The Pixel Present In The Iris And Once The Reflection Is Removed The Iris Textures Are Preserved For Extraction. The Reflection In The Eye Due To Light Is Shown In The Figure 6 And This Light Is Removed By Calculating The Average Intensity Of The Pixels Present In The Iris Portion And Comparing With The Individual Pixel's Intensity Value.

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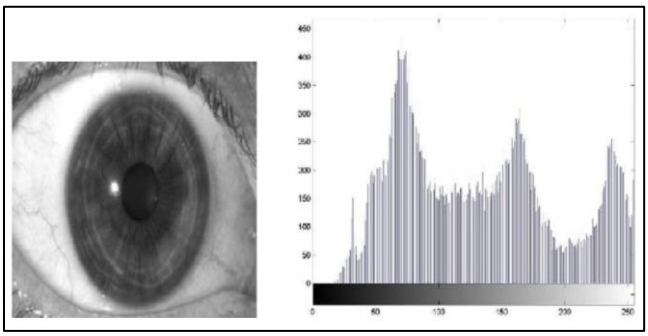

Figure 6: Reflection Detected In The Iris Portion For Estimation

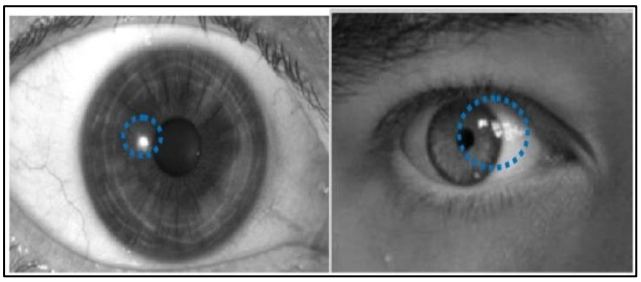

Figure 7: Input Image And Its Histogram

From The Figure 6, It Is Clear That The Intensity Value Of The Reflection Pixels Is High Since The Reflection Will Be Of White Region And The Calculation Is Carried Out To Detect This White High Intensity Values And Then Removed From The Iris Portion.

Image Enhancement

Basically Two Methods Of Image Enhancement Approaches Are Employed In This Research Work To Improve The Resolution Of The Iris Image To Extract And Process The Features Present In It And They Are Histogram Approach And Contrast Enhancement Method.

The Histogram Equalization Method Is One Of The Most Common And Powerful Method Employed To Improve The Contrast Of The Images [6]. The Important Process Carried Out In The Histogram Method Is,

1. Calculate The Cumulative Histogram Of The Image For Equalization (I.E.) Aggregate Histogram Has To Be Found.
2. Normalize The Cumulative Histogram To The Maximum Intensity Value In The Gray Scale 255(0 – 255)
3. Normalized Cumulative Histogram Value Is Used As A Mapping Function To Improve The Contrast Of The Input Iris Image.

ISSN: 2233-7857 IJFGCN

Procedure DetectPupil (Input image I)

Input: Input image I
Output: Pupil

Load the input image I
Generate binary image with threshold value >30
Perform morphological operation "detect" and "erode in the binary image
Perform flood fill operation
Apply Median filter to eliminate small regions
Compute the centroid of the detected pupil region (Px, Py)
Compute the radius of the pupil
END procedure

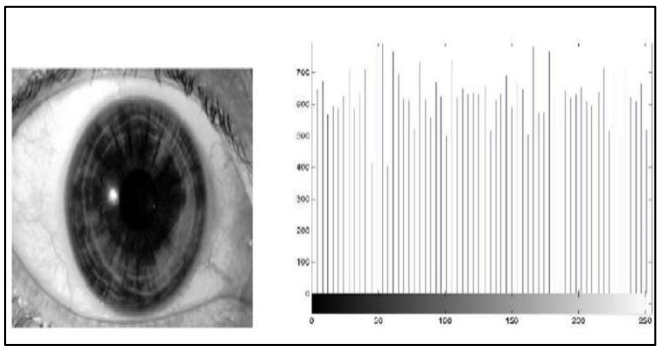

Figure 8: Enhanced Input Image After Histogram Equalization

Function Of The Histogram Equalization Is To Normalize The Intensity Values Of The Entire Pixels Present In The Image And Increases The Low Contrast Areas In To High Contrast Areas.

Segmentation Of Iris

The Segmentation Of The Iris Plays A Primary Role In The Authentication And Extraction Of The Most Important Features Present In The Iris And This Defines The Most Important Part Or Features Of The Eye Image And Segments It For Further Analysis And Processes. The Segmentation Involves Many Major Processes Like,

1. Discovery Of The Pupil Boundary
2. Discovery Of Pupil Portion
3. Discovery Of The Iris Boundary And Iris

The Segmentation Process Comprises Of Two Main Functions In Discovering The Pupil And Iris Boundaries And Then Identifies The Iris Portion Of The Eye To Be Processed Further To Extract The Key Features. The Preprocessed High Quality Iris Image Is Used For Segmentation And The Important Obstructions, Criteria And Factors Which Affect

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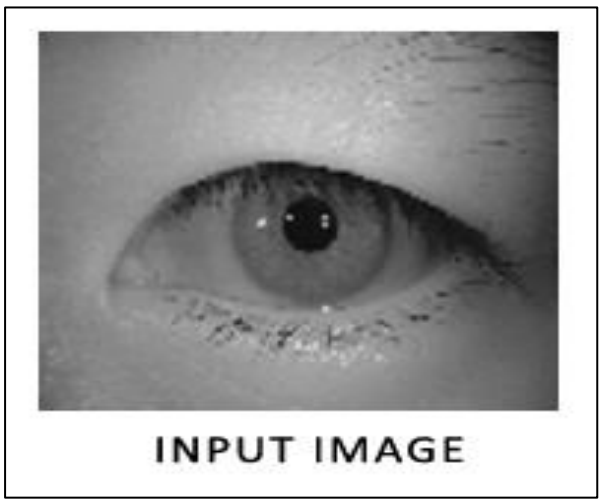

The Segmentation Process Are First Evaded And A Clear Noiseless Image Is Used For Segmentation Process. To Discover The Pupil Boundary And Pupil Region The Thresholding Method Along With Median Filter Is Utilized And To Discover The Iris Boundary Hough Transform Along With Canny Edge Detection Method Is Employed.

The Image Acquired From The Capturing Device Will Not Only Contain The Iris Portion Rather It Will Also Contain A Large Portion Of The Eye A Where The Iris Region Lies. Here The Segmentation Process Is Needed To Fetch The Regions Between The Pupil And Sclera. So The Boundaries Of These Regions Are First Found With The Discovery Of The Center Part Of The Pupil And Then The Iris Part Is Segmented For Extraction.

Discovery Of Pupil

The Pupil Of The Human Eye Is Usually Dark And Blacker Than The Iris Region And This Intensity Change Is Easier To Find And The Pupil Portion Is Marked Quite Easily Using Thresholding Method And By Applying Median Filters To Discover Pupil In The Eye. The Algorithm To Discover The Pupil Is Shown In The Figure 9.

The Enhanced Input Image Is Initially Fed And The Image Is Then Converted Into A Binary Image Where The Threshold Value T Is Set Higher Than 30 And This Threshold Value T Will Create A Binary Image Of The Eye Which Is Shown In The Figure 10. Two Main Morphological Operations “Detect” And “Erode” Is Applied In The Newly Created Binary Image And The Unwanted Parts Are Initially Detected And Then The Parts Re Removed By Erode Process. After The Two Morphological Operations, Flood Fill Is

Applied In The Binary Image To Get The Pupil From The Input Eye Image. The Center Of The Pupil Is Calculated And The Radius Of The Pupil Is Accurately Detected As Shown In The Figure 13.

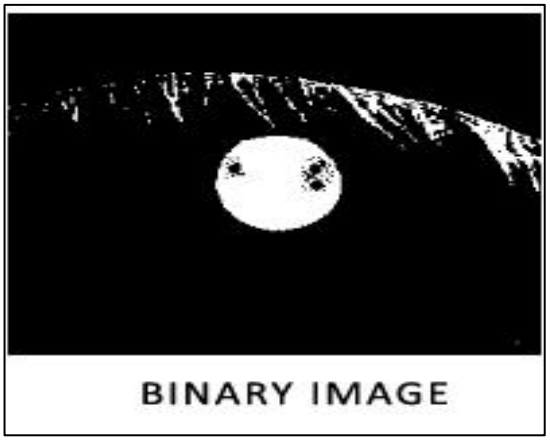

Figure 9: Pseudo Code Of Detectpupil Procedure

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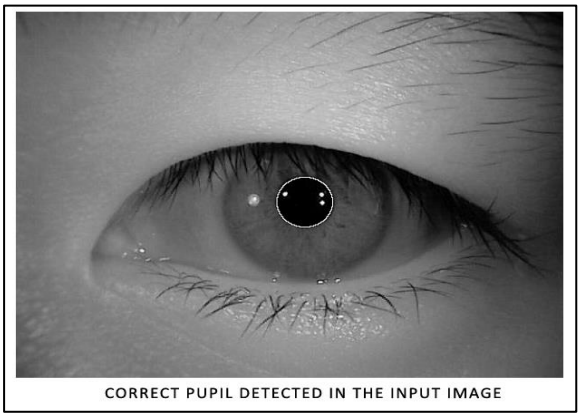

Figure 10: Binary Image Generated

The Figure 10 Clearly Shows The Binary Image Created By Using The Threshold Value Greater Than 30 And This Image Undergoes Morphological Operations To Discover The Pupil Region.

Figure 11: Flood Fills And Morphological Operations

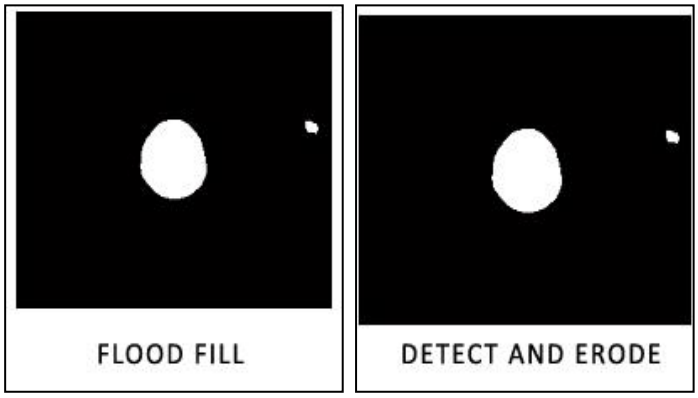

Figure 12: Filtered Image Figure 13: Finally Detected Pupil In The Input Eye Image

The Filtered Image Is Considered And Then The Center Of The Pupil Is Detected Accurately To Compute The Radius Of The Pupil. One The Radius Of The Pupil Is Detected, The Boundary Of The Pupil Is Found And The Exact Pupil Present In The Eye Input Image Is Detected Accurately As Shown In The Figure 13.

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Extract The Iris Feature

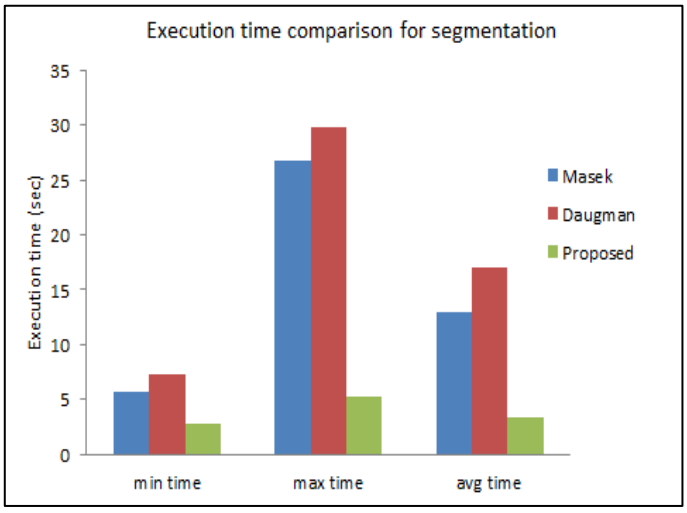
The Extraction Of The Iris From The Image Is Shown In The Figure 14 And Here The Canny Edge Detection And Hough Transformation Is Used To Carry Out The Task.

Procedure Extractiris (Input Image I)
Input: Input Image I **Output:** Iris Load The Input Image I Read The Input Image I Initialize Votes =0 Use Canny And Find The Edges Define The Radius Range To Be Used For Each Edge E Points Do Draw A Circle With That Edge Point E As Center And Radius R If The Edge Coincides With The Circumference Of The Circle Increment The Votes=Votes + 1 Close If Store Votes Separately In Array Close For Find The Maximum Votes In Array Fetch The Radius, And Centers (A,B) Plot A Circle Using Radius And Centers End Procedure

Figure 14: Pseudo Code Of Extractiris Procedure

The Procedure To Detect The Iris Is Shown In The Figure 14 And The Iris Outer Boundary Along With The Inner Boundary Is Detected Accurately And The Iris Portion Is Correctly Detected As Shown In The Figure 15.

Figure 15: Detected Iris Boundaries



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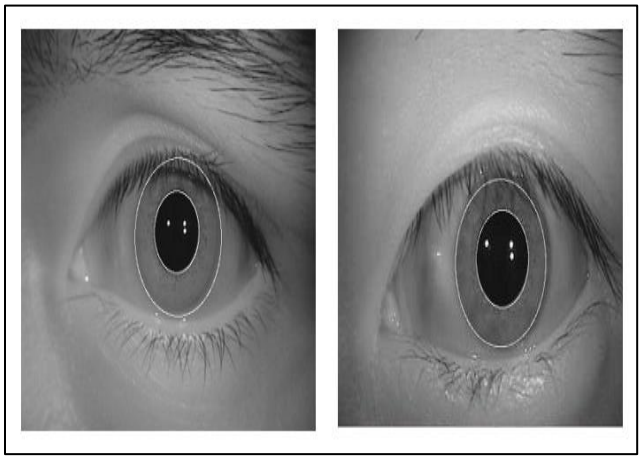

Figure 16: Segmented Iris Image

The Segmented Iris Image Shown In The Figure 16 Is Normalized Then The Important Features Are Retrieved To Generate The Key Needed For The Cryptosystem And The Execution Time Required For The Segmentation Time Is Compared With The Existing Works.

Experimental Results

The Entire Work Is Carried Out And Implemented On Intel Core I3 2.4 Ghz Processor Comprising Of 4gb Ram And The Experiments Are Conducted In Matlab7.12. To Evaluate The Performance Casia Lamp Database Is Used And 50 Images Of 8 Bit Gray Level Of Resolution 480 X 640 Are Considered And The Comparison Is Shown In The Table 1

Algorithm	Execution Time(S)		Average Time(S)
	Min Time	Max Time	
Masek	5.67	26.78	12.98
Daugman	7.22	29.82	16.99
Proposed	3.78	7.32	4.42

Table 1: Execution Time In (Sec) Comparison For Segmentation

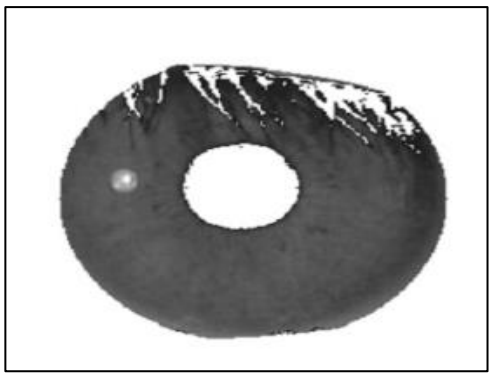

Figure 17: Execution Time Comparison Graph For Segmentation

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From The Table 1 And Figure 17 It Is Quite Clear That The Proposed Approach Performed Extremely Well And Outscored The Masek Approach [7] Which Used Modified Canny, Hough To Detect Iris, Techniques To Isolate Eyelids, Thresholding To Remove Reflection And Lashes And The Daugman [8] Approach Which Used Integro-Differential Operation To Detect And Segment.

Conclusion

The Paper Clearly Portrayed The Smooth Process Of Extraction The Features From The Iris To Generate The Biometric Keys Which Are Used For The Cryptosystem And The Proposed Processes Like Preprocessing And The Segmentation Outscored The Other Existing Algorithms By A Big Magnitude With Respect To The Execution Time And Performed Extremely Well.

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