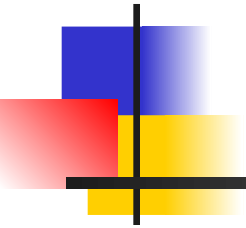
Efficient Iris Recognition System Based on Dual Boundary Detection Using Robust Variable Learning Rate Multi-layer Feed Forward Neural Network



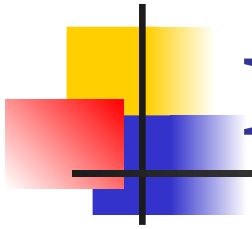
Presented

By

Mohtashim Baqar

Outline of the Presentation

- Introduction: Personal Identification objects
- What is the need of Biometric Identification?
- Motivation for Iris Recognition
- Drawbacks of past approaches for Iris Recognition
- Proposed Iris Recognition
  - Steps of proposed method
- Classification using Neural Networks
  - Why Neural Networks?
  - Robust time-varying learning rate Backpropagation
- Experimental Results
- Conclusion and Contribution



Introduction

Personal Identification Approaches

- Token-based:
  “something that you have”
- Knowledge-based:
  “something that you know”
- Biometrics-based:
  “something that you are”

What is the need for Biometric Identification Systems?

- System's security using
  - passwords,
  - secret codes or
  - identification cards.
- Problem
  - passwords or secret codes can be cracked
  - identification cards can be robbed

Motivation for Iris Recognition

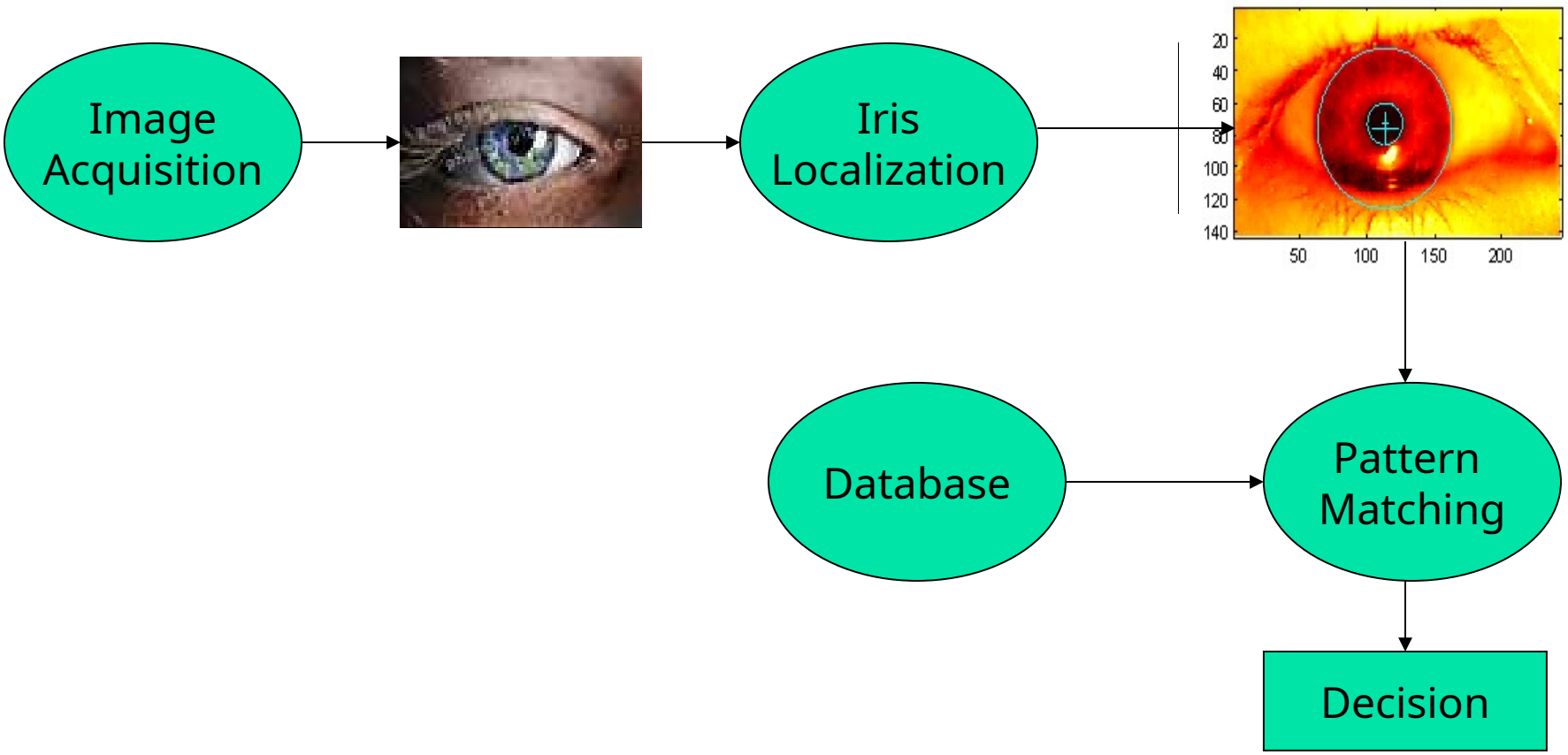
- The other biometric methods (voice, finger, face detections) are highly invasive. Typically person is required to
  - make physical contact with a sensing device (e.g., finger or hand contact).
  - take some special action (e.g. recite a specific phonemic sequence).
- Face recognition: Problems
  - variety of expressions
  - Twins may have same facial features

Is Iris an effective Biometric?

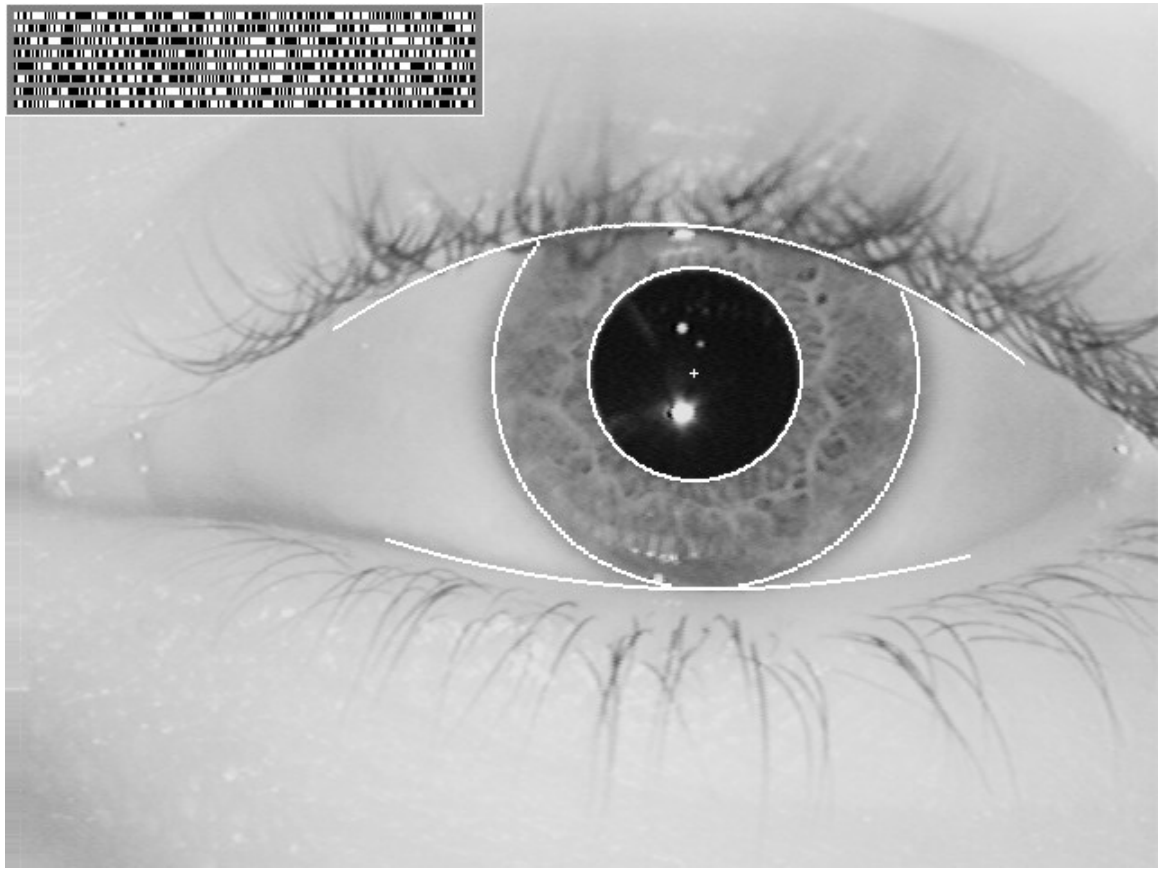
- Clinical observations show Iris is unique.
- Developmental Biology

  (i.e. Iris is genetically determined)
- Left and the Right Irises are unique
- Stable with Age

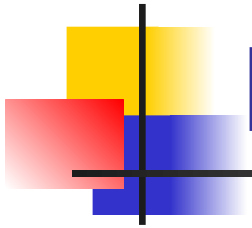
Typical Iris Recognition System



Example of An Iris Code (Daugman)



Drawbacks of Past Approaches for Iris Recognition



Most of the existing methods either of the following

- utilize 2D classification feature (Systems proposed by Daugman and Wildes et. al.) or
- apply certain transforms which increases the complexity (System proposed by Boles et. al.)
- use template matching (Daugman. Wildes et. al. and Boles et. al.)
- apply Neural Networks (NNs) but with 2D feature matrix (Alim et. al)

Proposed Iris Recognition System

Three Stage Approach:

1. **Iris image preprocessing**
   - Removal of specular highlight
   - Filtering the image to remove unwanted portions and noise from it
2. **Feature Extraction**
   - Iris localization.
   - Localizing the inner and outer boundaries of the iris.

Proposed Method (Contd.)

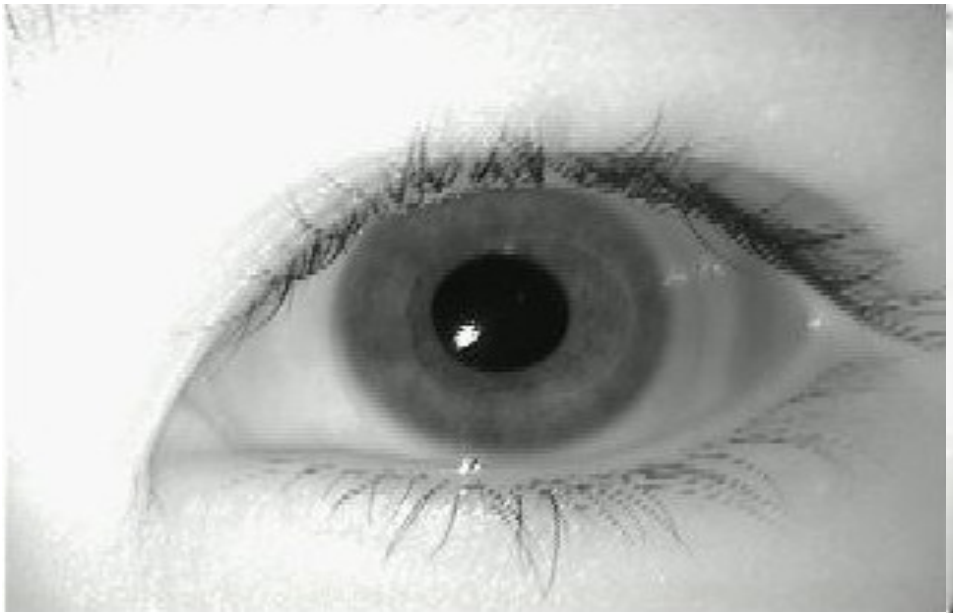
- Finding the contour of inner (Pupil-Iris) and outer (Sclera-Iris) boundaries of the iris.
- Obtaining the feature vector by concatenating the two contour vectors found in previous step, named as Iris Signature.
- Perform Up-sampling and Down-sampling operations to make the feature scale invariant.

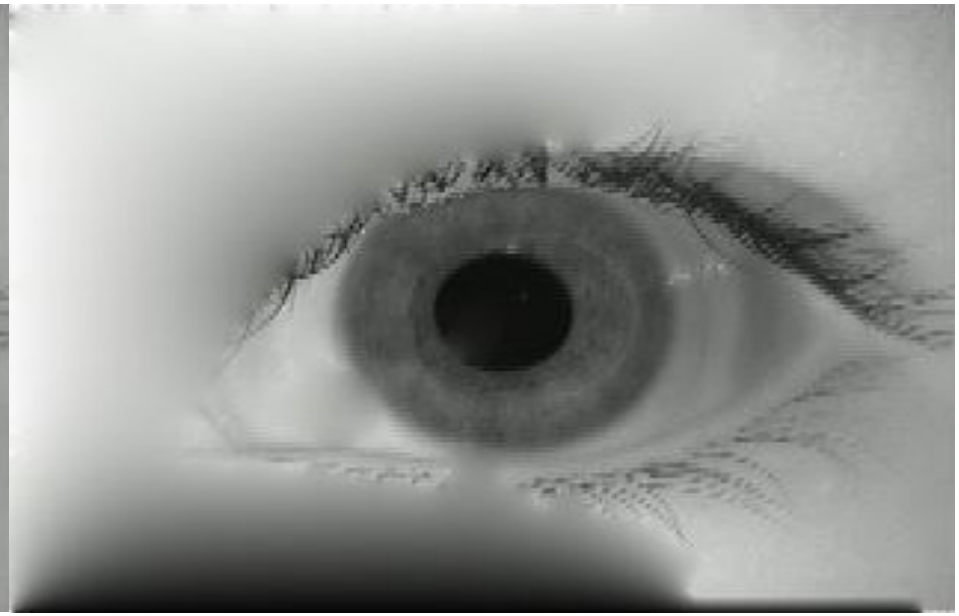
3. Classification using NN

- Employ a Robust Variable Learning Rate backpropagation algorithm with MFNN

Removal of specular highlight

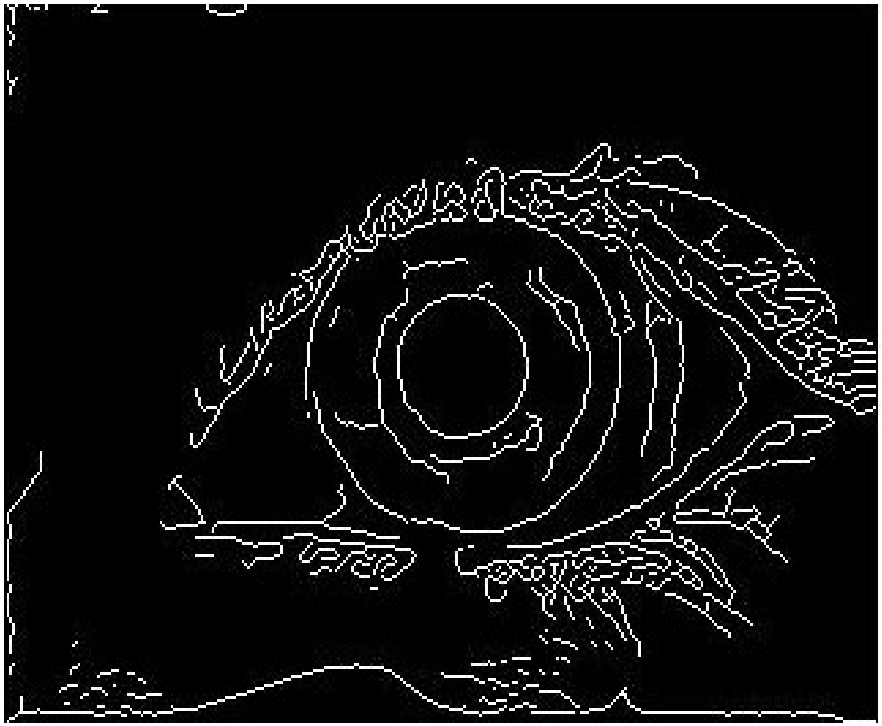
- The portions of the eye image with reflection marks are identified via boundary tracing and then the marked portion is dilated.
- The two dimensional interpolations are performed to recover the original portion it.





Edge Detection

- The canny method calculates the local maxima of the gradient using the derivative of a Gaussian filter.



Finding Centroid of An Eye Image

- Centroid refers to the point where weight's centre of the image lies.
- the centroid of an eye image is found to be near the centre of pupil.
- Finally, the position of the centroid is adjusted to make it to the center of the pupil as in real time image capturing the position of the pupil can get shifted.



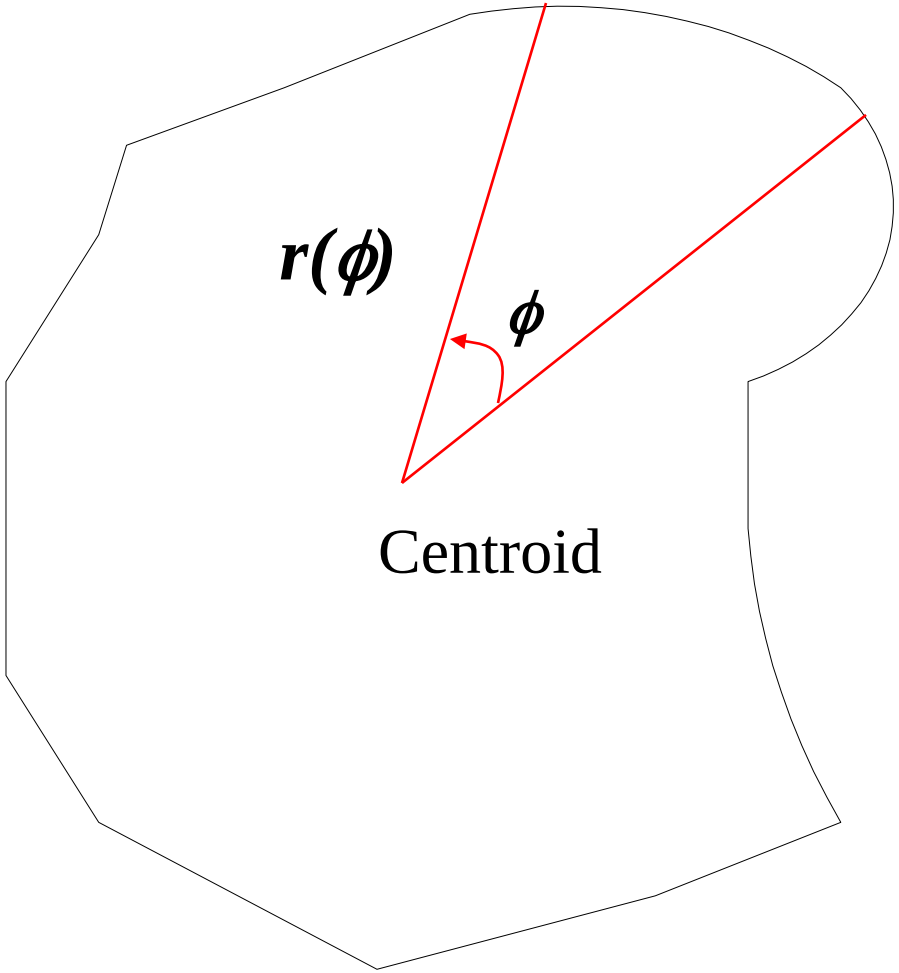
Centroid of an Image shown with a red dot

Adjusted Centroid

Extractiing Contour of Inner and Outer Boundaries of Iris

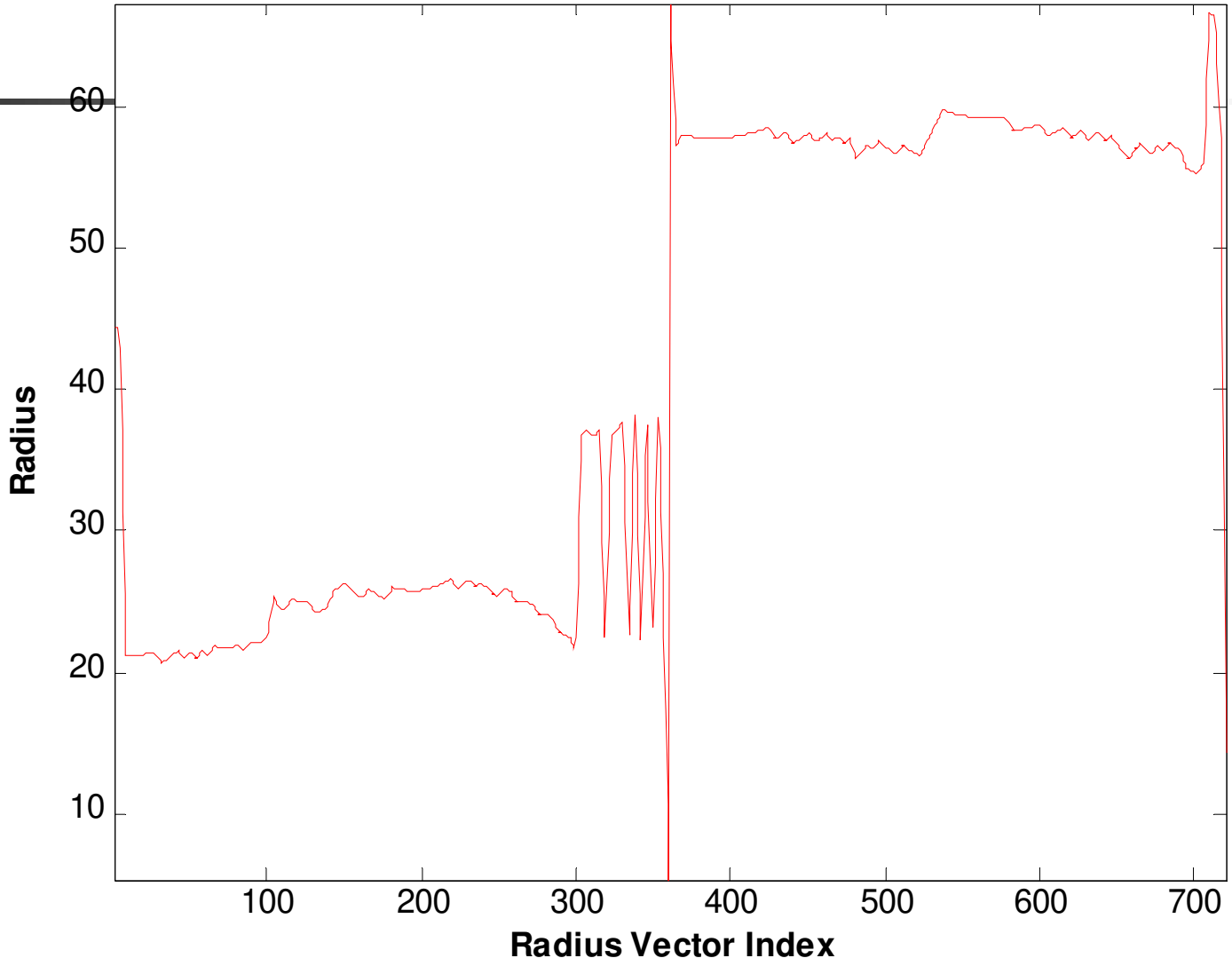
- Using centroid, the iris boundaries are stored via radius vector function method.
- Contour is started from the point which is at the maximum distance from the centroid.

Representing the Contour using Radius Vector Method

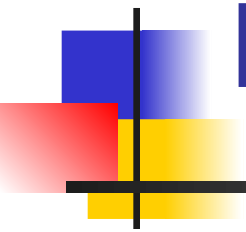


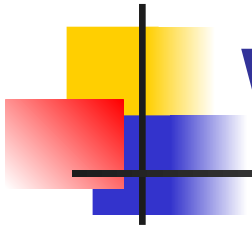
This method makes the algorithm rotation invariant

Sample Iris Signature



Classification using Neural Networks

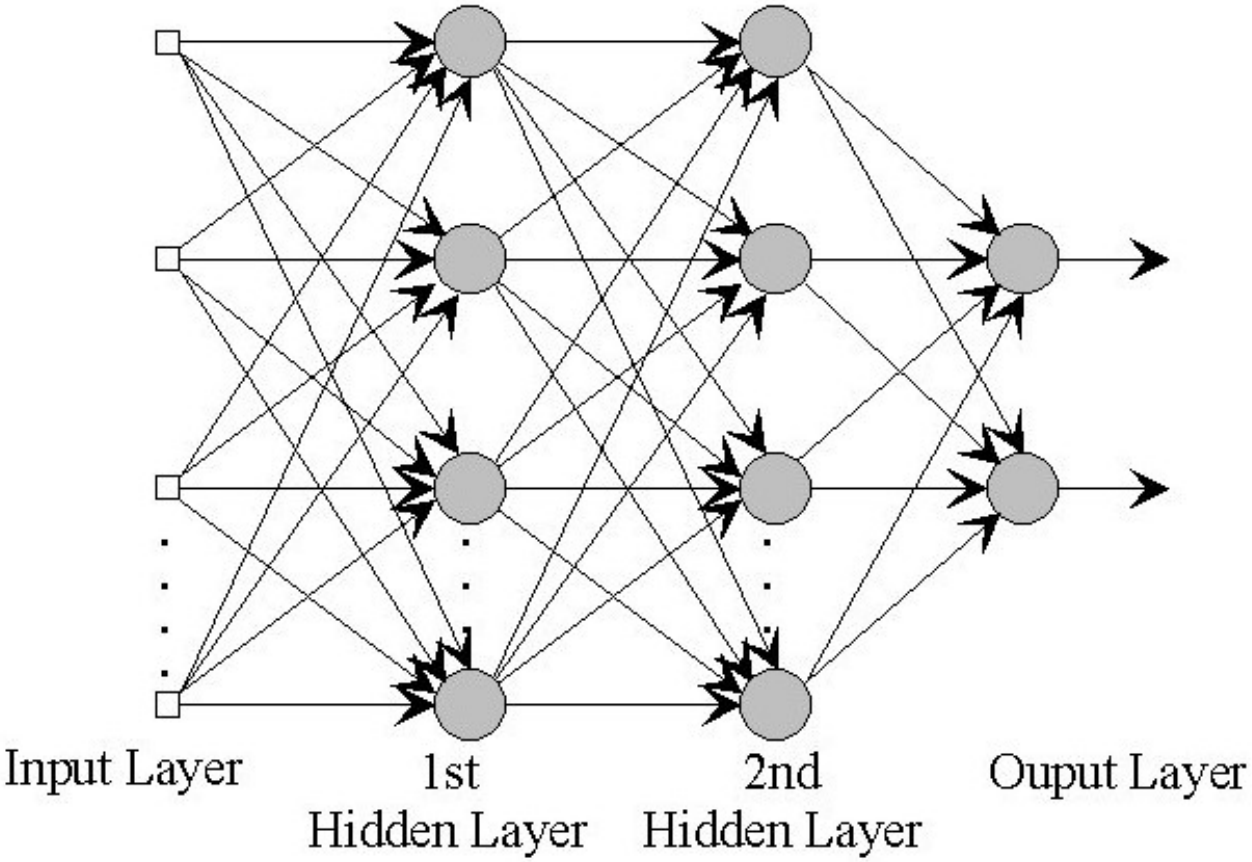




Why Neural Networks?

- Parallel Distributed Processor
- Adaptive Learning
- Self-Organization
- Nonlinear Structure

MFNN Structure



Modified Back-Propagation Algorithm

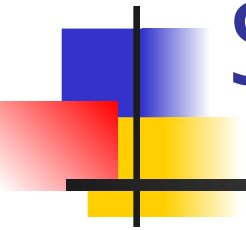
$$w_{ji}^{(l)}(n+1) = w_{ji}^{(l)}(n) + \mu(n)\ \delta_j^{(l)}(n)\ y_i^{(l-1)}(n)$$

New weights *Old weights* *Local gradient*

$$\delta_j^{(l)}(n) = \begin{cases} (d_j(n) - y_j^{(L)}(n))\phi_j'(v_j^{(L)}(n)), & \text{output layer,} \\ \phi_j'(v_j^{(L)}(n))\sum_k \delta_k^{(l+1)}(n) w_{kj}^{(l+1)}(n), & \text{hidden layer.} \end{cases}$$

$$\mu(n+1) = \alpha\mu(n) + \gamma p^2(n)$$

$$p(n) = \beta p(n-1) + (1-\beta)e(n)e(n-1)$$



Simulation Results

MFNN Specifications

- Single hidden layer
- 30 Neurons in the hidden layer
- 10 Neurons in the output layer
- For training of NN, noisy iris samples are generated by adding Gaussian noise at 12 dB, 14 dB and 16 dB SNRs

Results at 12 dB SNR

	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9	I_{10}	I_{11}
T_1	94	-	-	-	-	-	-	-	-	-	06
T_2	-	100	-	-	-	-	-	-	-	-	-
T_3	-	-	74	-	-	-	-	-	-	-	26
T_4	-	-	-	100	-	-	-	-	-	-	-
T_5	-	-	-	-	100	-	-	-	-	-	-
T_6	-	-	-	-	-	98	-	-	-	-	2
T_7	-	-	-	-	-	-	92	-	-	-	8
T_8	-	-	-	-	-	-	-	100	-	-	-
T_9	-	-	-	-	-	-	-	-	100	-	-
T_{10}	-	-	-	-	-	-	-	-	-	100	-

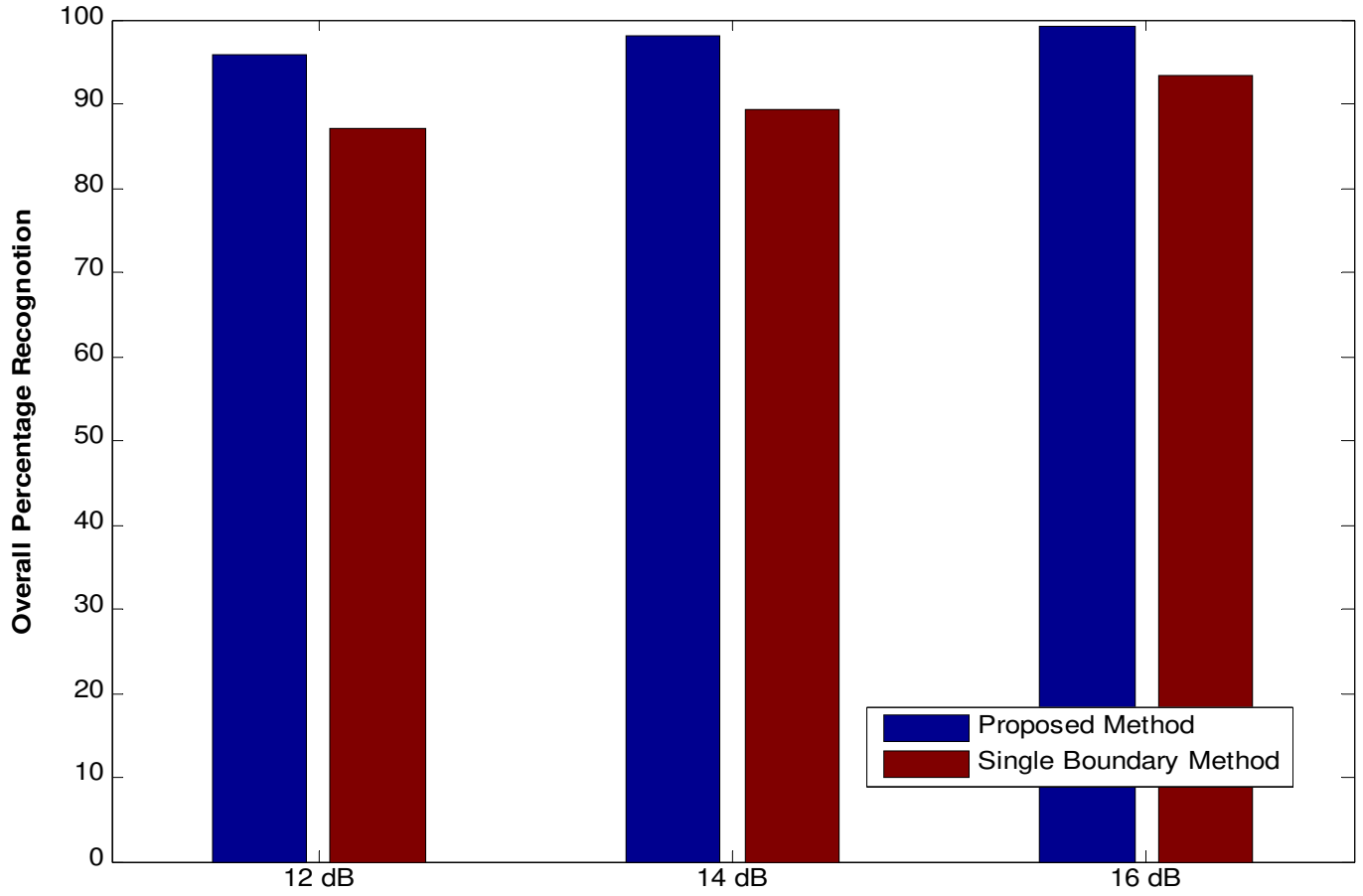
Results at 14 dB SNR

	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9	I_{10}	I_{11}
T_1	90	-	-	-	-	-	-	-	-	-	10
T_2	-	100	-	-	-	-	-	-	-	-	-
T_3	-	-	96	-	-	-	-	-	-	-	4
T_4	-	-	-	100	-	-	-	-	-	-	-
T_5	-	-	-	-	100	-	-	-	-	-	-
T_6	-	-	-	-	-	98	-	-	-	-	2
T_7	-	-	-	-	-	-	97	-	-	-	3
T_8	-	-	-	-	-	-	-	100	-	-	-
T_9	-	-	-	-	-	-	-	-	100	-	-
T_{10}	-	-	-	-	-	-	-	-	-	100	-

Results at 16 dB SNR

	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9	I_{10}	I_{11}
T_1	99	-	-	-	-	-	-	-	-	-	1
T_2	-	100	-	-	-	-	-	-	-	-	-
T_3	-	-	97	-	-	-	-	-	-	-	3
T_4	-	-	-	100	-	-	-	-	-	-	-
T_5	-	-	-	-	100	-	-	-	-	-	-
T_6	-	-	-	-	-	99	-	-	-	-	1
T_7	-	-	-	-	-	-	98	-	-	-	2
T_8	-	-	-	-	-	-	-	100	-	-	-
T_9	-	-	-	-	-	-	-	-	100	-	-
T_{10}	-	-	-	-	-	-	-	-	-	100	-

Comparison of Overall percentage recognition of proposed method with the single boundary method



Conclusion and Contributions

- A novel technique is proposed for representing the iris using contour of inner (Pupil-Iris) and outer (Sclera-Iris) boundaries of the iris.
- The proposed method is capable of mitigating the effect of specular highlight.
- The classification is performed using the MFNN via a Robust Variable Learning Rate backpropagation algorithm.

Conclusion (Contd.)

- Lesser complex and more efficient than the existing neural networks based techniques.
- Experimental result for percentage recognition shows that the proposed method outperforms the single boundary method.



Thank You !