Sparsity Inspired Selection and Recognition Of Iris Images

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We use sparse representations to develop an iris selection and recognition algorithm which can reject images with non sparse errors such as blur and segmentation errors and can perform good recognition even in the presence of sparse errors like occlusion due to eyelids and eye lashes. Hence precise segmentation of eyelids and eye lashes is no longer necessary for iris recognition. The proposed algorithm can be used for recognizing non ideal iris images obtained in partially co-operating and non co-operating user scenarios. Our algorithm can also be extended to recognition from iris videos.

Motivation

• Iris images acquired from a partially cooperating user suffer from many distortions.
• Directly applying the existing iris recognition algorithms on these images give poor results.
• We propose an algorithm to select the good iris images from the incoming video and subsequently recognize them.

Novelties

• The proposed method performs selection and recognition in a single step
• It can handle a wide variety of distortions such as blur, occlusions, specular reflections and segmentation errors..
• The quality measure is also a measure of recognition confidence.

Formulation

- The training images are stacked together to form a dictionary Matrix D.
- x_{ij} denotes the j[th] training image of the i[th] class.

$$\mathbf{D} = [\mathbf{D}_1, ..., \mathbf{D}_L] \in \mathbb{R}^{N \times (n.L)}$$
$$= [\mathbf{x}_{11}, ..., \mathbf{x}_{1n} | \mathbf{x}_{21}, ..., \mathbf{x}_{2n} | ......| \mathbf{x}_{L1}, ..., \mathbf{x}_{Ln}]$$

- The test vector y can be written as a linear combination of the gallery images of the true class.
- It can hence be written as a linear combination of all the gallery images as follows

$$\mathbf{y} = \sum_{i=1}^{L} \sum_{j=1}^{n} \alpha_{ij} \mathbf{x}_{ij} \qquad \mathbf{y} = \mathbf{D}\alpha$$

- If the number of classes is high, the representation of the test vector in terms of the training images of its true class is the sparsest representation.
- The coefficients in the sparsest representation of the test image in terms of the training images can be obtained by solving
  1. Basis Pursuit problem or

$$\hat{\alpha} = \arg \min_{\alpha' \in \mathbb{R}^N} \| \alpha' \|_1 \quad \text{subject to} \quad \mathbf{y} = \mathbf{D}\alpha'$$

  2. Basis Pursuit DeNoising problem.

$$\hat{\alpha} = \arg \min_{\alpha' \in \mathbb{R}^N} \| \alpha' \|_1 \quad \text{subject to} \quad \|\mathbf{y} - \mathbf{D}\alpha'\| \le \varepsilon$$

- If the test iris image is poorly acquired, it will not have discriminating texture features.
- Hence, the coefficients in its representation as a linear combination of the gallery images will no longer be sparse.
- So one way to measure the quality of the iris image is by the Sparse Concentration Index SCI. defined by

$$SCI(\alpha) = \frac{\frac{L.\max \|\Pi_i(\alpha)\|_1}{\|\alpha\|_1} - 1}{L - 1}$$

- It is a measure of the fraction of the energy present in the best class.
- The iris images with low SCI value are rejected.

Theory

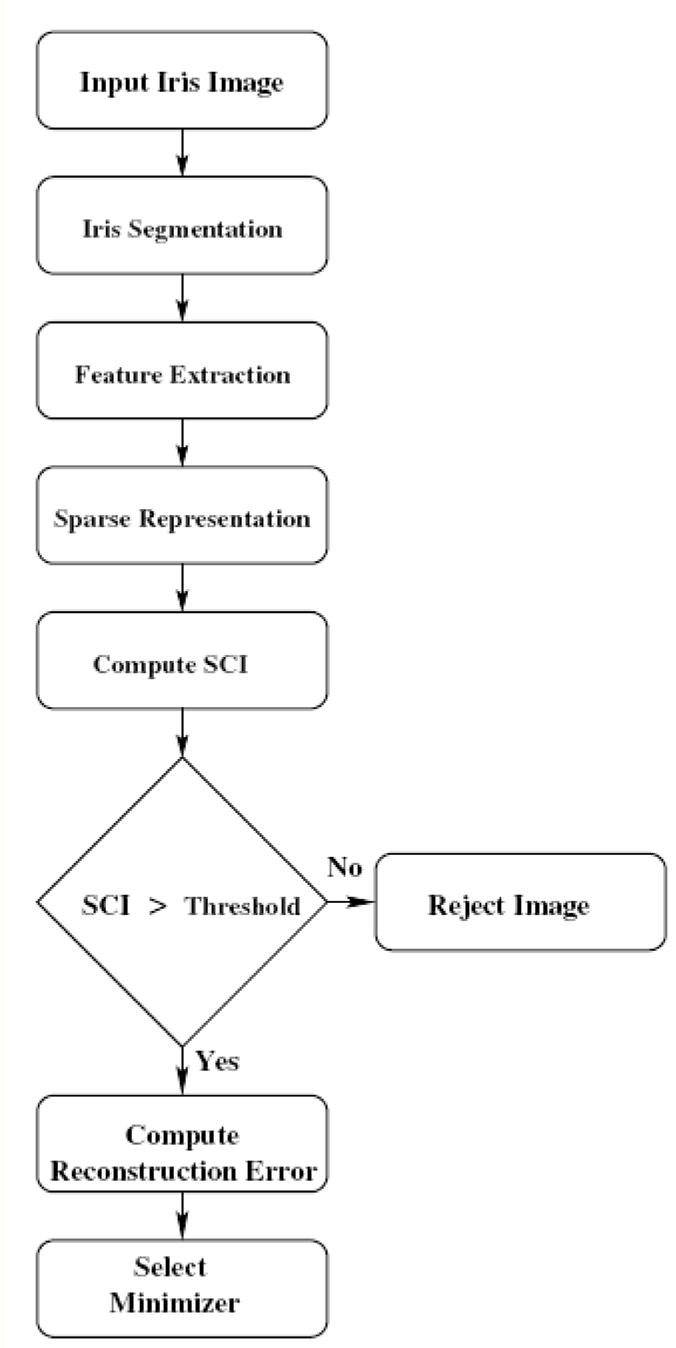
• Well acquired iris images can be represented as a linear combination of training images of the same class.

•Hence, its representation as a linear combination of all the gallery images is sparse.

•From the recovered sparse coefficients, the class of the test image can be obtained.

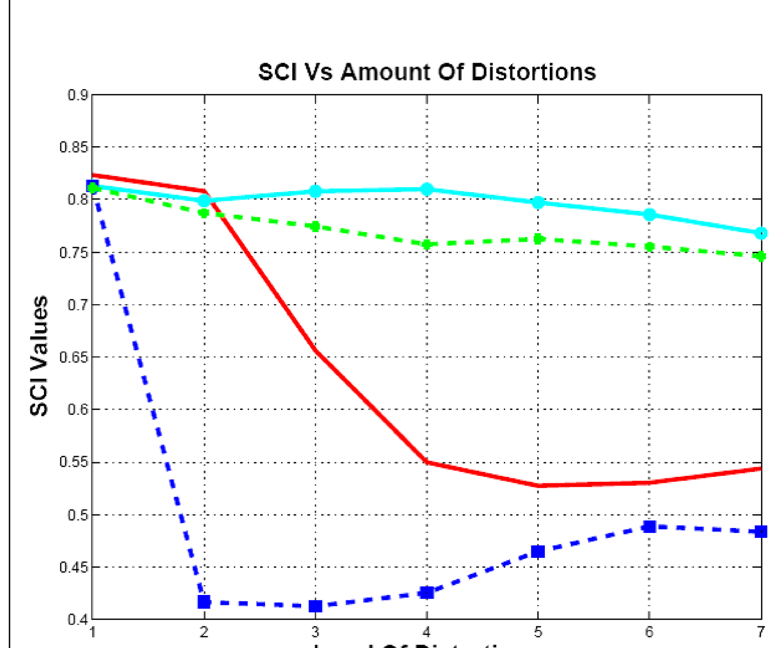
•Iris images suffering from distortions will not have a sparse representation and hence can be rejected.

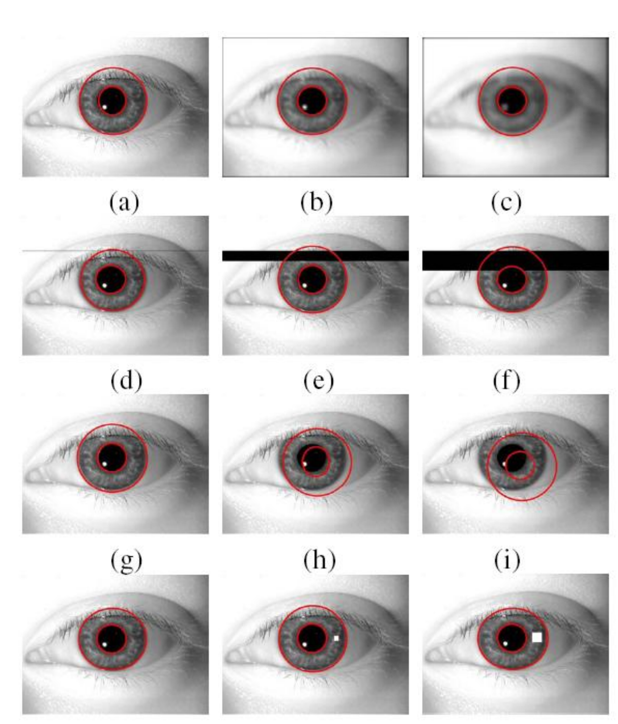
Block Diagram



Experimental Results

Variation of SCI with Simulated Iris Distortions





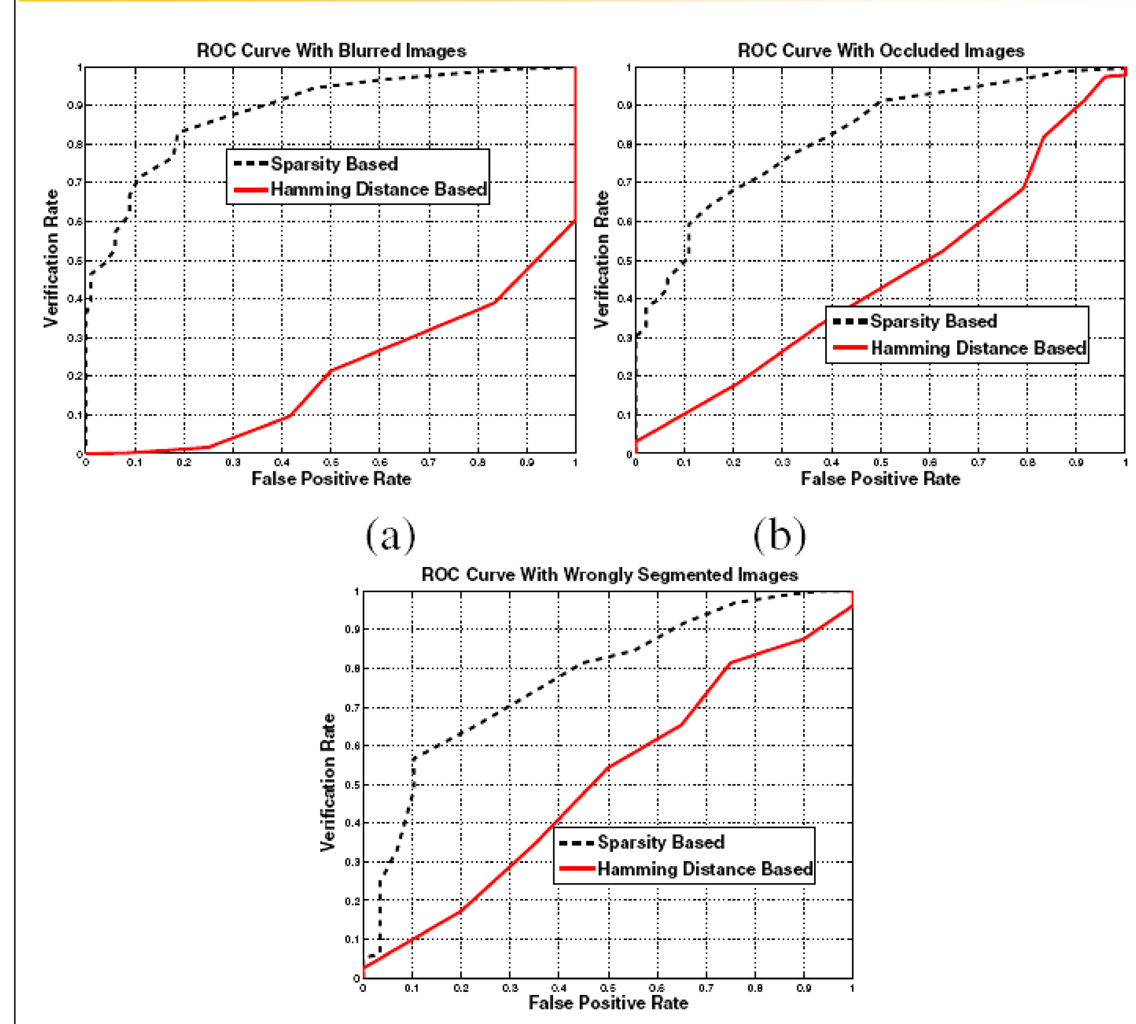
Iris Images with Simulated Distortions

Recognition Results on the ND-IRIS-0405 Dataset

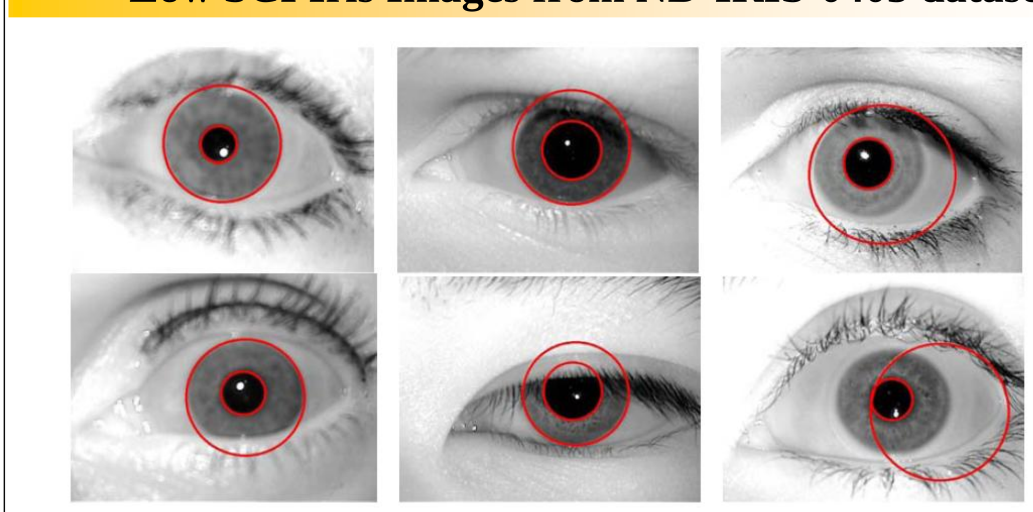
Image Quality	NN	Masek's Implementation	Our Method
Good	98.33	97.5	99.17
Blured	95.42	96.01	96.28
Occluded	85.03	89.54	90.30
Seg. Error	78.57	82.09	91.36

Experimental Results

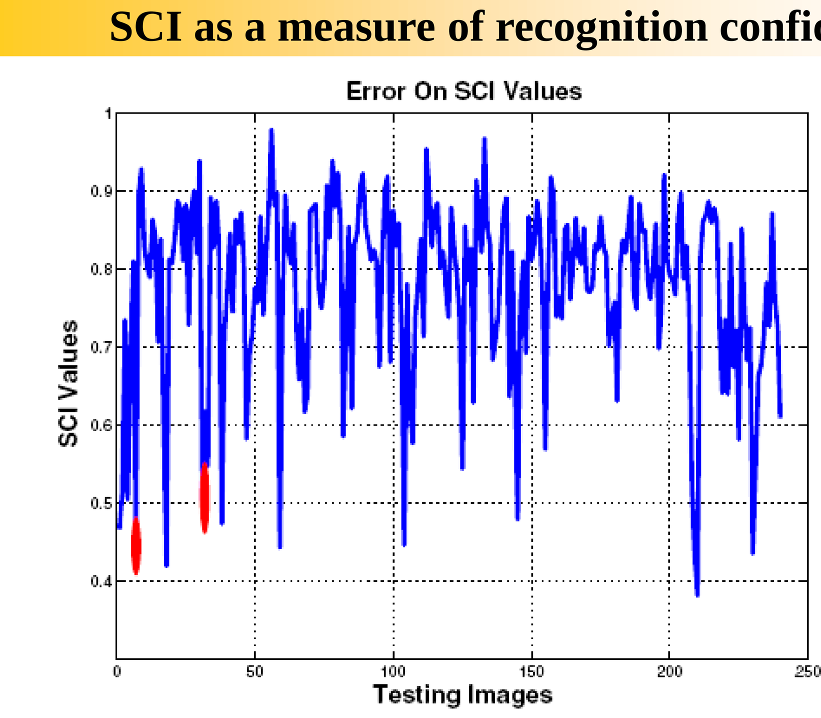
ROC Plots For Image Selection



Low SCI Iris Images from ND-IRIS-0405 dataset



SCI as a measure of recognition confidence.



Conclusions

•We have developed a unified approach for iris image selection and recognition.
• Proposed method can handle wide variety of distortions including blur, occlusions and segmentation errors.
• We are currently working on handling the poor quality iris images rather than rejecting them.
•This is a major challenge in our grand goal of developing iris recognition systems for unconstrained environments.