Accurate Iris Segmentation for Non-Cooperative Iris Recognition through Multi-task Network

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Abstract:
Iris image suffer from noise due to non-cooperative situation. It creates challenge for segmentation. Here we propose deep learning based efficient segmentation method. It provides complete solution for such situation. To train this we have used various databases, which involved various illumination and imaging sensors. The proposed segmentation method can be utilized for all iris recognition methodology to improve performance in non-cooperative iris recognition.

Key words: *Iris Segmentation, multi task learning, iris localization, iris recognition.*

INTRODUCTION
The iris recognition is one of the stable, accurate and efficient identification techniques. It is widely used by intelligence bureau in forensic lab. It consists of various steps such as image acquisition, pre-processing, segmentation, feature extraction and finally matching. To solve this issue lot of work had been done in past. However, there is common problem with many techniques. The fig.1 shows various degraded images with different type of noises.

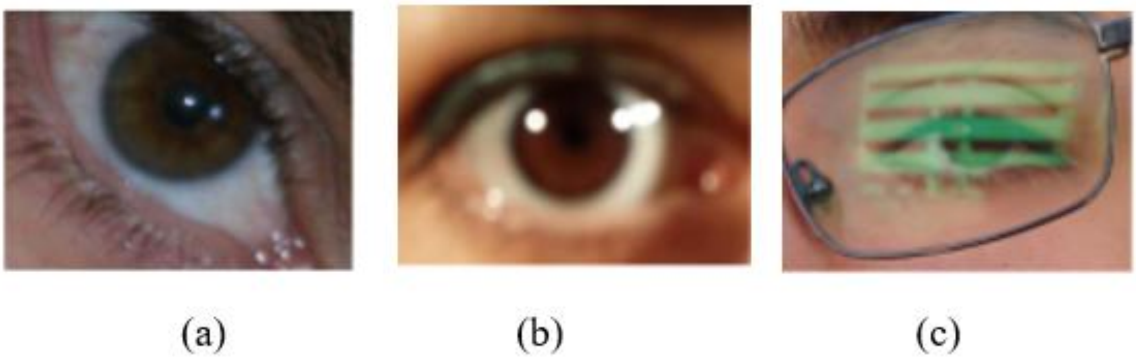

FIGURE 1: Degraded images (a) Iris rotation, (b) blur and (c) glasses occlusion

The iris segmentation has mainly two parts: first is pixel level identification for all regions and second is to obtain inner and outer boundaries. It can be seen in fig.2.

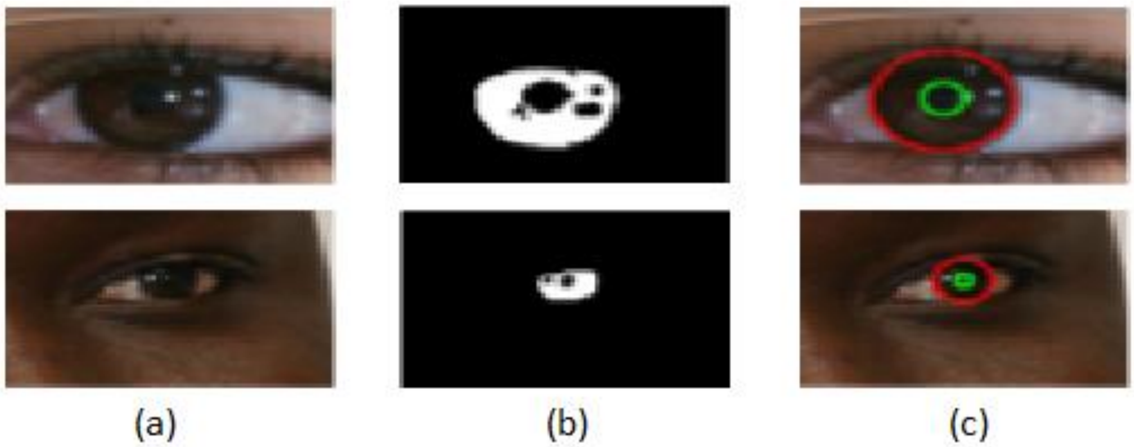

FIGURE 2: Incorrect segmentations: (a) iris images, (b) iris mask and (c) iris boundaries

TECHNICAL METHODS

Here, we discuss entire process of iris recognition system and later about our proposed system's approach. The entire system can be described under pipeline, multi-task attention network, post processing and training objectives. First, we illustrate iris segmentation, normalization, feature extraction and matching. Which comes under pipeline of iris recognition system.

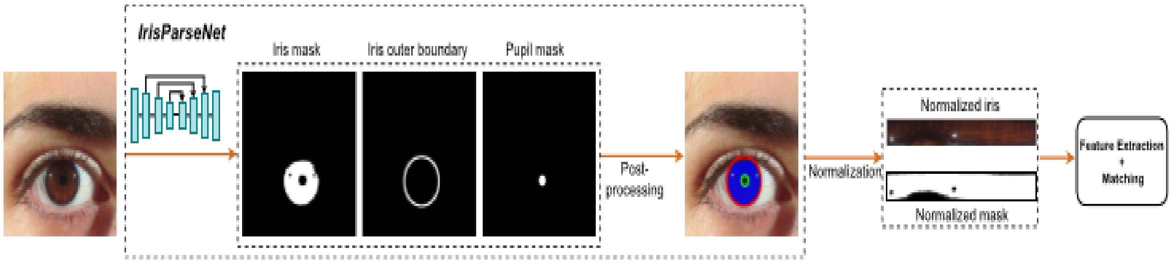

FIGURE 3: Iris recognition system

The irisParseNet takes iris image as input and produce iris mask. Further, it produces iris outer boundary and pupil mask. It is given to post processing step. Normalization is performed on this obtained result. It decreases influence of iris size as well as pupillary dilation on feature extraction and matching. After achieving feature maps, the convolution with 32 filters are applied.

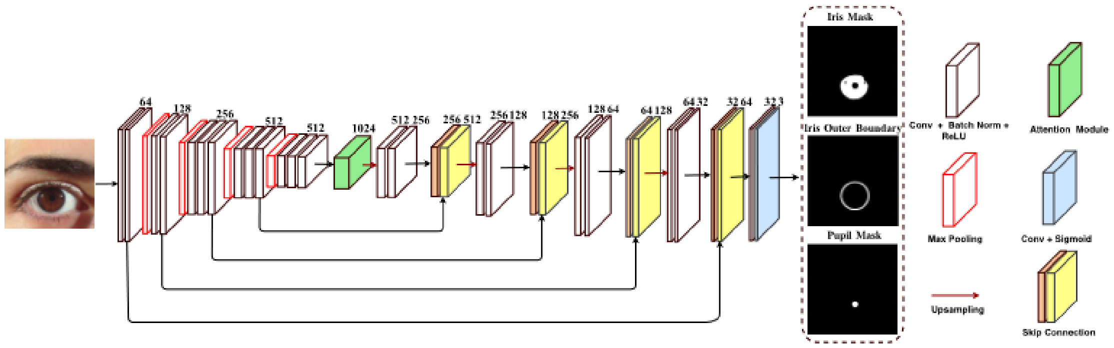

FIGURE 4: Proposed multi-task network architecture

The multi-task network has five stages and each stage consists of two or three convolutions of size 3x3. Every step deals with bilinear un-sampling. The attention module extracts contextual features by using atrous spatial pyramid pooling (ASPP). The five modules are given as:

$$D1(P) = ReLu\left(BN\left(Conv1_{1\times 1}(P)\right)\right) \quad (1)$$

$$D2(P) = ReLu\left(BN\left(Conv_{3\times 3}^{6}(P)\right)\right) \quad (2)$$

$$D3(P) = ReLu\left(BN\left(Conv_{3\times 3}^{12}(P)\right)\right) \quad (3)$$

$$D4(P) = ReLu\left(BN\left(Conv_{3\times 3}^{18}(P)\right)\right) \quad (4)$$

$$G(P) = Up\left(ReLu\left(BN\left(Conv_{1\times 1}\left(AvgPool(P)\right)\right)\right)\right) \quad (5)$$

The feature maps are fused as:

$$H = D1(P) \oplus D2(P) \oplus D3(P) \oplus D4(P) \oplus G(P) \quad (6)$$

In the post processing, iris mask & outer boundary and pupil mask are predicted through the network. To avoid the noise, eight neighbourhood component analysis is done. The overall loss is calculated in object training.

RESULTS AND CONCLUSION

Images of adopted databases are obtained under non-cooperative environments. Some examples with accurate location of iris boundaries as well as elimination of noise is shown in fig.5. The equal error rate (EER) and Daugman's decidability index (DI) are used to evaluate iris recognition performance.

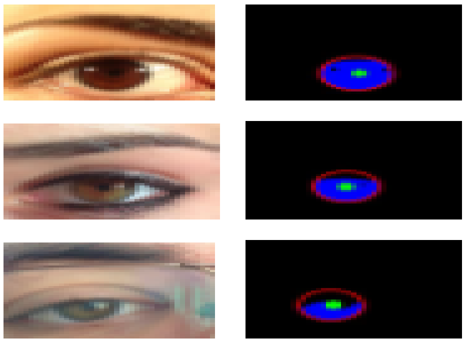

FIGURE 5: Example Images and outputs

The samples of segmentation results with proposed method is shown in fig.6. It is best viewed in colour images and with magnifications.

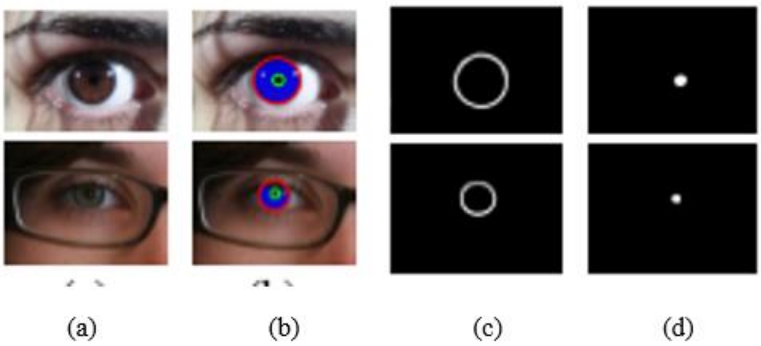

FIGURE 6: Sample of segmentation (a) Iris images, (b) Iris mask blue, (c) Iris outer boundary, (d) pupil mask

ACKNOWLEGEMENT

We would like to thank Nivedita and Vagish Roy for their help and supports at each step.

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