Fully Convolutional Networks and Generative Adversarial Networks Applied to Sclera Segmentation

Diego R. Lucio[1] Rayson Laroca[1] Evair Severo[1]
Alceu S. Britto Jr.[2] David Menotti[1]

[1]Department of Informatics
Federal University of Paraná
Curitiba, Paraná, Brazil
{drlucio,rblsantos,ebsevero,menotti}@inf.ufpr.br

[2]Department of Computer Science
Pontifical Catholic University of Paraná
Curitiba, Paraná, Brazil
alceu@ppgia.pucpr.br

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Introduction

- Biometry
- Eye Regions
- Importance of Segmentation

Biometry

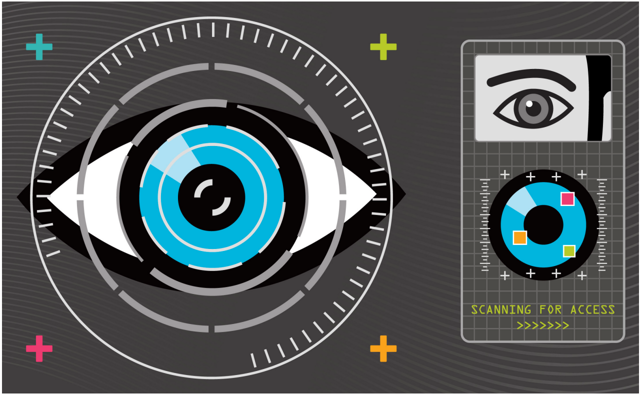


Figure: Example of a biometrics system

Eye Regions

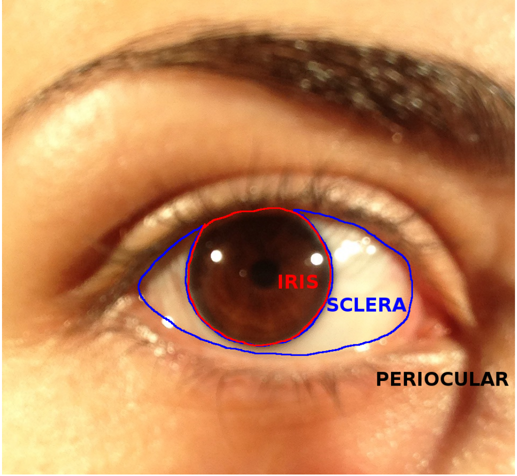


Figure: Eye regions

Segmentation Example

(a) Mask

(b) Image

Figure: Miche iPhone 5 example image

Segmentation Approaches

- Generative Adversarial Network
- Fully Convolutional Network
- Encoder-decoder (SegNet)

Generative Adversarial Network (GAN)

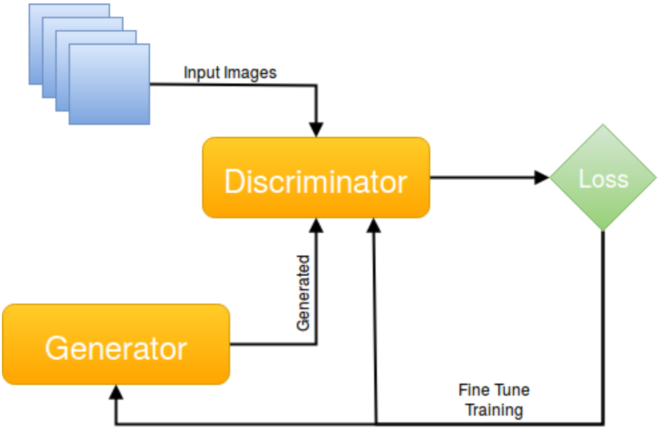


Figure: GAN Architecture

Figure: Painting styles

Transfer Style

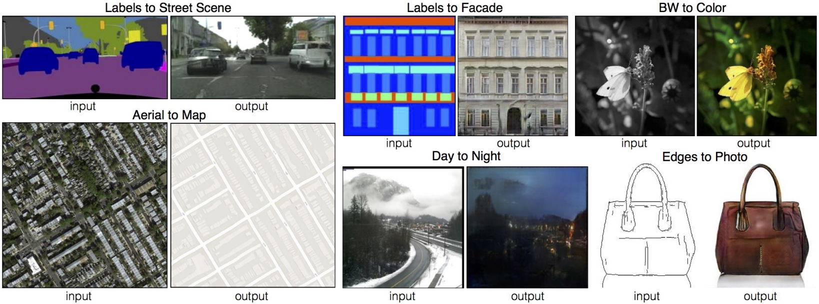


Figure: Other examples

Fully Convolutional Network (FCN)

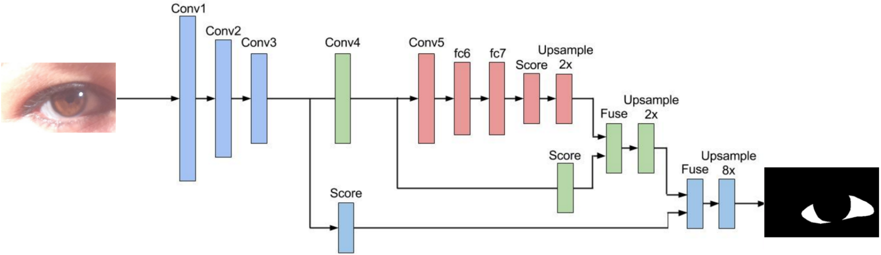


Figure: FCN8 example

FCN Results

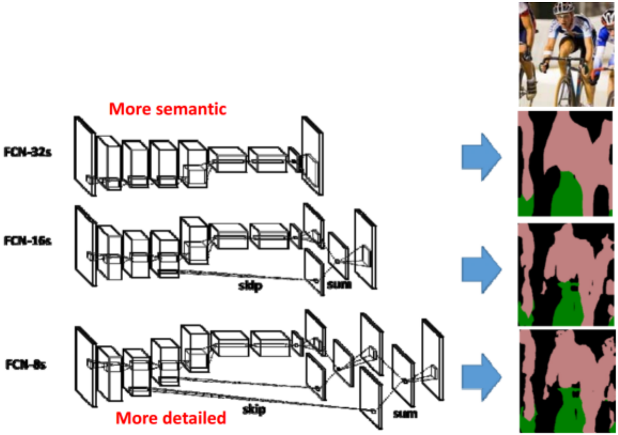


Figure: FCN's Results

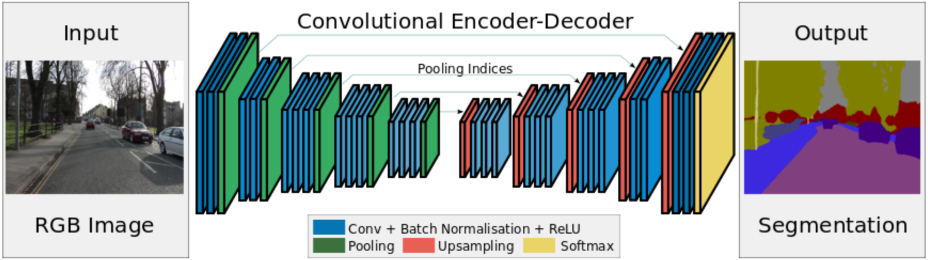


Figure: Encoder Decoder Architecture

Table: Overview of the datasets used in this work. All of these are a subset of the original dataset.

Dataset	Images	Subjects	Resolution
UBIRIS.v2	500	261	400×300
MICHE-I	1,000	92	Various
MICHE-GS4	333	92	Various
MICHE-IP5	323	92	Various
MICHE-GT2	344	92	640×480

Proposed Approach

- Periocular Region Detection
- Sclera Segmentation

Periocular Region Detection (Fast-YOLO)

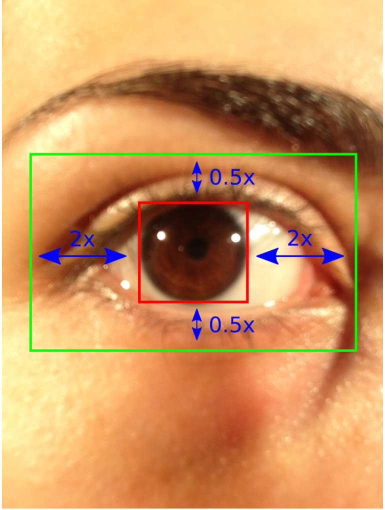
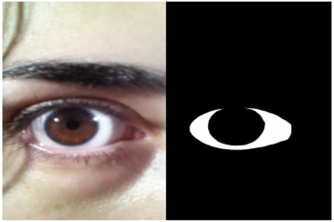


Figure: Detection example

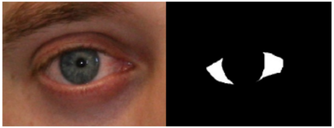
Images without preprocessing

(a) MICHE-IP5



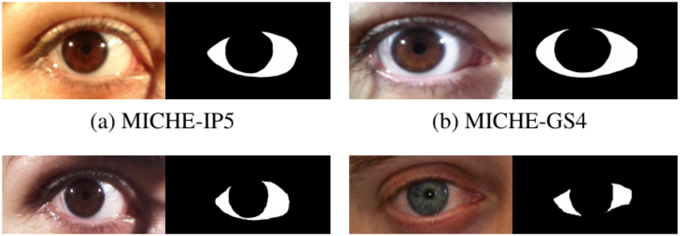
(b) MICHE-GS4

(c) MICHE-GT2



(d) UBIRIS.v2

Figure: Images without preprocessing



(a) MICHE-IP5 (b) MICHE-GS4

(c) MICHE-GT2 (d) UBIRIS.v2

Figure: Preprocessed images

Results

Table: Results achieved using the proposed protocol.

Database	Approach	Recall %	Precision %	F-score %
UBIRIS.v2	GAN	87.48 ± 08.19	87.10 ± 08.16	86.82 ± 05.88
	SegNet	72.48 ± 17.15	87.52 ± 08.53	77.82 ± 13.08
	FCN	**87.31 ± 06.68**	**88.45 ± 06.98**	**87.48 ± 03.90**
MICHE-I	GAN	87.07 ± 10.81	86.39 ± 12.02	86.27 ± 09.97
	SegNet	64.59 ± 24.73	83.39 ± 18.53	69.87 ± 22.34
	FCN	**87.59 ± 11.28**	**89.90 ± 09.82**	**88.32 ± 09.80**
MICHE-GS4	GAN	85.72 ± 12.53	86.12 ± 13.01	85.20 ± 11.31
	SegNet	66.50 ± 26.34	76.09 ± 23.80	67.92 ± 23.87
	FCN	**88.24 ± 12.03**	**88.65 ± 10.62**	**88.12 ± 10.56**
MICHE-IP5	GAN	88.11 ± 07.40	87.71 ± 07.71	87.42 ± 05.43
	SegNet	31.90 ± 26.05	79.40 ± 32.93	40.95 ± 29.19
	FCN	**87.51 ± 11.61**	**89.32 ± 05.22**	**87.80 ± 08.24**
MICHE-GT2	GAN	86.20 ± 15.02	83.81 ± 15.73	84.50 ± 14.28
	SegNet	73.77 ± 21.20	76.46 ± 18.29	72.33 ± 18.26
	FCN	**87.86 ± 12.23**	**88.50 ± 12.68**	**87.94 ± 11.59**

Results - Comparison

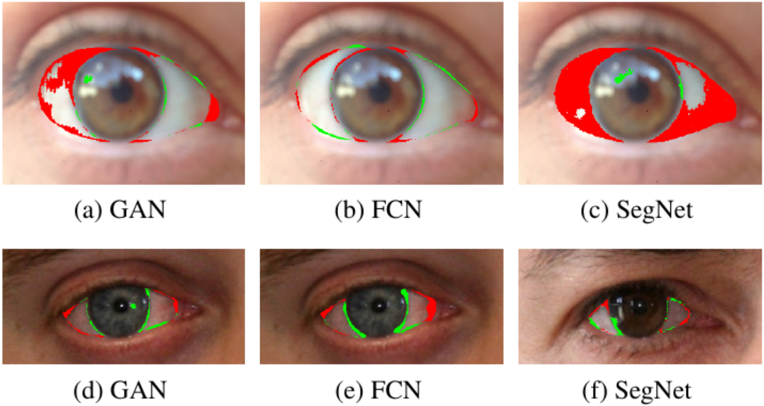


Figure: Samples of scleras segmented using the ground truth for highlighting errors: green and red pixels represent the FPs and FNs, respectively.

Future Work

- To design novel and better network architectures
- To create a unique architecture that integrates the periocular region detection stage
- To employ a post-processing stage to refine the segmentation given by the proposed approaches

Future Work

- To design a general and independent sensor approach, where the image sensor is first classified and then the sclera is segmented with a specific approach
- To compare the proposed approaches with methods applied in other domains such as iris segmentation and periocular-based recognition.

Questions?

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http://www.inf.ufpr.br/drlucio/

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