Fully Convolutional Networks and Generative Adversarial Networks Applied to Sclera Segmentation

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1. Introduction

2. Segmentation Approaches

3. Datasets

4. Proposed Approach

5. Results

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Introduction

- Biometry
- Eye Regions
- Importance of Segmentation
Figure: Example of a biometrics system
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
Figure: Other examples
Figure: FCN8 example
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.

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Images</th>
<th>Subjects</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>UBIRIS.v2</td>
<td>500</td>
<td>261</td>
<td>$400 \times 300$</td>
</tr>
<tr>
<td>MICHE-I</td>
<td>1,000</td>
<td>92</td>
<td>Various</td>
</tr>
<tr>
<td>MICHE-GS4</td>
<td>333</td>
<td>92</td>
<td>Various</td>
</tr>
<tr>
<td>MICHE-IP5</td>
<td>323</td>
<td>92</td>
<td>Various</td>
</tr>
<tr>
<td>MICHE-GT2</td>
<td>344</td>
<td>92</td>
<td>$640 \times 480$</td>
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</tbody>
</table>
Proposed Approach

- Periocular Region Detection
- Sclera Segmentation
Periocular Region Detection (Fast-YOLO)

Figure: Detection example
Images without preprocessing

Figure: Images without preprocessing

(a) MICHE-IP5
(b) MICHE-GS4
(c) MICHE-GT2
(d) UBIRIS.v2
Figure: Preprocessed images

(a) MICHE-IP5
(b) MICHE-GS4
(c) MICHE-GT2
(d) UBIRIS.v2
Table: Results achieved using the proposed protocol.

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

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