A New Efficient Method for Digital Hair Removal by Dense Threshold Analysis

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Context

Several **computer-based methods** exist for **automatic analysis** of skin lesions (e.g. naevi, melanoma) for diagnostic and/or prognostic goals. However, such methods are often severely affected by the presence of **hairs** in the lesion area.

Digital Hair Removal (DHR)

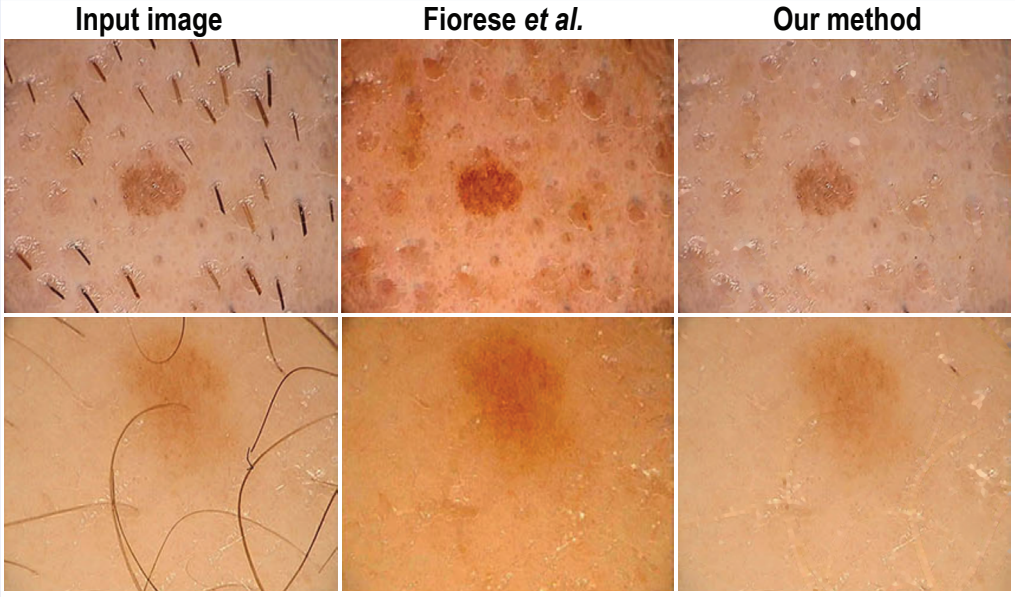
We propose a new DHR method based on the detection of thin-and-elongated structures at all 256 luminance levels of the input image [7]. Thin-and-elongated shapes being found are next classified into hairs or non-hairs based on a morphological analysis using the shape skeleton [1]. True-positives (hairs) are replaced by surrounding skin texture using standard image inpainting methods [9].

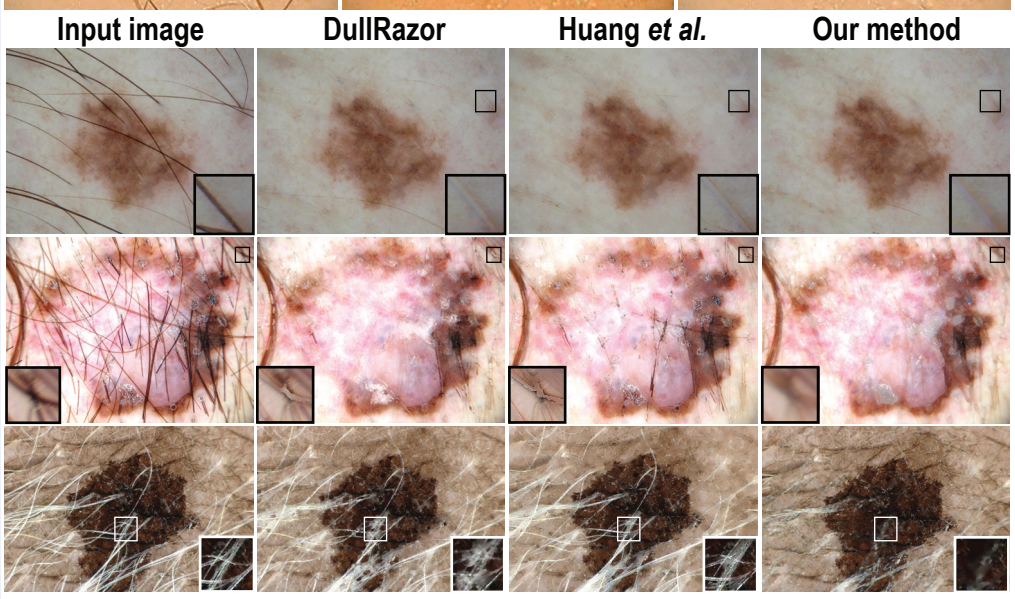
Materials and Methods

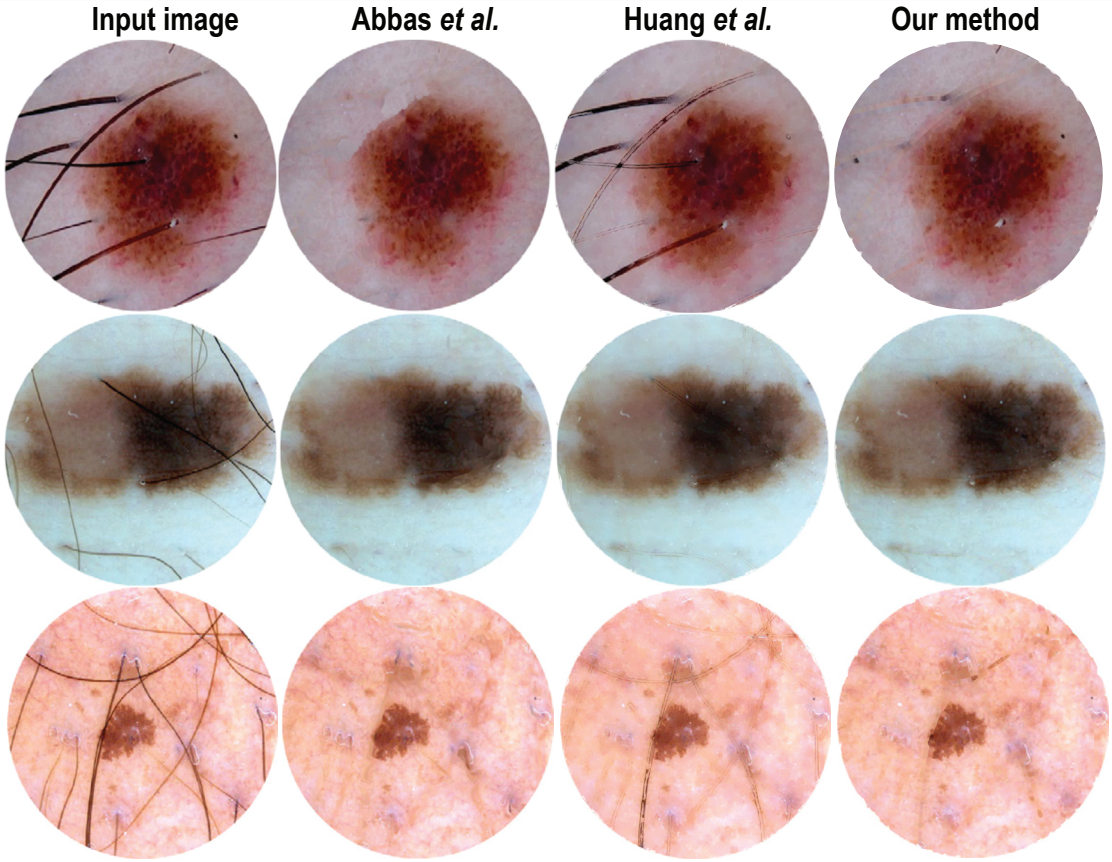
We compared our DHR results with five state-of-the-art methods on over 300 skin images:

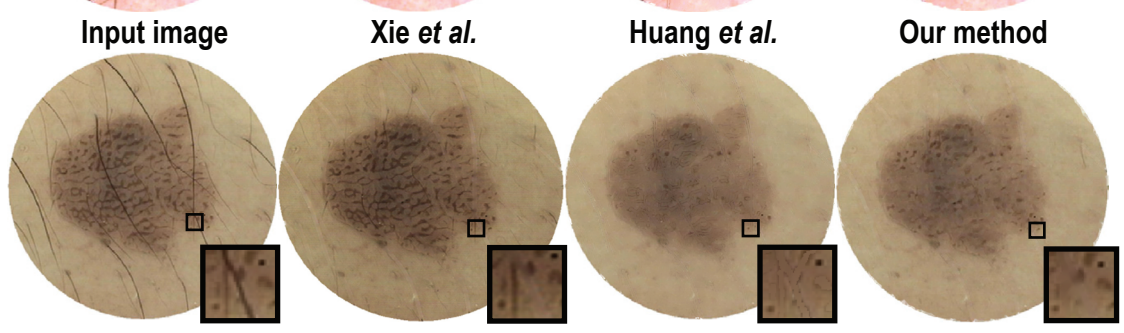
1. DullRazor (Lee et al.) [1]
2. VirtualShave (Fiorese et al.) [3]
3. PDE-based unsupervised repair (Xie et al.) [4]
4. Morphological fast marching scheme (Abbas et al.) [5]
5. Linear discriminant analysis (Huang et al.) [8]

Quality assessment was done by answering the question whether the input and DHR-processed images would be visually perceived as identical (from diagnosis viewpoints) by a dermatologist.









Discussion

Quality: Our method detects and removes low-contrast, dense, thin, crossing, and curled hair better than its competitors (less false-negatives). Non-hair structures are left untouched (no false-positives).

Comparison: To our knowledge, our work is the most extensive comparison of DHR methods published up to date. The second best such comparison is [5] (100 images, three DHR methods compared).

Speed: On a 3.2 GHz Linux PC with a GTX 690 graphics card, we obtained the following timings (all for a full-color input skin image of 1024x1024 pixels)

DullRazor: 4 seconds (CPU implementation only, no parallelization)
Fiorese *et al.*: 7 seconds (CPU implementation only, no parallelization)
Our method: 18 seconds (using a parallel CUDA implementation of [9])
Abbas *et al.*: 40 seconds (CPU implementation only, no parallelization)
Xie *et al*: 150 seconds (CPU implementation only, no parallelization)
Huang *et al*: 10 minutes (CPU implementation only, no parallelization)

Ease of use: Our method is fully automatic (no user parameters need to be set)

Implementation: Full implementation details are given in [7,9,1] for the interested reader.

References

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More details, results, and software implementation: http://www.istuff.ro/research/melanoimage