Qualitative Comparison of Multiscale Skin Tumor Segmentation Methods

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Context

Several **computer-based methods** exist for **automatic segmentation** of skin lesions (e.g. naevi, melanoma) from surrounding healthy skin tissue. However, a comparative study of the effectiveness and efficiency of such methods still lacks.

Aim

To better assess the pro's and con's of such methods, we performed a comparative qualitative study of four recent skin segmentation methods along three criteria:

- **level of detail** (how well the small-scale tumor-boundary details are captured)
- **localization** (how close is the segmentation to the perceived tumor boundary)
- **ease of use** (amount of manual input required and computational speed)

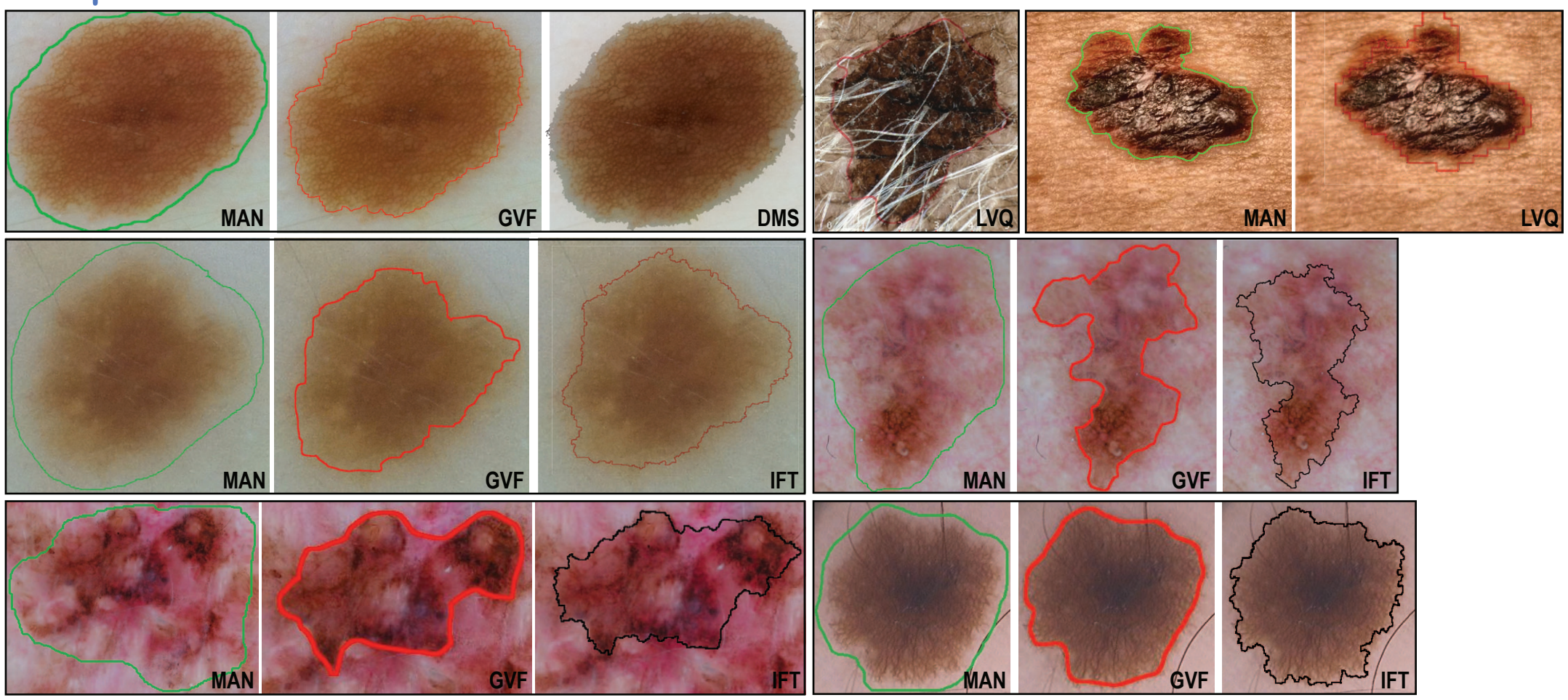
Materials and Methods

We acquired over 100 images of a wide variety of naevi types by several dermatoscopic imaging modalities. Next, we segmented the visible skin lesions using four computer-based techniques:

1. Dense multiscale skeletons (**DMS**) [1]
2. Learning vector quantization (**LVQ**) [9]
3. Gradient vector flow (**GVF**) [6]
4. Image foresting transform (**IFT**) [8]

Next, we compared the segmentation results between themselves, and also with manual lesion segmentations (**MAN**) performed by dermatologists. We also compared the computational time required for segmentation and the amount of user input needed by the computer-based methods.

Comparison Results



Discussion

Level of detail: IFT and DMS capture fine-grained tumor-border detail even for low-contrast images. In comparison, GVF - and even more so LVQ - considerably smooth out such details (similar to MAN).

Localization: The IFT and GVF contours follow the tumor borders best. In contrast, DMS yields a loose segmentation (quite far outside the tumor). LVQ has the loosest segmentation, which misses important tumor areas and/or encloses healthy skin (i.e. produce many false-positive and false-negative areas).

Ease of use: IFT requires some manual input (2..3 mouse clicks inside and outside the tumor). DMS also requires the user to manually select 2..3 peaks in its contour histogram [1]. In contrast, LVQ and GVF work fully automatically, with no user intervention whatsoever.

Speed: We benchmarked all methods on a 2.33 GHz PC (4 GB RAM, NVidia 690 GTX, Windows 7). For an image of 2448 x 3264 pixels (Handyscope [10]), the segmentation times are:

GVF: 0.6 seconds (using a parallel CUDA implementation of [6])
IFT: 3 seconds (using a CPU single-threaded implementation of [8])
DMS: 5 seconds (using a parallel CUDA implementation of [1])
LVQ: over 1 hour (using a Matlab implementation of [9])

Concluding, **IFT** and **GVF** offer the best prospects for fully automatic, near-real-time, and accurate segmentation of high-resolution skin lesion imagery to support future automatic diagnostic research.

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