Finger analysis in video using multi-scale ridge detection

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Introduction

Eye tracking is widely used in psychological research (figure 1). There are many cases in which hand and finger tracking would be very useful. Single-camera machine vision approaches are desirable for their use of non-specialized hardware, and usability in unrestricted environments. We adopted a multi-scalar ridge detection algorithm to enable robust finger tracking in such a setting.

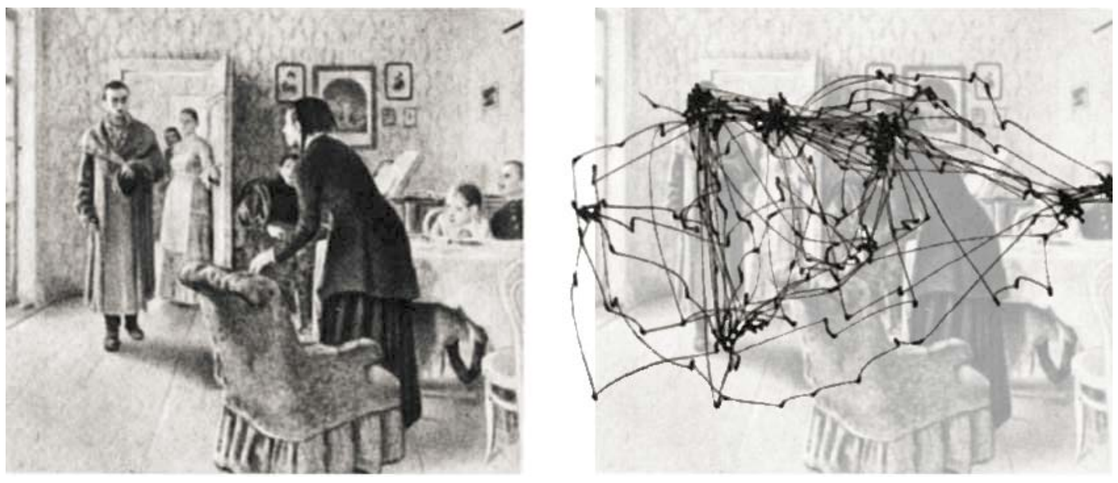

figure 1. eye-tracking (adapted from DeAngelus and Pelz, 2009)

Intrinsic geometry and ridge detection

Our algorithm uses ridge detection with gauge coordinates, which takes the second derivative in an intrinsic, local coordinate system: gauge coordinates. Examples of this method are shown in figure 2.

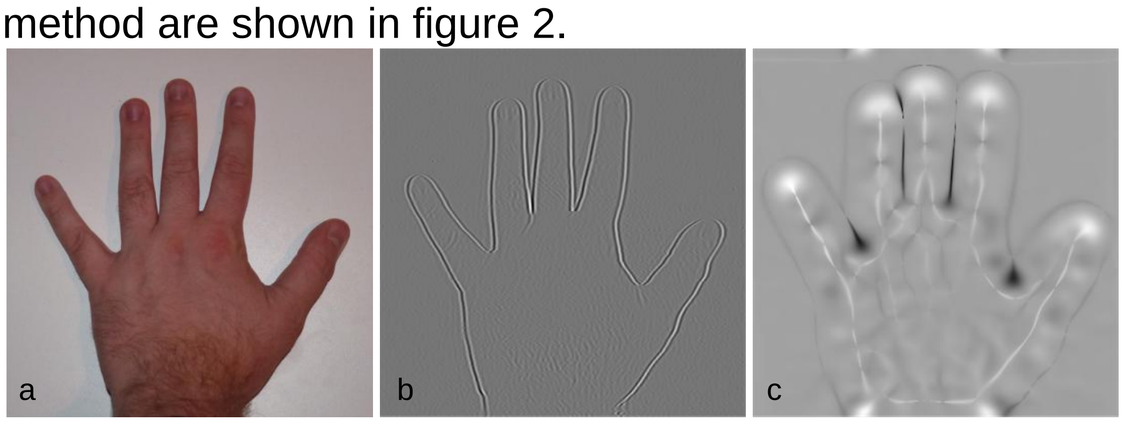

figure 2. a: original image of a hand. b: second Gaussian derivative applied to the original image in the extrinsic coordinate system *(x,y)*. c: second Gaussian derivative in the local intrinsic gauge coordinate system *(v,w)*.

Methods

Figure 3 shows output from our finger-tracking algorithm.

Data

We have videos of 14 volunteers performing tasks with tactile maps. Figure 4 shows finger-tracking results from one of these trials, in which the subject was asked to determine if there was a loop in the walking path.

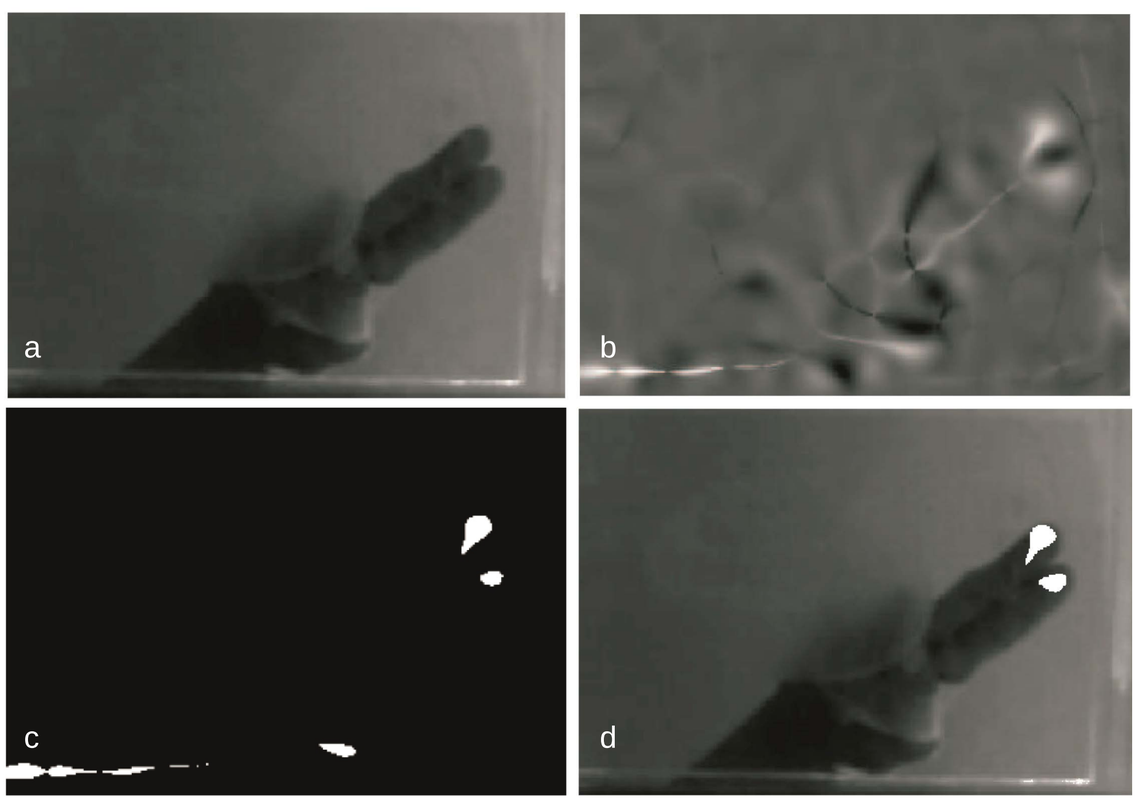

figure 3. Finger-tracking algorithm procedure using ridge-detection. a: original image cropped from video. b: ridge-detection applied to original image. c: thresholded output from ridge detection. d: final result showing 2 fingertip clusters overlaying the original image.

Results

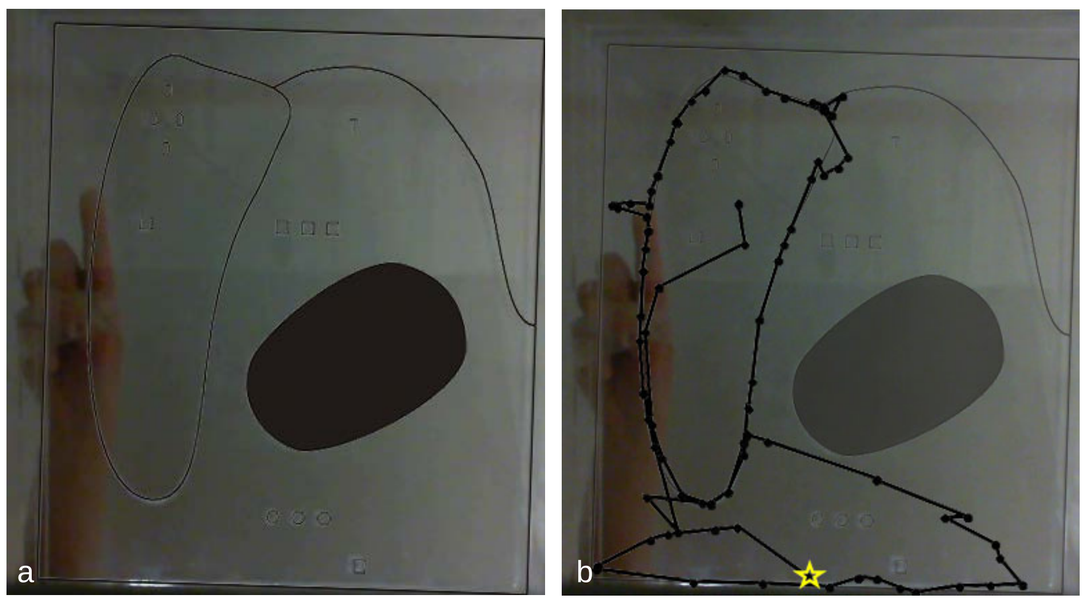

figure 4. a: image with tactile map shown on top. b: same image with the path followed by the volunteer shown on top, the star is the starting point.

Percent on border: 18 %

Percent on empty space: 20 %

Percent on loop: 62 %

Conclusion

We have developed a robust method to quantify the path of peoples fingertips in video, and can indentify with which parts of the stimuli the fingertips are in contact.

References

- DeAngelus, M., Pelz, J. (2009), Top-down control of eye movements: Yarbus revisited*, Visual Cognition, 17(22), 790-811*

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