Automated Facial Wrinkles Annotator

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Abstract. This paper presents an automated facial wrinkles annotator for coarse wrinkles, fine wrinkles and wrinkle depth map extraction. First we extended Hybrid Hessian Filter by introducing a multi-scale filter to isolate the coarse wrinkles from fine wrinkles. Then we generate a wrinkle probablisitic map. When evaluated on 20 high resolution full face images (10 from our in-house dataset and 10 from FERET dataset), we achieved good accuracy when the result of coarse wrinkles was validated with manual annotation. Furthermore, we visually illustrate the ability of the annotator in detecting fine wrinkles. We advances the field by automate the localisation of the fine wrinkles, which might not be possible to annotate manually. Our automated facial wrinkles annotator will be beneficial to large-scale data annotation and cosmetic applications.

Keywords: wrinkles annotator, hessian filter, wrinkles depth

1 Introduction

The appearance of wrinkle is affected by many factors. Even though wrinkles are highly associated with ageing, it is observed that some individuals have less wrinkles than others. Wrinkle growing pattern and its rates are still not well understood. Wrinkles detection has gained popularity recently and many automated computerised methods were proposed [3, 5, 4, 8, 9] to localise wrinkles. Although the research reported a good reliability of the wrinkle detection algorithms [8, 9, 3, 6], there are still a few limitations of current work:

- The majority of previous research was only validated on forehead datasets.
- Due to the majority of the wrinkles orientation are horizontal [2], some algorithms [8, 9] focused on the horizontal wrinkles only.
- The evaluation methods for wrinkle detection were based on wrinkle lines (line segment after thinning process), not wrinkle regions.
- The existing algorithms were not able to separate coarse wrinkles and fine wrinkles.
- The existing algorithms were not able to provide clear definition of wrinkles depth.

To address the issues above and the limitations of human annotation, we propose an automated facial wrinkles annotator for full face high resolution images, represent wrinkle as region (not line) and we demonstrate that our annotator is able to separate fine wrinkles from coarse wrinkles. Our key contributions are:

- Automated annotation of coarse and fine wrinkles regions on high resolution face images.
- Generation of Probabilistic Wrinkle Map alongside with the wrinkles regions to provide wrinkle depth information.
- Demonstration of the robustness of our facial wrinkles annotator across two datasets.

2 Proposed Method

The focus of this work is to demonstrate the ability of our proposed wrinkles annotator in extracting coarse and fine wrinkles, including the width and depth information. Hence, only high resolution images are used to demonstrate the capability of proposed method, particularly in detecting fine wrinkles. To generate the ground truth from human annotation, we are not able to use large-scale dataset due to it is a time consuming and arduous process. Therefore, we have selected 20 full face images, 10 images from our in-house social habit dataset [10, 1] and 10 images from FERET dataset [11]. Similar to the state-of-the-art research, we have generated ground truth based on manual annotation.

Given an input image I, the directional gradient $\left(\frac{\partial I}{\partial x}, \frac{\partial I}{\partial y}\right)$ of I is computed. $\frac{\partial I}{\partial y}$ (denoted as $\mathcal{I}$)) emphasizes a horizontal variation, which was proposed by [8, 7] to detect horizontal wrinkles. $\frac{\partial I}{\partial x}$ (denoted as $\mathcal{V}$) emphasizes a vertical variation, where we used it to detect vertical wrinkles regions. Both are used as the input for Hessian filter $\mathcal{H}$ calculation [7] at location (x, y) denoted by

$$\mathcal{H}_\sigma(x,y) = \begin{bmatrix} \mathcal{H}_{a,\sigma}(x,y) & \mathcal{H}_{b,\sigma}(x,y) \\ \mathcal{H}_{b,\sigma}(x,y) & \mathcal{H}_{c,\sigma}(x,y) \end{bmatrix} \tag{1}$$

where σ is the filter scale; $H_{a,\sigma}$, $H_{b,\sigma}$ and $H_{c,\sigma}$ are the second derivatives of $\mathcal{I}$ along horizontal, diagonal and vertical directions, respectively. In this work, we use the parameter σ as multi-scale filter to differentiate coarse and fine wrinkles.

For both the horizontal and vertical wrinkles detection, our proposed wrinkles annotator focuses on two filter scale (σ). One scale is for coarse wrinkles (σ_c) and one scale is for fine wrinkles (σ_f). The size of FERET dataset is 512×768 and the size of our in-house dataset is 1000×1300. From our empirical experiment, the best settings for FERET dataset: $\sigma_f = 2$ for fine wrinkles and $\sigma_c = 4$ for coarse wrinkles; and for our in-house high resolution dataset: $\sigma_f = 3$ for fine wrinkles and $\sigma_c = 6$ for coarse wrinkle. This is due to different resolution requires different filter scale for wrinkles extraction. When applying the filter σ_f, the location of coarse wrinkles were also detected. To separate the fine wrinkle from coarse wrinkles, we perform a post-processing stage. Let R_f be the regions detected as fine wrinkles and R_c be the regions detected as coarse wrinkles, the updated R'_f

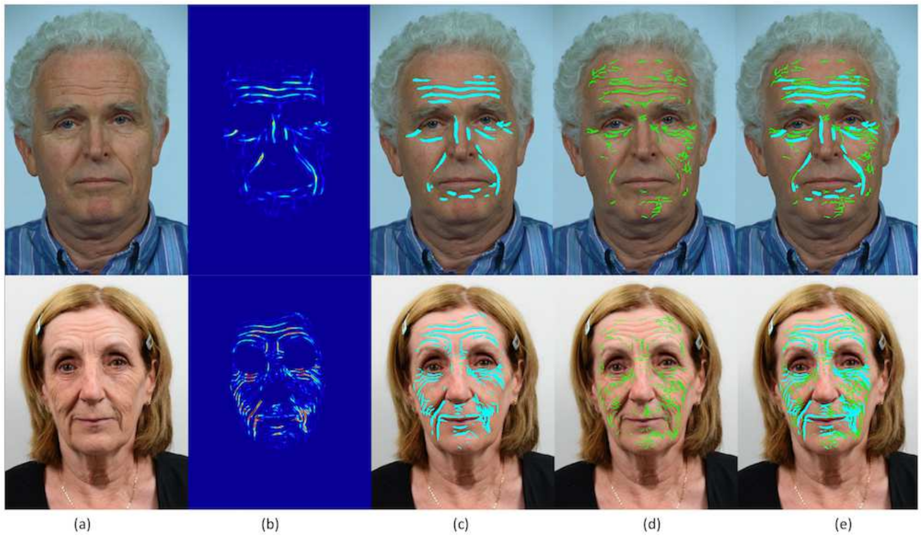

Fig. 1. Visual illustration of automated extraction of coarse wrinkles and fine wrinkles regions: (a) Original image, (b) Probabilistic wrinkles map, (c) Coarse wrinkles, (d) fine wrinkles, and (e) Combined wrinkles regions.

is defined as $R'_f = R_f \notin R_c$. We generated probabilistic wrinkle map as in Fig. 2. This map is generated alongside with the annotator to provide wrinkles depth information. The high value indicates deep wrinkle and vice versa.

3 Results and Discussion

Fig. 1 illustrates the step by step results of our proposed method on coarse and fine wrinkles annotation. Fig. 1(a) shows the input image from FERET dataset (first row) and in-house social habit dataset (second row). Fig. 1(b) illustrates the probabilistic map (depth information) for the images. Fig. 1(c) and (d) display the results of coarse wrinkles and fine wrinkles, respectively. Then, Fig. 1(e) illustrates the combined annotated wrinkles. When validate the coarse wrinkles detection results with ground truth label in terms of *Jaccard Similarity Index (JSI)*, the annotator achieved accuracy of 80%. When overlay the manual annotated wrinkles onto the probabilistic map, we observed the majority of the annotated lines overlay on high probability regions, as in Fig. 2(d), which we defined it as coarse wrinkles. This is due to the difficulties for human to annotate the detailed and fine wrinkles. Thus, this proposed automated annotator will be useful to annotate fine wrinkles.

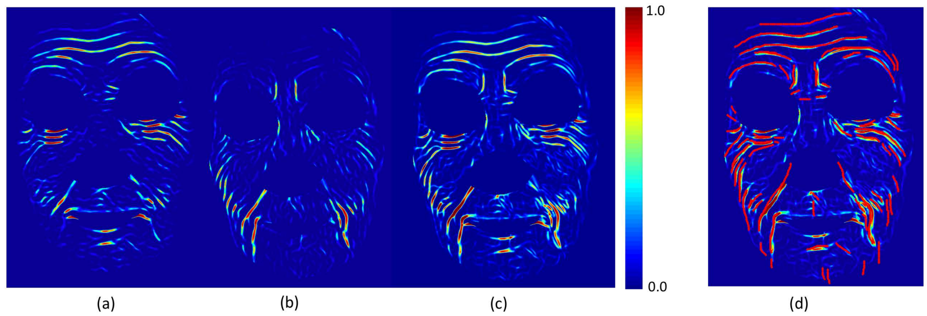

Fig. 2. Probabilistic map on: a) Horizontal wrinkles; b) Vertical wrinkles; c) Probabilistic map by our proposed method; and d) Manual annotation of Wrinkle lines (RED) overlay on our probabilistic map.

4 Conclusion

We proposed a new fully automated wrinkles annotator for coarse wrinkle and fine wrinkle labeling. With the rapid growth of the use of deep learning in computer vision, automated annotator for data labeling play an important role for ground truth preparation. Since it is impossible to manually annotate the fine wrinkles, our proposed method will benefit data driven approaches. In addition, it can be used to assess the skin quality in terms of fine lines.

As in many areas of computer vision, we illustrated that images captured from different devices and settings are the main challenges in dataset acquisition. Whilst this method required adjustment on filter scale based on empirical experiment, future work with machine intelligence will be able to overcome the problem.

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