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NOISE REDUCTION METHOD FOR SKELETONIZED IMAGES

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Annotation. Scale-space-based denoising approaches adopt scale space filters before the binarization stage to smooth the potential noise. These kinds of methods can simultaneously suppress both inner noise and border noise. Thinning framework that based on the scale space technique to automatically extract skeletons from images without manual-tuning. The proposed framework can increase the robustness of the thinning algorithm, it not only can suppress the boundary noise, but also can alleviate the inner noise. These two types of noise generally cause the appearance of the abundant of the unwanted branches in the outcome of the thinning algorithm, which arise the difficulties of the later recognition or matching process in skeleton.

Keywords. Skeleton. Robustness. inner noise. boundary noise.

Skeletons information can be used in many fields, such as image matching [1], sketch-based modeling [2], and medical image segmentation [3]. And in recent years, hand gesture recognition and human action recognition based on skeletons are attracted much focus. For the task of recognition or classification, since the later recognition depends on the extracted skeleton, it is very important to extract a stable skeleton. There are two main approaches to obtaining skeletons, which are hardware approaches and software approaches. The hardware approach uses a depth camera such as Kinect. These skeletons obtained from Kinect are robust to lighting, shade, and color changes, so these skeletons can be deemed stable. The software approaches use traditional skeletonization to extract the skeleton from the normal camera. Since existing skeletonization methods are sensitive to noise, the skeleton may be altered according to the noise; it is necessary to adopt denoising strategies to make the skeleton more stable.

Conventional skeletonization algorithms extract skeletal images from input binary images composed of foregrounds and backgrounds. Skeletons are extracted from those foregrounds area. Generally, images obtained from a standard camera are colorful images instead of binary images. Therefore, several preprocessing is needed before skeletonization, including converting the RGB images to grayscale images and then following binarization on grayscale images to acquire binary images. From the perspective of binary image, there are two types of cases in which even tiny changes may significantly alter the result of the skeletonization algorithm; since stable skeletons are expected to reflect the overall structure instead of small structures, these two cases are considered as border noises and inner noise according to their position, respectively.

Pruning methods [4] are proposed in the past decade for removing the redundant branches. These methods can dramatically improve the thinning algorithm robustness against to the border noise. These methods are generally applied directly on the skeleton that extracted by the thinning procedure from the original pattern. However, one of the limitations of these methods is that it fails to suppress the inner noise.

A scale-space method for thinning both grayscale and binary images has proposed by Hoffman and Wong [5]. This method first produces filtered versions of an input image and then extracts skeleton by searching some special pixels from it, which includes peak, ridge, and saddle pixels. These pixels are named as the most prominent ridge line pixels (MPRL) by authors and they are used to form the skeleton. In the image scale space pyramid, each MPRL pixel is a pixel such that all ridge-line pixels have greater second derivatives in sub-pyramid. The robustness of the skeleton against to the noise strongly depends on a parameter, which requires manual tuning.

In this paper, an improved thinning framework based on Houssem's method is presented. The framework uses different scales to blur the original image so that internal and boundary noise can be filtered out. Then, we pass the blurred image to the binarization procedure, the skeletonization procedure and the evaluation procedure in turn to obtain an ideal skeleton. The whole framework is described as follows.

Input: Original grayscale image I, maximum scale σ_{max}, increase step σ_{init}.

Output: The best skeleton I_{best}

Step 1: Initialize the scale of the Gaussian filter σ with 0;

Step 2: use Gaussian filter with a scale of σ to blur the image I and obtain a grayscale image I_G;

Step 3: Binarize I_G to generate a binary image I_B;

Step 4: Extract the skeleton I_{th} from I_B using the FPSA thinning algorithm;

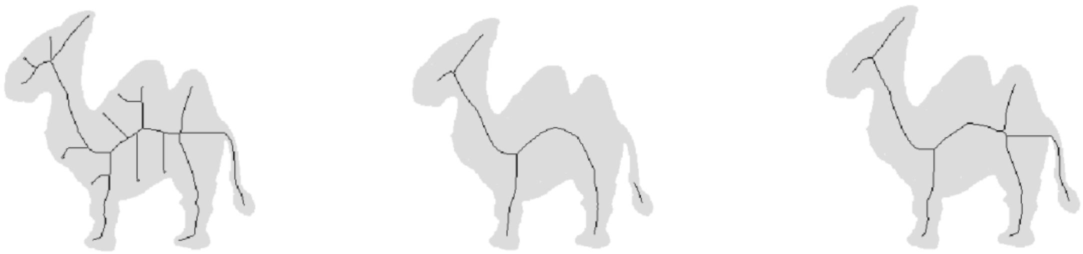
Step 5: Calculate the sensitivity measure S_σ of the skeleton I_{th} and record it in the memory;

Step 6: If the sum of σ and the σ_{init} is less than σ_{max}, increase σ with a given step σ_{init} and go to the step 2; Otherwise, go to step 7;

Step 7: Find the smallest S_σ and then obtain corresponding skeleton I_{best}

Experiments and results

Obviously, in the figure below, the skeleton extracted by FPSA has many redundant branches caused by internal noise. Both Houssem's method and the proposed method can eliminate this branch very well. But Houssem's method cannot preserve the original topology because some important skeletons are lost. The method proposed in this paper can basically get a good skeleton.



a b c

Conclusion

It is experimentally demonstrated that the proposed method in this paper can suppress internal noise and boundary noise and has better performance than the existing Houssem framework in terms of topology preservation and connection preservation.

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