Human Hair Segmentation In The Wild Using Deep Shape Prior

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Motivation:

- **Virtual human hair dying** is becoming a popular Augmented Reality (**AR**) application in recent years.
- **Human Hair Segmentation In The Wild:** Perform hair segmentation in an **unconstrained** view **without** any explicit prior face/head-shoulder detection.
- A problem in practical application: **Cluttered Background** disturbs deep CNN segmentation especially when the dataset is small, which brings **spurious detections:**

Proposition: Using Shape Prior

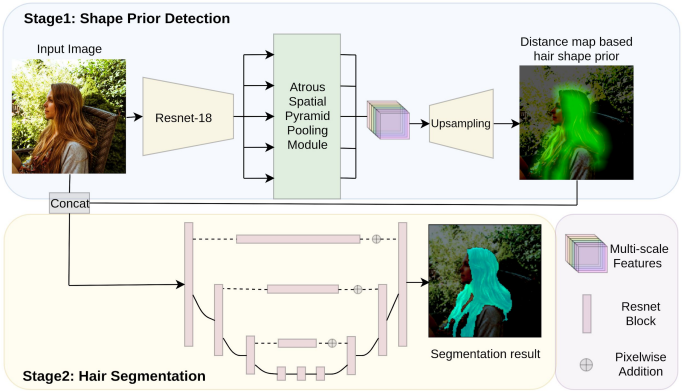
- We propose to construct a **shape prior** to **constrain** and **guide** the hair segmentation.
- In **stage1**, we propose to detect a hair shape prior.
- In **stage2**, we concatenate the shape prior and the image to find the exact boundary of the human hair.
- The construction of shape prior is based on **distance transform with inverse boundary erosion**:

$$dt_{mask}(p) = d_{max} - \min(d_{max}, \min_{p^+ \in I^+} \|p^+ - p\|)$$

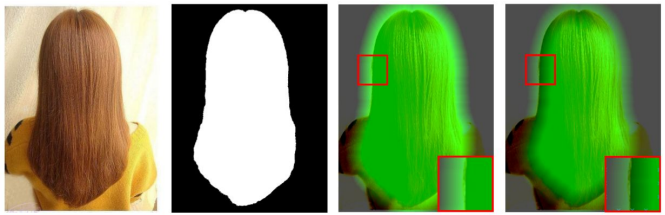
$$dt_{inv}(p) = e_{max} - \min(e_{max}, \min_{p^- \in I^-} \|p^- - p\|)$$

$$dt = dt_{mask} - dt_{inv}$$

Shape Prior Integrated Segmentation Pipeline:



Visualization of Shape Prior:



Reference:
[1]: Ronneberger et al. Unet: Convolutional networks for biomedical image segmentation. MICCAI 2015
[2]: Chen et al. Encoder-decoder with atrous separable convolution for semantic image segmentation. ECCV 2018
[3]: Muhammad et al. Hair detection, segmentation and hairstyle classification in the wild. IVC 2018
[4]: Liu et al. Face parsing via recurrent propagation. BMVC 2017
[5]: Kae et al. Augmenting CRFs with Boltzmann machine shape priors for image labeling. CVPR 2013

Results:

Method	Precision(%)	F1 score(%)	mIoU(%)	Acc(%)
U-Net [1]	95.63	94.39	89.69	96.36
DeeplabV3+ [2]	96.86	95.05	91.11	97.07
Muhammad et al. [3]	-	84.90	-	91.50
Only Stage2	95.64	94.53	89.91	96.56
Stage1 + Stage2	**97.25**	**95.09**	**91.15**	**97.20**

Table 1: Hair Segmentation Results on Figaro1k [3].

Method	Precision-hair(%)	F1-hair(%)
U-Net [1]	89.11	87.66
DeeplabV3+ [2]	91.66	88.36
Liu et al. [4]	-	83.43
Only Stage 2	89.13	88.07
Stage1* + Stage2*	**98.24**	**88.94**

Table 2: Hair Segmentation Results on LFW-Part [5].