DEEP LEARNING-BASED HAIR SEGMENTATION IN UVFD IMAGES

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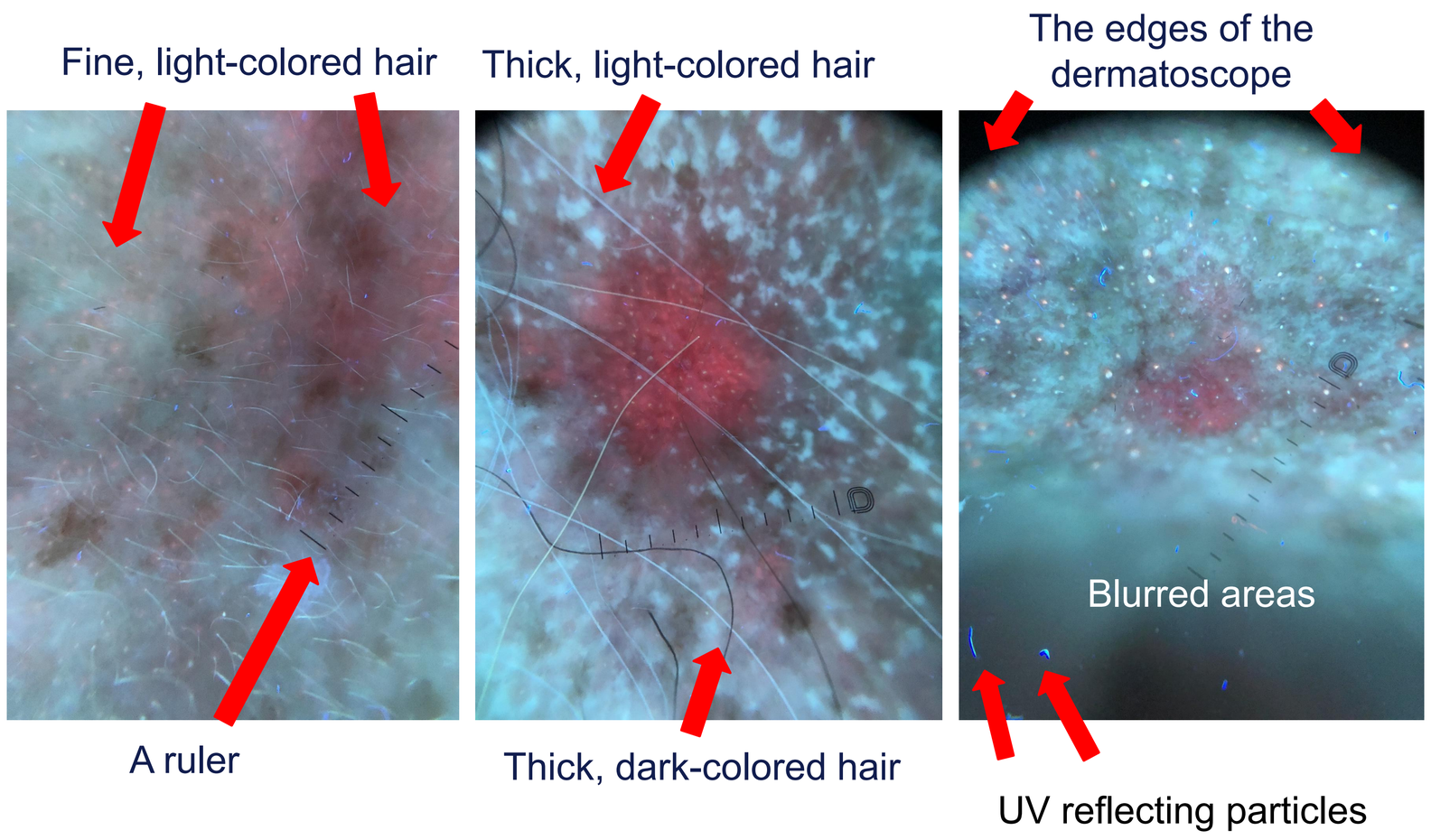
Objective

Ultraviolet-induced fluorescence dermatoscopy (UVFD) is an emerging technique that reveals diagnostic fluorescence signals in skin lesions. The presence of artifacts (hair, ruler and other particles) impairs image quality, obscuring fluorescence patterns and complicating automated analysis[1].

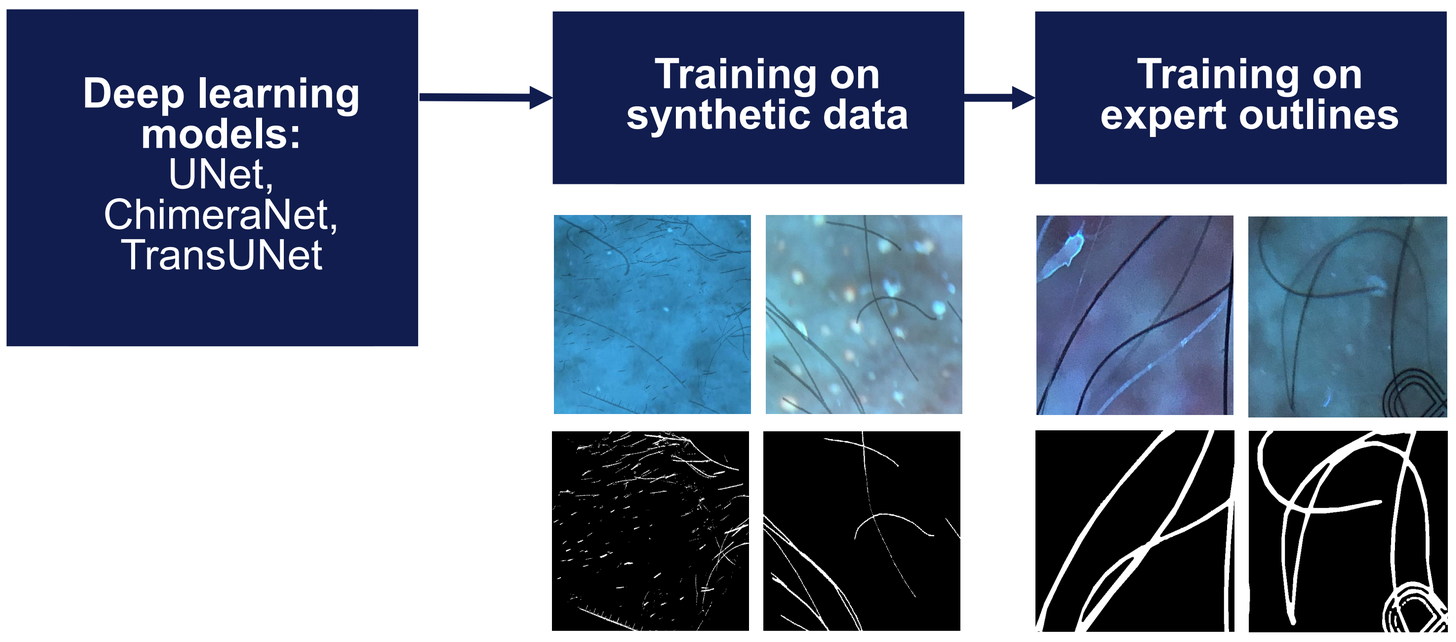
Traditional hair segmentation algorithms, such as DullRazor[2], are designed for images where hair is consistently darker than the skin. In UVFD, these assumptions fail as hair and background can exhibit varied intensities.



Methods

To address the lack of annotated clinical data, a large-scale synthetic dataset was created by augmenting hairless UVFD backgrounds with artificial hair masks generated using the HairSim tool[3].

We compared three state-of-the-art architectures for hair segmentation: UNet[4], ChimeraNet[5], and TransUNet[6]. Models were pre-trained on this synthetic data and fine-tuned on a real-world dataset of 120 expert-annotated images.



Results

Table 1. Models results on synthetic data

	Dice	IoU	Hausdorff dist.
Light hair			
UNet	**0.98 ± 0.1**	**0.97 ± 0.1**	**19.75 ± 33.3**
ChimeraNet	0.2 ± 0.2	0.12 ± 0.1	188.53 ± 88.8
TransUNet	0.97 ± 0.1	0.96 ± 0.1	46.67 ± 70
Dark hair			
UNet	0.95 ± 0.1	0.91 ± 0.1	22.21 ± 47.9
ChimeraNet	0.35 ± 0.2	0.23 ± 0.2	237.12 ± 116
TransUNet	**0.96 ± 0.1**	**0.92 ± 0.1**	**16.58 ± 39.6**

Table 2. Models results on real data

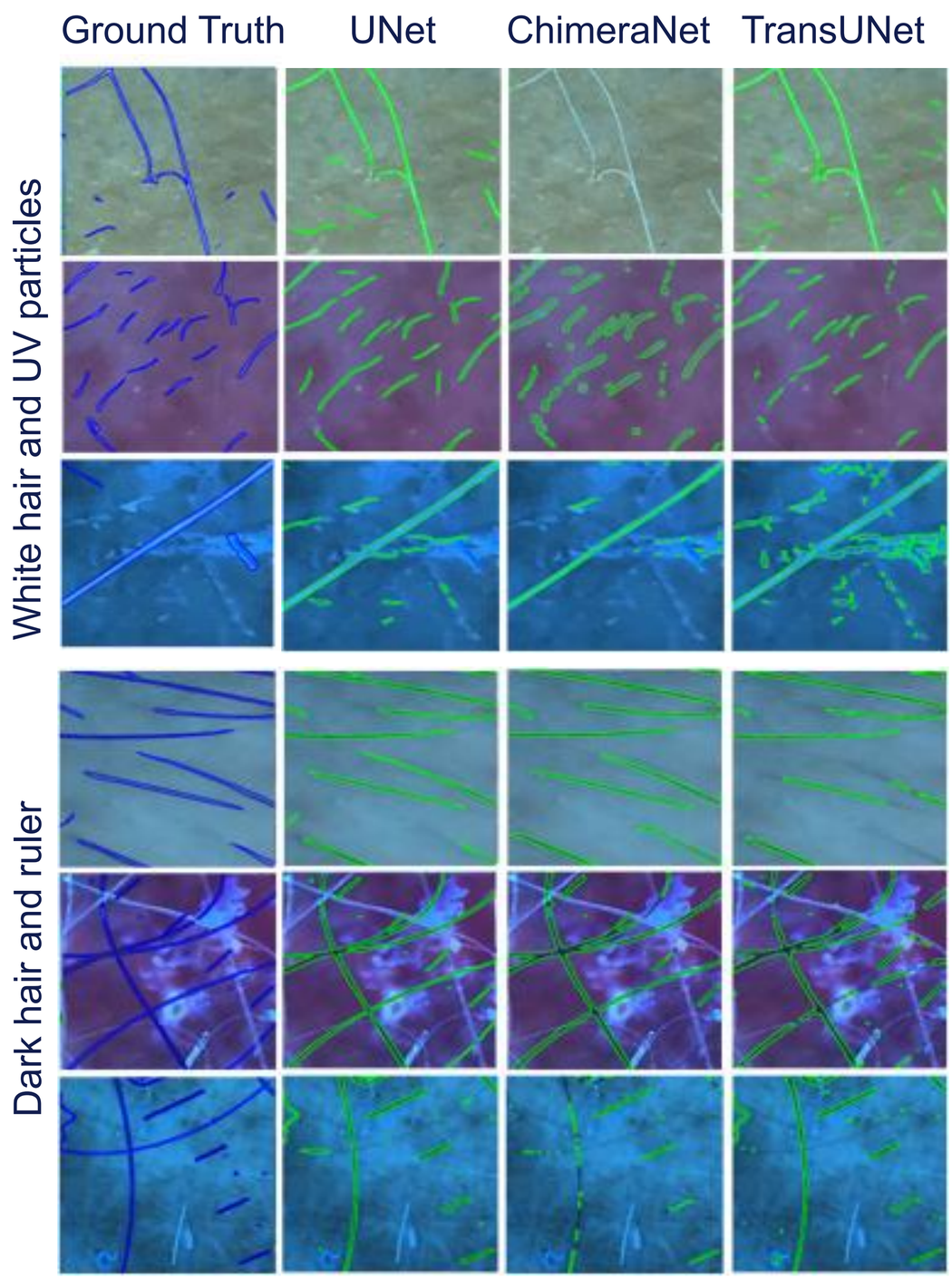
	Dice	IoU	Hausdorff dist.
Light hair			
UNet	**0.56 ± 0.3**	**0.42 ± 0.2**	**212.2 ± 123**
ChimeraNet	0.22 ± 0.3	0.15 ± 0.2	346.8 ± 147.8
TransUNet	0.49 ± 0.3	0.36 ± 0.2	243.8 ± 125.4
Dark hair			
UNet	0.61 ± 0.3	0.5 ± 0.3	194 ± 151.48
ChimeraNet	**0.65 ± 0.3**	**0.56 ± 0.3**	**124.9 ± 145.8**
TransUNet	0.64 ± 0.3	0.53 ± 0.3	160.81 ± 147.4

Conclusion

While performance on synthetic data was high (Dice scores of 0.96-0.98), the real-life data results demonstrated the complexity of UVFD images. For dark hair segmentation, ChimeraNet proved most effective with a Dice score of 0.65. For light hair and fluorescent particles, the UNet achieved the best results with a Dice score of 0.56.

Despite lower Dice scores, common in thin structure segmentation due to pixel-level sensitivity, the visual assessment of the masks generated from the models was satisfactory. The models were indeed able to accurately identify the location and direction of the hair.

The study confirms that training on synthetic data is a viable strategy for overcoming limited clinical datasets, however, the significant drop in accuracy between synthetic and real data suggests that better algorithms for generating synthetic images are required. This segmentation results provide a robust foundation for improving the automated computer analysis of UVFD images, facilitating more accurate feature extraction for lesion classification.



References

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