INTEGRATING AUTOMATED ANALYSIS OF HFUS IMAGES INTO CLINICAL WORKFLOWS

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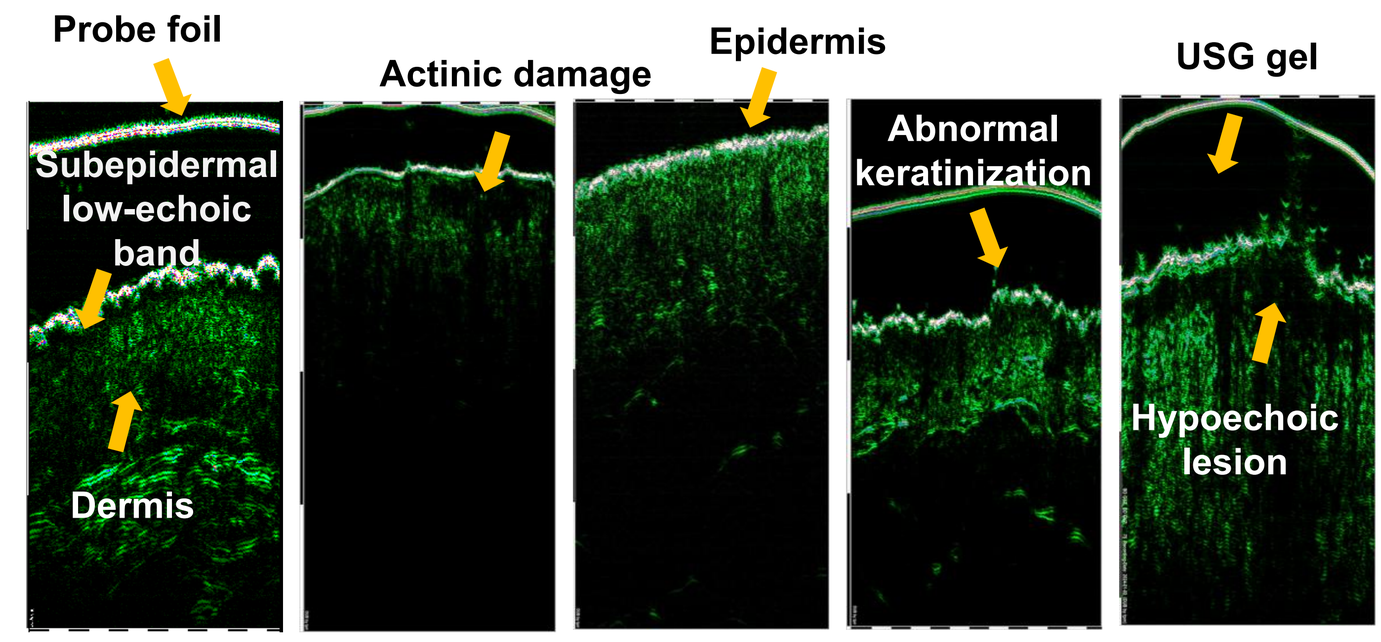
Objective

High-frequency ultrasound (HFUS) is a novel tool in modern dermatology, enabling non-invasive visualization of skin structures. HFUS is particularly useful in the diagnosis of inflammatory and neoplastic diseases, as well as in monitoring the effects of therapy[1].

The introduction of automation allows for consistent, objective results, independent of the diagnostician's experience or fatigue. Advanced DL architectures, such as nnU-Net, U-Net, AttentionUNet, CFPNet, ATT-CFP-Net or TransUNet, enable the automatic determination of parameters, including tumor thickness, precise surgical, and tissue echogenicity and the degree of tissue scarring[2].



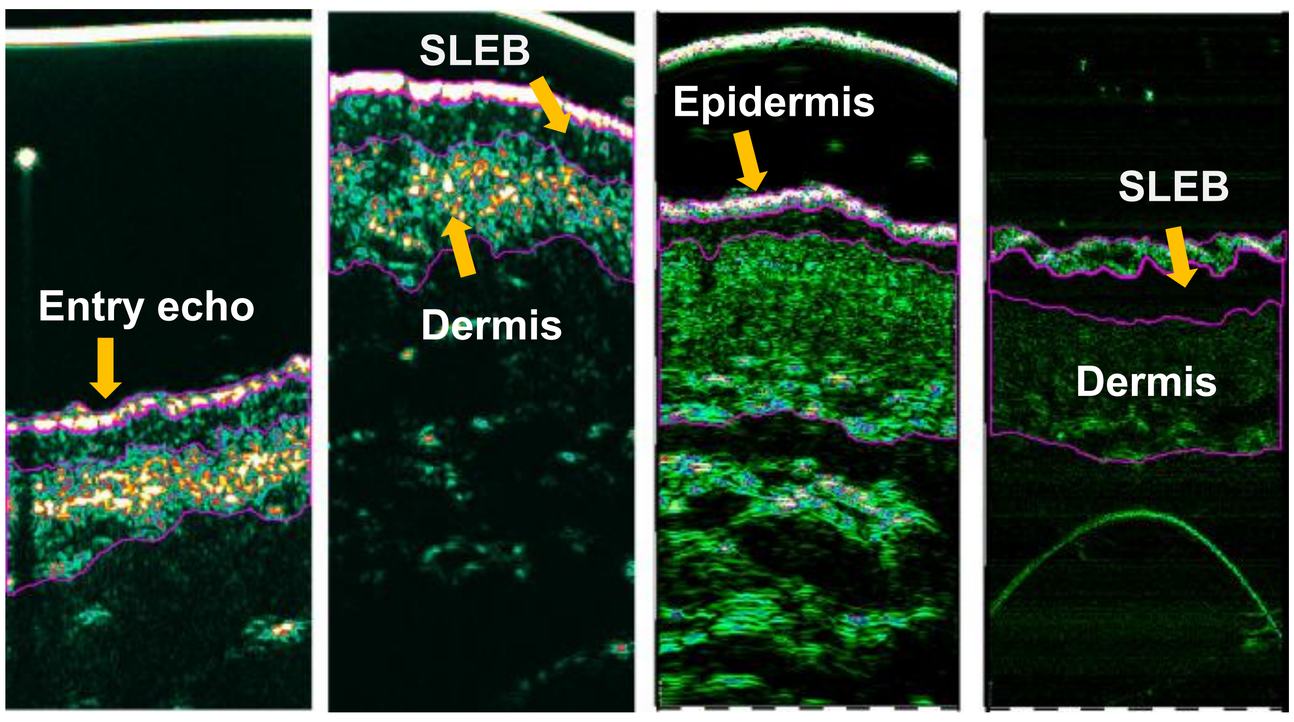
Methods

An overview of Deep Learning architectures used in medical image segmentation:

AAU-Net[3]
ACNet[4]
AttentionUNet[5]
CFPNet-M[6]
DC-UNet[7]
nnU-Net[8]
TransUNet[9]

865 HFUS images recorded with 20 MHz probe[10]

635 HFUS images recorded with 75 MHz probe[11]



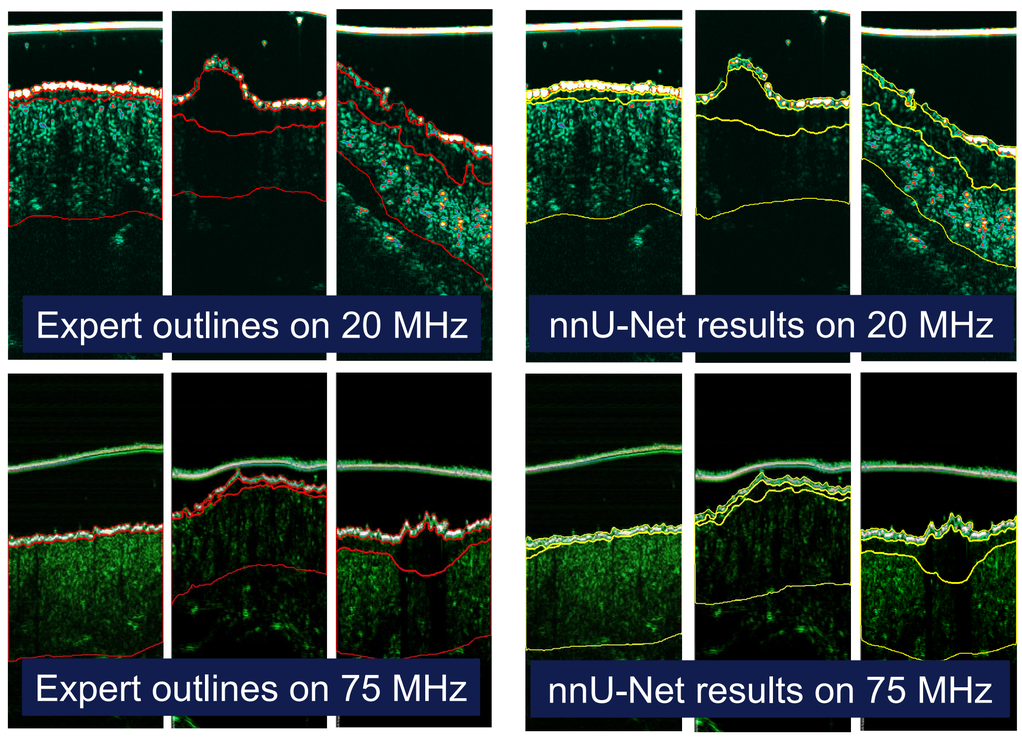
Results

Table 1. Average Dice obtained across 20 MHz dataset

	Entry echo	SLEB	Dermis	Avg
AAU-Net	0.94	0.70	0.91	0.88
ACNet	0.95	**0.83**	**0.93**	**0.90**
AttentionUNet	0.87	0.76	0.81	0.82
CFPNet-M	0.93	0.80	0.91	0.88
DC-UNet	0.88	0.73	0.80	0.80
nnU-Net	**0.95**	0.80	**0.93**	0.89
TransUNet	0.95	0.82	**0.93**	**0.90**

Table 2. Average Dice obtained across 75 MHz dataset

	Epidermis	SLEB	Dermis	Avg
AAU-Net	0.91	0.83	0.87	0.87
ACNet	0.91	**0.84**	0.79	0.85
AttentionUNet	0.90	0.80	0.88	0.86
CFPNet-M	0.91	0.83	0.78	0.84
DC-UNet	0.91	**0.84**	0.80	0.85
nnU-Net	**0.95**	0.79	**0.93**	**0.89**
TransUNet	0.91	**0.84**	0.92	**0.89**



Conclusion

A comparative analysis demonstrated the high effectiveness of the deep learning algorithms, achieving Dice scores > 0.95 for the epidermis (nnU-Net, 20 and 75 MHz) and 0.84 for the SLEB (ACNet, DC-Unet and TransUNet, 75 MHz) and 0.93 for the dermis (ACNet, nnUNet and TransUNet, 20 MHz and nnUNet 75 MHz). The high values of these coefficients indicate the usefulness of deep learning models in the automatic analysis of ultrasound images of the skin.

Automation not only increases the precision of parameter determination compared to manual methods, but also drastically reduces time of analysis. The future of HFUS diagnostics lies in the full integration of segmentation systems with ultrasound devices, creating real-time clinical decision support systems.

References

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