BAUMAN MOSCOW STATE TECHICAL UNIVERSITY

Determination the spectral composition of light for contactless morphometry of subcutaneous vascular bed in the near infrared spectrum

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Morphometry of subcutaneous vascular bed

Definition: «Morphometry is a field concerned with studying variation and change in the form (size and shape) of organisms or objects»

The subcutaneous vascular bed morphometry applications:

1. **Medical diagnostic procedures;**
2. **Biometric security systems;**

NIR visualization of subcutaneous vascular bed

The instrumental methods for imaging subcutaneous vascular bed:

1. CT & MRI tomography;
2. Radiographic contrast study;
3. Ultrasound study;
4. Near infrared visualization.

The benefits of the near infrared visualization:

1. Harmless;
2. Contactless;
3. Accessibility, simplicity.

Requirements for the video device

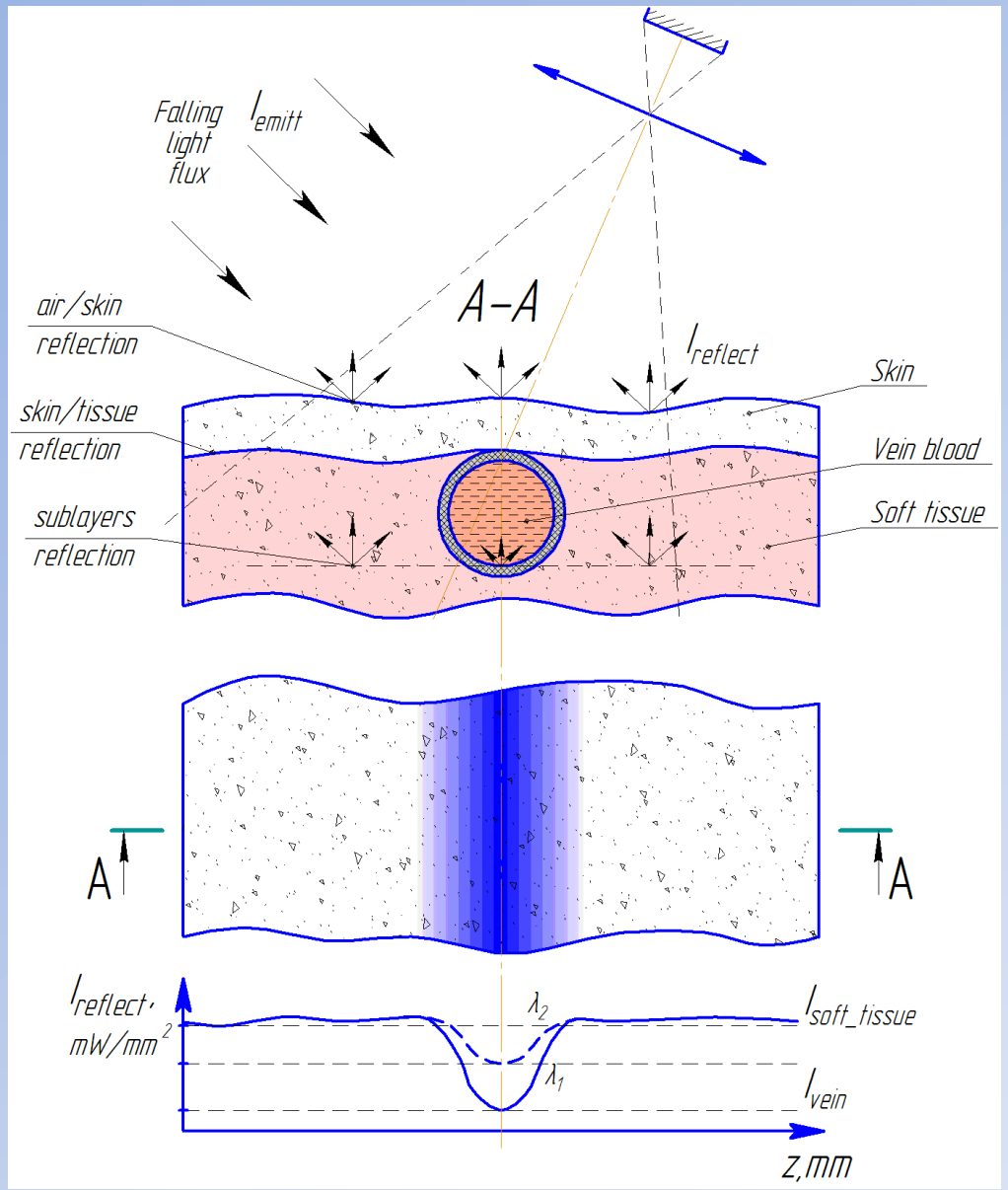
There are three basic requirements:

1. Image resolution. If we choosing as the size of the smallest detail of image the region about 0.5×0.5 mm ^{2} than the resolution must be better than 100 dpi (on booth dimensions);

2. Signal to noise ratio. For the threshold detection method and detection probability equal 95% the SNR must be greater then 25 dBl (for false alarm probability equal 0.01%);

3. Spectral sensitivity in the near infrared spectrum. The spectral sensitivity must cover wavelengths range 700 – 1100 nm.

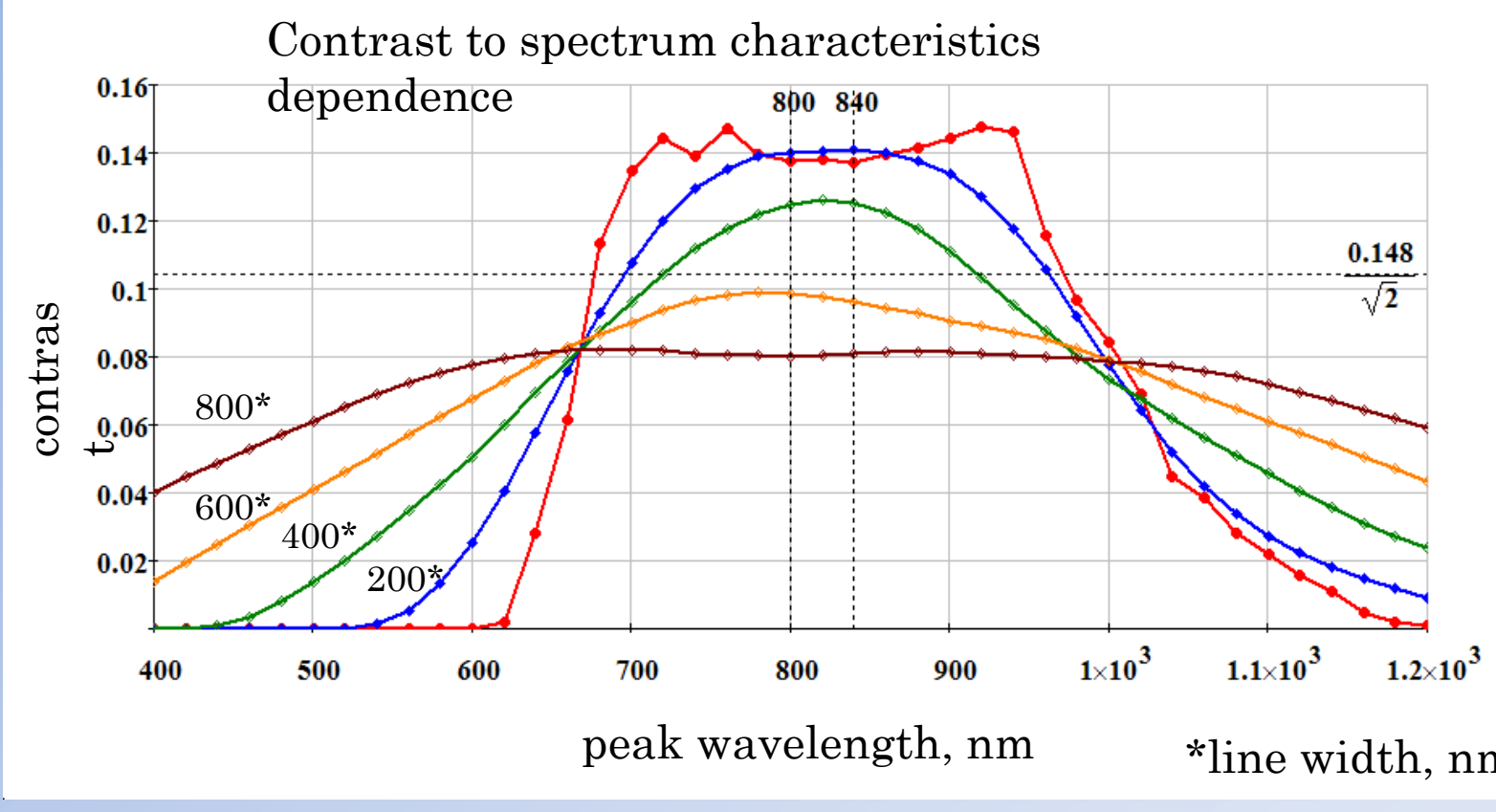
Modelling methods



The main chromophores of surface tissues:

1. **Water;**
2. **Melanin;**
3. **Oxyhemoglobin;**
4. **Deoxyhemoglobin.**

Results of modelling

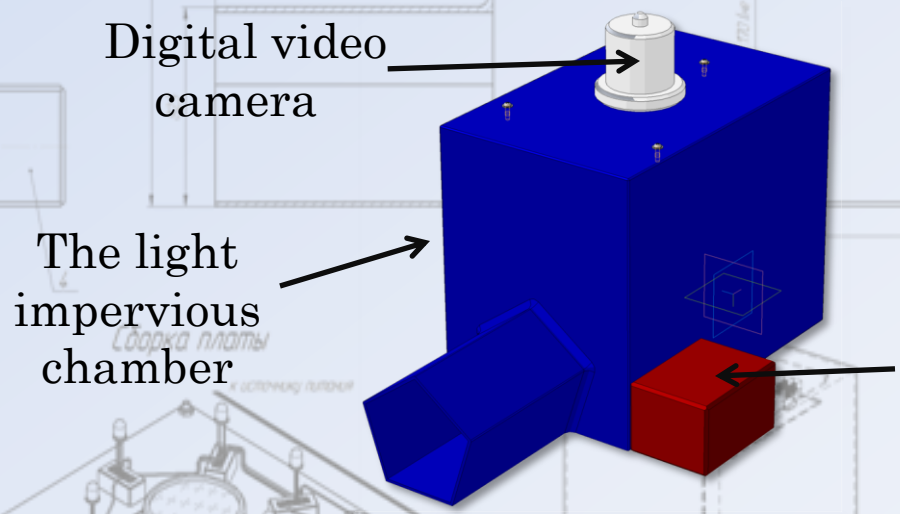


The maximum contrast was received for minimum line width (less then 1 nm 70% width) at 780 and 920 nm peak wavelength. For line width about 40 nm (that can be providing by LED) maximum contract is observed at 840 nm peak wavelength.

Practical research

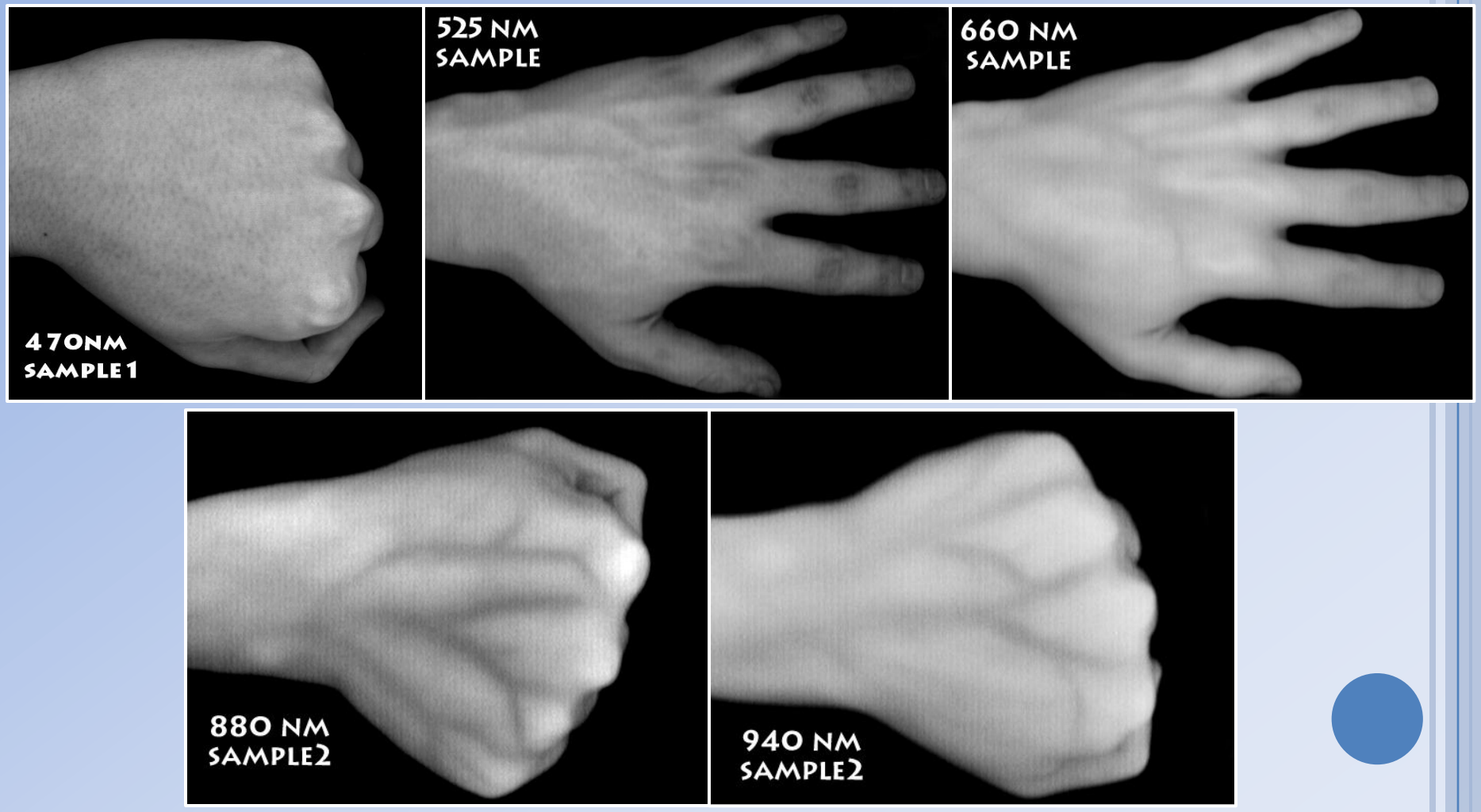
To conduct practical experiment was designed impervious to visible and NIR radiation chamber. This chamber was equipped by the backlight system with pre-installed spectrum characteristics:

1. 470/50;
2. 525/60;
3. 660/25;
4. 880/50;
5. 940/50.



The practical research was performed on nine male individuals from a range of age 22 – 24 years. As the video registration device was used digital video camera VAC-135 (with OV9121 as light-sensitive detector) with lens Infinity SCVHMA XX FIR.

Images of the subcutaneous venous network of the hands

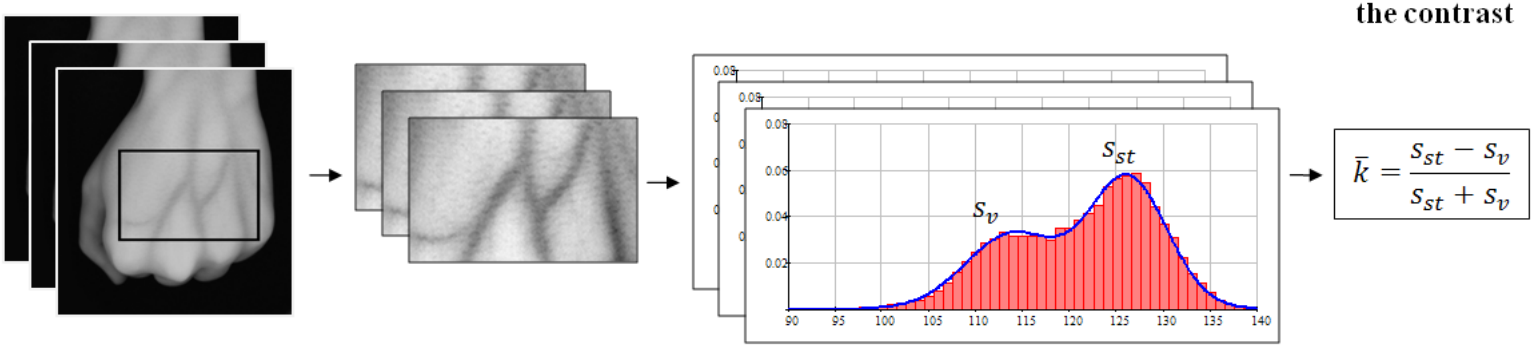


Results of the practical research

№ of subject	Hand	The backlight devices and their spectral characteristics									
		BetLux-L513UB 470/50		BetLux-L513PGC 525/50		BetLux-L513LR 660/25		BetLux-L513IRBC 880/50		BetLux-L513IRAB 940/50	
		Average	RMSE	Average	RMSE	Average	RMSE	Average	RMSE	Average	RMSE
1.	left	**0.078**	**0.029**	**0.062**	**0.026**	**0.220**	**0. 022**	**0.330**	**0.027**	**0.341**	**0.029**
	right	**0.105**	**0.031**	**0.121**	**0.034**	**0.223**	**0.028**	**0.352**	**0.026**	**0.340**	**0.025**
2.	left	**0.219**	**0.017**	**0.262**	**0.007**	**0.189**	**0.017**	**0.228**	**0.014**	**0.248**	**0.021**
	right	**0.221**	**0.020**	**0.211**	**0.014**	**0.201**	**0.019**	**0.234**	**0.021**	**0.221**	**0.021**
3.	left	**0.123**	**0.025**	**0.113**	**0.021**	**0.219**	**0.014**	**0.281**	**0.022**	**0.301**	**0.026**
	right	**0.084**	**0.019**	**0.094**	**0.022**	**0.211**	**0.019**	**0.292**	**0.027**	**0.287**	**0.025**

The contrast calculation algorithm

A) Getting → **B) Cropping** → **C) Calculation of the histogram modes** → **D) Calculating the contrast**



Result of the work

The main result of the work is the justification of requirements to the spectral composition of light for NIR visualization of the subcutaneous vascular bed: the maximum contrast of the NIR images of the subcutaneous vascular bed can be achieved if the spectral sensitivity of video device is limited by the wavelength range 800 - 880 nm.

This requirement can be achieved by using IR-LEDs, as a light source, or by using photographic infrared filters (in this case as the light source can be used ambient light, halogen or conventional bulb light). Anyway for NIR visualization of subcutaneous blood vessels you must work at wavelength region 800-880.

References and links

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