Asymmetry analysis for automated diagnostics of maxillary sinus pathologies in digital diaphanoscopy

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IAP RAS

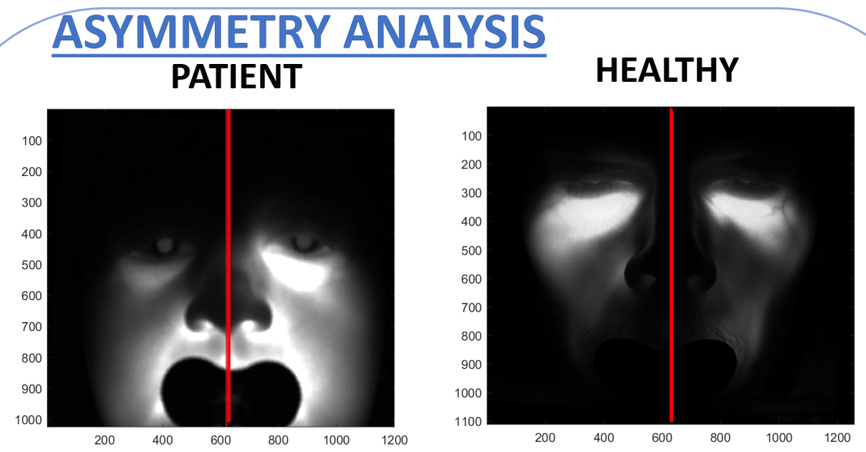
20% OF PEOPLE IN THE WORLD
SUFFER FROM DISEASES OF THE MAXILLARY SINUSES

>10 MILLION PEOPLE
IN RUSSIA

THE AIM OF RESEARCH

To automate the process of diagnosing maxillary sinus pathologies in digital diaphanoscopy based on asymmetry correlation analysis.

ASYMMETRY ANALYSIS



Step 1: Diaphanograms rotation to ensure vertical position of the central line;
Step 2: Determination of the face central line (symmetry axis)
Step 3: Calculation of the asymmetry coefficient *r*:

$$r = \frac{\sum_m \sum_n (A_{mn} - \bar{A})(B_{mn} - \bar{B})}{\sqrt{(\sum_m \sum_n (A_{mn} - \bar{A})^2)(\sum_m \sum_n (B_{mn} - \bar{B})^2)}}$$

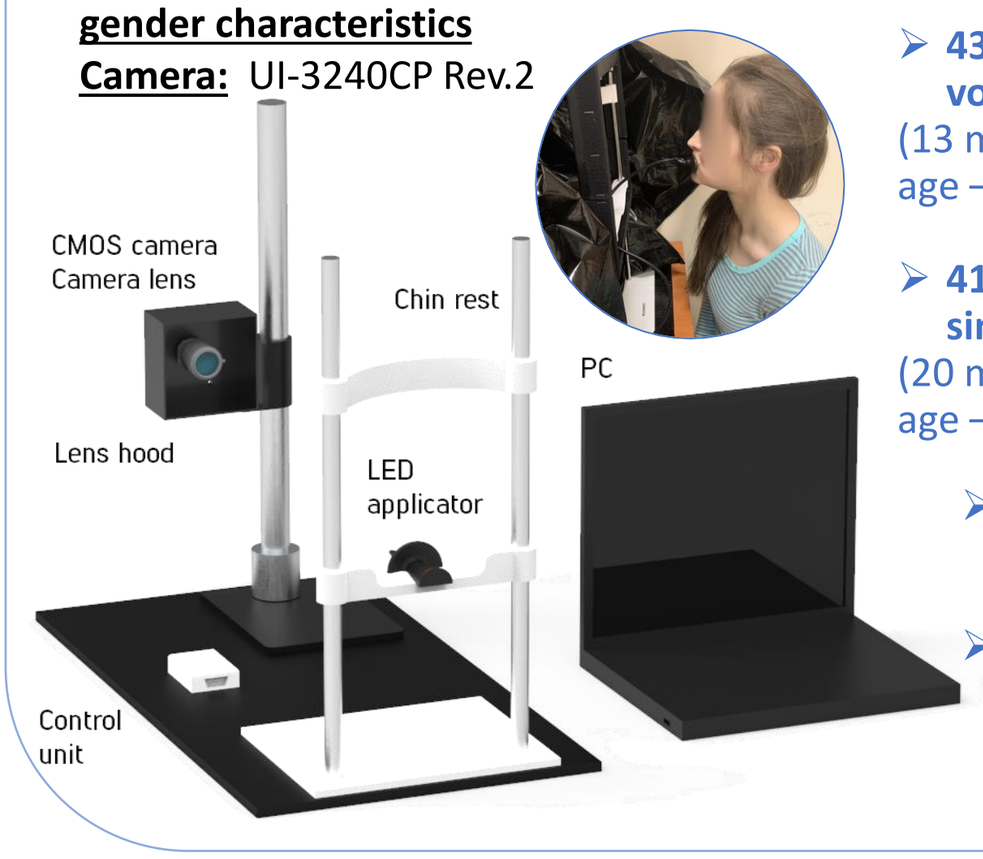
where A_{mn} and B_{nm} are pixel intensities in the left and right parts of a diaphanogram, respectively, $\bar{A}$ and $\bar{B}$ are the average intensities in the left and the right parts of the diaphanogram, respectively, m,n are number of rows and columns of the pixel matrix.

MATERIALS AND METHODS

Wavelengths of LED-applicator:
- 650 nm
- 850 nm

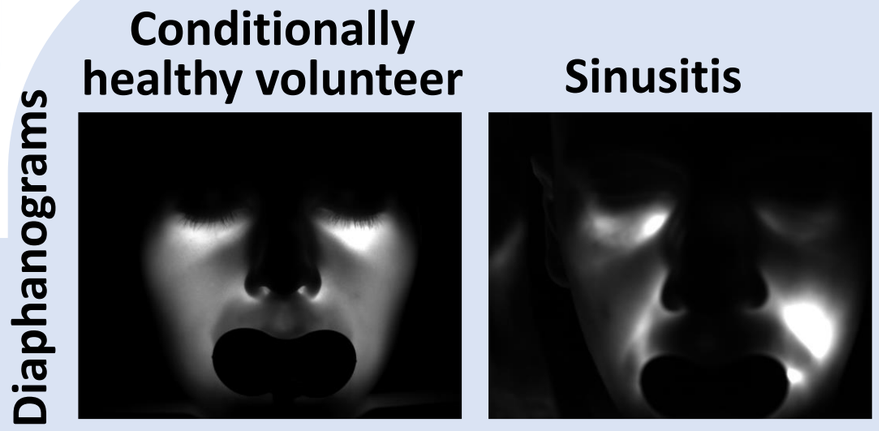
Adjustment of radiation power for patients with different anatomical and gender characteristics

Camera: UI-3240CP Rev.2



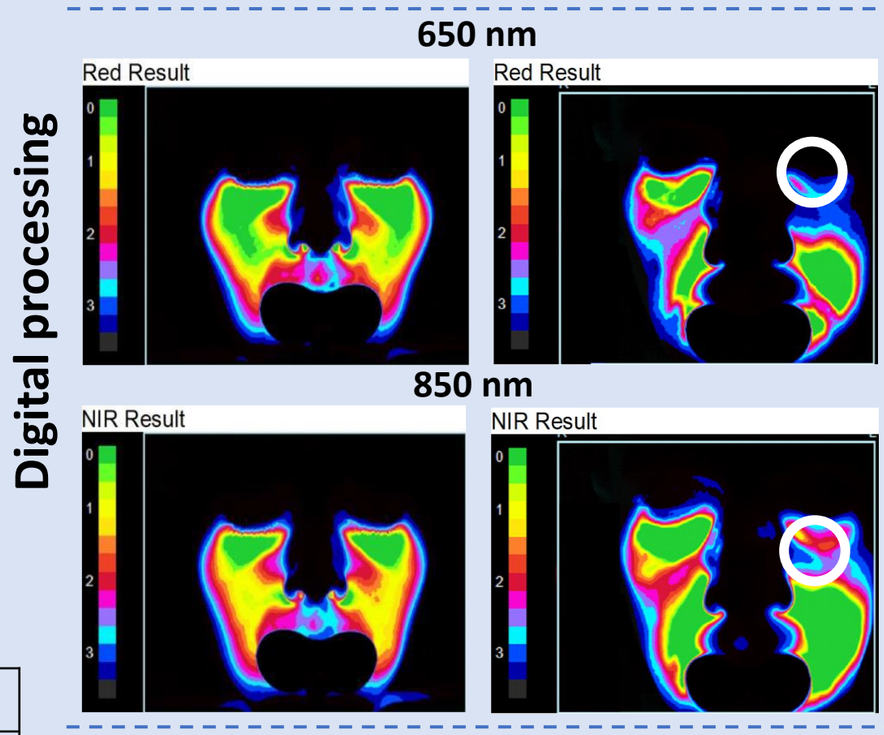
- **43 conditionally healthy volunteers** (13 male, 30 female, average age – 20±3 years old);
- **41 patients with maxillary sinus pathology** (20 male, 21 female, average age – 49±17 years old).
- **Reference diagnostic method** – CT;
- Confirmation of the diagnosis by the conclusion of an ENT doctor

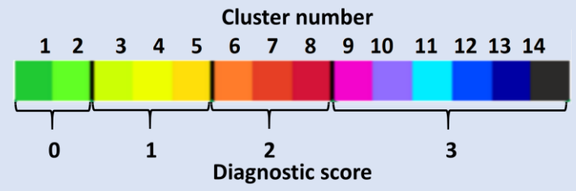
RESULTS AND DISCUSSION

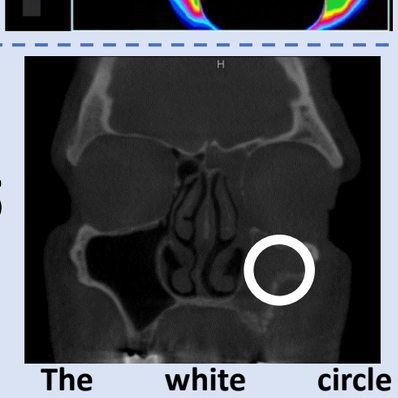


Digital processing:

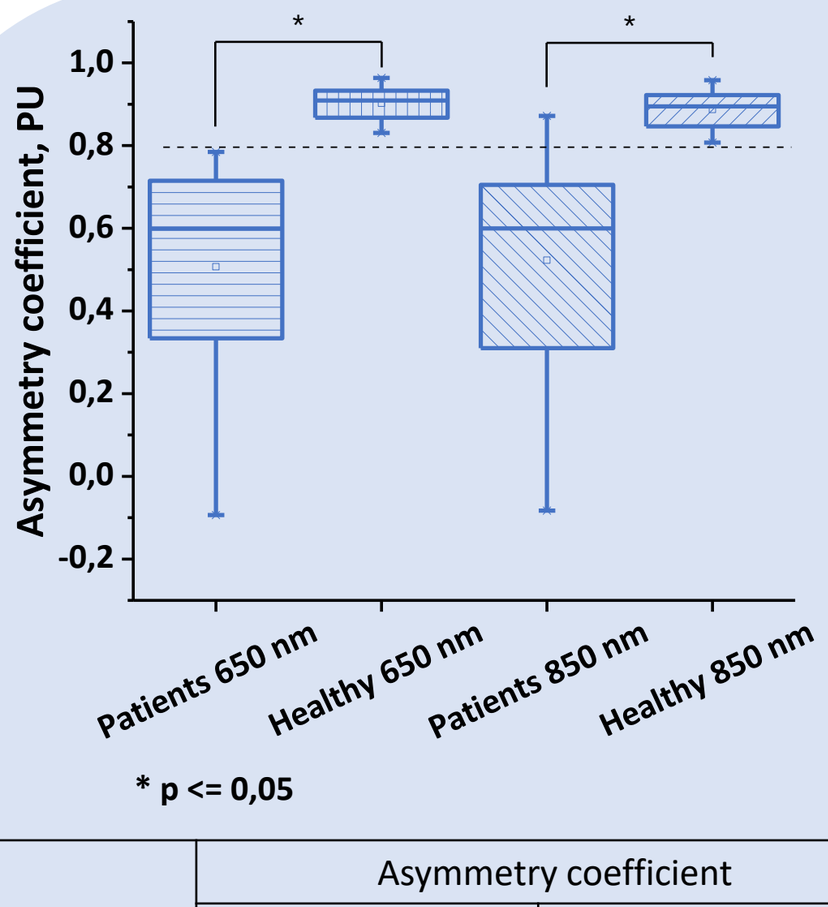
Step 1: Determination of the max and min intensity of the diaphanogram (from 0 to 255);
Step 2: Calculation of the calibration coefficient;
Step 3: Pixel-by-pixel pseudo-coloring depending on the intensity







The white circle indicates the area of the maxillary sinus with a pathological change revealed with CT.



*** p <= 0,05**

Wavelength	Asymmetry coefficient	
	Conditionally healthy volunteers	Patients
650 nm	0.909 ± 0.038 PU	0,599 ± 0,251* PU
850 nm	0.895 ± 0.046 PU	0.599 ± 0.236* PU

* – The significance of the difference between the values was confirmed with $p < 0.05$ according to the Mann-Whitney criterion.

CONCLUSIONS

- A database of diapahnograms of conditionally healthy volunteers and ENT patients was collected and subjected to further statistical analysis;
- A diapahogram asymmetry coefficient was proposed to serve as a criterion of pathology presence. A weak dependence of this parameter on the probing wavelength was revealed. Threshold values for detection of pathology cases were determined and tested.
- Following diagnostics accuracy values were achieved: sensitivity for 650 nm – 90,2%, specificity for 650 nm – 100%; sensitivity for 850 nm – 92,7%, specificity for 850 nm – 100%).

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