Evaluation of the constructed device along with the software for digital archiving, sending the data and supporting the diagnosis of cervical cancer

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OBJECTIVES

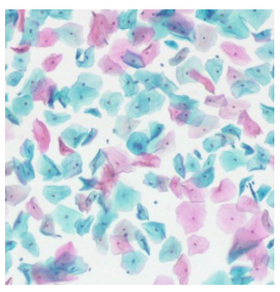
The incidence and mortality of cervical cancer are high in Poland. There are effective methods of the prevention and the early diagnosis however, they require well-trained medical professionals, including cytologists. Within this project, we built a prototype of a new device together with implemented software, to convert the currently used optical microscopes, to fully independent scanning systems for cytological samples.

The device is intended to improve the effectiveness of cytological screening and registration of cytological tests' results. The features of the software include digital backup, as well as transmission and telemedicine evaluation.

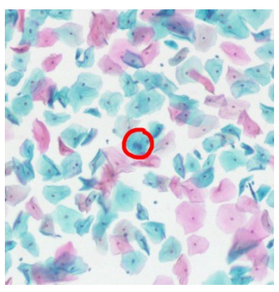
METHODS

The software uses the artificial neural network (U-NET architecture) designed to recognize suspicious regions and enhanced CNN neural network, allowing to determine the type of disorder such as: ASCUS, ASC-H, HIS, AGC, cancer.

7128 liquid based cytology (LBC) samples were evaluated by trained cyto-sreeners. Cytological abnormalities like : ASCUS, ASC-H, HIS, AGC, cancer were found in 254 (3.6%) cases. All samples were scanned and archived. Selected samples with diagnosed abnormality, were a model to teach the artificial neural networks.



Original image (LSIL)



Diagnostic analysis results (red color) – the ground truth.

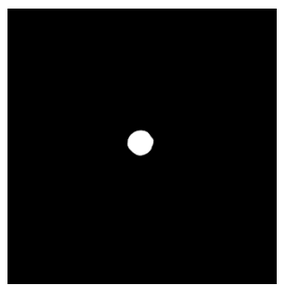
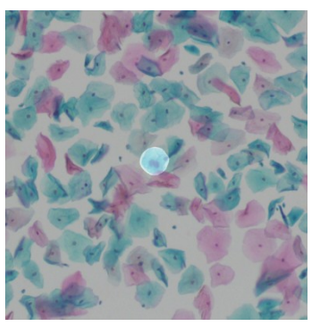


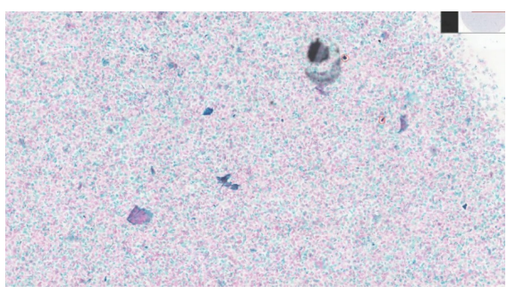
Image mask generated by neural network (U-NET)



Original image with overlayed neural network result. After comparing to diagnostic analysis result , we obtained 98% correct surface.

Last step was to use enchanced CNN neural network to obtain final diagnostic result. This image was finally diagnosed as LSIL.

Sample scan of LBC sample with the place marked by the system as ASCUS.

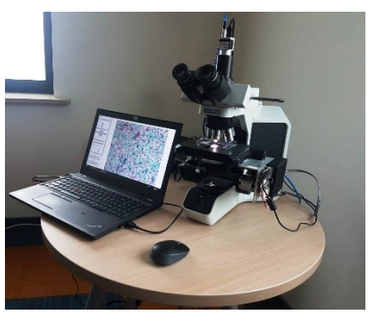


RESULTS

During LBC screening tests (distinguishing between positive and negative results) a **99,6% efficiency compliance with results obtained using standard methods** were achieved**.** There were no positive results misinterpreted.

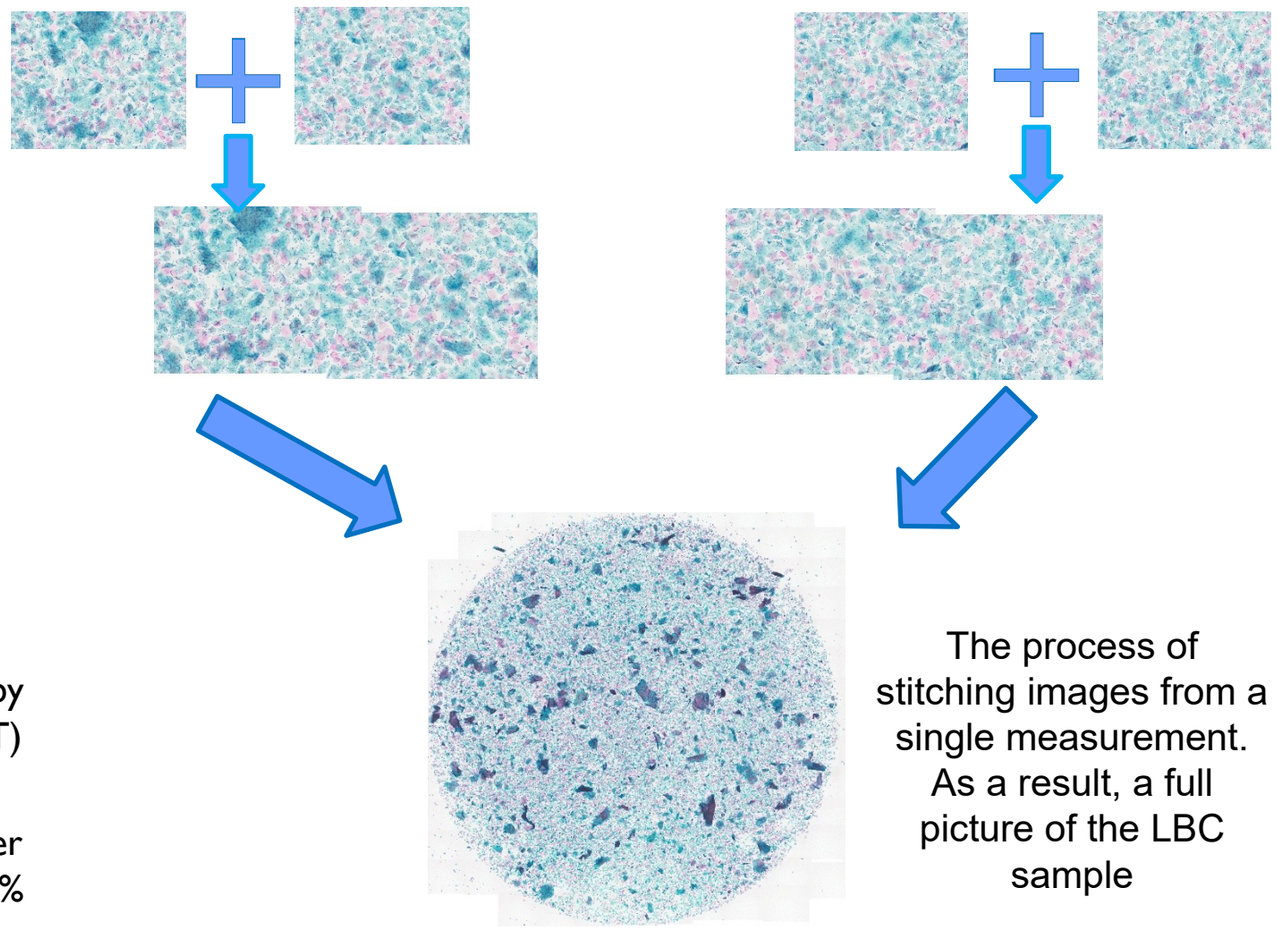
In the field of **distinguishing cytological abnormalities**: ASCUS, ASC-H, HIS, AGC, CA - **95,72% efficiency was achieved**.

Microscope with constructed device



All images were collected using prototype microscope slide scanners designed by us mounted on typical light microscopes (Olympus BX43 and CX43). Images were obtained with an Olympus 10x lens. The system was fully controlled by our software and each LBC sample was scanned in 1 minute 30 seconds.

Image stitching



The process of stitching images from a single measurement. As a result, a full picture of the LBC sample

CONCLUSIONS

The obtained results indicate high efficiency of the artificial neural networks, in supporting diagnosticians. The use of ANN is a promising for increasing the effectiveness of cervical screening. The low cost of neural networks usage, further increases the potential areas of application of the presented method.

European Funds Smart Growth

The National Centre for Research and Development

European Union
European Regional Development Fund

This project is co-financed with European Regional Development Fund within the Priority Axis I, Support for R&D activities for companies, Measure 1.2, Sectoral R&D Programmes, Sectoral Programme: "INNOMED – scientific research and development programme for innovative medicine economy sector".

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