REVIEW
BY THE FOREIGN SCIENTIFIC ADVISOR

on the dissertation work of Tankibaeva Akerke Kydyrbekovna titled «Information Technology for Detecting Anatomical Structures on Magnetic Resonance Tomography Images», submitted for the degree of Doctor of Philosophy (PhD) in the specialty 8D06101 – Information Systems (by industry)

The relevance of the chosen dissertation topic is determined by the current needs of medical diagnostics and the active integration of artificial intelligence technologies into clinical practice. The problem of accurate and reproducible recognition of meniscal injuries of the knee joint remains one of the most complex challenges in orthopedics and radiology. Although MRI is the most informative method for visualizing soft tissues, image interpretation heavily depends on the radiologist's experience, which leads to variability in diagnostic conclusions. Under these conditions, the development of automated methods for analyzing MRI images is of significant scientific and practical interest.

The dissertation work of Tankibaeva A.K. is devoted to developing methods and an information technology that ensure automation of anatomical structure extraction and diagnosis of meniscal injuries based on MRI image analysis. The dissertation comprehensively addresses issues of data collection, preprocessing, texture analysis, the use of deep learning models, and the development of an intelligent diagnostic system.

The dissertation presents a thorough literature review that includes the classification of meniscal injury types, analysis of imaging techniques, and an overview of modern approaches to medical image processing. The author has identified limitations of existing software tools, none of which are capable of automatically detecting meniscal tears on MRI scans. This highlights the scientific relevance of the approach proposed in the dissertation.

An important result of the study is the development of an information-texture diagnostic method that provides quantitative assessment of spatial heterogeneity in tissue structures on MRI slices. The author proposes a formalized approach that enables a transition from visual-analog perception of MRI images to their digital interpretation, thereby increasing the objectivity of analysis and providing an additional diagnostic tool.

Another significant scientific result is the proposed combined method of image preprocessing. The author conducted an extensive study of various filtering, contrast enhancement, and sharpening techniques, which made it possible to select the optimal method ensuring improved visualization quality while preserving anatomical details. This substantially enhances the effectiveness of subsequent neural network processing.

Particular attention should be given to the implementation of deep learning methods for automatic detection and localization of meniscal tears. For the first time, an approach based on the YOLOv8-x architecture is proposed, supplemented by a custom dataset and a combined MRI preprocessing method. The author conducted a comprehensive comparative analysis of YOLO and RT-DETR models, optimized hyperparameters, and evaluated prediction quality using rigorous metrics.

Based on the developed methods, Tankibaeva A.K. created an architecture of an intelligent diagnostic system for meniscal tears, which includes modules for image uploading, preprocessing, texture analysis, and neural network detection. The implementation of a three-tier structure—user, server, and database—ensures scalability, reliable operation, and integration with medical information systems (PACS, HIS). The system demonstrates a high degree of practical readiness and can be used in orthopedic and trauma care institutions to improve diagnostic accuracy and reduce the influence of subjective factors in MRI interpretation.

The scientific novelty of the dissertation lies in the author's original approach to automatic recognition of meniscal tears on knee MRI based on the YOLOv8-x architecture, which includes the development of a custom clinical dataset and a combined MRI preprocessing method.

The practical significance of the research results lies in the fact that the proposed solutions can be used in automated systems for diagnosing meniscal injuries of the knee joint and contribute to improving diagnostic accuracy.

The main results of Tankibaeva A.K.'s dissertation have been published in scientific journals and international conference proceedings. The dissertation is a completed, independent, high-level scientific study.

The dissertation of Tankibayeva A.K. fully meets all requirements established for dissertations submitted for the degree of Doctor of Philosophy (PhD). The completed research may be submitted for consideration by the Dissertation Committee, and its author fully merits the awarding of the PhD degree under the educational program 8D06101 – Information Systems (by fields).

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