



APPLICATION OF ARTIFICIAL INTELLIGENCE IN PATHOLOGY EDUCATION FOR STUDENTS AT THE MEDICAL UNIVERSITY OF PLOVDIV

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Abstract:

With the applications of artificial intelligence in pathology, biopsy analysis can be performed not only under a microscope but also with the assistance of computers, providing more accurate digital data and enabling the standardization of results. Digital microscope images have created the opportunity to extract more information from histological samples through image analysis. The digital transformation of pathology involves answering a number of questions that outline the need for hardware provisioning, software for visualization and data management, as well as the need for cloud services for training and education.

The project has three main objectives: 1. Integration of specialized software for the analysis of digital microscopic images into clinical and academic practice. 2. Application of the implemented software for scientific and research purposes. 3. Development of a methodology for scaling up the implementation of digital pathology.

The application of digital software will significantly facilitate the pathologist's workflow, contributing to increasing the quality and precision in assessing quantitative indicators of biopsy examinations. Innovative digital imaging and analysis methods enhance opportunities for continuous education and advanced training for students and specialists. Digital pathology also makes it possible to prepare a rich array of data base for demonstration and development of new teaching aids, exam tests and holding training seminars in an interactive environment.

For Bulgaria, this is an innovative and unique idea for creating a database and platform for education and training of medical certified pathologists, residents and students in digital pathology and artificial intelligence.

1. INTRODUCTION

General and clinical pathology is a core discipline in the educational course and curriculum of medical universities worldwide. A thorough understand-

ing of the microscopic structure and histological appearance of pathological processes is fundamental to medical education and training. Innovative digital imaging and analysis methods increase opportunities for continuing education and professional

development, both for employees, postgraduates and students. Digital pathology provides the opportunity to create a rich database for the demonstration and development of new educational materials, examination tests, and conducting training seminars in an interactive environment.

The Covid-19 pandemic has led to a change in our approach to student training in practical exercises as well as lectures. Many issues have arisen with the visualization of microscope slides, their presentation, description, and interpretation. It is not enough to have a classroom and a microscope; we also need internet access and a computer to present the slides in detail, with high-quality images. Students are no longer satisfied with files of recorded study materials. They need a website with access rights and digital photos that they can zoom in and out to understand the details of various pathological processes.

2. DIGITAL PATHOLOGY

With the application of artificial intelligence in pathology, biopsy analysis can be performed not only under a microscope but also with the help of computers, allowing more precise digital data and enabling the standardization of results.

Regarding the diagnosis of biopsy specimens in pathology departments, the heavy workload of pathologists requires the preparation of standardized protocols for work in hospitals, especially in conditions of a lack of a medical standard in Clinical Pathology. Developing software for such protocols using artificial intelligence will improve the quality of work and bring us closer to European standards.

Digital microimages of entire microscope slides save time in preparing teaching samples for each student and eliminate the need for specific storage spaces, such as histology archives, while ensuring consistent quality of the materials.

2. 1. APPLICATIONS

The application of digital software will greatly facilitate the work process of the pathologist by sorting the positive samples from the negative ones.

Innovative digital methods of imaging and analysis increase opportunities for continuing education and professional development for students and postgraduates. Digital pathology enables the creation of a comprehensive database for demonstrations, the development of new educational mate-

rials, examination tests, and the organization of training seminars in an interactive environment.

3. STRATEGIC PROJECT DIRECTION

The proposed project is directly aligned with the Scientific Domain (SD) of Digital Innovations in Healthcare under PSNIR. Unique challenges exist in the analysis of histopathological images, particularly in the features required for the potential application of this technology in clinical and educational settings.

The pathologist is the one who can provide feedback on the effectiveness of the system, as well as suggest new avenues of investigation that would provide useful information to the pathology community for diagnosis and research.

The potential for using quantitative image analysis and artificial intelligence is one of the driving forces behind digital pathology. Despite new methods for pathology image analysis described in many publications, few of them become widely adopted and are not applied in more than one study.

The explanation is often simple: the software implementing the method is simply not available or is too complex, incomplete, or data-dependent for others to use.

The result is a gap between what already seems possible in digital pathology and what is actually possible for anyone willing to implement it using currently available software.

3. 1. CONCEPT INNOVATION

The idea and concept of our proposed project have no equivalent or comparable initiatives. In Bulgaria, this represents an innovative and unique approach to creating a database and platform for training and educating medical professionals, pathologists, trainees, and students using digital pathology and artificial intelligence. Regarding the routine diagnostics of pathologists in a hospital, the proposed project can create a product that is applicable to optimizing the workflow and reducing the risk of errors with the help of the software used.

A key point is the integration of AI into the digital pathology tissue evaluation program. AI algorithms have become invaluable companions for pathologists, assisting with tasks ranging from calculating antibody expression intensity and percentage of positive cells in malignant tumors to developing algorithms and standardized protocols for reporting quantitative indicators.



The implementation of the proposed project aims to create a unique for Bulgaria methodology for training and diagnostics, which performs intelligent and fully automatic analysis with high resolution of microscopic images, in addition to the work of medical specialists.

The application of digital methods and AI algorithms in pathology can achieve the following objectives:

- Complete digitization of microscopic slides for global collaboration with other medical centers both regionally and internationally.
- Enhanced diagnostic accuracy and precision while reducing interpretation time.
- Facilitation of biomarker discovery for personalized medicine, offering significantly higher accuracy compared to widely used semi-quantitative assessment methods.
- High-resolution images provide pathologists with detailed information for analysis and diagnosis.
- Development of software with practical algorithms and user-friendly platforms, including access credentials for staff and students, enabling continuous professional education through real-time feedback.

3. 1. PROMOTING THE IDEA

The development and implementation of software products using artificial intelligence in Medical Universities and Colleges would increase students' interest in the area and discipline of pathology. The creation of platforms for the demonstration of study preparations with regulated access, also of exam tests with answers will improve their preparation for colloquiums and exams. Using the same mechanism, a platform can be developed with a database of interesting and challenging cases for training pathology residents and conducting educational seminars.

Artificial intelligence in digital pathology is the subject of a range of new research. Algorithms can analyze these digital images and assist the pathologist's work in areas such as tumor detection, grading and prognostic predictions.

Much recent work in digital pathology has focused on demonstrating how such questions can be approached more directly—without explicitly detecting or quantifying specific characteristics.

Similar strategies have been applied to predict mutations for many more genes in a wide range of tissue types. Other studies have shown that AI can be used to directly predict patient outcome from scans of hematoxylin and eosin stained slides.

In these cases, the output is a prediction that is not based on direct measurement of a specific characteristic or structure. This makes verifying the result more difficult, at least on an image basis. Confidence must be gained through: (1) large-scale validation studies using different data sets, and (2) the ability to visualize regions of the slide that contributed more or less strongly to the outcome. Such visualizations may reveal that the AI has learned to base its predictions on regions of the image already known to be clinically relevant.

3. 2. LEGAL AND ETHICAL STANDARTS

The use of digital pathology in practice does not violate any legal and ethical norms related to both patients and staff.

The diagnosis and interpretation of biopsy specimens is carried out by doctors with a specialty who are responsible for their actions and certify this with their signature.

3. 3. PERSPECTIVES AND TEAMWORK

Medical University of Plovdiv is a research center where, in addition to teaching students in various medical specialties in Bulgarian and English language, doctoral students are trained with interesting and innovative doctoral programs, intra-university and inter-university projects are gradually developed.

The Department of General and Clinical Pathology teaches students from all medical specialties and from the Medical College in Bulgarian and English. Many young assistants and doctoral students work in the department. The development and implementation of the present project will give new perspectives for training, research projects, publications and presentations of the teaching materials to students, at conferences and seminars.

This will increase the interest in the discipline of general and clinical pathology among Bulgarian and foreign students, will open doors for them to digital learning, exam test tasks and verification of answers.

4. CONCLUSION

The implementation of the hardware and software parts are inseparable elements of the digital pathology project, which will increase the level of work in the Department of General and Clinical Pathology and the interest of students in our discipline. This will contribute to raising the image of the Department in the academic community of pathologists in the country and abroad.

The opportunity to provide study slides, made and scanned by us for training and research gives new perspectives for working with researchers from different specialties. The research from this project will contribute to the implementation of similar software in all other pathology units in Bulgaria.

In addition to optimizing the learning process, this will also lead to the development of new theoretical knowledge and practical skills regarding the application of such software for the needs of daily practice for training and image analysis when assessing the expression of various markers in tumors of different localization.

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