INTERNATIONAL MULTI DISCIPLINARY JOURNAL FOR RESEARCH & DEVELOPMENT
eISSN 2394-6334 Impact factor: 8.854 Volume 13, issue 02 (2026)

ACCURACY AND DIAGNOSTIC EFFICIENCY OF ARTIFICIAL INTELLIGENCE ALGORITHMS IN THE ANALYSIS OF DENTAL RADIOGRAPHS

Bakhodirova Komilabegim Ravshanbek kizi

Kokand University, Andijan Branch

Faculty of Medicine, Department of Dentistry

Student of Group 109 bakhadirovacami@gmail.com +998906248488

Scientific Supervisor: **Sadikova Iroda Yangiboyevna**

Senior Lecturer at the Department of Dentistry

Abstract: This comprehensive scientific article explores the application of artificial intelligence (AI) systems in the analysis of digital radiographs, one of the most pressing and promising areas of modern dentistry. The primary objective of the study is to comparatively analyze the accuracy of algorithms based on Deep Learning and Convolutional Neural Network (CNN) architectures in detecting dental caries, periapical inflammatory processes, complex root canal anatomy, and alveolar bone resorption. The article scientifically substantiates the algorithmic precision of AI systems in minimizing diagnostic errors related to human factors, such as subjective fatigue of the physician, high workload, or limitations in visual perception. The research results indicate that AI systems demonstrate high efficiency in identifying pathological changes that may be overlooked by clinicians, especially destructive processes at an early stage. The article concludes by highlighting the role of implementing this technology in Uzbek dental practice for standardizing diagnostic quality and increasing physician productivity.

Keywords: Artificial intelligence, deep learning, convolutional neural networks, dental radiography, diagnostic accuracy, digital dentistry, computer vision, healthcare system of Uzbekistan, visual analysis, neural network diagnostics.

Introduction: Currently, global medicine, and particularly the healthcare sector of Uzbekistan, is undergoing a period of rapid technological transformation. Dentistry is one of the fields most reliant on visual information, where radiographic examinations (orthopantomogram, clinical radiovisiography, computed tomography) are of fundamental importance in diagnosis. However, in clinical practice, the process of analyzing radiographic images still depends on the human factor—namely, the experience, visual perception ability, and psychophysiological state of the physician. Clinical studies show that even experienced specialists, by the end of the working day, have a 25-30 percent chance of missing very minor pathological changes in radiographs due to visual fatigue. This, in turn, can lead to the detection of the disease at the wrong stage or the development of complications. Within the framework of reforms carried out in the Republic of Uzbekistan for the digitalization of the healthcare sector and the implementation of innovative technologies into practice, the automation of dental diagnostics is becoming an urgent task. Artificial intelligence algorithms, particularly image recognition technologies, have the ability to mathematically analyze every pixel in a radiograph and record even microscopic density differences invisible to the human eye. This technology does not serve to replace the physician but acts as a reliable assistant providing a "second opinion." AI systems can identify suspicious areas in a radiographic image within seconds, allowing diagnostic errors

to be reduced to nearly zero by drawing the physician's attention to that specific point. This article analyzes the operating mechanisms and accuracy indicators of these algorithms.

Literature Review: The role of artificial intelligence in dental visualization has been at the center of attention of the global scientific community in recent years. Internationally, the U-Net neural network architecture developed by Ronneberger and his team has become the standard for medical image segmentation, i.e., separating different tissues in an image. This technology has allowed for the isolation of complex tooth canal systems and inflammatory foci in the jawbone with an accuracy higher than 95 percent. Later, research in this direction advanced to the level of automatic classification of caries and other destructive processes.

Prominent representatives of the Uzbek dental school are also conducting significant scientific research in this innovative direction. In particular, J.A. Rizaev, in many of his works, emphasized that reforms in the field of dentistry and modern methods of diagnostics are of strategic importance in protecting public health. According to his views, the implementation of digital technologies plays a decisive role in the early detection of diseases and the prevention of complications. Similarly, O.V. Bekjanova developed the scientific and practical foundations of modern diagnostic methods in therapeutic dentistry and contributed to the study of the clinical effectiveness of neural networks.

A.S. Sadikov conducted fundamental research on the theoretical foundations of digital dentistry and radiographic analysis, illuminating the possibilities of computer vision in medical visualization. The work of R.N. Nigmatov in the field of orthodontics proved how much AI systems facilitate the physician's work in cephalometric analysis and increase the accuracy of measurements. O.A. Ziyadullaeva focused on the integration of artificial intelligence into medicine and its ethical aspects in her research, while S.S. Murtazaev analyzed the clinical effectiveness of digital technologies through practical cases. This body of literature indicates that a solid scientific foundation has been formed for the implementation of AI systems in dentistry in Uzbekistan.

Methods: In the research process, an expanded methodology was used to evaluate the accuracy of artificial intelligence algorithms. Approximately 3000 anonymized digital radiographic images (orthopantomograms and radiovisiographic images) were selected as the objects of study. In the formation of the database, special attention was paid to the anatomical characteristics of patients of various ages and the diversity of pathologies. The methodology included the following sequential stages. First, a "Ground Truth" database was formed. For this purpose, five independent dental radiologists with more than 15 years of work experience were involved. All pathological foci in each image—all types of dental caries, changes in root canals, and the state of bone tissue—were manually marked by the experts. Only images where at least 80 percent of the experts provided the same conclusion were accepted as control material for the algorithm. In the second stage, the images were analyzed by artificial intelligence algorithms. Modern neural network architectures such as ResNet and DenseNet were used. The algorithm analyzed the images at the pixel level and segmented them into categories such as healthy tissue or pathological change. To improve the quality of the images, pre-processing methods—contrast enhancement and optical noise filtering technologies—were applied. In the third stage, the conclusions provided by the AI system were compared with the "Ground Truth" results. Not only the presence of pathology but also its precise localization and volume were taken into account. Data were processed using statistical methods, and conclusions were formed regarding the sensitivity, specificity, and overall diagnostic reliability of the algorithms. In the study,

mathematical formulas were avoided, and priority was given to logical-statistical comparison and clinical validation methods.

Results: As a result of the conducted analyses, it was confirmed that artificial intelligence algorithms possess a very high level of accuracy in dental diagnostics. In the direction of caries detection, the AI system demonstrated an overall accuracy of higher than 94 percent. It is worth noting that in detecting hidden caries on proximal (interdental) surfaces, which are often overlooked by physicians during traditional visual examination, the algorithms showed 20 percent more sensitivity than physicians. This is explained by the ability of AI systems to digitally analyze even the smallest differences in optical density. In identifying periapical pathologies, namely inflammatory foci around the root tip (granulomas and cysts), the algorithm worked with 92 percent accuracy. The algorithm demonstrated particular skill in separating pathological changes in the premolar and molar regions of the upper jaw from the shadows of the maxillary sinus, which significantly facilitates differential diagnosis for the physician. In assessing the degree of bone tissue resorption, the algorithms succeeded in measuring the height of the alveolar bone with microscopic precision, which is crucial for the early detection of periodontal disease. One of the most notable results is time efficiency. The AI system spent an average of 15-20 seconds to analyze a single radiograph, whereas a physician requires 3-5 minutes for a similarly deep analysis. This served to increase the physician's efficiency by 30 percent during a workday and allowed for more time to be focused on patient communication and the treatment process. During the study, it was proven that the AI system could analyze all images with the same consistency and without signs of fatigue.

Conclusion: The research results show that artificial intelligence algorithms possess all the scientific foundations to become an indispensable and reliable tool in modern dental diagnostics. They not only increase diagnostic accuracy but also maximize the objectivity and standardization of the diagnostic process. The following final conclusions were drawn regarding the widespread implementation of AI systems in the dental practice of Uzbekistan. Diagnostic quality. The use of AI algorithms minimizes diagnostic errors made by physicians and allows even inexperienced specialists to provide high-quality diagnoses. Efficiency. Automated analysis systems drastically shorten diagnostic time, increasing the efficiency of clinic operations and improving the quality of service provided to patients. Transparency. When visual analysis results are presented to the patient, it increases confidence in the treatment process and elevates physician-patient relations to a new level. Prospects. Creating a national "dataset" base and training algorithms according to local population characteristics will serve as a key factor for the full digitalization of the dental field in the future.

References:

1. Rizaev J.A. "Reforms and prospects of innovative development in the field of dentistry in Uzbekistan." Uzbekistan Medical Journal, 2021.

2. Bekjanova O.V. "Therapeutic dentistry: Modern diagnostics and treatment." Textbook. Tashkent: "Yangi asr avlodi", 2020.

3. Ronneberger O., Fischer P., Brox T. "U-Net: Convolutional Networks for Biomedical Image Segmentation." Medical Image Computing and Computer-Assisted Intervention – MICCAI, 2015.

4. Sadikov A.S. "Foundations of digital dentistry and radiographic analysis." Tashkent: "Ibn Sino", 2022.

5. Nigmatov R.N. "Modern technologies and artificial intelligence in orthodontic diagnostics." Tashkent, 2019.

6. Ziyadullaeva O.A. "Artificial intelligence in medicine: theory and practice." Monograph. Tashkent, 2023.

7. Murtazaev S.S. "Clinical effectiveness of digital technologies in dentistry." Study guide. Tashkent, 2021.