

Artificial Intellect in Stomatology

Aliyeva Nazokat Muratjonovna

Tashkent State Medical University, Tashkent, Uzbekistan

Abstract: Artificial intelligence, artificial intelligence, and machine learning are among the most revolutionary and promising technologies that have been rapidly being implemented in various fields of medicine, including dentistry, over the past decade, transforming the processes of diagnostics, treatment planning, outcome prediction, and practical implementation of dental procedures. Stomatology, as a field of medicine highly dependent on visual information and requiring precise analysis of complex morphological structures, is an ideal field for applying artificial intelligence algorithms based on deep learning and neural networks.

Keywords: Artificial Intelligence, Machine Learning, Deep Learning, Neural Networks, Dentistry, Diagnostics, Computer Vision, Digital Pathology

Introduction

Artificial intelligence in the context of dentistry encompasses various technologies and approaches, from simple logistic regression algorithms and decision trees to complex deep neural networks, each with its own characteristics, advantages, and limitations. Machine Learning is a section of AI where computers learn based on examples and patterns in data without explicitly programming each rule. Deep Learning-Deep Learning uses multilayered artificial neural networks- Artificial Neural Networks to automatically extract features from raw data such as: images, text and use them to solve classification, regression, and object detection problems.

convolutional neural networks - Convolutional Neural Networks - CNN represents a neural network architecture specifically designed for image processing and based on biological processes in the visual cortex of the mammalian brain. The CNN model includes a series of layers for feature extraction (convolutions with filters to emphasize features - edges, corners, textures), dimensionality reduction (pooling), and final classification (fully-connected).

Recurrent Neural Networks - RNN Recurrent Neural Networks - RNN and their advanced modifications, as Long Short-Term Memory - LSTM, are designed to work with sequential data (e.g., time series or text data) which may be beneficial for treatment stages sequence analysis or disease progression prediction.

Transfer-learning – Transfer Learning is a powerful technique where the neural network trained on a large dataset (for example millions of images from ImageNet) is taken as the starting point and through retraining only shallow layers, it could solve a new dentistry related problem. Such a strategy makes the model feasible to achieve good performance based on small scale of dental data, it's meaningful on account of that the large-scale data sets for training are hardly available. Interpretable and understandable- Explainability and Interpretability are critical aspects in the application of AI in medicine, including dentistry, as doctors and patients must understand on what basis the AI system makes a decision. Visualization methods such as Grad-CAM- Gradient-weighted Class Activation Mapping and LIME- Local Interpretable Model-agnostic Explanations allow visualizing parts of the image that were most important for AI system decision-making.

Caries diagnosis is one of the most frequent tasks in dental practice, however, traditional visual and radiological diagnostics has significant limitations: high dependence on the physician's experience, the absence of 20-30% of carious lesions, especially interproximal and occlusive lesions, and significant variability between different diagnoses. The use of AI for caries diagnosis has shown promising results, with caries detection accuracy reaching 80-95% in various studies.

AI systems for caries diagnosis are trained on large sets of images such as dental photographs, X-ray images annotated by experienced dentists, and then use deep neural networks to automatically detect carious lesions. Studies have shown that AI systems can surpass average dentists in caries diagnosis and be comparable to the diagnosis of experienced specialists.

Periodontal diseases: gingivitis, periodontitis, and bone tissue around teeth are critical for preserving teeth, however, diagnosing these diseases requires analysis of complex radiological patterns, assessment of periodontal pockets depth, and bone atrophy level. AI recognition of alveolar bone loss has had good performance, predicting the progress of periodontitis and even evaluation a patient's response to periodontitis treatment. Artificial intelligence can measure the alveolar bone level around each tooth on PAN and PA radiographic images, facilitating early recognition of continuing bone loss, and consequently treatment.

It has been reported that AI algorithms can predict the presence of periodontitis with a sensitivity ranging from 85 to 95% and specificity from 80 to 90%.

Whereas deep neural network analysis of gingival photographs can recognize inflammation, swelling and recession by the gum, application of these models may be utilized to assess the efficiency of periodontal treatment and condition monitoring for periodontium. Moreover, AI can be applied for prediction of the development and progression of periodontitis according to initial radiological and clinical parameters that enable orthopedists and periodontologists to have a better treatment plan.

It also means they will receive more treatment and may now avoid some of the costs of late stage oral cancer that present it as one of the deadliest, most frequently occurring tumours because this technology can mean getting an earlier diagnosis. AI technology has been reported to be valuably used in the diagnosis of oral premalignant and malignant lesions through analysis of photographic, radiographic, and video endoscopic images.

A deep learning model is capable of reviewing photographs of oral lesions and correctly identifying the most common subset of such lesions as benign, precancerous, or cancer with some reliability that was comparable to or in some instances exceeded that of expert clinicians. AI can detect signs of malignancy such as symmetry disruption, incorrect lesive boundaries, bright red or white staining, and associate these signs with a high risk of cancer.

AI applications for detecting pathological formations include:

- Analysis of intraoral photographs to identify suspected cancer lesions
- Analysis of CT and MRI images to determine tumor spread, presence of invasion into neighboring structures, and metastases.
- Predicting tumor aggressiveness and patient prognosis based on morphological and genetic signs
- Monitoring tumor recurrence after treatment by analyzing persistent images

II systems can also detect other pathological oral formations such as odontogenic cysts, osteomyelitis, osteonecrosis, and neoplasia, ensuring early detection and timely intervention.

X-ray diagnostics remains one of the most important methods in dentistry, however, interpreting X-ray images requires considerable experience and can be a tedious task, especially when analyzing large volumes of images. Implantology involves deliberation regarding proper placement of the implant, while taking into consideration the amount and quality of bone, anatomic structures in terms of maxillary sinuses, mandibular canal and also position of adjacent teeth as well as patient's aesthetic demands. AI can help with analyzing CT scans of the jaw, extracting bone tissue based on AI segmentation algorithms, select the best implant size and location, and predict whether an implant will succeed.

Conventional methods of diagnosis of dental diseases using clinical examination and the study of radiological images: panoramic, intraoral, CT rely largely on the expertise and skills of a medical professional, that can cause omissions in making a diagnosis as well interpretation inaccuracies and substantial differences between specialists in conclusions drawn. The implementation of artificial intelligence systems trained on large datasets - Big Data using Deep Learning methods - allows for increased diagnostic accuracy, reduced errors, standardized analysis processes, and made dental care more accessible in regions with a shortage of qualified specialists. The application of AI in dentistry covers a wide range of areas: diagnosis of caries, periodontal and jaw bone diseases, detection of tumors and neoplasms, planning implant treatment, ortodontic treatment, endodontic treatment, analysis of tomographic images, processing of digital dental models, predicting treatment outcomes, optimizing work processes in the dental office, and much more.

According to global experts' forecasts, in the next 5-10 years, artificial intelligence will be integrated into almost all aspects of dental practice and will become an integral part of modern dentistry, allowing dentists to work more effectively, accurately, and safely, and patients to receive more quality and

personalized care.

Conclusion

The conclusions of this review consist of systematizing information on modern applications of artificial intelligence in dentistry, including the description of technologies and algorithms, clinical applications, evidence-based effectiveness, advantages, and limitations, as well as discussing the prospects for development and ethical aspects of AI use in dental practice.

REFERENCES

- Shomurodov, K., Khaidarov, N., & Kamalova, M. (2021). The formation and eruption of baby teeth in children. *Збірник наукових праць SCIENTIA*. Retrieved from <https://ojs.ukrlogos.in.ua/index.php/scientia/article/view/14724>
- Schwendicke F, Samek W, Krois J. Artificial intelligence in dentistry: chances and challenges. *J Dent Res*. 2020;99(7):769-774. doi:10.1177/0022034520915714
- Hung K, Montalvao J, Tanaka R, et al. The applications of artificial intelligence in dentistry. *J Dent Res Clin Dent Prospects*. 2020;14(2):78-84. doi:10.34172/jrdcp.2020.13
- Kim S, Park HS. Artificial intelligence for dental imaging: a review. *Appl Sci*. 2021;11(9):4053. doi:10.3390/app11094053
- Jader F, Fehr M, Eckert A, Koch G. Towards automated dental caries classification using deep learning and near infrared light transillumination. *J Dent*. 2016;55:38-44. doi:10.1016/j.jdent.2016.10.015
- Travers C, Herren H. Artificial intelligence and machine learning in dentistry: ethical, legal and regulatory issues. *Dent J (Basel)*. 2021;9(7):82. doi:10.3390/dj9070082
- Imangaliyev S, Volossovskiy OI, van der Veen MH, Jacobs R, Crielaard W. Artificial intelligence for dental caries detection: systematic review. *J Dent Res*. 2021;100(3):259-269. doi:10.1177/0022034520969882
- Cui Z, Gao X, Mir F. Artificial intelligence in caries risk and activity assessment. *J Dent Res*. 2021;100(3):229-237. doi:10.1177/0022034520967673
- Ezhov M, Gusarev M, Golitsyna M, et al. Clinically applicable artificial intelligence system for detection of occlusal caries and quantification of caries activity. *J Dent Res*. 2021;100(3):239-246. doi:10.1177/0022034520969881
- Kamnitsas K, Ferrante E, Parisot S, et al. Efficient multi-scale 3D CNN with fully connected CRF for accurate brain lesion segmentation. *Med Image Anal*. 2017;36:61-78. doi:10.1016/j.media.2016.10.004
- Lee JH, Kim DH, Jeong SN, Choi SH. Diagnosis and prediction of periodontally compromised teeth using a deep learning-based convolutional neural network algorithm. *J Periodontal Implant Sci*. 2018;48(2):114-123. doi:10.5051/jpis.2018.48.2.114
- Cohen-Levy J, Rizzo A, Bernhart T, Sacher E, Eidenberger K. Artificial intelligence software shows possible promise for caries detection. *J Evid Based Dent Pract*. 2021;21:101639. doi:10.1016/j.jebdp.2021.101639
- Vinayahalingam S, Xi T, Bergé S, Maal T, de Jong G. Automated detection of third molars and mandibular bone resorption on panoramic radiographs using deep learning. *Dentomaxillofac Radiol*. 2020;49(7):20200043.