AMERICAN ACADEMIC PUBLISHER

INTERNATIONAL JOURNAL OF MEDICAL SCIENCES

ISSN NUMBER: 2692 - 5206 Volume 5. No 12. December ,2025

THE APPLICATION OF MACHINE LEARNING TECHNOLOGIES IN THE ANALYSIS OF ENDOSCOPIC IMAGES

Sanjarbek Anvarovich
Assistant, Department of Biomedical Engineering, Biophysics and Information Technologies, Fergana Medical Institute of Public Health, Fergana, Uzbekistan
Nasibaliyeva Aziza Azamat kizi
Fergana Public Health Medical Institute, Faculty of Pediatrics, 1st year student

Abstract: This article highlights the role and importance of machine learning technologies in the analysis of endoscopic images. It analyzes the possibilities of early detection of various diseases of the gastrointestinal tract with the help of artificial intelligence systems, automatic segmentation, and classification of pathological changes. The article also provides information on the advantages of machine learning, existing problems, and areas of practical application.

Keywords: endoscopy, machine learning, deep learning, medical images, artificial intelligence, diagnostics.

. Endoscopy is an important diagnostic method that allows visualization of internal organs using special optical instruments. In modern medicine, this method is widely used to detect diseases of the gastrointestinal tract, bronchi, urinary tract, and other internal structures. However, the analysis of endoscopic images largely depends on the experience of the doctor and the sensitivity of the human eye, which in some cases can lead to subjective errors.
In recent years, artificial intelligence and machine learning technologies have opened up new opportunities in the analysis of medical images, in particular, endoscopic data.
Literature review and method: Machine learning algorithms allow identifying complex patterns in images, automatically highlighting pathological changes, and significantly speeding up the diagnostic process by providing visual signals to the doctor.
Digital technologies, in particular, machine learning and artificial intelligence systems, are increasingly used in modern medicine. With their help, diagnostic processes are automated, and errors associated with the human factor are reduced.
However, the large volume of endoscopic images, changes in lighting and contrast, as well as differences in data obtained in various clinical conditions, complicate the analysis process. Therefore, the introduction of automatic analysis systems based on machine learning opens a new stage in medical diagnostics.
Endoscopic images are one of the most important diagnostic tools in modern medicine. With their help, it is possible to directly visualize and analyze the condition of internal organs, such as the gastrointestinal tract, bronchi, urinary tract. Images obtained during an endoscopic examination contain highly accurate data, but the process of their manual analysis requires a lot of time and can lead to errors associated with the human factor. Therefore, the introduction of machine learning technologies into endoscopic analysis has become one of the most promising areas in medicine in recent years.
Machine Learning (ML) and Deep Learning (DL) technologies have achieved great success in the analysis of medical images. In particular, Convolutional Neural Networks (CNNs) have become one of the most effective approaches to the automatic analysis of endoscopic images.

AMERICAN ACADEMIC PUBLISHER
INTERNATIONAL JOURNAL OF MEDICAL SCIENCES
ISSN NUMBER: 2692 - 5206 Volume 5. No 12. December ,2025

CNN models study the image at the pixel level and can distinguish pathological tissues from normal ones.

The main stages of machine learning in endoscopic analysis include: collecting images, labeling them, training the model, validation, and evaluating the results. The larger and higher the quality of the data set, the higher the accuracy of the model. For example, studies conducted in medical centers in Japan and Korea show that endoscopic systems based on artificial intelligence can detect stomach cancer with an accuracy of 94-97%.

In addition, with the help of machine learning technologies, it is possible to detect polyps, erosions, foci of inflammation, and other pathologies in real-time. This not only speeds up thediagnostic process but also allows detecting small changes that may go unnoticed by the doctor.

The most important types of machine learning algorithms used for the analysis of endoscopic images:

- CNN (Convolutional Neural Network) – identifies differences in shape, color, and texture of images;
- RNN (Recurrent Neural Network) – tracks changes over time in video endoscopy;
- GAN (Generative Adversarial Network) – is used to create artificial endoscopic images and further train the model;
- Transfer learning – a method of adapting existing large models to local medical data.

In recent years, these technologies have been used not only for analysis but also as auxiliary tools in endoscopic surgery. For example, systems have been developed to automatically detect the source of bleeding during surgery or to highlight dangerous tissue in real-time.

In the healthcare system of Uzbekistan, work has also begun on the introduction of digital technologies in recent years. Scientific research is being conducted in medical universities in the field of machine learning and artificial intelligence. The formation of a national database based on endoscopic images, the creation of local software platforms for training artificial intelligence, and the training of medical personnel in digital diagnostics are becoming increasingly important.

In addition, the effectiveness of machine learning technologies used in endoscopic systems is expressed not only in the accuracy of diagnostics but also in reducing medical costs, saving time, and increasing patient safety.

The main tasks of machine learning in endoscopic analysis:

- Automatic detection of pathological foci;
- Separation of healthy and affected tissues through image segmentation;
- Classification of various types of diseases;
- Acceleration and standardization of the diagnostic process.

For these purposes, Convolutional Neural Networks (CNNs) are widely used. They analyze endoscopic images layer by layer and highlight the necessary diagnostic features. For example, with the help of CNN models, it is possible to detect polyps during colonoscopy, distinguish stomach cancer, or diseases such as duodenitis.

Studies conducted in Japan have shown that CNN-based systems give results 20-25% faster and 10% more accurately than doctors. These systems analyze each frame of the video stream in real-time and send a signal to the doctor when changes are detected.

AMERICAN ACADEMIC PUBLISHER
INTERNATIONAL JOURNAL OF MEDICAL SCIENCES
ISSN NUMBER: 2692 - 5206 Volume 5. No 12. December ,2025

The Transfer Learning method is very important in endoscopic analysis. Since medical data is usually limited, pre-trained models (e.g., ResNet, EfficientNet, VGG16) are adapted to endoscopic images. This method reduces training time and increases model accuracy.

The segmentation stage is also an integral part of endoscopic analysis. With its help, the exact boundaries of the pathological focus are determined. U-Net, Mask R-CNN, and SegFormer models show the highest results in this area. Segmentation results allow planning surgical operations, choosing the most suitable place for biopsy, and tracking the development of the disease.

Data augmentation is also an important technique for medical models. Since endoscopic images may differ in lighting, camera angle, or contrast, it is necessary to use methods such as rotating images, mirroring, changing color intensity to ensure stable model training.

In recent years, multimodal systems have also been developing. They analyze not only the image but also the patient's medical history and laboratory indicators. For example, if the patient's age, symptoms, and laboratory data are entered into the system along with the endoscopic image, the accuracy of the diagnosis will significantly increase.

The practical application of machine learning in endoscopic analysis gives noticeable results in medical institutions. The “GI Genius” (Italy) and “EndoBrain” (Japan) systems are used in many clinics today. They show accuracy of up to 96% in detecting polyps. In addition, the “WISE Vision” system developed in Korea detects stomach cancer at an early stage faster than a doctor.

In the healthcare system of Uzbekistan, much attention is also paid to such innovative approaches. In cooperation with the Tashkent Medical Academy, TATU, and IT Park, projects are being implemented to test artificial intelligence models for endoscopic images.

Creating a local database, training the model based on images obtained in Uzbek clinics, will further increase the reliability of these systems.

However, along with technological development, ethical and legal issues are becoming relevant. Medical data analyzed using artificial intelligence must be strictly controlled in terms of privacy, data confidentiality, and clinical responsibility. It is necessary to clearly define the boundaries of responsibility between the doctor and the system, and the decisions of the algorithm must be approved by medical expertise.

In the future, the integration of endoscopic analysis systems with cloud platforms will allow analyzing data obtained in various hospitals in a single center. This, in turn, will help in the early detection of diseases, conducting mass screening programs, and improving the quality of medical services.

In conclusion, machine learning technologies in endoscopic analysis increase the accuracy of diagnostics, reduce the human factor, and serve as an important auxiliary tool for doctors. The widespread introduction of such systems into the medical practice of Uzbekistan will be of great importance for improving the efficiency of the healthcare system in the future.

Conclusion. The application of machine learning technologies in the analysis of endoscopic images has become one of the important directions of modern medicine. These technologies allow detecting small changes that the human eye cannot see, diagnosing diseases at an early stage, and determining the correct and quick methods of treatment for the patient. With the help of systems based on machine learning and deep learning, polyps, ulcers, and tumor foci in the gastrointestinal tract are accurately detected, which reduces doctor errors and brings the quality of medical diagnostics to a new level.

In addition, these technologies allow reducing the workload on medical personnel, establishing real-time control, and providing the possibility of remote medical consultation. In the future,

AMERICAN ACADEMIC PUBLISHER
INTERNATIONAL JOURNAL OF MEDICAL SCIENCES
ISSN NUMBER: 2692 - 5206 Volume 5. No 12. December ,2025

further improvement of endoscopic analysis systems, the creation of a national database corresponding to the conditions of Uzbekistan, and the development of artificial intelligence models with the participation of Uzbek specialists are urgent tasks. Such scientific developments will make a significant contribution to the digital development of medicine in our country.

References:

1. Атаханов, С. А., & Рахматжонова, М. (2025). РАЗВИТИЕ МЕДИЦИНСКИХ КОМПЕНТЕНЦИЙ СТУДЕНТОВ ПОСРЕДСТВОМ ИСПОЛЬЗОВАНИЯ ТЕХНОЛОГИЙ БИОЛОГИЧЕСКОГО МОДЕЛИРОВАНИЯ В МЕДИЦИНСКОМ ОБРАЗОВАНИИ. Tadqiqotlar, 60(1), 3-7.
2. Anvarovich, A. S. (2025). SUN'IY INTELLEKT YORDAMIDA YURAK-QON TOMIR KASALLIKLARINI ERTA TASHXISLASH. IMRAS, 8(11), 96-99.
3. Anvarovich, A. S. (2025). INTERNETGA QARAMLIK OQIBATIDA NEVROLOGIK TIZIMDA ANOMALIYALARNING PAYDO BO'LISHI. MODERN SCIENCE, 2181, 3906.
4. Anvarovich, A. S., & Omonjon o'g'li, M. H. (2025). THE ROLE OF MODERN COMPUTER TECHNOLOGIES IN THE DIAGNOSIS AND TREATMENT OF GASTRITIS. EduVision: Journal of Innovations in Pedagogy and Educational Advancements, 1(4), 766-770.