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ANALYSIS OF MEDICAL IMAGES (X-RAY, CT, MRI) BASED ON MACHINE LEARNING

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Abstract

In modern medicine, automating diagnostic processes and improving detection quality is a pressing issue. This thesis examines methods for analyzing medical images, specifically X-ray and magnetic resonance imaging (MRI) results, using Data Mining technologies. The possibilities of detecting diseases at early stages, improving diagnostic accuracy, and supporting physicians in the decision-making process through data mining technologies are analyzed.

Keywords

Data Mining, medical images, X-ray diagnostics, MRI analysis, machine learning, image processing, artificial intelligence, medical diagnostics.

The use of Magnetic Resonance Imaging (MRI) in healthcare and the emergence of radiology as a practice is relatively new compared to classic medical specialties. The use of MRI grew rapidly, giving rise to new directions. One such development is the use of computing technology to analyze MRI images in a similar manner. In particular, the development of imaging technologies such as X-ray, MRI, and CT is providing high accuracy and speed in disease detection. Data Mining processes also serve to find hidden patterns in medical images, early detection of pathological signs, and improving diagnostic quality. Especially, deep learning methods — in particular, convolutional neural networks (CNN) — enable faster and more accurate analysis of complex image structures than humans.

The main advantages of automated analysis of medical images include:

- improves the possibility of early disease detection;
- serves as an additional support system for physicians in the decision-making process;
- speeds up the diagnostic process;
- reduces human error.

The main objective of the research is to study and apply methods for analyzing X-ray and MRI images using Data Mining and deep learning algorithms.

Medical imaging methods such as X-ray, CT, MRI, and ultrasound provide important information by visualizing tissues and tumors that help diagnose and treat various diseases. These methods evaluate organs such as the brain, bones, and soft tissues and provide a clear view of internal anatomy necessary for patient care. X-rays produce 2D images based on variable absorption of radiation. They are used to detect fractures, pulmonary diseases, cancer, osteoporosis, and dental caries. Fast and cost-effective, they require precautionary measures due to radiation exposure.

CT (computed tomography) enhances X-rays by creating 3D images with better precision and contrast. It is widely used in cardiology, oncology, and vascular radiology to detect tumors, injuries, and assess the spread of cancer, particularly breast cancer.

Image Segmentation

Image segmentation is the process of dividing a medical image into meaningful parts. Deep learning architectures such as U-Net, FCN (Fully Convolutional Networks), and DeepLab are achieving high results in segmentation.

Feature Extraction

Feature extraction refers to identifying disease-specific markers from images. This includes shape, size, texture, intensity, and other parameters. SIFT, HOG, and CNN-based methods are widely used.

Classification

Classification refers to categorizing images by different disease categories. Support Vector Machine (SVM), Random Forest, and deep neural networks (CNN, ResNet, VGG) are considered the most effective methods.

Analysis of X-Ray Images

In analyzing X-ray images, Data Mining methods are applied in X-ray diagnostics in the following areas:

Pulmonary Disease Diagnostics: Detection of pneumonia, tuberculosis, lung cancer, and COVID-19 in chest X-rays. CNN-based models are achieving up to 95% accuracy.

Bone Fracture Detection: Automated detection systems for bone fractures and cracks have been developed using transfer learning and YOLO (You Only Look Once) algorithms.

Cardiovascular Pathologies: Detection of heart size, cardiomegaly diagnostics, and identification of vascular anomalies.

Analysis of MRI Images

MRI provides multi-layered and high-dimensional data, requiring more complex Data Mining methods:

Brain Disease Diagnostics: Detection and classification of Alzheimer's disease, stroke, and brain tumors. 3D CNN and ResNet3D architectures demonstrate high efficiency in brain MRI analysis.

Tumor Detection and Segmentation: U-Net and Attention U-Net models are used to detect gliomas, meningiomas, and other brain tumors. These methods achieve Dice coefficients above 90%.

Practical Applications

Data Mining-based systems are being successfully applied in leading medical institutions worldwide. For example, Google Health's LungScreen model detects lung cancer with higher accuracy than radiologists. IBM Watson Health offers an AI platform for analyzing X-ray and MRI images, and Zebra Medical Vision enables automatic detection of more than 40 diseases.

There is also a need to introduce these technologies in Uzbekistan's medical institutions, and pilot projects are being carried out at the Republican Specialized Scientific-Practical Medical Center and other major hospitals.

Analyzing X-ray and MRI images with the help of Data Mining improves diagnostic quality and helps provide accurate diagnoses and proper treatment for patients.

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