Top 5 uses of AI in medical imaging

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Uncover how imaging AI is empowering healthcare providers and improving patient outcomes

Artificial intelligence is rapidly emerging as a transformative technology in the healthcare industry, particularly in medical imaging. Through deep learning frameworks, improved medical imaging, AI development, and deployment, researchers are using computer vision to perform accurate, early detection, medical classification, and advanced 3D automated segmentation. When these models are taken to the clinical environment, they help clinicians streamline imaging workflows, uncover hidden insights, improve productivity, and connect multimodal patient information for deeper patient understanding.

With the integration of medical imaging and AI, the industry is seeing efficiencies once thought impossible. Workflows are now automated, clinicians have immediate clinical support toward diagnosis, and patient outcomes are improved. For instance, AI is removing tedious, manual processes so that what once took minutes to hours can now be accomplished within seconds. As a result, clinicians can focus more on interacting with patients and engaging in other value-add activities, such as research. Additionally, they're able to improve the accuracy and efficiency of critical tasks and detect problems earlier to improve patient outcomes.

The convergence of AI and medical imaging also addresses key industry challenges that include a global shortage of radiologists, an aging population, and the growing demand for medical imaging. It's projected that medical imaging analysis, the largest use case in healthcare, will reach $2.6 billion (23 percent CAGR) in 2027.[1]

It's anticipated that by 2025, 40 percent of healthcare providers globally will have invested in AI-enabled imaging solutions[2], as worldwide increasingly exploring the use of AI tools to manage heavy reporting workloads and a growing demand for precision medicine. For example, the Sydney Neuroimaging Analysis Centre (SNAC) is building a comprehensive neuroimaging AI platform with solutions embedded in radiology workflows to improve reporting efficiency and accuracy. These solutions will also facilitate the rapid, accurate quantification of brain disease progression by automating labor-intensive analysis tasks with AI.

From automating workflows to improving processing speed and image quality, there are numerous ways AI can help detect and diagnose disease. **Here are the top 5 use cases.**

As the use cases for AI in healthcare evolve, high-performing computing capabilities are clearly required in flexible form factors that span local, enterprise, and cloud resources.

Lenovo workstations are purposely designed to enable AI analyses in the healthcare environment and are a perfect fit for the data and security demands of AI-enabled medical imaging. These modern workstations support intensive software requirements, faster image processing, multiple displays, and the unique requirements of clinical settings.

Working together, Lenovo and NVIDIA power AI reading and analysis as well as data management and model training — scalable from clinics, to ER and hospital departments, and to system-wide enterprise-level deployments.

Segmentation

Segmentation refers to the process of outlining and separating specific structures within an image, such as tumors, organs, blood vessels, or bones. The goal is to identify and isolate a specific region of interest within an image for further analysis or manipulation of that area.

From diagnosis to treatment planning and image-guided surgery, segmentation is a key step in many medical imaging applications. For example, in the diagnosis of cancer, it can be used to isolate and analyze a tumor within an image of the patient's body to determine size, volume, shape, and location. When planning patient treatment, segmentation can identify and isolate specific structures, such as organs or blood vessels. It can also guide a surgeon during image-guided surgery.

There are several different techniques used for segmentation: manual, semiautomatic, and fully automatic. With manual segmentation, a clinician manually segments a particular area of interest, a time-consuming process subject to human error. In semiautomatic segmentation, a combination of human input and computer algorithms are utilized, which reduces the time and effort required from the clinician. However, with this method, interobserver variability is still present. Finally, there's fully automatic segmentation that uses an algorithm and minimal clinician input.

AI-assisted segmentation automates the processes of outlining and separating specific structures. As a result, not only is the consistency of segmentation greatly improved, but there's also a significant reduction in the time and effort required by the clinician. Deep learning is used in AI-assisted segmentation to understand features and patterns of specific structures, such as tumors or organs, and to segment new images by identifying and outlining the structures it's been trained to recognize.

For instance, the State University of New York (SUNY) Upstate Medical University Department of Urology is developing AI-powered imaging tools to speed up cancer diagnosis and time to treatment. 3D volumetric segmentation algorithms are typically challenging to implement, requiring a great deal of customization and fine-tuning. However, SUNY is using MONAI to streamline the process and accelerate deep learning training with techniques like transfer learning for localization of the prostate in pelvic imaging. Through AI-enabled technologies, SUNY is using its prostate segmentation learnings to build new models for kidney stone identification and cancer detection.

Detection

As with segmentation, detection is used in diagnosis, treatment planning, and image-guided surgery. The process of detection involves identifying and locating specific structures, patterns, or abnormalities within an image. This can include tumors, blood clots, or other pathological conditions, as well as identifying and locating normal structures such as blood vessels or organs. Like segmentation, the three techniques used for detection in medical imaging are manual, semiautomatic, and fully automatic. AI can improve patient outcomes and clinician efficiencies by automating the process of identifying and locating specific structures, patterns, or abnormalities. AI-enabled detection does this by learning the features and patterns that are characteristic of specific structures and then identifying and locating the structures it's been trained to recognize in new images. Another technique used for AI-assisted detection is computer-aided detection (CAD) systems, which use algorithms to analyze medical images and detect abnormalities. This improves diagnostic accuracy and reduces the time clinicians spend on manually reviewing images, giving them more time to spend on patient care.

Classification

Classification uses computer algorithms to categorize or label specific structures, patterns, or abnormalities within an image. This can include categorizing or labeling tumors, blood clots, or other pathological conditions, as well as identifying normal physical structures.

An example of classification is categorizing a detected tumor as malignant or benign to determine the best course of treatment. In treatment planning and image-guided surgery, classification can also be used to identify and locate specific structures within an image to improve patient outcomes.

Methods used for classification include manual, semiautomatic, and fully automatic. In manual classification, a clinician puts in laborious hours through visual inspection of an image and categorizes or labels specific structures, patterns, or abnormalities. Semiautomatic classification uses a combination of clinician input and computer algorithms, and fully automatic classification relies primarily on algorithms.

In recent years, AI-assisted classification has been increasingly used to analyze medical images and classify abnormalities that can be difficult to interpret with the human eye. AI-enabled classification is having a big influence on hospital care by greatly reducing the time and effort required for clinicians. Diagnoses are made faster and more accurately so that clinicians can obtain results quicker, reduce patient time to treatment, and improve health outcomes.

A common classification use that AI is improving is the detection of breast cancer. Early detection through mammography is critical when it comes to reducing breast cancer deaths, but breast density can make it harder to detect the disease. The American College of Radiology (ACR), Diagnósticos da America (DASA), Ohio State University (OSU), Partners HealthCare (PHS), and Stanford University collaborated to improve an AI model for breast density classification using MONAI. Each institution obtained a better-performing model with superior predictive power on their local dataset. They were able to improve breast density classification from mammograms, which can lead to better breast cancer risk assessment.

Registration

By aligning and merging multiple images of the same body part taken from different modalities or at different times, clinicians can create a composite image that provides more information than individual images alone. For example, in cancer diagnosis, registration can be used to align and merge images from CT or MRI scans to create a composite image that provides more information about the size, shape, and location of a tumor. Additional use cases include tracking disease progression and guiding a surgeon during a procedure. As with the other use cases explored, registration techniques include manual, semiautomatic, and fully automatic, with tactics ranging from manual processes to utilizing computer algorithms with minimal input from clinicians.

Through AI-assisted registration, machine learning algorithms improve accuracy and consistency, as well as unburden clinicians from physically registering a multitude of images. This not only improves workflow efficiencies but also precision in diagnosis and treatment planning. Additionally, AI-assisted registration can be trained to recognize specific features and patterns, is capable of extracting image features like edges and corners, and can be used in optimization-based registration, which is helpful when images have different modalities or contrasts.

Reconstruction

Reconstruction in medical imaging is building images from the complex signals, such as those acquired by MR and CT machines. This process can be used to create detailed images of internal bodily structures that otherwise aren't visible. For example, reconstruction can create detailed 3D depictions of a tumor that clinicians can use to determine size, shape, and location.

Reconstruction relies primarily on computer algorithms. AI can automate and accelerate the reconstruction process, while improving the quality of results.

MRI uses reconstruction techniques to transform raw data from the scanner into images that can be interpreted by clinicians. These reconstruction techniques are critical for obtaining accurate and detailed images for diagnostic and therapeutic purposes.

For instance, MRI is commonly used to diagnose conditions such as blocked or narrowed blood vessels, injuries to bones and ligaments, and neurological disorders like brain tumors and strokes.

AI-enabled technologies can improve MRI imaging by automating the process of creating detailed, accurate images, reducing noise and artifacts, and increasing the visibility of small structures not visible to the human eye. As a result, the accuracy and consistency of reconstruction are improved and the amount of radiation time a patient is exposed to is greatly reduced.

Workstations designed for high-powered GPUs

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*NVIDIA RTX GPU models can vary depending on processor and/or customer choice

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Building AI capabilities begins with a technology partner like Lenovo, experienced with cross-industry best practices for compliance, security, and data management, along with deep healthcare expertise.

In addition to workstations, Lenovo offers flexible AI infrastructure, including servers, high-performance computing (HPC), edge devices, and storage — customized for your current needs and scalable as your AI implementation evolves.

AI in the data center requires significant system power, and the energy expense can outweigh the potential for AI cost efficiencies. Lenovo's Neptune® Liquid Cooling enables maximum performance and reliability of critical AI systems, while reducing energy consumption by up to 40 percent to ensure optimal operation without overheating or downtime.

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The challenges of AI in medical imaging

AI is already transforming how healthcare is delivered, leading to better care outcomes for patients and improving the experience of healthcare providers by freeing up their time to focus on patient care. As more healthcare organizations realize the benefits of AI, it's becoming more top of mind for many key decision-makers.

Yet, industry-wide challenges remain, including a lack of adoption readiness, the need to meet regulatory requirements, and scalability issues. Delivering AI solutions at scale — namely, creating, training, validating, deploying, monitoring, and using AI in medical imaging — requires an enterprise approach to meet the demands of today's healthcare institutions.

Researchers and clinicians need a collaborative learning environment that enables research hospitals and institutions to exchange ideas and develop more robust AI algorithms without sharing private data. Foundational models are needed for quicker training. To accelerate the development and adoption of AI in clinical practice, radiologists must be involved in the creation of AI tools at their institutions. And AI components need to be integrated into a variety of clinical settings, including hospitals, imaging departments, private medical practices, skilled nursing facilities, clinics, and patients' homes.

Ready to get started?

To learn more about Lenovo workstations and AI infrastructure, visit: **www.lenovo.com/Health**

To learn how MONAI and NVIDIA NIM Microservices accelerate the development of medical AI applications, visit **https://www.nvidia.com/en-us/clara/medical-imaging**

Sources
1 Omdia, "Artificial Intelligence Software Market Forecasts—2H22 Data," November 2022
2 Gartner®, "Innovation Insight for AI-Enabled Diagnostic Imaging Interpretation," G00765732, 26 May 2022

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MONAI: Providing deep learning infrastructure and workflow optimization for medical imaging

MONAI is an open-source, collaborative framework designed to accelerate research and clinical collaboration in medical imaging. Its goal is to accelerate the pace of innovation and clinical translation by providing a robust software framework that benefits nearly every level of medical imaging, deep learning research, and deployment. MONAI offers specialized tools and libraries tailored to medical imaging, including advanced algorithms like UNETR for 3D segmentation. Built on top of PyTorch, MONAI offers a standardized and optimized approach to creating and evaluating deep learning models, ensuring reproducibility and capturing best practices in AI development for healthcare.

NVIDIA MONAI is a fully managed platform offering enterprises a range of capabilities, from infrastructure to pre-built state-of-the-art models and AI workflows. Part of the NVIDIA AI Enterprise suite, NVIDIA MONAI provides enhanced features and enterprise-grade support tailored for commercial applications.

Expanding the MONAI Ecosystem: MONAI Foundational Models

The landscape of medical AI is rapidly evolving with the emergence of Vision Language Models (VLMs) and Generative AI (GenAI). These cutting-edge technologies hold immense potential for transformative applications, including automated generation of radiology report and enhanced image interpretation. MONAI Foundational Models offer a streamlined pathway for deploying MONAI-trained models into clinical workflows. These models include VISTA-3D for interactive 3D segmentation, MAISI for synthetic CT data generation, VISTA-2D for cell segmentation and morphology analysis, and VILA-M3 for enhanced VLMs with expert AI models.

The Future of Medical AI: Multimodal

The MONAI framework extends beyond single modalities with MONAI Multimodal. This advancement integrates sophisticated agentic architectures, fostering a comprehensive multimodal medical AI ecosystem. By leveraging diverse data sources such as CT, MRI, X-ray, ultrasound, EHRs, clinical documentation, multimodal AI promises deeper clinical insights and more holistic patient understanding. MONAI Multimodal platform features advanced agentic AI, which leverages autonomous agents for multistep reasoning across images and text as well as specialized LLMs and VLMs, which are tailored models designed for medical applications that simplify cross-modal data integration. Furthermore, NVIDIA NIM microservices offer a streamlined pathway for deploying MONAI-trained models into clinical workflows. These optimized containers simplify the inference process and streamline the development of medical AI applications.

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