ADLINK
Leading EDGE COMPUTING

ADLINK Application Note

Medical Imaging Improves Precision With Speed and Clarity

Medical imaging equipment makes a quantum leap with GPU-driven and AI-assisted image reconstruction for precision diagnosis and surgery

The State of the Art: Challenges and Benefits of Persistent Innovation

Medical imaging equipment helps doctors investigate signs and symptoms, take biopsies, and treat lesions. Relentless innovation allows medical imaging equipment to consistently offer improved real-time visual guidance in surgeries and reduce the time it takes for an image to be created; patients' risk is lowered while more total patients are served. Image quality is also key to precise diagnosis, and advances in this area must be made without increasing patient exposure to harmful radiation. Beyond these significant challenges, portability is another major asset; a mobile version of advanced medical imaging technologies is invaluable in both operating rooms and rural clinics where local doctors can consult with peers through telemedicine.

For manufacturers of medical imaging equipment, demand for constant improvements in image reconstruction speed, image quality and size presents formidable, but not insurmountable, challenges in the development of embedded GPU-enabled platforms.

The Technological Processes of Progress

The medical imaging reconstruction process involves a series of complex signal and image computations. In computed tomography (CT), X-ray signals pass through a patient's body from multiple angles and are registered by detectors. The raw data is then converted into 2D cross-sectional images or 3D volumetric images by a computer via iterative mathematical calculations.

The computer suppresses image "noise" which could be picked up when acquiring X-ray signals or amplifications of previous calculations, removes artifacts which are features in the image but not in the patient's body, adjusts contrast to make the target organ more noticeable than the surrounding background and applies other image enhancement techniques to assure image quality is maximized for clinical use.

These mechanics give the merest glimpse of the intricacy of the image reconstruction process on current state-of-the-art medical imaging equipment.

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Meanwhile, medical imaging equipment is evolving to offer a larger field of view, higher resolution, better quality and color-rich anatomical structure. AI is the latest progress in optimizing image reconstruction, improving speed, quality and even algorithms. The new developments contribute to exponential growth in data volume and computing workload which cannot be resolved without the help of embedded GPU-enabled platforms.

Full Speed Ahead: Embedded GPU-Enabled Platforms

Embedded GPU-enabled platforms integrate graphics processing units (GPUs). They have the ability to acquire a large amount of data without I/O bottlenecks while parallelizing intensive data computations in the pipeline. In some cases, its form factor and power efficiency must be meticulously thought out to make mobile medical imaging equipment clinically viable. This is where ADLINK's embedded GPU-enabled platform DLAP Series comes in (Figure 1).

ADLINK's DLAP Series, designed with GPU-accelerated computation, aims for edge computing and edge AI applications. A key technology enabler is NVIDIA® Quadro® embedded GPUs powered by Turing™ architecture.

Enabling a Data Shortcut

A Quadro embedded graphics card, as opposed to a graphics card for gaming, offers a higher data throughput. By implementing NVIDIA GPUDirect™ remote direct memory access (RDMA), an 80% boost in data throughput can be achieved by giving external data sources direct access to the GPU's external memory[1]. Without this feature, data would be copied into a CPU's memory before reaching the GPU, needlessly increasing data transmission delay and latency.

Accelerating Image Reconstruction

Meanwhile, the Turing architecture achieves a 50% improvement in delivered performance per CUDA® Core when compared with the previous Pascal™ generation[2]. Ray tracing, which is fundamental to 3D volumetric imaging, can now be rendered in real time on a single GPU with hardware accelerators known as RT Cores. The integrated Tensor Cores are another highlight providing speed-ups for matrix computations at the heart of deep learning neural network training and inferencing operations.

Fitting in an Overcrowded Space

The DLAP Series supports two GPU standards: the popular PCI Express Graphics (PEG) card and the less-known Mobile PCI Express Module (MXM). ADLINK's embedded MXM GPU modules offer major size, weight, and power (SWaP) advantages. With respect to size, the Type A MXM module is less than one-third and one-fifth the size, respectively, of the half- and full-length PCIe graphics cards.

Considering the substantial computing workloads image reconstruction requires and the massive amount of heat this generates, the high performance-per-watt and extended temperature options of ADLINK's embedded MXM GPU modules could dictate the speed and accuracy of image reconstruction and make ADLINK's DLAP-3000 one of the most compact embedded GPU-enabled platforms for use in portable equipment.

Offering Over 3x the Lifespan

More importantly, as an NVIDIA Quadro Embedded Partner, ADLINK offers embedded graphics cards with a five-year product life. Non-embedded graphics cards can be expected to be discontinued in as little as 18 months. Given the stringent, time-consuming development, verification and validation processes of medical devices, availability of key components like GPU could mean the difference between continuity and end of life for medical imaging equipment.

At the Heart of It All: Better Medical Care

Medical imaging equipment integrating all the above features provides several benefits. For example, in the CT application above, a CT scanner with a high data throughput can process more X-ray signals from multiple detector arrays, relying on GPU-accelerated computation for image reconstruction and enhancement while reducing radiation doze and automatically suppressing motion artifacts during scanning.

• **For clinical examinations,** higher image quality can be achieved by removing image noise, artifacts and distortions that could obscure correct diagnosis. Images can be generated in near real time with more details and higher contrast, showing a clear distinction between abnormal and healthy tissues and preventing doctors from missing an infection caused by latency.

• **For intraoperative intervention,** mobile magnetic resonance imaging (MRI) and portable C-arms can achieve not only performance gain for real-time stereotactic navigation but also higher power efficiency that can translate into more system uptime in the event of sudden power outage or occasions where reliable power supply may not always be available.

The image reconstruction process is similar in principle, though one type of medical imaging equipment might be much more sophisticated than another. Embedded GPU-enabled platforms are the catalysts allowing stationary and portable CT, MRI, endoscopy and ultrasonography medical imaging equipment to continuously evolve, bringing cutting-edge techniques to operating rooms and other points of care.

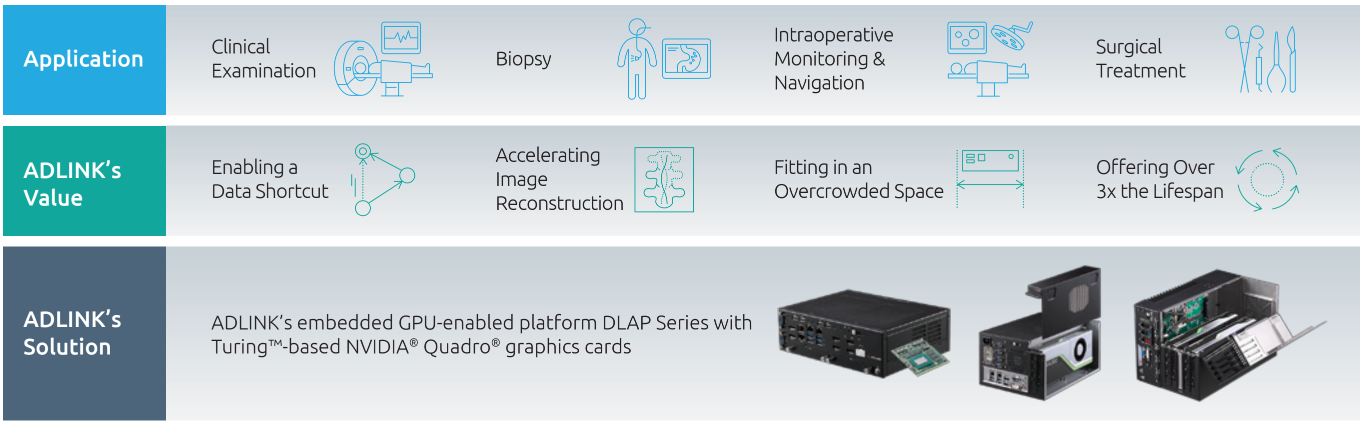

Figure 1. ADLINK's DLAP Series enables medical imaging equipment to continuously evolve, bringing cutting-edge techniques to operating rooms and other points of care.

[1] The software and workloads used in performance tests may have been optimized for performance on ADLINK platforms. Performance tests are measured using specific computer systems, components, software, operations and functions. Tests performed under different conditions may produce varying results. Contact ADLINK for more information about performance and benchmarks.

[2] NVIDIA Turing Architecture In-Depth, https://devblogs.nvidia.com/nvidia-turing-architecture-in-depth/