Introduction

In 2020, more than 19 million new cancer cases were diagnosed around the world.\textsuperscript{1} The global cancer burden is expected to rise to 28.4 million cases in 2040, with the majority in developing countries.\textsuperscript{1} Hospitals are actively working to streamline the cancer diagnosis workflow to keep up with increases in workload. Histopathology, the diagnosis and study of diseases based on tissue and fluid samples, is used to confirm over 90\% of cancer cases but also represents a significant bottleneck.\textsuperscript{2} Given these challenges, the medical industry is investigating the use of AI-enabled Digital Pathology and Medical Imaging to help improve accuracy and reduce time-to-diagnosis by medical professionals.

Integrating AI into the Shared Platforms for Digital Pathology and Medical Imaging

Medical Imaging refers to generating scans including CT, MRI, and ultrasound, whereas Digital Pathology is the process of digitizing biopsy slide samples into whole slide images. In a hospital environment, Medical Imaging scans and Digital Pathology whole slide images are stored on industry-standard Picture Archiving and Communication System (PACS) servers. Such servers interface with patient records and billing to support both clinical and business aspects of hospital operations.

Introducing AI-enabled technology to the practice of Digital Pathology helps accelerate previously manual processes for slide handling and examination and mitigates bottlenecks in the diagnosis process. Digitization also supports the practice of information sharing, acquiring second opinions and side-by-side comparisons, and reduces the burden of physical slide storage. AI-enabled Digital Pathology relies on trained AI models to detect and segment or classify biological structures in a whole slide image. Such AI models can augment a pathologist’s diagnosis, which can potentially result in faster and more accurate interpretations.\textsuperscript{3}

Intel-Powered Platforms Enable Fast AI for Digital Pathology

Organizations looking to migrate to an effective Digital Pathology solution need to do so in a way that makes efficient use of current resources, accommodates limited budgets, and provides flexible deployment options for a range of CPUs, GPUs, and hardware accelerators. The Intel\textsuperscript{\textregistered} Distribution of OpenVINO\textsuperscript{™} toolkit running on Intel\textsuperscript{®} architecture-based platforms can help simplify the move to Digital Pathology for clinics and research facilities. With the OpenVINO\textsuperscript{™} toolkit, pathologists can optimize pre-trained models for inferencing on general-purpose Intel\textsuperscript{®} CPU–based hardware, iGPUs, and dedicated accelerators. The solution also supports multi-device inferencing using industry standard APIs.
Demonstrating Intel-optimized AI Inference Capabilities in a Proof of Concept

Wistron Corporation, an IT service provider and design manufacturer, recently deployed a proof of concept (POC) that explores the use of AI model optimization and high-precision inference capabilities in Digital Pathology. Still in use today, Wistron’s HepatoAI POC is a computer-aided diagnostics platform that leverages the OpenVINO toolkit to optimize AI inference on Intel® Xeon® Scalable processors.

This POC leverages the OpenVINO™ Model Server (OVMS), a scalable and high-performing microservice to build and deploy multi-model pipelines and to manage DevOps workflows. In this example, the OVMS component allowed Wistron’s HepatoAI platform to deploy AI models at scale in a production environment, using the same gRPC and REST APIs as TensorFlow, facilitating easy integration with existing hospital environments.

Accelerating Delivery of Inference Results

This platform, built on an Intel Xeon Scalable processor-based system, is designed to enable scalability of multi-vendor and multi-tenant Digital Pathology solutions while helping to maintain data security throughout a network of hospitals. Pathologists at workstations would prompt the PACS server to feed whole slide images and Medical Imaging scans into a central server utilizing OVMS to manage inference requests, balance workloads, and transfer/store results. Clinicians can access annotated images through an application user interface, accessible through workstation browsers over a secure HTTPS connection. This solution further enables secure collaboration with third parties and second opinions by affording transfer of large images across hospital infrastructure.

The Importance of Digital Pathology

Histopathology traditionally relies on human experts to manually review whole slide images or medical images to make diagnoses. As the rate of cancer caseloads continues to grow, the shortage of trained pathologists will disproportionately impact patient care amongst vulnerable populations and developing countries.

Patients per pathologist, by country:

- 19,000 patients per pathologist in the United States
- 74,000 patients per pathologist in China
- 103,000 patients per pathologist in Malaysia
- 784,313 patients per pathologist in Sudan
- 1,555,500 patients per pathologist in Uganda

Figure 2. The Wistron POC is enabled by OpenVINO™ Model Server with the potential to streamline AI model management throughout the system architecture.

Figure 3. Pathologists and radiologists would see the AI-labeled scan through a browser-based interface over a secure connection. Image source: Wistron Corporation.
Today a single hospital can generate more than 200k glass slides per year. Physical samples in the form of glass slides need to be shipped between healthcare providers for second opinions, historical trend analysis and educational purposes introducing the risk of loss, breakage and biohazard exposure. In highly regulated countries, slides and associated documents may be archived for up to ten years, requiring hospitals to maintain massive amounts of physical storage facilities.

Figure 4. The challenges associated with traditional, non-digital pathology.

Telepathology: Digital Pathology at a Distance

Telepathology is the practice of Digital Pathology over telecommunication and networking technologies, involving collaboration between multiple hospitals or research facilities. Telepathology can extend the capabilities of Digital Pathology by providing diverse datasets to garner second opinions, train clinicians, and improve AI model accuracy. As healthcare providers are strategizing how to meet the challenges posed by a global shortage of pathologists, telepathology can help by enabling hospitals to share their resources and expertise across borders and regions.

Overcoming Challenges with Whole Slide Image Data and File Size

Whole slide images can produce files as large as 80 GB uncompressed. This presents unique challenges in transferring data between institutions with disparate or slow networks. One solution is the use of Intel® Smart Edge to manage multiple trained AI models across different hospitals within a system. Intel Smart Edge enables computing platforms at the network edge to manage applications and network functions. With Intel Smart Edge, it is possible to transfer only AI model data over low-latency, wireless 5G connections, rather than entire datasets of whole slide images and CT scans.

Since AI models are specific to distinct sets of disease indicators, a hospital may utilize multiple AI models—meaning that eliminating the transfer of datasets for these models is critical to the adoption of telepathology. Intel Smart Edge can also help keep multiple models updated across any number of hospitals within an organization, removing the burden on data scientists to manually carry out this process.

Figure 5. Intel Smart Edge can be used to manage the distribution of consistent and updated AI models across multiple hospitals using a 5G connection.
Conclusion: Improving Global Accessibility to AI Digital Pathology

Digital Pathology has the potential to deliver incredible new innovations in AI-enabled diagnoses for healthcare and research organizations all over the globe. In the future, hospitals worldwide may be able to use this technology to bring more detailed and accurate analyses to doctors, and researchers. The goal is to enable AI technologies that give more patients better access to diagnosis and treatment, essential to address an increase in global cancer rates and a shortage of pathologists worldwide.