Case Study

OpenVINO™ Toolkit

AI-infused Mobile X-ray System Automatically Highlights Retained Objects in the body, Protecting Patients from Physical Risks and Offloading Medical Tasks

3X faster inference, with generated x-ray images for screening in less than 15 seconds

Shimadzu Corporation

Head office: 1, Nishinokyo Kuwabara-cho, Nakagyo-ku, Kyoto, Japan

Formation of Limited Company: September, 1917 (established March, 1875)

Capital: 26,648 million yen

Business outline: Development, manufacture, sales, and maintenance of analytical instruments, testing and measuring instruments, medical systems, industrial machinery and equipment, aircraft equipment, marine device, and magnetic measurement

https://www.shimadzu.com/

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Challenges

- To prevent surgical gauze or other tools being left in patients after surgery
- To offload medical practices such as visual checks

Solutions

- Retained object confirmation support image processing "Smart DSI" (Shimadzu Corporation)
- OpenVINO™ toolkit
- Intel® Core™ Processors for Embedded Applications

Results

- Automatically highlights whether or not there is any unintended surgical items left in patient's body at the end of each surgery by AI
- 3X faster Inference processing
- Deployment on existing x-ray equipment is possible without any need of additional hardware or modifications

Smart DSI Highlights Any Foreign Objects Inadvertently Left Inside Patients with AI Technologies

In keeping with its philosophy "Contributing to Society through Science and Technology", Shimadzu Corporation develops the business centered on analytical and measuring instruments, medical systems, aircraft equipment, and industrial machinery. Currently the company is committed to infection control, advanced healthcare, and development of next-generation energy, aiming to solve social issues including pandemics and climate changes.

Its medical devices incorporate advanced image processing technology to deliver intuitive medical systems that minimize patients' stress. As a result, medical institutions around the world can earlier detect and treat infections, cancer, and other diseases.

As part of its medical business, Shimadzu has released Smart DSI—AI-infused, post-surgery image processing to confirm objects left in patients—in Nov. 2022.

Following a post-surgery x-ray, Smart DSI displays patient's body that could contain items such as gauze, suture needles or forceps, highlighting with color-coded images on a monitor. Tomonori Sakimoto, Head of the Application Group in the Shimadzu Technology Department, explains why they developed Smart DSI:

"In US hospitals, there are between 4,500 and 6,000 cases of surgical objects that remain in patients after an operation per year. Dozens of such incidents occur annually also in Japan. These retained foreign objects are on average 70 percent gauze and 30 percent others. Usually these objects are detected by confirming the number of gauzes before and after the surgery using a mobile x-ray system after the procedure for visual confirmation. However, these approaches are prone to human error, like miscounting or overlooking in x-ray images. That's why we've developed our Smart DSI to help highlight retained objects through x-ray images."

Smart DSI is installed on the mobile x-ray system "MobileDaRt Evolution MX8 Version c type."

After x-ray irradiation, the mobile system displays the image on a monitor for health care workers to check-up anything left in patient's immediately.

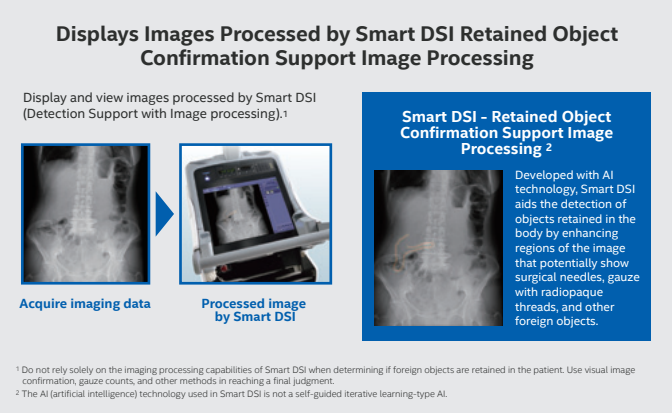


Figure 1. Retained object confirmation support image processing "Smart DSI"

Accelerated Inference with OpenVINO™ Toolkit

Smart DSI uses TensorFlow to process images, training deep learning models with deep neural networks. Meanwhile, Shimadzu employs Intel® Distribution of OpenVINO™ toolkit to generate optimized inference models, due to its stunning inference speed.

"As any retained object must be detected right after surgery, the fastest processing is critical," says Sakimoto. "We set 15 seconds at most as the required time between x-ray irradiation and image displaying. However, we found that inference models trained with TensorFlow would not meet the requirement, so we adopted OpenVINO™ toolkit to accelerate this processing."

In another boon for Shimadzu, its mobile x-ray system is powered by Intel® Core™ Processors for Embedded Applications, enabling the company to deploy OpenVINO™ toolkit without altering hardware.

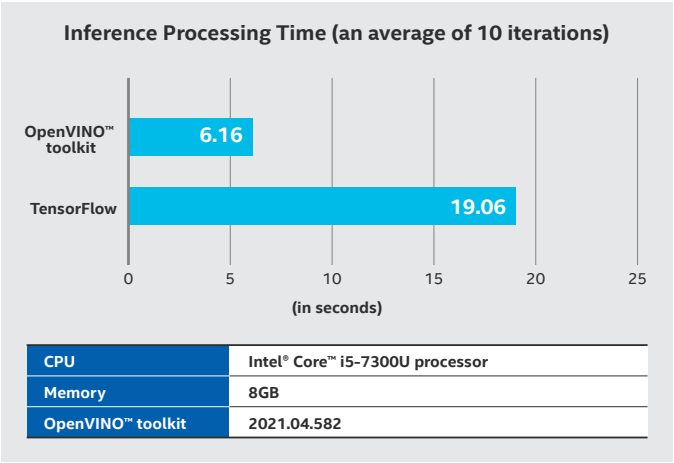
Shimadzu ran evaluation tests on a dataset of x-ray images before adopting OpenVINO™ toolkit. These tests compared the inference speed of TensorFlow against that of an inference engine with OpenVINO™ toolkit using TensorFlow-trained models converted to an intermediate representation (IR) via the OpenVINO™ toolkit model optimizer. As a result, the TensorFlow-trained model took an average of 19.06 seconds per 10 iterations, while the optimized model needed just 6.16 — around 3X faster.

According to Sakimoto, "The result drove us to install Smart DSI with an optimized inference engine on a mobile x-ray system equipped with OpenVINO™ toolkit's runtime library to process images. This delivered a sub-15-second time between x-ray irradiation and displaying images."

The setup allowed Shimadzu to effortlessly convert and optimize models already trained with OpenVINO™ toolkit. Although the company faced a challenge in converting some models with their expected accuracy, swift support from Intel solved the issue and minimized development time.

For more accurate recognition, Shimadzu is expanding variations on training processes assuming differences in patients' body thickness or diverse imaging conditions on x-ray systems.

"We created learning models by generating tens of thousands of mock images from hundreds of patient x-rays and repeatedly trained the models under all manner of conditions," explains Sakimoto. "Training requires repeated trial and error while balancing between sensitivity to identify something is left and specificity (avoidance of false positives) not to inadvertently identify body parts as foreign objects—leading to highly sensitive detections."



CPU	Intel® Core™ i5-7300U processor
Memory	8GB
OpenVINO™ toolkit	2021.04.582

Figure 2. Inference processing time

Directly Implementing Learning Models Optimized to Existing Mobile X-ray Systems

OpenVINO™ toolkit enabled Shimadzu's systems to highlight retained surgical objects in less than 15 seconds from x-ray images. The toolkit is known for its feature to be installed directly on existing mobile x-ray systems powered by Intel® processors with no need to add hardware.

"In the case of a mobile x-ray system moving around the hospital, we don't think it is feasible to embed our image recognition engine in external hardware and connecting it to the mobile x-ray systems to do ward rounds," says Sakimoto. "Because all Shimadzu digital mobile x-ray systems use Intel processors for embedded applications, learning models optimized with OpenVINO™ toolkit can be installed, so our customers can use the systems at their examinations without increasing workloads."

Shimadzu has just started selling mobile x-ray systems equipped with Smart DSI, and they plan to develop solutions globally in the future. The company is planning to implement OpenVINO™ toolkit also on their different image screening systems under a vision for more efficient clinical environments, reduced workloads, and patients' safety through AI technologies.

According to Sakimoto, "OpenVINO™ toolkit is useful for all aspects of image processing in working with a broad range of Intel hardware, so we'll continue to use it to develop applications which can increase our customer's value."

Intel will continue to be there to support Shimadzu in developing AI solutions with OpenVINO™ toolkit and the Intel® Core™ processors.

For more information on OpenVINO™ toolkit, visit:
https://www.intel.com/content/www/us/en/developer/tools/openvino-toolkit/overview.html

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