Canon

CT / White paper

INSTINX Workflow: A highly intuitive AI-assisted CT experience

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Introduction

Canon Medical's new INSTINX workflow for CT combines a human-centered, intuitive design with artificial intelligence to drive a fast, simple, and accurate workflow experience. INSTINX is designed to alleviate some of the challenges of staff shortages and patient backlog in today's overburdened clinical environment by being instinctively easy to use. Featuring a user interface (UX) honed by experts in user-centered design, INSTINX eliminates complex, language-based scan set up in favor of intuitive icons, reducing clicks and the number of interactive steps by 40%. INSTINX reinvents scan planning by replacing the traditional two-dimensional scanogram acquisitions with a dose neutral, helical 3D Landmark Scan. Powered by artificial intelligence, Anatomical Landmark Detection (ALD) uses the 3D Landmark Scan to automatically generate scan range start and end positions as well as tailor the field of view to the individual patient. The 3D Landmark Scan with ALD results in accurate and consistent scan planning across shifts, systems, and facilities.

From easier patient positioning supported by gantry-mounted Canon cameras to a clear, intuitive UX with automatic scan planning, the INSTINX workflow was developed to make scanning instinctively simple and help the operator keep their attention where it belongs, on the patient.

Hakujyuji Hospital, Japan

Hakujyuji Hospital is an acute care hospital in Nishi Ward, Fukuoka City, Japan, providing advanced healthcare services such as trauma, cardiac and stroke care for the local area. This hospital installed the first CT scanner with INSTINX worldwide and was involved in the workflow studies described in this white paper.

A whole new user experience

The INSTINX user interface was built with one guiding principle: to be intuitively easy to learn and use. The increasing complexity of CT systems and reality of today's busy clinical environment demands a user interface that not only improves usability and clinical workflow but also helps the operator keep their focus on the patient. The INSTINX user interface is the result of a five-year iterative design process employing a multidisciplinary worldwide team of experts, including UX designers, graphic designers, software engineers, and CT technologists, to create a novel user interface that appeals to user intuition on a whole new level.

The design philosophy behind INSTINX was guided by extensive user feedback on their biggest challenges with CT user-interface design. Based on this research, the INSTINX UX was designed to eliminate unnecessary redundancies and superfluous information that can overwhelm an operator. Instead, INSTINX features what users need most: recognizable icons placed in intuitive locations on the screen, consistent terminology, a clear visual flow from patient registration to the end of the exam, as well as useful feedback available to the operator at any point during scan set up.

Figure 1 shows the protocol navigator for an example protocol on INSTINX. The layout employs a simple left-to-right flow of scan progression that appeals to user intuition with clearly labelled badges to represent each scan and in situ waiting times between each scan.

The result of this initiative is a new interface that significantly reduces the learning curve for healthcare professionals, with most users requiring less than half a day of training to feel confident operating the system. Additionally, the intuitive design reduces workflow steps by 40%*, helping to reduce operator stress.

Figure 1: Four Phase liver scan protocol with intuitive left-to-right scan progression.

> *"It only takes a short time and little training to become proficient with the INSTINX interface. Younger and less experienced technicians at our hospital are able to operate the scanner without extra training and quickly gain confidence."*
>
> Mr. Hiroyuki Yamaguchi, Hakujyuji Hospital, Japan

*Based on conversion of manual steps requiring interaction to automated steps, due to the camera, 3D Landmark scan/ALD, and hanging layout.

INSTINX UX design process

INSTINX began as a literal blank screen and was created from scratch over five years of development. That blank screen evolved into the highly efficient, intuitive INSTINX UX via an intensive iterative design process. Working with technologists both familiar and new to Canon CT as well as with radiologists, the user interface went through repeated stages of vetting. Evaluators were provided working UX mockups and asked to conduct a variety of clinical tasks, such as to perform a mock CT Pulmonary Angiogram scan on a 55-year-old female patient from patient registration to the close of the exam. Any elements that failed to provide a straightforward, easy-to-use experience were replaced and evaluated fresh in the next round of testing. By incorporating users of all skill levels and from different geographical regions, the design and development process accounted for regional variations in workflow ensuring the user experience would be universally simple and intuitive.

INSTINX gantry mounted camera

Prior to scanning, INSTINX takes advantage of dual gantry-mounted cameras to help automatically position the patient relative to the isocenter (Figure 2). After the patient lies on the couch, the cameras detect patient features and spatial orientation; INSTINX automatically adjusts the couch height and longitudinal position, in preparation for the acquisition of a 3D Landmark Scan.

Eye tracking case studies have shown camera-assisted patient positioning keeps the operator's focus on the patient and the patient's comfort. In the example below (Figure 3), the operator can keep their attention on the patient, rather than alternating focus between the gantry panel and patient. The circle size indicates time spent looking at the point. In A with INSTINX, the operator looks at the touch panel and then moves to view the patient without moving back to the touch panel. In B, the user repeatedly looks between the buttons and the patient during positioning.

> *"The intuitive universality of INSTINX UX makes it easy to learn whether the operator is familiar with Canon or was trained on a completely different CT scanner."*
>
> Mr. Hiroyuki Yamaguchi, Hakujyuji Hospital, Japan

Figure 2: Dual gantry mounted cameras

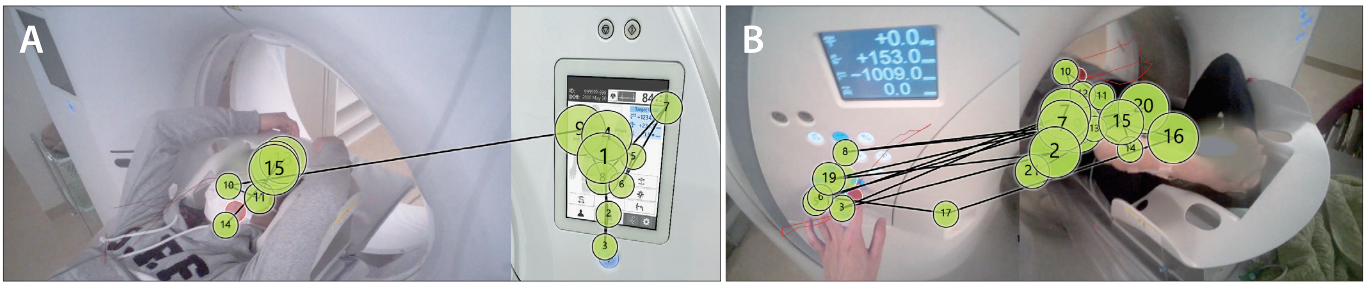


Figure 3: Eye tracking case study results. In A, with INSTINX, the operator looks at the touch panel and then moves to view the patient without looking back at the touch panel. In B, the user repeatedly looks between the gantry buttons and the patient during positioning as indicated by the multiple lines.

3D Landmark Scan and Anatomical Landmark Detection (ALD)

Traditionally, dual planar radiographs are used to establish the scan range for a given protocol. These scanograms, however, are inherently two-dimensional and are unable to provide a precise guide to internal anatomy. As a result, a non-optimized scan region is projected onto the AP and Lateral views and the operator must adjust the planned scan regions for every patient. With INSTINX, the traditional dual planar acquisition is replaced with an ultra-low dose, three-dimensional helical scan called a 3D Landmark Scan. Canon's SilverBeam energy-shaping filter, used to remove low energy photons from X-ray beam, ensures the 3D Landmark Scan is acquired at a radiation dose equivalent to a traditional dual 2D planar acquisition. The resulting 3D Landmark Scan images are 1 mm in slice width and offer a wealth of anatomical detail that can be used by artificial intelligence to drive Anatomical Landmark Detection (ALD) for quick, accurate, and consistent scan planning. 3D landmark Scan vs 2D scanograms allow for highly accurate detection of internal landmarks to determine scan start and end positions and FOV.

When building a protocol, the user can take advantage of an interactive anatomical avatar to indicate the desired start and end locations. For example, as shown in Figure 4, this abdominal protocol will plan patient scans to begin 1 cm above the dome of the diaphragm and end at the iliac crest. Based on these user-determined "snap points," the ALD takes advantage of the three-dimensional anatomical information in the 3D Landmark Scan images to automatically generate start and end positions, as well as field of view, for the individual patient being scanned, with 97% accuracy. For operator convenience, these scan range regions are projected on an Anterior Posterior projection and a Sagittal projection if manual adjustments are desired for any reason.

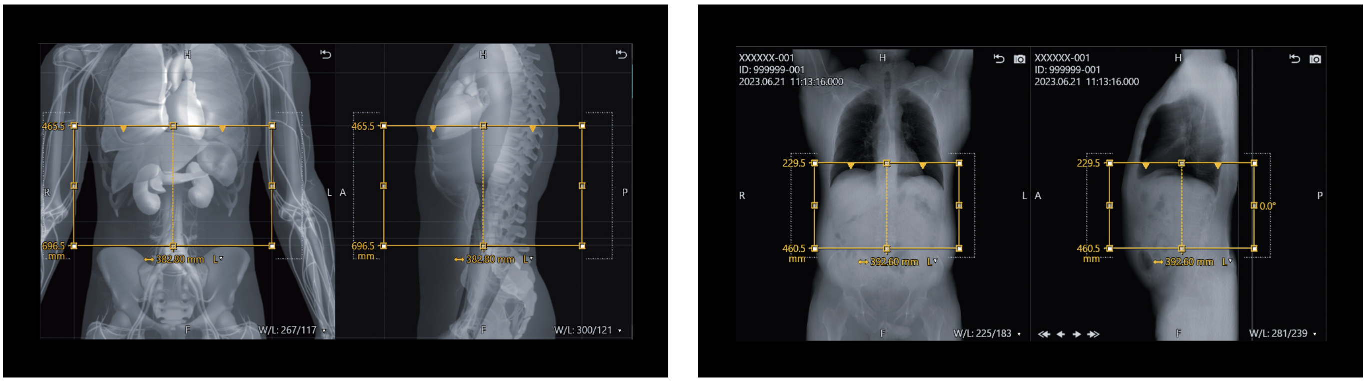


Figure 4: Abdomen protocol showing the scan range set in the scan protocol and then in the actual patient scan.

The Anatomical Landmark Detection algorithm was trained on 3D Landmark Scans for all relevant anatomy, including common clinical variations, such as arms down versus arms up. ALD works by first segmenting anatomical regions and then applying a random forest algorithm, which combines the results of a large number of classifiers trained on a variety of features, to identify the six planes which define start, stop, and field of view.

Anatomical Landmark Detection not only helps save operator time by 24% but also helps promote more consistent scan planning. With traditional dual planar radiographs, the literature has shown over-scanning beyond optimal limits can add extra, unnecessary centimeters to the scan range and unnecessary radiation dose to the patient[1]. The amount of over-scanning can vary significantly with the institution or experience level of the individual operator[1]. In addition, under-scanning can lead to missing anatomy and repeat examinations. INSTINX uses ALD to help enable the operator to focus on the patient and promote consistent scan planning.

In addition to scan range planning, 3D Landmark Scan lets the operator set a region of interest for bolus tracking without any additional scan or radiation dose. Similarly, selecting the slice location and needle planning for CT fluoroscopy requires no additional planning scan acquisition.

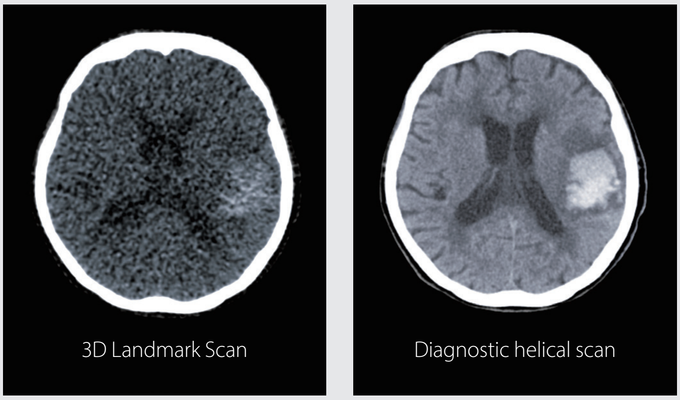
> *"INSTINX automatically sets the scan range with ALD, and that makes it easy for anyone to set the scan plan, reduces the entire exam time and improves patient throughput."*
>
> Mr. Hiroyuki Yamaguchi, Hakujyuji Hospital, Japan

> *"Since we don't need an additional ^{SURE}Start scan, we can move on to the next scan and next exam more quickly."*
>
> Mr. Hiroyuki Yamaguchi, Hakujyuji Hospital, Japan

Case study
Hakujyuji Hospital 3D Landmark scan

At Hakujyuji Hospital, we took advantage of the 3D Landmark Scan axial images available on console to save critical time in our stroke workups. We know immediately if we are dealing with a cerebral hemorrhage or acute cerebral infarction at the beginning of the process.

This knowledge lets us begin arranging additional scanning and gathering the right clinical team prior to the main CT scan. In the diagnosis of stroke, where time is very important, being able to distinguish between cerebral hemorrhage and stroke is expected to accelerate the time to start treatment and improve prognosis.



Suspected brain hemorrhage with 3D Landmark Scan and the diagnostic helical scan.
The 3D Landmark scan provides a hint to the pathology enabling prompt arrangement of the next steps in treatment.

Mr. Hiroyuki Yamaguchi
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Conclusion

INSTINX workflow combines intuitive, user-centered design and artificial intelligence to drive fast, easy, and accurate workflow. The INSTINX UX is intuitively simple to learn and use, helping to ease operator stress and decrease training times. The 3D Landmark Scan and AI-driven Anatomical Landmark Detection offer an innovative solution to ensure quick, accurate, and consistent CT exams.

References

1. Schwartz F, Stieltjes B, Szucs-Farkas Z, Euler A. Over-scanning in chest CT: Comparison of practice among six hospitals and its impact on radiation dose. Eur J Radiol. 2018 May;102:49-54.

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https://global.medical.canon

Model number: TSX-307A MWPCT0013EAA 2024-05 CMSC/xx/Printed in Japan

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