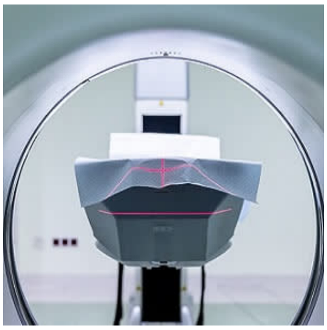
Abdominal auto-contouring method for MRI-guided adaptive radiotherapy



Magnetic resonance imaging (MRI) guided adaptive radiation therapy (MR-ART) consists of daily modification of the radiation therapy plan based on patient-specific functional and anatomic changes during the course of radiation treatment. Manual contouring is laborious, subject to variability and inconvenient for MR-ART. To address this problem, an international team of researchers have developed a new artificial intelligence-based, auto-contouring method for abdominal MR-ART modelled after human brain cognition for manual contouring.

According to the research team, they have combined "top-down and bottom-up" methods to achieve a multiple-level, hybrid method integrating low-level features to object level models in addition to simulating the human fusion process. "To our knowledge, no such strategy in auto-contouring has been previously considered. We report the initial results in four abdominal organs and note that our method can be generalised for other organs," the team noted.

Typically, a plan is generated for each radiation therapy session based on the image data acquired immediately prior to the session while the patient is on the treatment table. This requires on-board imaging, and with advanced technology, MR-ART has been implemented in clinical and research settings. Manual contouring, the delineation of clinical target volumes (CTVs) and organs at risk (OARs), remains the most laborious and time-consuming task in traditional radiation therapy. Moreover, manual contouring is subject to intra- and inter-operator variation. Inspired by the human contouring processing model, the researchers developed a novel auto-contouring method for MR-ART.

In a study published online in the journal Artificial Intelligence In Medicine, the research team explains that their new algorithm was developed based on two types of information flow (i.e., top-down and bottom-up). Top-down information is derived from simulation MR images. It grossly delineates the object based on its high-level information class by transferring the initial planning contours onto daily images. Meanwhile, bottom-up information is derived from pixel data by a supervised, self-adaptive, active learning based support vector machine. It uses low-level pixel features, such as intensity and location, to distinguish each target boundary from the background.

The final result is obtained by fusing top-down and bottom-up outputs in a unified framework through artificial intelligence fusion, according to the research team. For evaluation, the team used a dataset of four patients with locally advanced pancreatic cancer treated with MR-ART using a clinical system (MRIdian, Viewray, Oakwood Village, OH, USA). Each set included the simulation MRI and on-board T1 MRI corresponding to a randomly selected treatment session. Each MRI had 144 axial slices of 266 × 266 pixels. Using the Dice Similarity Index (DSI) and the Hausdorff Distance Index (HDI), the researchers compared the manual and automated contours for the liver, left and right kidneys, and the spinal cord.

Based on the results, the average auto-segmentation time was two minutes per set. Visually, the automatic and manual contours were similar. Of note, fused results achieved better accuracy than either the bottom-up or top-down method alone. The DSI values were above 0.86. The spinal canal contours yielded a low HDI value.

"A DSI above 0.7 usually suggests a good overlap. Except for the spinal canal, DSI values obtained using this method were above 0.82 and, therefore, our results demonstrate a high accuracy with a minimal computational time for both soft and rigid organs," the study authors wrote. "To our knowledge, this is the first fully automated contouring approach using T1 MRI images for adaptive radiotherapy."

While manual segmentation is adequate for defining organs, it remains poor for yielding consistent, confident distinction of organ boundaries at some tissue interfaces, even among clinical experts. "Compared with an average of nine minutes with manual contouring, our algorithm represents a solution for the time and accuracy barriers and, therefore, contributes to the eventual consideration of the use of adaptive radiation therapy," the authors added.

Source: [Artificial Intelligence In Medicine]()
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