Washington University in St. Louis
Office of Technology Management

DEEP LEARNING ALGORITHM TO EXPEDITE MRI-GUIDED ADAPTIVE RADIOTHERAPY PLANNING

Fu, Yabo, Yang, Deshan

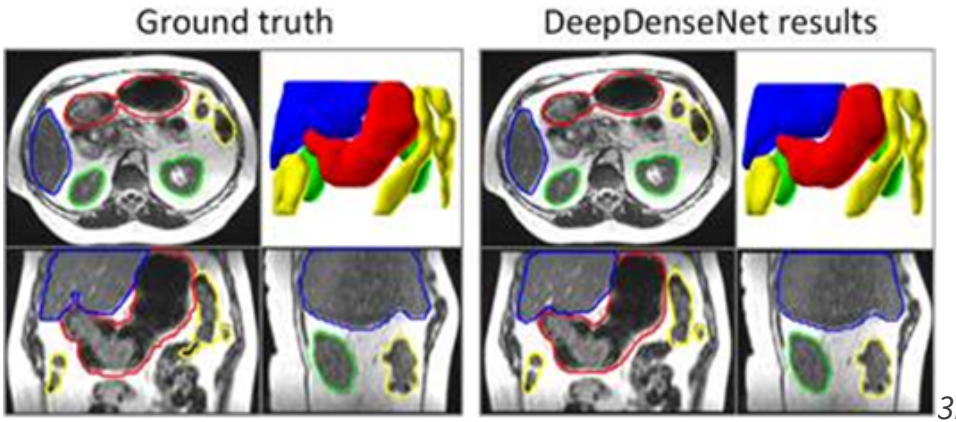
Maland, Brett

T-018708

Technology Description

Researchers in Prof. Deshan Yang's laboratory have developed a deep-learning method for fast, robust, automated MRI segmentation to expedite treatment planning for patients undergoing MRI-guided adaptive radiotherapy (MR-IGART). Specifically, this technology utilizes a convolutional neural network (CNN)-based algorithm that enhances contouring in regions with both stable and unstable Organs at Risk (i.e., "OARs" in the abdomen such as the liver, kidney, stomach and intestines).

In order to maximize coverage of the tumor while minimizing damage to surrounding healthy tissue, the time-consuming process of OAR contouring must be adapted to patient anatomy daily and shortly before treatment. This creates a principal bottleneck in MR-IGART treatment planning. This segmentation software can perform the contouring ~4x faster than manual contouring, reducing wait times for patients and increasing overall utilization of MRI-guided machines. The technology has applications in both research and clinical settings.



3D surface comparison between CNN-based segmentation results (surfaces) and ground truth (meshes) for liver (blue), kidneys (green), stomach (red) and duodenum (cyan).

Stage of Research

The inventors developed the algorithm with retrospective training on 100 dataset, validated it on 10 datasets and tested on 10 data sets. The deep learning model segmented organs with good accuracy and was four times faster than manual contouring from scratch.

Applications

- **MRI-guided adaptive radiotherapy (MR-IGART)** – treatment planning for abdominal cancer treatment, especially for the online adaptive radiation therapy cases, with end-user

implementation as:
    - treatment planning software integrated in MRI radiotherapy equipment; or
    - stand-alone software tool deployed adjacent to the radiotherapy equipment
- **Medical imaging deep learning research** - pre-segmentation of 3D MRs prior to manual correction when preparing training datasets

Key Advantages

- **Fast, robust, automated** contouring for OAR segmentation
    - 2-5x faster than manual contouring for abdominal organs
    - objective, automated analysis decreases inter-observer variation
    - robust performance from one single forward prediction algorithm that does not require careful parameter fine tuning
    - in clinical settings, reducing time of scan-plan cycle could **increase patient throughput and overall utilization** for MRI-guided machines
    - in research settings, could **improve availability of training sets**
- **Analyzes stable and unstable organs** – this method can be used for contouring unstable digestive organs (stomach, bowel, duodenum) as well as stable organs (liver, kidney), whereas previous segmentation technologies focus only on stable organs

Publications

- Fu, Y., Mazur, T. R., Wu, X., Liu, S., Chang, X., Lu, Y., ... & Yang, D. (2018). A novel MRI segmentation method using CNN□based correction network for MRI□guided adaptive radiotherapy. *Medical physics*, 45(11), 5129-5137.

Patents

- Provisional U.S. Patent Application Pending

Website

- Yang Lab