MACHINE LEARNING METHOD FOR FAST, RELIABLE QUALITY ASSURANCE OF PATIENT IMAGING IN RADIATION THERAPY OR COMPUTER-AIDED DETECTION

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Technology Description

A team of researchers at Washington University has created a machine learning method to quickly and reliably validate patient contours in digital medical images for radiation therapy and computer aided image analysis.

Currently, automated contouring tools for delineating tumor boundaries and critical organs in medical images are error prone and require labor-intensive, manual quality assurance (QA) to ensure optimal radiation therapy. However, this tedious QA process is highly subjective and creates a bottleneck in radiation treatment planning and on-line adaptive radiation therapy (OL-ART). To improve the efficiency and reliability of QA, this new system provides an automated technique that uses a population-based "knowledge base" of historical metrics to facilitate automated, rapid assessment. A machine learning component of the system allows the metrics to evolve with more input data, including patient-specific information for OL-ART. This software can be used with any imaging modality (e.g., CT, MR, PET) and generates a 3D image that identifies structures that are likely to be incorrect. The user-friendly interface also enables real-time corrections and manual refinement. Overall, this adaptable and customizable platform can be integrated into the clinical workflow to improve efficiency and enable precise spatial targeting of tumors while limiting collateral damage to healthy organs at risk (OAR). In addition, it could be adapted for general radiology uses such as detecting tumors from screening images.
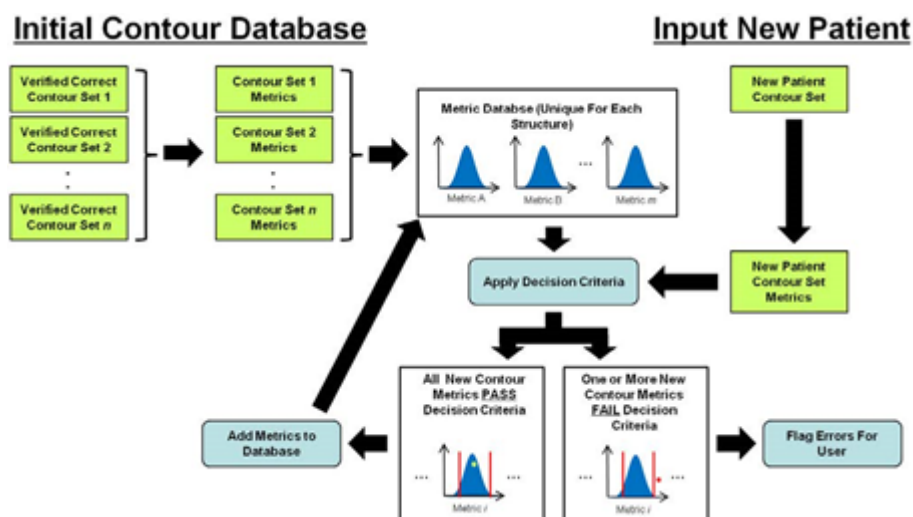
Schematic of the automatic contour QA methodology, which uses a database of verified contour datasets to describe the evaluation metrics and

decision criteria (left side). New contours are input and evaluated as described on the right side of the diagram. A feedback loop shows how validated contours can be added to the database and used for further evaluation.

Stage of Research

The inventors have developed prototype software and performed a pilot study on images of patients with head and neck cancer using a knowledge based derived from 9 critical OAR contours. The results showed that this method can reliably identify contouring errors and has great potential for improving the radiation therapy workflow.

Applications

- **Radiation oncology software** – QA of digital contours for treatment planning and adaptive radiation therapy (both off-line and on-line)
- **Computer-aided detection in radiology** – quality assessment of contouring from digital imaging with end user applications such as detecting tumors from screening images

Key Advantages

- **Fast:**
  - ~1 - 1.5 minutes for automated QA review compared with 15-60 minutes for traditional manual review
  - tremendously increases QA efficiency for greater clinical throughput
- **Automated and objective:**
  - robust and reliable analysis with limited human error and reduced variability between assessments
  - artificial intelligence embedded to improve the model with verified contours
- **Flexible with user-friendly interface:**
  - user can adjust rules for analysis
  - users can refine and correct abnormal contours in real-time
- **Broadly applicable and customizable:**
  - can be used to analyze MR, CT, PET and or any digital image of human anatomy analyzes digital medical images
  - not specific to any vendor-based program or software package

Publications

- Hsin-Chen Chen, Jun Tan, Steven Dolly, James Kavanaugh, Mark A. Anastasio, Daniel A. Low, H. Harold Li, Michael Altman, Hiram Gay, Wade Thorstad, Sasa Mutic, Hua Li*, Automated Contouring Error Detection Based on Supervised Geometric Attribute Distribution Models for Radiation Therapy: A General Strategy, *Medical Physics*, 2015, Vol. 42, No. 2, pp:1048-59.
- Altman, M. B., Kavanaugh, J. A., Wooten, H. O., Green, O. L., DeWees, T. A., Gay, H., ... & Mutic, S. (2015). A framework for automated contour quality assurance in radiation therapy including adaptive techniques. *Physics in Medicine & Biology*, 60(13), 5199.

Patents

- System and method for the validation and quality assurance of computerized contours of human anatomy (U.S. Patent Nos. 9,626,757 and 10,376,715; additional claims pending)