JULY 12–16 2020 VIRTUAL JOINT AAPM | COMP MEETING

Quantifying Patient Shifts Using In-vivo EPID images

Jorge Zavala, Casey Bojechko

University of California San Diego, La Jolla, CA

UC San Diego Health

RETHINKING MEDICAL PHYSICS

INTRODUCTION

- Using EPIDs in-vivo have been demonstrated to detect large errors as well as patient anatomy changes (1).
- However, shifts in the patient position can escape detection (2).
- Once the magnitude and direction of shifts are known, the dosimetric impact can be estimated by simulating the error in a treatment planning system.

AIM

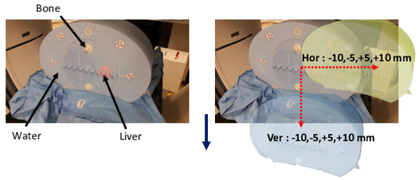
- We propose an analysis method which can detect and quantify the magnitude of in-vivo patient shits that escape current approaches.

METHOD

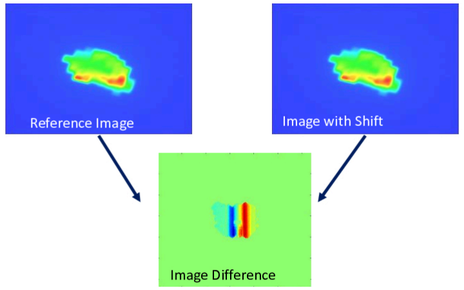
- Current approach's such as the gamma pass rate analysis measure the change in transmitted radiation.
- A shift in the patient typically does not have a large impact on the overall transmitted radiation.
- However within a treatment field, shifts of smaller structures which have different attenuation properties, such as bone and liver, can create features in transmission images.
- EPID images in this study were acquired on a Varian Halcyon linear accelerator, which comes equipped with a Varian aS1200 digital megavoltage imaging panel that is mounted directly opposite to the single energy 6X-FFF MV source.
- The size and position of the imager ensures that complete image data is collected for all treatment fields. During treatment, the EPID integrates the readout obtained from the entire treatment field.

METHOD

- The Gammex anthropomorphic phantom with material equivalent to water, bone and liver was used to make shifts of 5,10, and 20 mm.



In-vivo EPID images were collected for each position.



- An analysis of the difference of two images in the high dose region was performed.
- Profiles of the image difference were investigated to extract information of the shifts.

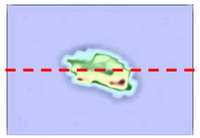


Image Difference

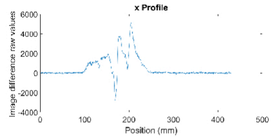


Image Difference Profile

- In-vivo EPID Images of IMRT patients' treatments were also investigated. Comparing images to the first fraction of treatment.

RESULTS

- The shifts were measured using a single IMRT beam, taken from a clinical prostate plan.
- Comparing EPID images of the phantom with relative shifts, profiles of the image difference produces one negative and one positive peak, an analysis of the profile yields:
  - *The full width half maximum of peaks estimates the magnitude of the shift.*
  - *The separation of the peaks indicates the object size*

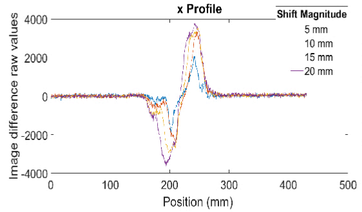


Image Difference Profile For phantom shifts

- For shifts of bone equivalent material perpendicular to the direction on the IMRT beam.
  - The estimated shift from measuring the full width half max of the peaks was within 3 mm of the actual shift.
  - From the separation of the peaks, the size of the shifted object was estimated to within 6 mm.
- For the interface of water and liver, the profiles contained more noise and the error in the estimate of shift increased to 5 mm.
- From the 2D image difference and profile of two fractions of a supraclavicular treatment. The ribs and a chemo port were observed to move between the two fractions. The magnitude of the shift was estimated to be 8 mm. This corresponded to an increased lung dose ($V_{20\%}$ increases by 6%) .

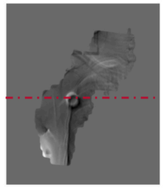


Image Difference

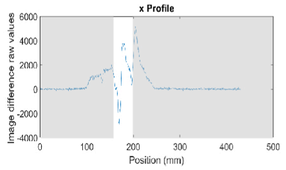


Image Difference Profile

CONCLUSIONS

- For phantom data shifts perpendicular to the beam direction can be detected for
  - Bony anatomy with a 3 mm error
  - Liver: with a 5 mm error
- Shifts parallel to the beam direction can not be detected.
- For a patient case study a lateral shift of 8 mm was measured. This corresponded to an increased lung dose ($V_{20\%}$ increases by 6%) for one fraction during the course of treatment.

REFERENCES

1. Mans A, Wendling M, McDermott LN, Sonke JJ, Tielenburg R, Vijlbrief R, et al. Catching errors with in vivo EPID dosimetry. Med Phys 2010;
2. Bojechko, C. and Ford, E.C. (2015), Quantifying the performance of *in vivo* portal dosimetry in detecting four types of treatment parameter variations. Med. Phys., 42: 6912-6918.

ACKNOWLEDGEMENTS

Work supported by Varian Medical Systems

CONTACT INFORMATION

Dr. Casey Bojechko

Email: cbojechko@ucsd.edu