Real Time Plan Verification of Radiotherapy Treatment Plans Using Couch and Gantry Mounted Camera

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INTRODUCTION

1) Ability to image complex radiotherapy plans in real-time and high resolution is of great importance in modern radiotherapy clinics.

2) **High resolution and high frame rates** achievable using **optical imaging** and **ideal dosimetric properties of liquid scintillators**, render optical imaging as an ideal tool for patient specific quality assurance.

3) While, 2D planar comparison of measured dose to the treatment planning software (TPS) simulated dose is frequently performed in clinics, obtaining a 3D dose distribution is more clinically relevant.

4) We propose **using two CMOS camera** (gantry and couch mounted) or a **single couch mounted camera with additional information about beam fluence obtained from delivery log files** to reconstruct a 3D dose distirubtion inside the volume of a cylindrical radioluminescent phantom.

2D PROJECTION IMAGING

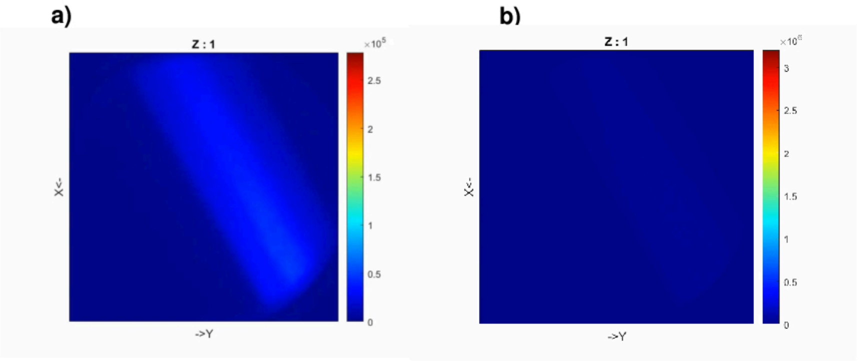

Figure 2. a) 2D projection view of a Pancreas plan (sped up 10x) obtained via the couch mounted camera. b) Cumulative sum of the Pancreas plan.

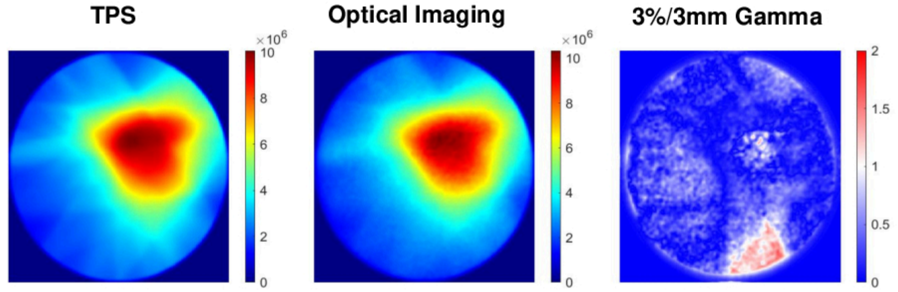

Figure 3. 2D gamma analysis of the measured dose distribution using optical imaging compared to the projected TPS dose distribution. A 90% passing rate was achieved. A value of <1 in the gamma index map indicates that pixel successfully passes the given criteria (3%/3mm). A passing rate of 90% was achieved.

METHODS

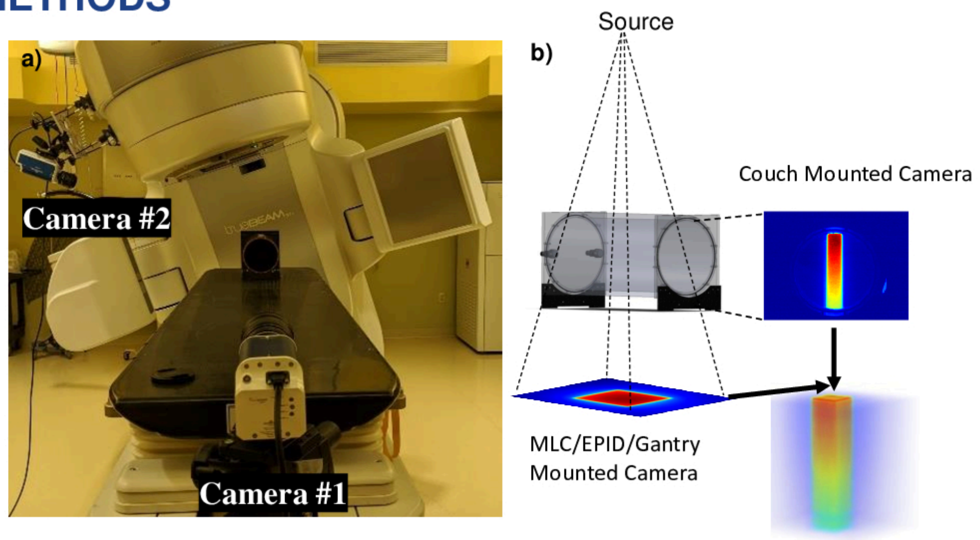

Figure 1. a) Setup for imaging dynamic, complex radiotherapy plans. **Camera # 1 provides depth dose information, whereas the camera # 2 can be used to image incident photon fluence on the surface.** b) 3D reconstruction algorithm, which requires two perpendicular views to reconstruct a 3D volume. A couch mounted camera typically provides data perpendicular to the beam axis, and the beam fluence incident on the phantom can be obtained using EPID, MLC log files or another gantry mounted camera..

1) **Camera 1, mounted on the couch,** provides projected 2D images perpendicular to the beam's axis

2) When wrapped with a scintillating sheet, **Camera 2, mounted on the gantry head** provides fluence incident on the phantom surface, similar to beam apertures that can be obtained by delivery log files.

3) Using the **two orthogonal views**, a 3D volume can be reconstructed using the technique specified by **Bruza et al[1,2].** (Illustrated in Figure 1b)

4) Initially, the algorithm was used with beam apertures defined **using delivery log files and the projected view obtained with Camera 1 to image a Pancreas plan**

5) Next, static square beams MLC defined beams were images with the gantry and couch mounted cameras and a 3D volume was reconstructed.

3D RECONSTRUCTION USING DELIVERY LOG FILES AND COUCH MOUNTED CAMERA

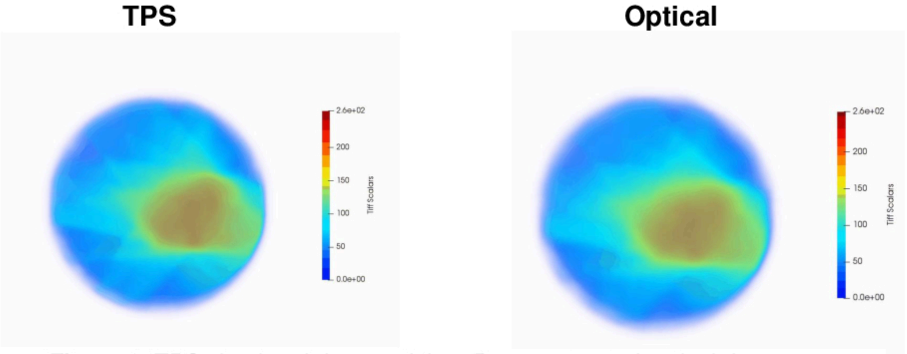

Figure 3. TPS simulated dose and the 3D reconstructed optical dose distribution at a voxel size of 0.5 mm^3

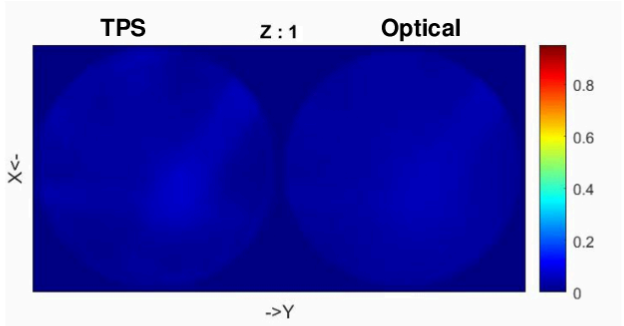

Figure 3. Comparison of slices of the 3D dose distribution (TPS and Optically reconstructed) along the optical axis (perpendicular to the beam axis). Slice thickness is 0.5 mm.

3D RECONSTRUCTION USING TWO CAMERAS

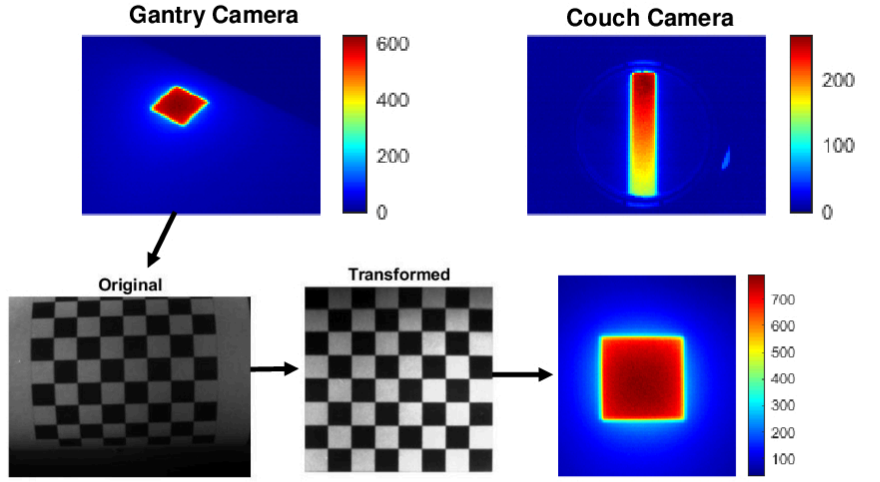

Figure 4. Since the gantry mounted camera images a cylindrical surface, it is required that a transformation be applied so that a view perpendicular to the couch mounted camera be obtained (similar to the view provided by the MLC log files/ EPID. To this end, a 2D polynomial transformation was applied to the gantry camera image.

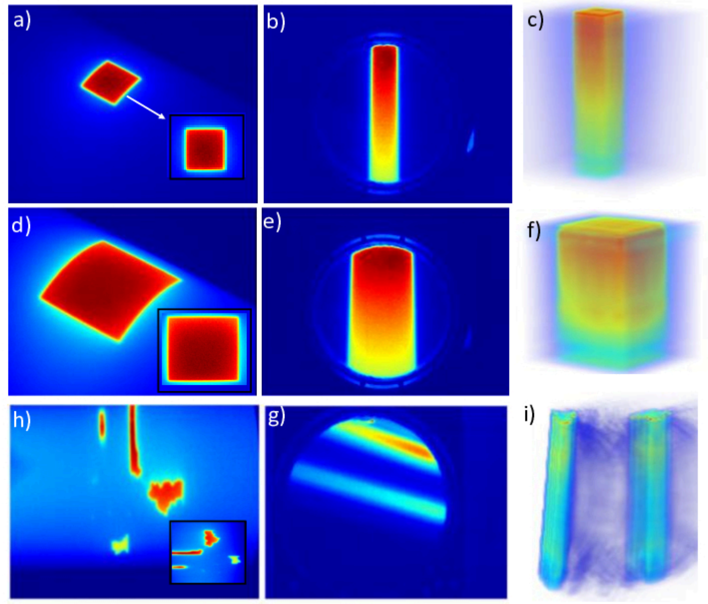

Figure 5 a), b) show the images captured by the gantry and couch mounted camera, respectively for a 3 x 3 cm^2 beam. The inset in a) shows the planar image obtained by applying a polynomial transformation. **c)** shows the final reconstructed volume for a 3 x 3 cm^2 beam. **d), e) and f)** show the equivalent images for the 7 x 7 cm^2 image. **h) and g)** show the two-camera view for the static MLC multitarget aperture simulating a typical control point for radiosurgery. The gantry angle was set to 105.5 ° for this acquisition. **i)** final 3D volume for the multitarget aperture (rotated to back to 0° with respect to the gantry rotation axis)

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