

### 3D Surface Scanning for Tumour Localization in Non-Melanoma Skin Cancer

Anna Ilina<sup>1\*</sup>, Csaba Pinter<sup>1</sup>, Andras Lasso<sup>1</sup>, Ingrid Lai<sup>2</sup>, Chandra Joshi<sup>2</sup>, Kevin Alexander<sup>2</sup>,

L. John Schreiner<sup>2</sup>, Timothy Hanna<sup>2</sup>, Gabor Fichtinger<sup>1</sup>

<sup>1</sup>Laboratory for Percutaneous Surgery, Queen's University, Kingston, Canada

<sup>2</sup>Department of Physics, Engineering Physics, and Astrophysics, Queen's University, Kingston, Canada

**Introduction.** Non-melanoma skin cancer (NMSC) is characterized by a tumour present on the surface of the skin. When the tumour presents in the head and neck region, surgical excision of the tumour can cause poor cosmetic outcome. Orthovoltage radiation therapy (ORT) is a non-invasive treatment commonly used to treat such superficial tumours, providing better cosmetic results than surgical removal [1]. Presently, there is no treatment planning system commercially available for ORT. As the first step of the treatment planning process, the tumour must be localized in a CT scan [2]. We propose localizing the tumour using optical 3D surface scanning, to acquire a colored textured image of the patient, since NMSC tumours are not visible in CT. The tumour is then segmented from the surface scan image, and its contour overlaid onto the patient's CT images for dosimetry planning.

**Methods.** A male plastic head and neck mannequin was used as a phantom, with a red sticker placed on the face representing a skin lesion. The phantom was segmented from CT using thresholding based on image intensity. The Artec Eva 3D Surface Scanner (Artec 3D, Luxembourg) was used to scan the surface of the phantom's face, resulting in a full-coloured textured 3D mesh (Figure 1). Five fiducials were manually placed on the nose tip, inner corners of eyes and front of ears to pre-register the model segmented from CT and the surface scan model. The Iterative Closest Points (ICP) algorithm was used after pre-registration to align the two models more precisely and yield the final registration (Figure 2). The tumour was localized by manually segmenting it to a depth of approximately 1cm, mimicking the depth of superficial NMSCs. The segmented tumour was saved with the CT scan to DICOM-RT, for use in treatment planning. Segmentation and registration was done in 3D Slicer, an open-source software platform for medical image visualization and analysis [3].

**Results.** The workflow of 3D surface scanning, segmenting head and neck from CT, registering the surface scan model to the segmented phantom model and segmenting the tumour required approximately 7 minutes. The red sticker representing a skin lesion was clearly visible on the textured mesh created using the 3D surface scanner's software, and could be easily segmented following the contour of the lesion. Following pre-registration using fiducials, the ICP algorithm yielded the final registration, with a mean distance after registration of 0.25mm. Mean distance was computed between the points of the surface scan model and the nearest corresponding points on the surface of the model segmented from CT.

**Conclusion.** Using 3D surface scanning allows for a quick workflow for localizing a tumour at the surface of the skin, eliminating the need for more complex procedures. This project is the first step towards a free open-source treatment planning system for ORT. This method of localizing the tumour using surface scanning may be extended beyond non-melanoma skin cancers, to any superficial tumours which are visible at the skin's surface.

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**References.** [1] Kharofa J, Currey A, Wilson J (2013) Patient-Reported Outcomes in Patients with Nonmelanomatous Skin Cancers of the Face Treated with Orthovoltage Radiation Therapy: A Cross-Sectional Survey. *International Journal of Radiation Oncology* [2] Burnet N, Thomas S, Burton K, Jefferies S (2004) Defining the tumour and target volumes for radiotherapy. *Cancer Imaging* 4(2):153-161 [3] Fedorov A et al. (2012) 3D slicer as an image computing platform for the quantitative imaging network. *Magnetic Resonance Imaging* 30(9):1323-41

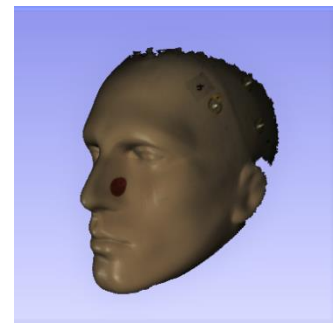


Figure 1: 3D surface scan model of head and lesion on nose.

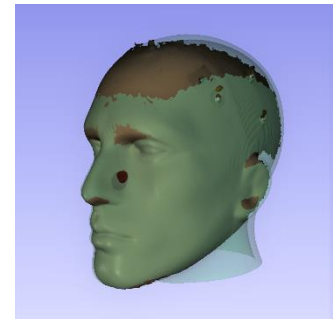


Figure 2: Surface scan model is registered to head model segmented from CT.