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

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Introduction

- Non-melanoma skin cancer is characterized by shallow tumours visible at the surface of the skin.
- Orthovoltage radiation therapy (ORT) is commonly used to treat patients with skin cancer, and can produce cosmetically favourable results compared to surgical excision [1].
- Currently, there is no commercially available treatment planning system for ORT. The first step of treatment planning is localizing the tumour in a computed tomography (CT) scan of the patient [2]. Since superficial skin tumours are not visible in CT scans, another method must be used to localize these tumours.

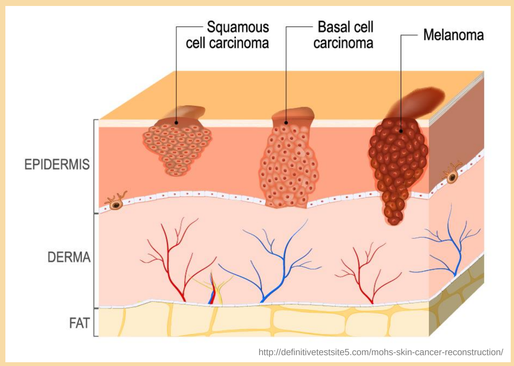

Fig 1. Different types of skin cancer

Fig 2. An orthovoltage machine

Objective

- Localize superficial skin cancer on CT volumes using optical 3D surface scanning, for radiation therapy treatment planning.

Methods

- A male plastic head and neck mannequin was used as a phantom. A red sticker was placed on the nose representing a skin lesion.
- A coloured, textured 3D mesh of the mannequin's face was obtained using 3D surface scanning.
- The phantom's head and neck were segmented from a CT image using thresholding based on image intensity. The resulting segmentation was cropped to keep just the head.
- Five fiducials were placed on the nose tip, inner corners of eyes, and ears to preregister the surface scan model to the model segmented from CT. The Iterative Closest Points (ICP) algorithm was used to yield the final registration.
- The tumour was segmented from the surface scan and saved with the CT image for treatment planning.

Fig 3. Head phantom with red sticker representing skin lesion

Fig 4. The Artec Eva 3D surface scanner (Artec 3D, Luxembourg)

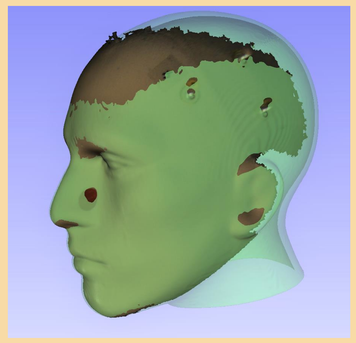

Fig 5. Surface scan model is registered to the model segmented from CT

Results

- The red sticker representing a skin lesion was clearly visible on the 3D surface scan, 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.
- 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 took about 7 minutes.
- Segmentation and registration was done in 3D Slicer, an open-source software platform for medical image visualization and analysis [3].

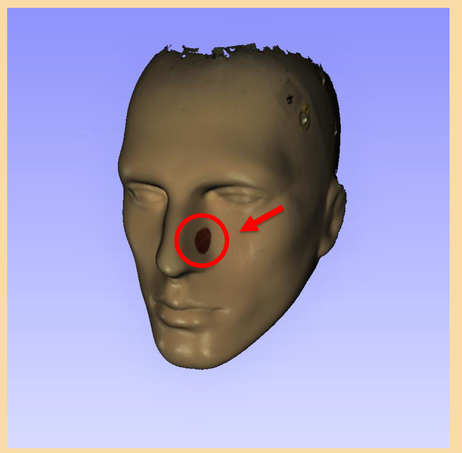

Fig 6. 3D surface scan of mannequin head, with sticker on nose representing a skin lesion

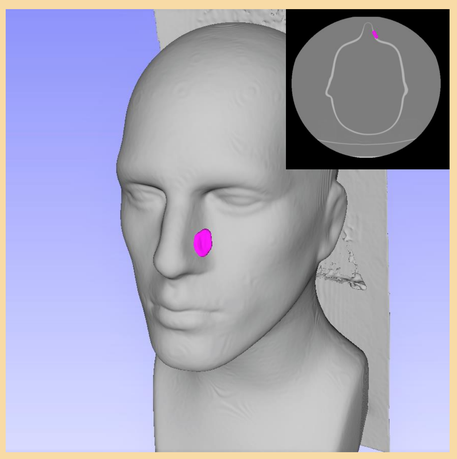

Fig 7. Tumour is localized in head and neck CT, for treatment planning

Conclusion

- 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 orthovoltage radiation therapy. This will be especially useful for planning radiotherapy treatment in areas with complex geometries, such as the ear or nose.

Acknowledgement

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Reference

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