Motion Capture Pillow (MCP): A novel method to improve comfort and accuracy in radiotherapy

Authors: Simon Goldsworthy, [A] Helen McNair[B] and Sanja Dogramadzi[C]

Aims

The delivery of radiotherapy has changed significantly over the last few decades. Recent advances in radiotherapy practice may increase patient discomfort. A key challenge to improve patient comfort is the common use of a thermoplastic mask for patients with head and neck cancers. Patients suffer from discomfort and the claustrophobic effect of the mask, or as they lose soft tissue due to treatment and gain undesirable movement in the mask. A prototype system using a robotic motion capture pillow (MCP) is investigated for proof-of-concept and is pictorially presented for the potential replacement of thermoplastic masks.

Methods

A 6D head position tracking device – the MCP (Fig 1) was designed and tested by robotics engineers in a limited user study. The pillow is a biologically-inspired sensing device based upon the deformation of the epidermal layers of the human skin. Deformation of MCP-head interaction is measured optically by tracking the movement of internal artificial papillae pins on the inside of the pillow skin (Fig 1). These papillae pins create an image with a matrix of dots captured by a single camera inside the pillow. The head position image on the pillow has been matched with an absolute head position captured by an optical infrared system (Polararis NDI) with a tracking tool attached to the person's mouth. The aim of the study was to validate accuracy of the MCP by measuring its resolution (smallest detectable input) and repeatability (the maximum deviation of output for the same input).

Results

Five basic movements of the head were detected; two translations across the MCP, laterally (Tx, x-axis) and longitudinally (Ty, y axis), one translation vertical to the pillow (Tz, z axis) and two rotations of the head, roll (α) and pitch (β). A graphic user interface was created in Matlab to view and analyse the two sets of data – Polaris (Tx, Ty, Tz, α, β) and MCP data. A minimum detectable deformation of the MCP in translation is 1 mm, and in rotation is 0.3° (α) and 0.6° (β). The repeatability test showed a maximum of one pixel output deviation for the same position.

Fig 1. The Motion Capture Pillow with posterior sensing dots

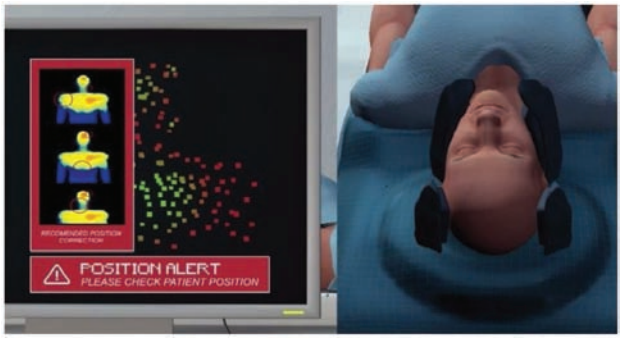

Fig 2. Proposed solution

Conclusion

The prototype MCP has been internationally patented and proof of concept has shown potential for consideration in clinical practice. The sensing resolution of the MCP can be improved by a larger number of dots per area or adaptations to the software algorithm. There is a small ambiguity between lateral translation and yaw rotations that can be resolved by an initial MCP calibration. The current challenge and future work is to develop a clinical system that will cause limited radiation attenuation, preserve some skin sparing, and is non-ferrous when considering magnetic resonance imaging. The preliminary prototype data calls for further investigations in the laboratory, including how to stabilise jaw movement and cranium, prior to being investigated in clinical practice (Fig 2). ■

Conflict of interest statement

There are no conflicts of interest.

Authors: [A]Radiotherapy, Taunton & Somerset NHS Foundation Trust, Taunton; [B]Radiotherapy, Royal Marsden Hospital, Institute of Cancer Research, London; [C]Bristol Robotics Laboratory, University of the West of England, Bristol, UK