A Freehand Natural Interaction System for Mixed Reality Healthcare Demonstration

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Abstract

This work presents a novel system for mixed reality healthcare demonstration using freehand natural interaction. The system employs an exocentric mixed reality environment which integrates a practitioner in real time with multimodal patient data. The system provides natural interaction with virtual anatomical models, medical data and patient case information. A freehand Natural User Interface (NUI) is employed derived by empirical user interaction models. This aims to improve a user's level of natural interaction with the virtual models and provide a more realistic control in the mixed reality setting. We demonstrate applications for this system in procedure visualisation, remote consultation, medical education and sterile working environments.

Introduction

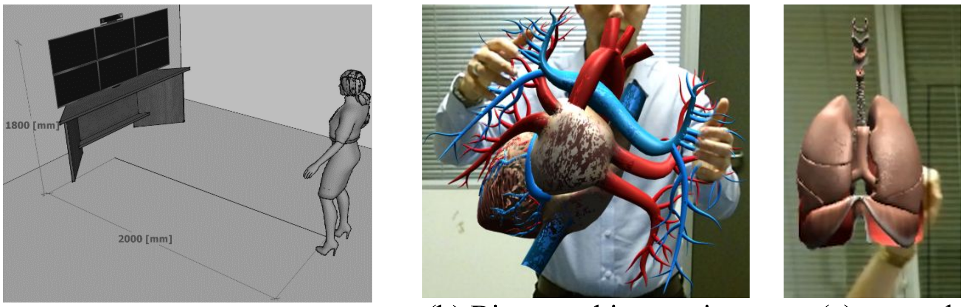
Mixed and Augmented reality (MR and AR), where a real scene is enhanced with virtual objects, allow the seamless integration of digital information into the real world. MR has enormous potential within the medical field, with healthcare being profoundly affected by recent developments[1].MR technology can also provide the platform for facilitating a seamless doctor-patient communication[2], however these systems often rely on bespoke sensors and cumbersome wearable devices. Recent studies have shown that these wearable devices often cause fatigue and discomfort[3] and that freehand natural user interaction is more desirable. Freehand natural user interaction is the automatic analysis of natural human behaviour, while interacting with a system using no wearable devices. This interaction method enables a more realistic virtual interface, bridging the gap between users and technology.

Freehand user interaction systems aim to mimic the most natural form of interaction between a user and a system without the use of wearable devices. This interaction method enables a more realistic virtual interface, bridging the gap between users and technology.

Within this work we present a natural user interaction system using grasping methods derived from interaction analysis[4]. The system merges virtual anatomical patient models and data information with the real environment thus allowing a freehand interaction in a unique real time in a collaborative space without wearables.

Methods

The system integrates the use of a Microsoft Kinect2, a SyncMasterX61 feedback monitor and is developed in Unity using C# and the Microsoft Kinect SDK. It employs two interaction methods - bi-manual, allowing for 3D virtual model manipulation (see Fig. 1b); and manual, enabling grasping interaction and system navigation (see Fig.1c).



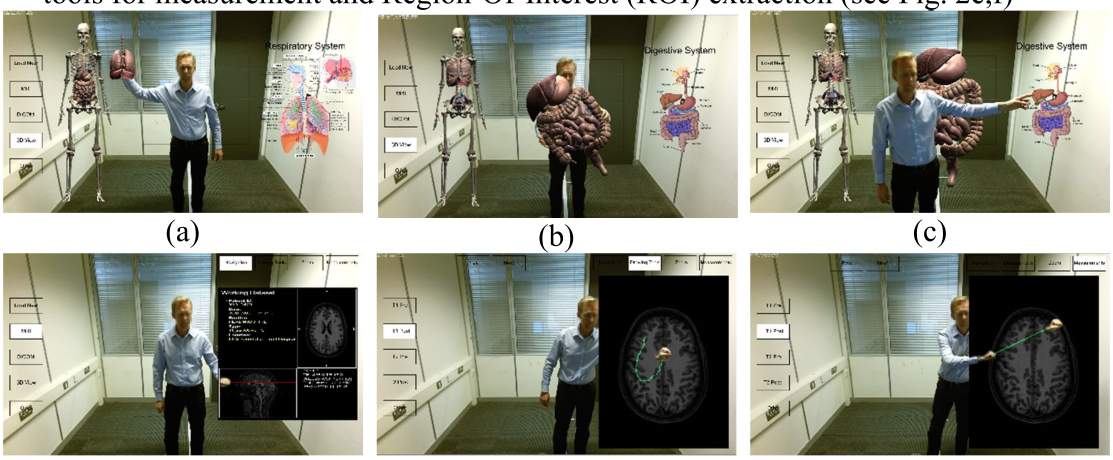
(a) Interaction environment (b) Bi-manual interaction (c) manual

Figure 1 Interaction configurations

Results

We present a mixed reality interaction system merging virtual anatomical models and medical data with a real environment, and offers the following level of functionality:

- A natural interaction system for real time healthcare demonstration (see Fig. 2)
- A model based natural interaction giving an improved user interaction (see Fig.2b)
- Natural interaction with models allowing scale, rotation, occlusion and translation in real time (see Fig. 2a,b,c)
- Patient-driven customization of models allowing personalised demonstrations
- Freehand interaction with multi-modal patient data (see Fig. 2d) giving customizable tools for measurement and Region-Of-Interest (ROI) extraction (see Fig. 2e,f)



(a) (b) (c)

(d) (e) (f)

Figure 2 Different levels of functionality presented in the system

Discussion

The potential of mixed reality to bridge the gap between patients and clinicians has been proven to be a key factor in healthcare in the near future[1,2]. The use of natural user interaction techniques may help to remove the barriers between users and technology.

The combination of these two, together with the customization capabilities of the system presented, may create the breeding ground for introducing new fully customized medical software developments targeted at patients. This customizable system has the potential to be applied in the following areas:

1. **Educational self-awareness interactive tool**
   Practitioners and patients interact and manipulate, in real time with personalised virtual 3D models to promote self-awareness of medical conditions (i.e. smokers' lungs, showcase medical procedures)
2. **Mixed reality interactive medical appointments**
   Practitioners present in an immersive MR environment patient's medical records, interacting with them during the appointment
3. **Interactive educational games for children**
   Children can interact with models and anatomical data in a fun and relaxed educational environment (mixed reality version of "operation")
4. **Freehand interaction with medical data in sterile environments**
   Clinicians can interact with patient data (ie. MRI and CT sets)

Beyond these scenarios we envisage future use in a variety of different fields and disciplines from education through to manufacturing.

References

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