

Wii – Highly Sensitive Tracking of Patient Motion

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Introduction

Numerous medical MRI applications suffer from patient motion and require motion control. MRI-based digitization of the tooth surface for a dental impression [1] is an example of such applications, as it requires extremely high resolution to be achieved *in vivo* and relies completely on the quantitative analysis of the acquired data. The purpose of this paper was to develop a low-cost motion tracking and analysis system that allows for detecting buccal/head motion of the patient with sensitivity below 100µm, with a potential to be used in the MR scanner room.

Subjects and Methods

For motion tracking an infrared light detection camera built-in in a Wii Remote (Nintendo of Europe GmbH) was used in combination with an infrared LED (SFH415, Siemens). The Wii Remote uses built-in accelerometers and infrared detection camera (1024×768 pixels) to sense its motion in 3D space. An open source code in C# available online was used to analyze the data received from the Wii Remote via Bluetooth. The GUI of the program visualizes infrared light sources as colored circles and displays their coordinates in pixels (Fig. 1). **Calibration.** For calibration of the system, the Wii Remote and the LED were fixed on optical benches at a distance of 2cm from each other. The LED was moved along the optical bench and the sensitivity of the camera was calculated. **Patient motion measurement.** Five volunteers underwent the following measurement procedure. The volunteer was placed outside the scanner room in the prone position on a vacuum cushion (Fig. 2), according to the dental MRI measurement procedure [1]. The LED was attached on top of the Wii Remote that was placed at a distance of 2cm from the volunteer's head. The infrared light emitted by the LED was reflected by a reflecting strap fixed around the volunteer's head and detected by the camera of the Wii Remote. Due to the uneven surface of the reflecting strap, it could act as a moving infrared source, reflecting infrared light by one small facet at a time. Calibration was verified for this setup too. For each volunteer a five-minute measurement was performed. The change of two spatial coordinates was detected, corresponding to the motion of the volunteer's head in the head-foot direction (X in Fig. 2) and anterior-posterior direction (Y in Fig. 2).

Results

Calibration. The camera sensitivity was calculated to be $(39\pm 7)\mu\text{m}$, given the distance between the camera and LED is 2cm. **Patient motion measurement.** The motion of the volunteers showed a periodicity, apparently caused by the respiratory motion, with an additional drift of the mean value. The maximal displacement within 5 minutes reached on average $(351\pm 168)\mu\text{m}$ in the head-foot direction and $(448\pm 200)\mu\text{m}$ in the anterior-posterior direction.

Discussion and Conclusion

The proposed setup for motion tracking and analysis based on the Wii Remote allows for detecting patient motion with sensitivity below 40µm. The measurements performed on volunteers showed displacements that can affect quality of MR images acquired with a submillimeter nominal resolution, such as MRI-based dental impression. The proposed setup can be used for optimization of the patient's fixation. The Wii-based system can potentially be used for real-time motion tracking and analysis during MRI measurement in the scanner room (Fig. 3). It can become a simple and low-cost solution for a wide range of MRI applications, in which real-time patient motion control is required.

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References [1] Tymofiyeva O *et al.* Concept Magn Reson B: Magn Reson Eng 2008, 33B, p. 244-251

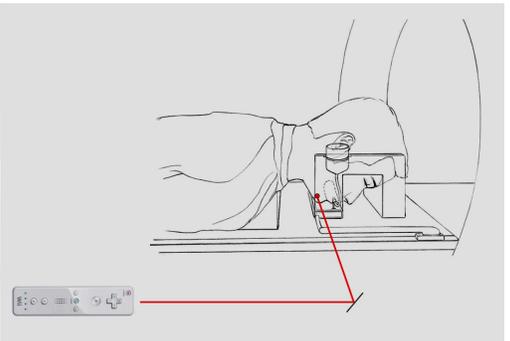


Fig. 1. Wii Remote Tester GUI. Fig. 2. Motion measurement setup. Fig. 3. Real-time patient motion tracking in the MR scanner room.