Development of a wireless intra-operative MR geometry planning system

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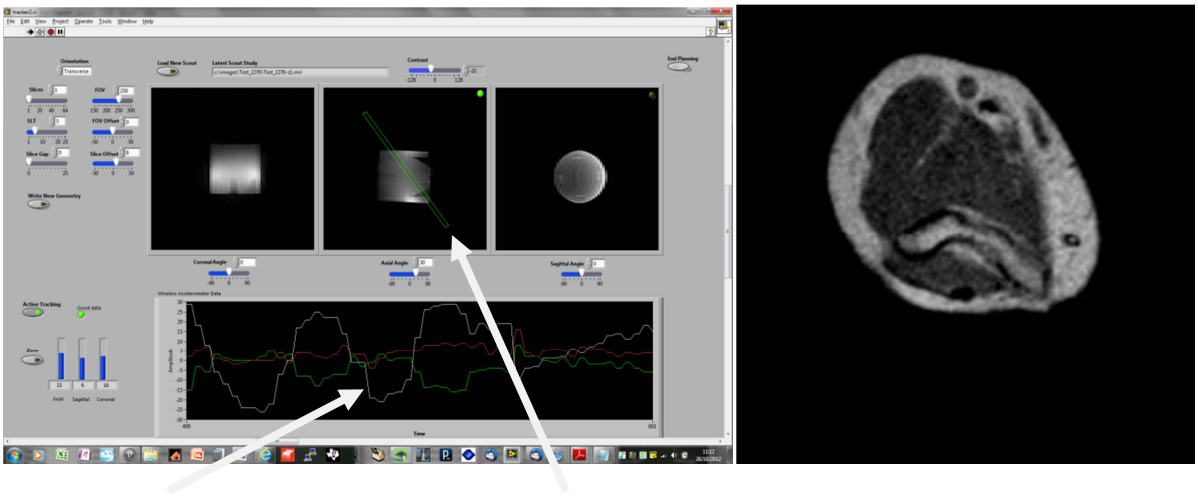
INTRODUCTION Real time interactive positioning of scan planes is required to allow, for example, tracking of biopsy needles or surgical instruments during interventional MR procedures such as breast biopsy. Various interface device such as trackballs, joysticks, touch-screens as well as optical and MR based fiducial tracking devices have been used previously but usually need complex contact with the operator or line of sight access for correct operation. This study investigated use of a low cost wireless interface device to track controlled rotational motions produced by the operator to adjust the MR scan plane in real time.

METHODS A wireless accelerometer operating at 868MHz (EZ-Chronos 430, Texas Instruments, Austin, Tx) was interfaced to scan geometry planning software. The acceleration outputs of the device were allocated to the plane rotation angles and to the slice offset or FOV offset as chosen by the operator. Zero position was set with the device located horizontally and pointing into the magnet. Rotation of the accelerometer by +/-90 degrees around two axes was then calibrated and used to adjust the selected scan plane angle and offset interactively. Testing was performed on a dedicated 0.17T MR orthopaedic/neonatal scanner (InnerVision MRI, London, UK) and a 0.5T Intra-Operative MR Scanner (Specialty Magnetics Ltd, Middlesex, UK) both using LabView based research spectrometers (ISD Ltd., Bradley, UK). A USB PC interface to the wireless accelerometer including a TI CC1111 low power RF transceiver was housed in the scan computer located outside the screened room to receive the wireless data stream.

RESULTS The wireless interface operated effectively with the two open, interventional MR scanners at 0.17T and 0.5T during image acquisition and could be used to interactively adjust the scan plane in real time (50ms update time) based on operator wrist rotation with no other physical contact to the system. The wireless device was not affected by the magnetic or radiofrequency fields (the device was kept outside the transmit coils) and did not produce interference on the images. Images of a volunteer's elbow were acquired at 0.17T dependent on the wireless accelerometer output with an angular accuracy of +/-3 degrees and a slice offset of +/-1mm (as assessed previously using a test object).



Accelerometer Output Planned Slice Oblique Planned Elbow Image

DISCUSSION Real time interactive scan plane control has been demonstrated using a wireless accelerometer device which allows rapid and precise control of the slice angle and offset from simple rotational movements of the accelerometer device providing sterile and position independent interaction with the MR geometry planning software.