A Feasibility Study In Measuring Soft Tissue Artifacts On The Upper Leg Using Inertial and Magnetic Sensors

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Introduction

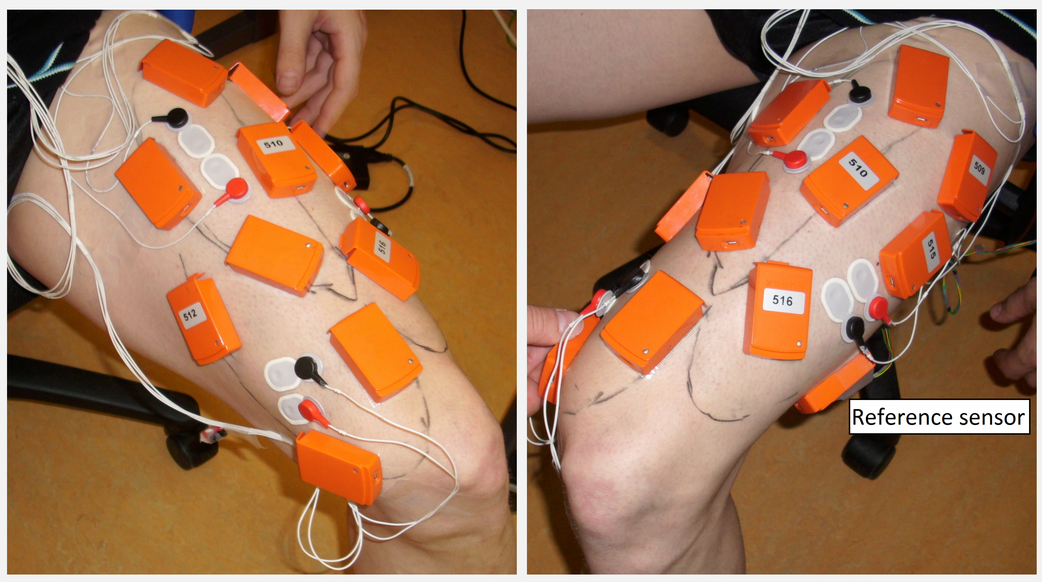
Soft-tissue artifacts cause inaccurate estimates of body segment orientations. The inertial sensor is orientating or displacing with respect to the bone, due to muscle and skin movement [1].

During impacts while walking, soft tissue motion of up to 7 cm has been observed when comparing skin attached optical markers with markers directly attached to the bone of the same segment [2].

The goal of this study is to ambulatory estimate and eliminate these soft tissue artifacts using inertial and magnetic sensors.

Methods

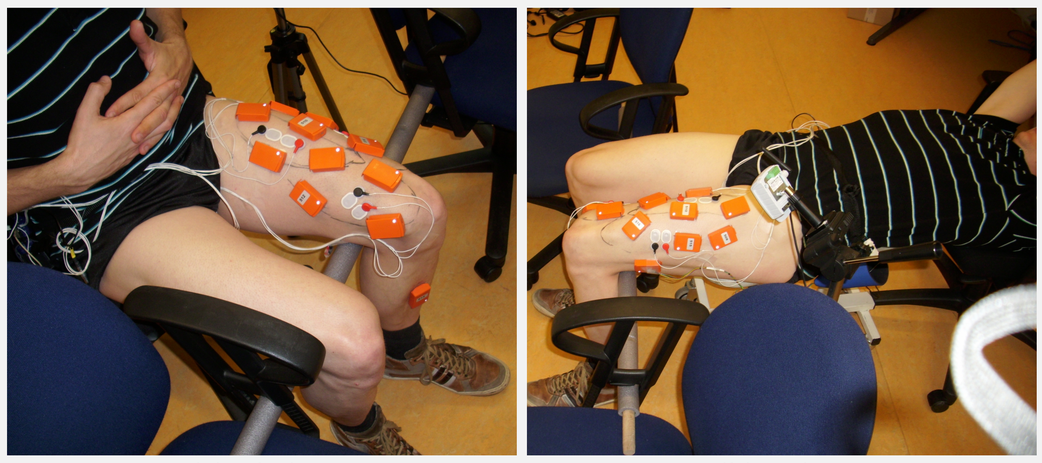
Eleven inertial and magnetic sensors (MTw, Xsens Technologies) were placed on the upper leg (Figure 1). One sensor was positioned on the tendon plate lateral to the quadriceps (as used in Xsens MVN [1]) and used as reference sensor (Figure 1b).



(a) Medial side **(b) Lateral side**

Figure 1: Positions of the 11 inertial and magnetic sensors on the different muscles of the upper leg.

Walking, active and passive knee extensions and muscle contractions without flexion/extension were recorded in one subject (Figure 2).



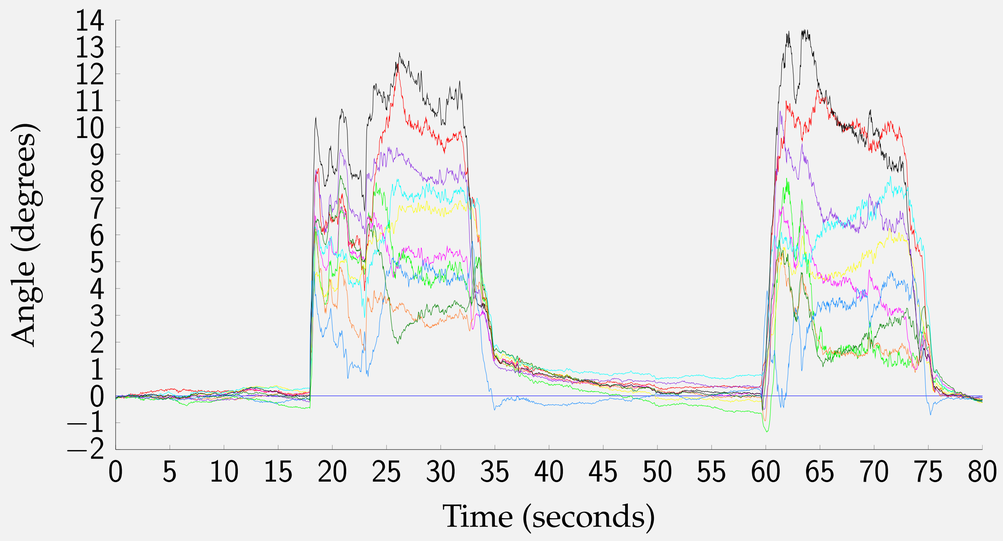
(a) Sitting **(b) Lying**

Figure 2: Different measurement settings. The horizontal bar is used for stability, but the subject is not resting on it.

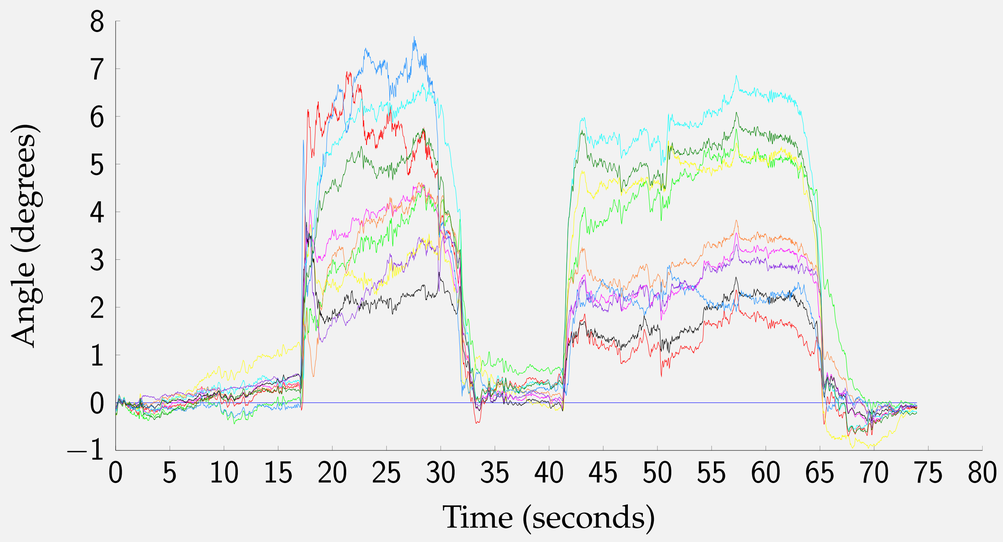
The orientation of each sensor with respect to the reference sensor was calculated.

Results

During walking, relative orientations of up to 28.6° were measured (22.4±3.6°). During muscle contractions without flexion/extension the largest relative orientations were measured on the rectus femoris (up to 11.1°, Figure 3) [3].



(a) while sitting



(b) while lying

Figure 3: Orientation (axis-angle representation) of each sensor with respect to the reference sensor (–) during muscle contractions without flexion/extension.

Conclusions and future work

In future work a new sensor system containing smaller sensors will be used to investigate soft-tissue artifacts more accurately; in particular we will focus on in-use estimation and elimination of these artifacts.

Acknowledgment

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References

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[2] M. T. G. Pain and J. H. Challis, "Soft tissue motion during impacts: their potential contributions to energy dissipation," *PAIN*, 2002.

[3] A. G. Stevens, "Measuring the deformation of the m. quadriceps femoris with inertial and magnetic measurement units," *Bachelor thesis, University of Twente*, 2012.

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