Motion tracking to support surgical skill feedback and evaluation

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Title

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Introduction & Aims

Performance evaluation of technical surgical skill is done by direct observation by expert surgeons. This is time intensive, costly, and requires training of assessors. Motion tracking could complement direct observation to provide immediate feedback during training and to support objective performance assessment. A recent study by Ahmed et al. (2017) showed that expert feedback combined with validated metrics resulted in greater performance improvement for novices. However, current motion tracking methods are expensive, non-portable, or very sensitive to disturbances from the environment. We hypothesize that combining technologies solves these limitations. The goal of the current study was to design a wireless, low-cost motion tracking system to support 1) real-time individual performance feedback and 2) objective assessment of technical surgical skills.

Description

An iterative, research-based design process with rapid prototyping was followed. First, we performed a needs assessment with a literature review and survey to a broad range of surgeons to identify relevant motion parameters. Second, various prototypes using an Inertial Measurement Unit (IMU) and a Leap motion sensor were tested in an authentic surgical environment for 1) robustness and 2) accuracy.

Outcomes
Twelve surgeons (experience range = 2 - 27 years) from five different hospitals and a range of surgical specialties completed the survey and rated ‘precision of movement’ and ‘minimizing unnecessary movements’ as most important motion parameters of surgical skill. Furthermore, unnecessary or excessive movements and secondary tissue damage were reported as most common errors.

The final prototype can be seen in Figure 1. The IMU is embedded in a sleeve and detects fine motor skills such as small hand movements, tremors, and strokes. The Leap Motion sensors complement this with infrared tracking of the hand in 3D space and time. The devices proved robust under changing lighting and gowning conditions. Accuracy of motion tracking was however influenced by instrument use.

Discussion

Our device offers the possibility for immediate performance feedback aiding trainees’ self-assessment during training. By discriminating good from poor performers in training early on, training can be adapted to an individual trainee’s needs and facilitate deliberate practice. Future research includes expert benchmarking and parameter selection. Motion tracking analysis complements subjective assessment that is prone to bias and reduces assessors’ workload.

Novelty of methodology
Motion tracking to support surgical skill assessment is not yet common practice. The device offers a robust, affordable, and wearable alternative to current motion tracking devices.

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