

Quantitative comparison of movements for medical training

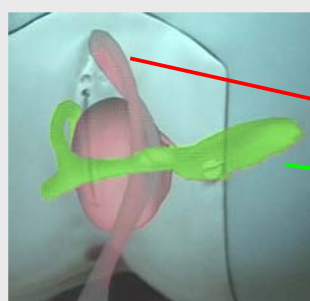
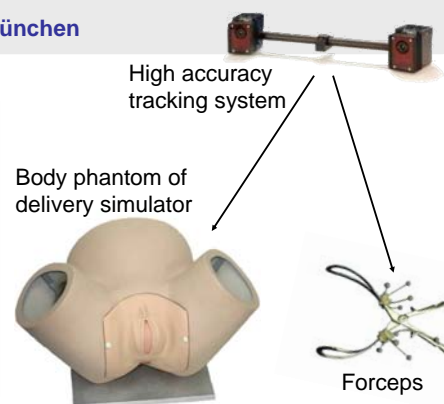
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Scenario

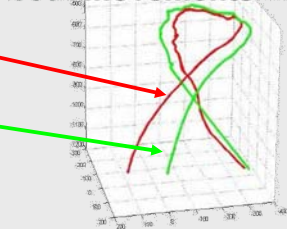
- Expert performs medical act
- Students perform the same action
- Systems automatically provides *quantitative* differences in performance

Challenge

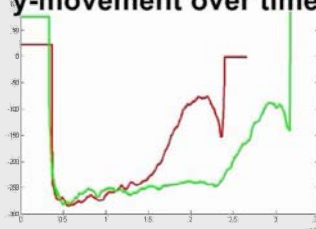
- *Variable speed* of performance of the same valid action
- Each point in one curve must be *temporally registered* to a point in other curve (no bijectivity)



both movements in 3D



y-movement over time



simple transformation

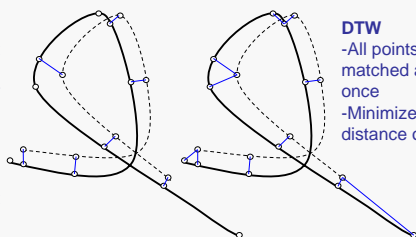


Each line represents a trajectory of a forceps that is displayed in the Augmented Reality system

Comparison of existing algorithms: LCSS vs. DTW

LCSS

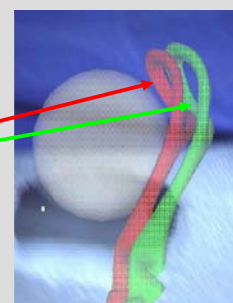
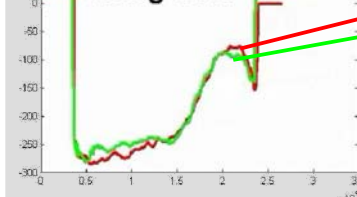
- Points are matched or not (impractical for replay)
- Each point is matched only once
- Threshold matching
- Maximizes matched points (this distance measure is not optimal for different update rates of tracking systems)



DTW

- All points are matched at least once
- Minimizes sum of distance of matches

synchronization using DTW



Outcome

- Both, DTW and LCSS solve temporal registration problem with the same computational effort, but DTW gives superior results
- After synchronization (temporal registration) a direct comparison is possible:
 - by AR 3D visualization from different viewpoints at any speed
 - as a quantitative measure of success in reproducing actions
- Statistical comparison of many experts' performances allows automatic classification of important parts of complex movement
- Alignment of data not limited to 3D trajectory, e.g. forces, other parameters of simulator
- First promising trials on online synchronization



Offline synchronization for

- Comparing novice to expert
- Obtaining typical (average) movements of experts
- Finding critical parts of a performance

Online synchronization provides:

- Interactive feedback during performance
- Context dependent information