Sleight of Hand: Perception of Finger Motion from Reduced Marker Sets

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Abstract

As it is not always possible to simultaneously capture finger and full-body motions, hand motions are often either omitted, manually created by animators, or captured during separate sessions and spliced with full body animation. In this poster, we investigate the perceived fidelity of hand animations where all the degrees of freedom are computed from reduced marker sets. In a set of perceptual experiments, we found that finger motions reconstructed with inverse kinematics from a reduced marker set of eight markers per hand are perceived to be very similar to the corresponding motions reconstructed using a full set of twenty markers. We demonstrate how this reduced set enables us to simultaneously capture the finger and full-body motions of two actors performing a range of relatively unconstrained actions.

Categories and Subject Descriptors (according to ACM CCS): I.3.7 [Computer Graphics]: Three Dimensional Graphics and Realism—Animation;

1. Introduction

Because of the complexity of the hand’s anatomy and the consequential difficulties in capturing all its subtle movements, finger motions are often either omitted, manually created by animators, or captured during separate sessions and later spliced with full body animation [MZF06]. When recorded separately, it requires skilled animators to ensure that the synchrony between the full body and the hand movements is maintained, since it has been proven that humans rely heavily on synchrony to communicate [McN05].

In this poster, we reprise our paper presenting a set of perceptual experiments investigating the perceived fidelity of hand motions [HRMO12]. We examine a variety of different action types, ranging from pointing and grasping to conversational gestures. Our aim is to find the optimal trade-off between perceived fidelity and the number of markers needed to capture finger motion. We found that finger motions reconstructed with inverse kinematics [RG91] from a reduced marker set of eight markers per hand (Figure 3.c) are perceived to be very similar to the corresponding motions reconstructed using a full set of twenty markers. We also demonstrated that we can use this marker configuration to simultaneously capture the full-body and finger motion of two actors performing a range of relatively unconstrained actions across our full capture space (Figure 1).

2. Experiments

We recorded a large range of high quality finger movements (20 6mm markers per hand) with simultaneous full-body motion (51 14mm markers), with different properties of finger coordination and velocity (Figure 2). We then generated new finger animations using different subsets of the captured finger markers, with inverse kinematics to approximate the missing motions. Participants in our studies were asked...
to compare these animations to a Gold Standard (generated with the full marker set).

**Experiment 1.** To evaluate the perceived fidelity of finger animations constructed from a variety of marker sets, we generated animations using the marker sets of Figure 3, top row. Forward Kinematics (FK) was used to recompute the motion of the fingers and thumb from 4 markers, while inverse kinematics (IK) was used whenever only 2 markers were driving a finger/thumb. The animation of non-captured fingers was reconstructed using linear interpolation.

**Experiment 2.** From the first experiment we found that 12 markers per hand produced natural animations (Figure 3.b), but this configuration is still difficult to capture in practice in a large space where too many large markers would be needed. Therefore, we designed additional marker sets (Figure 3, bottom row) simplifying the capture of the metacarpal bones. We were also interested in evaluating the effect of computing the thumb configuration using IK (2 markers) vs. FK (4 markers). This experiment was performed on the subset of the motions from Figure 2 for which the perceptual difference between capturing four (Figure 3.b) or two (Figure 3.c) fingers was the highest.

**Figure 3:** Sets of markers used in these experiments (Top: first experiment; Bottom: second experiment). $x$F-$y$T stands for $x$ markers for the animation of the four Fingers and $y$ markers for the Thumb.

### 3. Results

The results showed that people are not highly sensitive to all the subtle details of finger animation. We found that using IK to compute the motion of the four fingers was considered to be perceptually similar to the FK animations, even when removing the two markers at the base of the medium and ring fingers. Also, capturing only the index and pinky fingers leads to perceptually correct animations when the displayed motions do not exhibit independence of motion between fingers. We also found that the simplification of the thumb model (IK vs. FK) did not significantly change the perception of the finger motions.

Therefore, the following guidelines for finger motion capture can be drawn from our results:

- For the majority of cases, a simple 8 marker hand model (6 for the fingers, 2 for the thumb) should produce sufficiently high quality motions. This solution is particularly useful when simultaneously capturing full-body and finger movements in large capture areas, due to the fact that it allows the use of a smaller number of large markers.
- For motions where finger curvature is very important, IK may flatten the fingers too much. In this case, we recommend using FK with a full set of markers in a small capture area.
- When independence between fingers is not important and processing time is limited, capturing only the thumb, index and pinky fingers (2 markers each) should produce reasonable results.

### Acknowledgments

This work was previously published in the Proceedings of the ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games 2012 [HRMO12]. It was sponsored by Science Foundation Ireland as part of the Captavatar, Natural-Movers and Metropolis projects.

### References


