

# Electronic Supplementary Materials 1 – Description of acquisition and processing of hand kinematics data

This document is an electronic supplementary material (ESM1) for the article entitled “*Influence of force-length relationship and task-specific constraints on finger force-generating capacities*”

## Article information

### **INFLUENCE OF FORCE-LENGTH RELATIONSHIP AND TASK-SPECIFIC CONSTRAINTS ON FINGER FORCE-GENERATING CAPACITIES**

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## Marker placement

A motion capture system (Qualysis, Göteborg, Sweden; 100 Hz) composed of six cameras was used to track 13 markers with an 8-mm radius placed on anatomical landmarks of the hand and wrist (Figure s1 and Table s1.1). The radius was tracked by three markers placed on the dorsal aspect of the distal forearm. The 2<sup>nd</sup> and 3<sup>rd</sup> metacarpals were tracked by four markers placed on the dorsal aspects of hand. Phalanges were tracked by six markers, including three markers mounted on a dorsally shifted support.

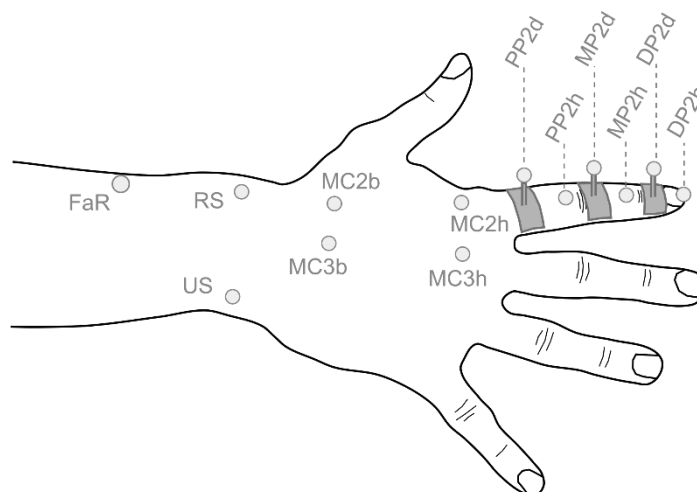


Figure s1 – Illustrations of the marker placement. See Table s1.1 for exact placement

Table s1.1 – Name and locations of the markers.

Name	Location
Forearm	
US	Most caudal-medial point on ulnar styloid
RS	Most caudal-lateral point on radial styloid
FaR	5 cm in the proximal direction from RS along the radius
3 <sup>rd</sup> metacarpal	
MC3h	Most dorsal point of the 3 <sup>rd</sup> metacarpal head
MC3b	3 cm in the proximal direction from MC3h along the 3 <sup>rd</sup> metacarpal
Index finger	
MC2h	Most dorsal point of the 2 <sup>nd</sup> metacarpal head
MC2b	3 cm in the proximal direction from MC2h along the 2 <sup>nd</sup> metacarpal
PP2h	Most dorsal point of the proximal phalanx head
PP2d	3 cm in the dorsal direction from the axis defined by MC2h and PP2h
MP2h	Most dorsal point of the proximal phalanx head
MP2d	3 cm in the dorsal direction from the axis defined by PP2h and MP2h
DP2h	Most distal point of the distal phalanx head
DP2d	3 cm in the dorsal direction from the axis defined by PP2h and MP2h

### Joint angle computation

The marker coordinates were first filtered (Butterworth low pass zero-phase filter at 10 Hz, order 2) and averaged on the same 500-ms window as the finger force to compute the joint angles of the index finger and wrist were estimated from the markers' 3D coordinates. The wrist and index finger metacarpophalangeal (MCPi) joints were described by two degrees of freedom (DoF) in flexion/extension and radial/ulnar deviation. The index finger distal (DIPi) and proximal (PIPi) joints were described by one DoF in flexion/extension. For each joint, a distal and a proximal segment coordinate system were calculated from the positions of 3 markers (Table s1.2).

Table s1.2 – Equations used to compute axes of segment coordinate systems

	1 <sup>st</sup> axis	2 <sup>nd</sup> axis	3 <sup>rd</sup> axis
Radius	$\vec{x} = \vec{u}_{(RS, FaR)}$	$\vec{y} = \vec{u}_{(US, RS)} \times \vec{x}$	$\vec{z} = \vec{x} \times \vec{y}$
3 <sup>rd</sup> Metacarpal	$\vec{x} = \vec{u}_{(MC3h, MC3b)}$	$\vec{y} = \vec{u}_{(MC3h, MC2h)} \times \vec{x}$	$\vec{z} = \vec{x} \times \vec{y}$
2 <sup>nd</sup> Metacarpal	$\vec{x} = \vec{u}_{(MC2h, MC2b)}$	$\vec{y} = \vec{u}_{(MC3h, MC2h)} \times \vec{x}$	$\vec{z} = \vec{x} \times \vec{y}$
Phalanges	$\vec{x} = \vec{u}_{(Pp, Pd)}$	$\vec{z} = \vec{u}_{(Pd, Py)} \times \vec{x}$	$\vec{y} = \vec{z} \times \vec{x}$

$\vec{u}_{(P1, P2)}$  represents the unit vector associated to the vector going from the P1 to the P2 points. For the phalanges, Pp and Pd refer to the points representing the proximal and distal ends of the segment, respectively, and Py refer to the point positioned upwardly on the supports

First, the longitudinal ( $\vec{x}$ ) axis was computed as the unit vector from the distal to the proximal marker vector. For the radius and metacarpal bones, the second axis was the coronal ( $\vec{y}$ ) one and was orthogonal to the plane defined by  $\vec{x}$  and a vector pointing radially. For the phalanges, the second axis was the sagittal ( $\vec{z}$ ) one and was orthogonal to the plane that includes the  $\vec{x}$  and the dorsally shifted marker. The third axis was the cross product of the two others. Then, joint angles were extracted from the relative orientation (distal to proximal) matrix segment rotation matrix using a Z-Y-X (flexion/abduction/pronation) sequence of Cardan angles. Flexion, and radial deviation angle were considered positive.