Egocentric Normalization of Kinematic Path

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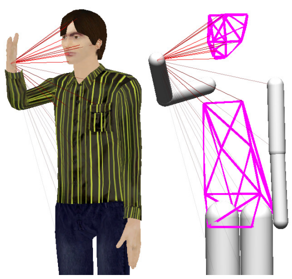
Retargetting for online performance animation on two postures. (a, d) Performed postures (b, e) Results of Kulpa et al. [1]. (c, f) Our results.

Motivation

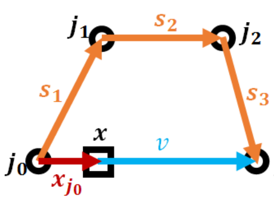
- Mapping postures with self-interaction onto characters with different size and proportion may produce self-collisions and alter the intended semantics.
- We introduce a technique to normalize the spatial relationship vectors between the body parts of the source character.
- This allows for morphological adaptation of these vectors, hence preserving the semantics in postures with/without body-contact.

Spatial relationship vectors



1. Sample the important body parts
2. Build a crude body mesh (magenta)
   * Capsules are used for the limbs
3. Given the body part to express
   a. Find the closest point on each convex primitive
   b. Record the displacement vector(red lines).
4. Assign importance values inversely proportional to the distance (intensity of the red lines)

Kinematic Path Normalization



$\boldsymbol{v}$: Source spatial rel. Vector
j_i: Joints
$\boldsymbol{x}$: Surface point
$\boldsymbol{v}'$: Mapped vector
$\boldsymbol{s}_i$: Segment vectors
$\boldsymbol{x}_{j_0}$: Parent joint position of x

1. Decompose the vector into the kinematic path

$$\mathbf{x}_{j_0} + \mathbf{v} = \sum_{i=1}^{n} \mathbf{s}_i \rightarrow \mathbf{v} = \sum_{i=1}^{n} \mathbf{s}_i - \mathbf{x}_{j_0}$$

2.Measure the contribution of each segment vector

$$\mathbf{s}_{i\rightarrow v} = |\mathbf{s}_i| \cos_i(\alpha), \ where \ \cos_i(\alpha) = \frac{\mathbf{v}}{|\mathbf{v}|} \cdot \frac{\mathbf{s}_i}{|\mathbf{s}_i|}$$

3. The normalization factor

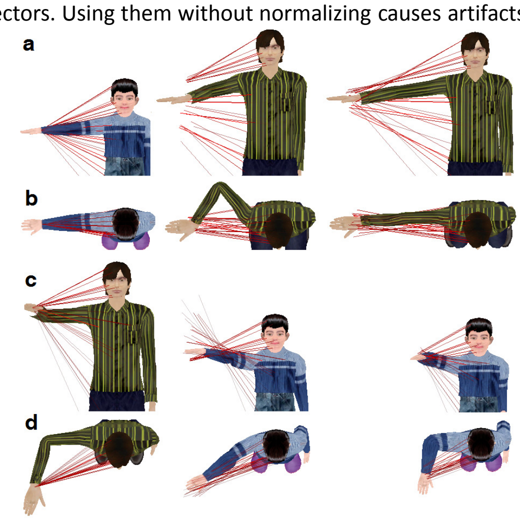
$$\tau = \sum_{i=1}^{n} |\mathbf{s}_i| |\cos_i(\alpha)|, \ such \ that \ \hat{\mathbf{v}} = \frac{\mathbf{v}}{\tau}$$

4. Retarget the spatial relationship vector

$$\mathbf{v}' = \tau' \hat{\mathbf{v}} \text{ where } \tau' = \sum_{i=1}^{n} |\mathbf{s}'_i| c_i \ \text{ and } c_i = |\cos_i(\alpha)|$$

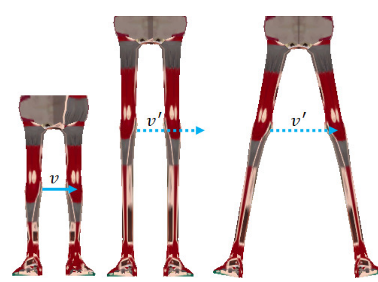
Retargetting spatial relationships

The mapped hand position is obtained as a weighted average of the vectors. Using them without normalizing causes artifacts.



(a, b): Small source character with tall target character
(c, d): Tall source character with small target character
Left: The source pose.
Middle: Results without normalization (Al-Ashqar et al. [2]).
Right: Our results

Why not limb length normalization?



$\boldsymbol{v}$: The captured vector
$\boldsymbol{v}'$: The mapped vector
Left: The source pose.
Middle: The target character with the same pelvis width but longer legs.
Right: Resulting posture.

In the case of a standing posture, for instance, since legs are nearly orthogonal to the relationship vector between knees, the pelvis width determines the projected gap, so normalizing it with the limb's length causes an unnatural pose.

References
[1] Kulpa R., Multon F., Arnaldi B.: Morphology-independent representation of motions for interactive human-like animation. *Computer Graphics Forum (*2005), 343-352.
[2] Al-Asqhar R. A., Komura T., Choi M. G.: Relationship Descriptors for interactive motion adaptation. *In Proceedings of SCA'13*, pp. 45-53.