# Pose-Conditioned Joint Angle Limits for 3D Human Pose Reconstruction

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## 1 The PosePrior Dataset

*Previous priors are either not general enough to represent all human poses or not restrictive enough to avoid invalid 3D poses.*

**Why a new dataset?**

- Joint-angle limits can be used to test the validity of a pose but they are **pose-dependent.**
- The complete configuration of pose-dependent joint-angle limits for the full body is unknown.
- Existing MOCAP datasets are insufficient to learn true joint angle limits.

**Joint-limit dataset**

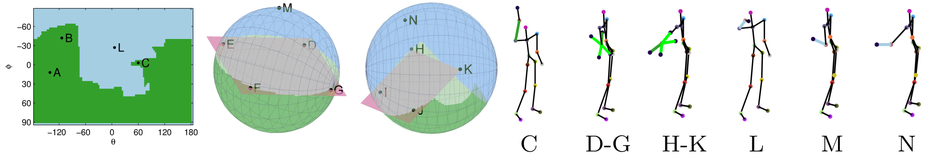
New dataset for learning pose dependent joint angle limits.

Includes an extensive variety of stretching poses.

We use this dataset to learn pose-conditioned joint-angle limits.

Available for research purposes

## 2 Pose-Conditioned Pose Prior



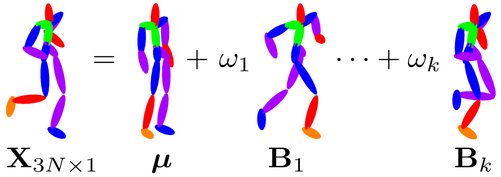

(a) elbow distribution (b) cond-wrist distribution for A & B (c) valid samples (C to K) (d) invalid samples (L-N)

**Pose-dependent joint-angle limit.** (a) Occupancy matrix for right elbow in azimuthal and polar angles: green/sky-blue areas represent valid/invalid poses as observed in our capture data. (b) Given the elbow locations at A and B, the wrist can only lie on the green regions of the spheres.

Given a 3D human pose ($N$=17 point skeleton), verify if each bone is valid or not?

$$isvalid(\mathbf{X}) : \mathbb{R}^{3\times N} \rightarrow \{0,1\}^N$$

**A Sparse Representation of 3D Pose**




$$\hat{\mathbf{X}} = \boldsymbol{\mu} + \sum_{i=1}^{K} \omega_i \mathbf{B}_i = \boldsymbol{\mu} + \mathbf{B}^*\boldsymbol{\omega},$$

$$\{\mathbf{B}_i\}_{i\in\mathcal{I}_{B^*}} \in \mathbf{B}^* \subset \mathcal{B},$$

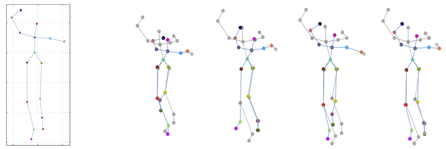
($\mathcal{B}$ is an over-complete dictionary of bases)


$$\min_{\boldsymbol{\omega}} \|\mathbf{X} - (\mathbf{B}^*\boldsymbol{\omega} + \boldsymbol{\mu})\|_2^2 + C_{\text{prior}}$$

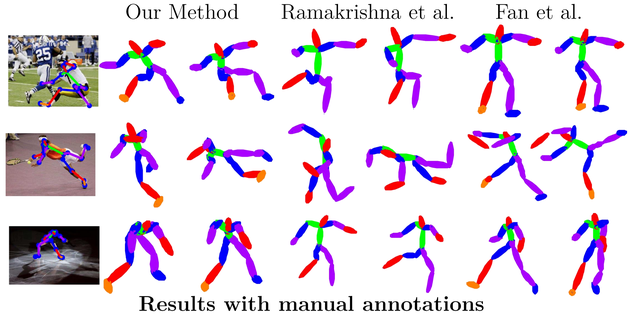
$$C_{prior} = \begin{cases} 0 & \text{if} isvalid(\mathbf{X}) \\ \infty & \text{else} \end{cases}$$

## 3 2D to 3D Pose Estimation

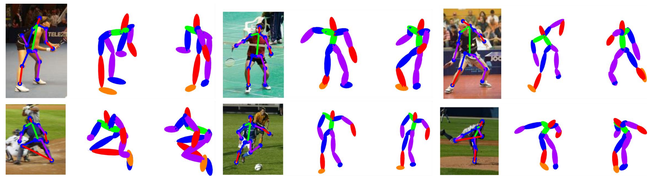
We use our pose prior and the sparse representation to compute 3D pose from 2D points.




**Ambiguities in 3D pose estimation from 2D**




**Results with manual annotations**



**Results with a part-based detector**

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The model, the source code, and mocap dataset are available at http://poseprior.is.tue.mpg.de/