HULC: 3D HUman Motion Capture with Pose Manifold Sampling and Dense Contact Guidance

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Overview
We propose a new approach for 3D human MoCap which is aware of the scene geometry.

• simultaneously estimate global 3D human pose and body scale guided by estimated contacts
• The first method that regresses the dense body and environment contact labels
• A novel pose manifold sampling yielding better results by imposing hard constraints on incorrect body-environment interactions
• Large-scale body contact annotations on the GTA-IM dataset

Why sampling-based optimization?

• Environment collisions appear due to the convergence at a bad local minima even with collision penalty loss term in the gradient-based optimization

Our novel pose sampling optimization handles the collisions in a hard manner

Method overview

Stage(a)

Dense contact estimation loss
\[ L_{labels} = \| c_{en} - c_{en}^{opt} \|^2 + \lambda \text{BCE}(c_{bo}, c_{bo}^{opt}) \]

Implicit function-based environment contact estimation
\[ c_{en} = \Omega_{en}(f_{2}, f_{3}) \]

Stage(b)

Contact-based optimization

\[ \mathcal{L}_\text{opt}(\tau, h) = \lambda_2\mathcal{L}_\text{2D} + \lambda_\text{smooth}c_{\text{smooth}} + \lambda_\text{con}c_{\text{con}} \]

Reprojection loss

\[ \mathcal{L}_\text{reproj}(\theta, \Phi) = \lambda_\text{data}L_{\text{data}} + \lambda_\text{sl}L_{\text{sl}} + \lambda_\text{sl}L_{\text{sl}} \]

Data term (e.g., 2D reprojection)

Contact sliding loss

3D error comparison on PROX dataset

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