

Hand Puppets: 3D Hand Pose Prediction from Shadow Puppet Images

Authors: Abhishek Tandon, Gaini Kussainova, Rakshith Srinivasa Murthy, Rutika Moharir | Team Number: 25

16825: Course Project

Problem Statement:

Given a single image of interacting hands' shadow, predict the corresponding 3D hand pose.

Hand Pose Prediction Model:

ϕ = Orientation of wrist joint θ = Joint pose parameters τ = Translation parameters
 J_{3D} = Predicted 3D MANO joints S = Predicted shadow image S_i = Input shadow image

Pose Prediction Constraints:

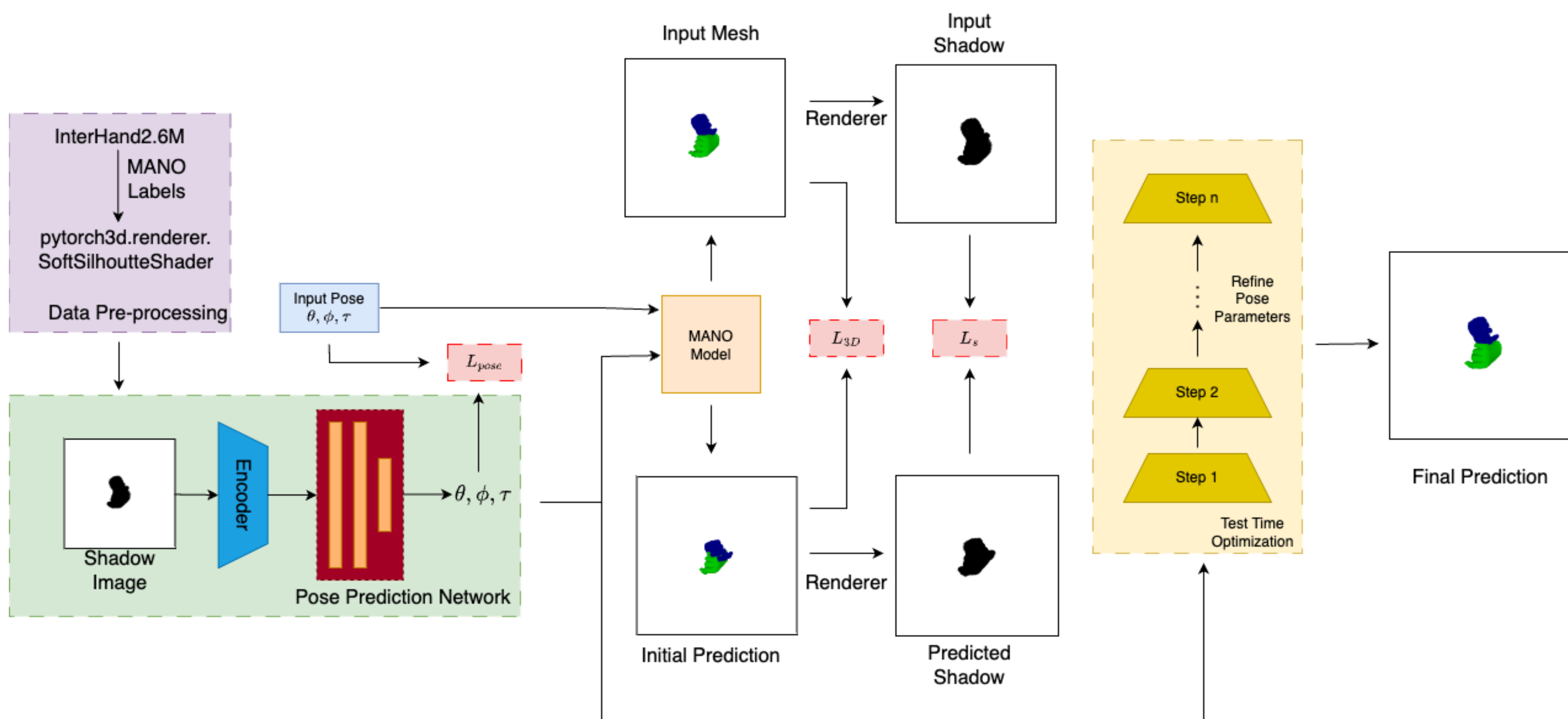
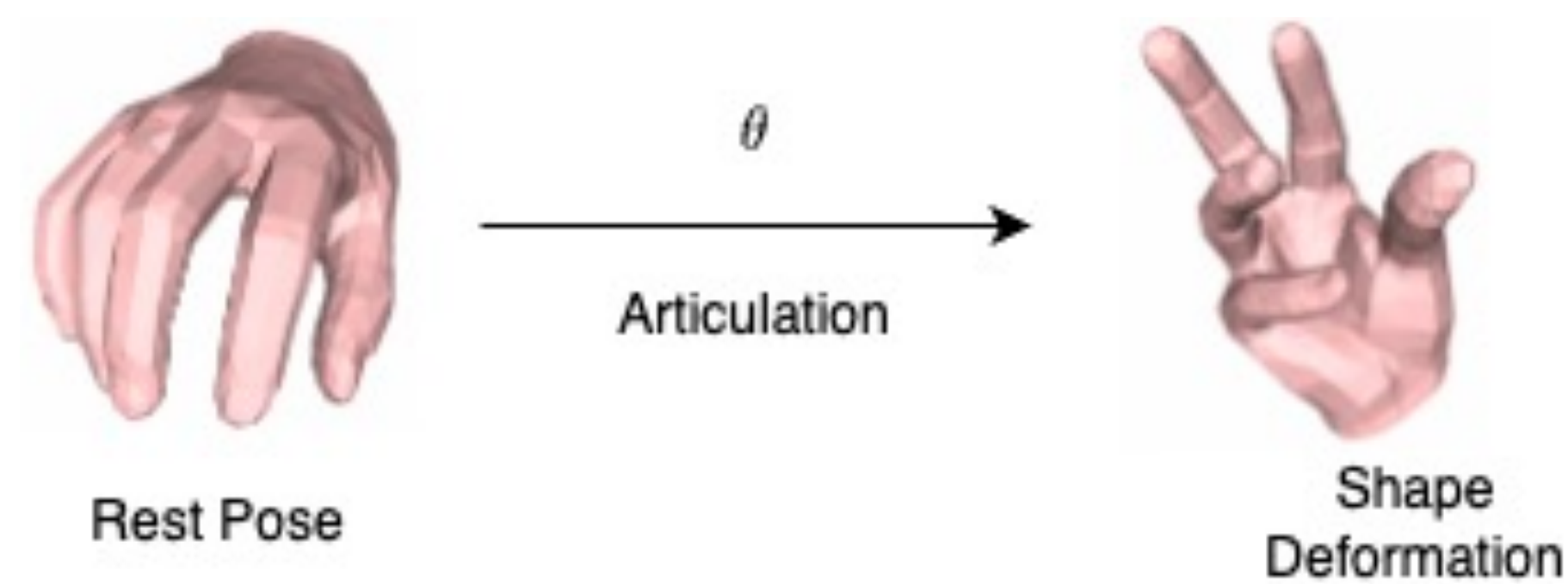
1. Pose parameter Loss:

$$L_{pose} = ||\tau - \hat{\tau}||_2^2 + ||\phi - \hat{\phi}||_2^2 + ||\theta - \hat{\theta}||_2^2$$

2. Joint 3D Loss: $L_{3D} = ||J_{3D} - \widehat{J}_{3D}||_2^2$

3. Rendering Loss: $L_s = ||S - S_i||_1$

MANO Model: Infers pose parameters using known vertex correspondences.



Possible Improvements :

- Collision Loss: A penetration loss can be used at test time optimization to reduce the collisions observed between the two interacting hands.
- Regress MANO Shape Parameter: Model network to predict β to capture variations in hands.
- Pose for shadow images in the wild: Predict camera pose with prediction of MANO params.

Results:

Input Shadow Image	Predicted Pose	Shadow of Predicted Pose

Failure Cases:
