Supplement to Intersection-Free Garment Retargeting

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1 IMPLEMENTATION DETAILS

The main part of our pipeline is two nonlinear optimizations: The first one inflates the avatar geometry back to its original shape while maintaining the intersection-free state between the garment and avatar; the second one fits the garment to the avatar that is fixed in place.

1.1 Step 2. Avatar Inflation

In this step, we solve the optimization problem using the Augmented Lagrangian (AL) method described in [Li et al. 2020]. Function AvatarInflation (Algorithm 1) takes the original garment vertices as input, and starts from $t = 0$, corresponding to the shrunk avatar. At each iteration, it performs a Newton solve on t and V^g with the AL weights λ_1, λ_2 fixed, and updates the AL weights after each Newton solve based on the current t. After each iteration, we check if snapping t to 1 causes any penetration between the avatar and garment meshes in IsValidSnapping, and finish the AL loop when the snapping is valid.

In each Newton solve (Algorithm 2), the degrees of freedom are $t \in [0, 1]$ and the garment vertices V^g, we denote $x = [t,\ V^g]$ as the concatenation for simplicity. Following [Teran et al. 2005], the function PSDProject projects the per-element Hessian matrix to semi-positive definite before the assembly. Function StepSizeUpperBound performs the Continuous Collision Detection (CCD) and returns the largest possible step size $\alpha \in (0, 1]$ such that there is no penetration in between x and $x + \alpha p$.

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Algorithm 1 Avatar Inflation

procedure AvatarInflation(V^g)
  $t \leftarrow 0$
  $V^g_{\text{init}} \leftarrow V^g$
  $\lambda_1 \leftarrow 1$
  $\lambda_2 \leftarrow 0$
  do
    $[t,\ V^g] \leftarrow \text{ProjectedNewton}([t,\ V^g])$
    $\eta \leftarrow 1 - \sqrt{|1 - t|}$
    if $\eta < 0$ **then**
      $V^g \leftarrow V^g_{\text{init}}$
      $t \leftarrow 0$
      $\lambda_1 \leftarrow 2\lambda_1$
    end if
    if $\eta < 0.99$ and $\lambda_1 < 10^6$ **then**
      $\lambda_1 \leftarrow 2\lambda_1$
    else
      $\lambda_2 \leftarrow \lambda_2 + \lambda_1(1 - t)$
    end if
  while IsValidSnapping($t,\ V^g$) == False
  return V^g
end procedure

Algorithm 2 Projected Newton

procedure ProjectedNewton(x)
  do
    $x_{\text{prev}} \leftarrow x$
    $E_{\text{prev}} \leftarrow \mathcal{L}(x)$
    $H \leftarrow \text{PSDProject}(\nabla^2 \mathcal{L}(x))$
    $p \leftarrow -H^{-1} \nabla \mathcal{L}(x)$
    $\alpha \leftarrow \text{StepSizeUpperBound}(x,\ p)$
    do
      $x \leftarrow x_{\text{prev}} + \alpha p$
      $\alpha \leftarrow \alpha/2$
    while $\mathcal{L}(x) > E_{\text{prev}}$
  while $\|\nabla \mathcal{L}(x)\| > \epsilon_{\text{tol}}$
  return x
end procedure

1.2 Step 3. Garment Fit

In this step, we fix $t = 1$ in Step 2, and include an extra $\mathcal{L}_{\text{fit}}$ in the total objective. Since t is fixed, the AL is not needed anymore, and the problem reduces to a single solve using ProjectedNewton (Algorithm 2) with the degree of freedom being V^g only.

1.3 Parameters and Weights

For contact handling, the barrier support size is $\hat{d} = 0.002$. The weights of each objective are $w_{\text{contact}} = 10^8$, $w_{\text{fit}} = 2$, and $w_{\text{pos}} = 10$.

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