Single view 3D face reconstruction
Facial expression reconstruction and modification
Using only Internet photos (no 3d priors)

Internet-based Morphable Model

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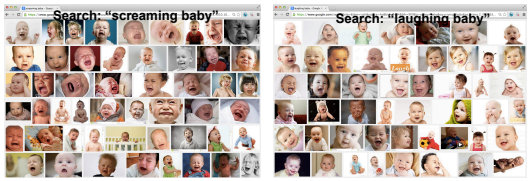
Internet face photos



Each set of photos is called a cluster

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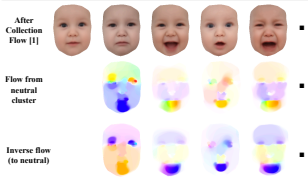
Within cluster dense correspondence

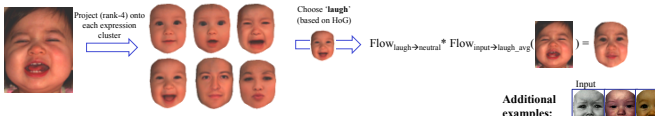
Averages over ~300 photos of different people per cluster. Flow aligned photos computed using collection flow [1]. Note how sharp the flow-aligned averages are.

Across cluster dense correspondence



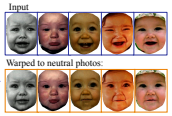
Examples of "warped to neutral" averages:

Given a new input image…



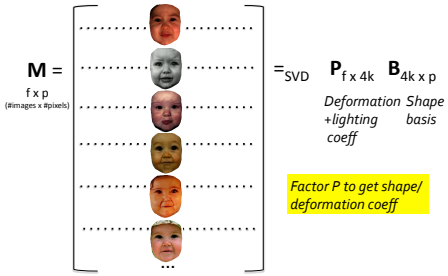
...

Additional examples:



References:
[1] Kemelmacher and Seitz, "Collection Flow", CVPR12

Single View 3D Reconstruction Algorithm



Factor P to get shape/ deformation coeff

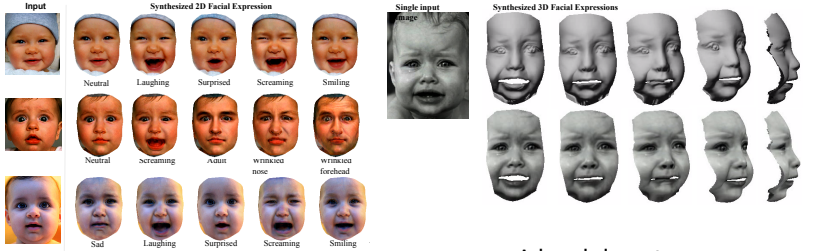
$$M(i,:) = P(i,:)_{1\times 4k} B_{4k\times p} = L_{1\times 4} \sum_{j=1}^{k} \alpha_j B_j$$

Unwarp neutralized shape to original expression

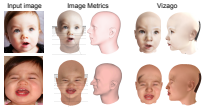
Data: M is $f \times p$ matrix of images;
$M = UDV'$;
denote $P = U\sqrt{D}$ and $B = \sqrt{D}V^T$;
Result: P and B for which the rank-1 condition holds
while *until convergence* **do**
  for *every image* i **do**
    $P(i,:)$ is $1 \times 4K$;
    reshape $P(i,:)$ to $4 \times K$ matrix P';
    run SVD on $P' = udv^T$;
    set $\alpha = u(:,1)d(1,1)$;
    set $l = v(:,1)$;
    reshape αl^T to $1 \times 4K$ vector;
    $P(i,:) = [\alpha l^T]_{1\times 4K}$;
  end
  Estimate B s.t. $\min ||M - PB||^2$;
end
Algorithm 1: Modify P and B to hold rank-1 condition

handles ambiguity

Changing expression in shape, texture, and pose



Compare to classical morphable model



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