Towards Generic Fitting Using Multiple Features 
Discriminative Active Appearance Models

Pedro Martins ● Jorge Batista
Institute of Systems and Robotics
Department of Electrical and Computer Engineering, University of Coimbra, Portugal

Abstract

- Solution for discriminative based Active Appearance Models (AAM).
- The model consists in a set of descriptors which are covariances of multiple features evaluated over the neighborhood of landmarks whose locations are governed by a Point Distribution Model (PDM). The covariances are a special set of tensors that lie in a Riemannian Manifold. Is possible to measure the dissimilarity and to update them, imposing temporal appearance consistency.
- The fitting method uses a combination of exhaustive local search, finding modes with mean-shift and clustering for each landmark independently. The global optimization then constrains each landmark location update by the PDM.

Discriminative Active Appearance Models

The covariance computation is not invariant to scale and rotation effects.

Image Normalization

- Minimizing the covariance dissimilarity between the model and the covariance computed at a shifted location — constrained to be consistent with the PDM — for all the v patches

Goal

\[
\arg \max \sum p \mathbf{c}_i (w(x,y,p,q), C_i(v_i))
\]

- Find local optimal displacements \( \Delta v \) = \arg \max \{c_i(x_i + \Delta x, \Delta y, v_i)\}
- Construct local updates to be in the subspace spanned by the PDM

Weighted LS Solution

\[
\Delta p = (\Phi \Phi')^{-1} \Phi \Delta y
\]

Similarly Warp

Impose Temporal Appearance Consistency By Updating Model Covariances Across Time

Evaluation on the Talking Face Sequence

Algorithm:

- Start with an estimate for the position of the face [AdaBoost]
  - For each landmark \( k \)
    - Generate a PDM instance \( PDM(x_c, \theta_c) \)
    - Warp image into the base mesh
    - Jacobsins of the Warp \( \nabla \Phi = (\hat{\Phi}^T \hat{\Phi})^{-1} \Phi \Delta y \)
    - Response maps by exhaustive local search
    - Use mean-shift to find models (local minima)
    - Unsupervised search for the clusters
    - Select the best cluster \( k \)
    - Assign landmark matching weight \( w_k \)
    - Find weighted warp update \( \hat{\Delta} \)
    - Update shape and pose parameters

This work was supported by the Portuguese Science Foundation (FCT) by the project “Dinâmica Facial 4D para Reconhecimento de Identidades” with grant PTDC/EIA-CCD/108791/2008. Pedro Martins also acknowledges the FCT for support through the grant SFRH/BD/47178/2008.