Active Pictorial Structures

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Active Pictorial Structures

APS consist of three GMRF-based models:
1) Shape model: SVD on the inverse of the precision matrix $Q^*$ based on an undirected graph $G^* = (V^*, E^*)$.
2) Part-based Appearance model: Mean $\mu$ and precision matrix $Q^*$ based on an undirected graph $G^* = (V^*, E^*)$;
   an appearance vector (concatenation of features from patches)
3) Deformation prior: Precision matrix $Q^*$ based on a directed graph $G^* = (V^*, E^*)$.

Cost function consists of two Mahalanobis distances:
\[
\begin{align*}
\arg\min_p \| A(s, p) - \mu \|_Q^2 + \| B(s, p) - \mu \|_Q^2,
&= \arg\min_p \left[ A(s, p) - \mu \right]^T Q^{-1} \left[ A(s, p) - \mu \right] + \left[ B(s, p) - \mu \right]^T Q^{-1} \left[ B(s, p) - \mu \right]
\end{align*}
\]

The $\Delta$ of the $p \rightarrow - \Delta p$ update at each iteration is a matrix multiplication (Hessian and Jacobian are fixed):
\[
\Delta p = -H^{-1}(p) \nabla A(s, p) = -H^{-1}(p) \nabla Q^{-1/2} A(s, p) \nabla Q^{-1/2}
\]

Pictorial Structures

PS learn a patch cost for the appearance of each part of an object and model the appearance using spring-like connections between landmarks based on a tree structure.
\[
\begin{align*}
\arg\min_{\xi} \left[ \sum \xi_i + \sum \xi_i \phi_i \right] s.t. \sum \xi_i = 0, \quad \xi_i \in \{0, 1\} \end{align*}
\]

Advantages/Disadvantages of APS

- The sums of the PS cost function become matrix multiplications at the APS cost function.
- The deformation prior makes APS very robust to bad initializations.
- Weighted IC with fixed Jacobian and Hessian is close to real-time.
- The complexity is independent of the selected graph structure.
- Many existing models can be derived from APS by changing the structure of $Q^*$. 
- $Q^*$ is very large and requires a lot of memory.

Experiments

SIFT, Training: LFPW/train, Testing: LFPW testset = AFW, Initialization with DPM basis.
- Comparison with other inverse compositional with fixed Jacobian and Hessian (TORC)
- Comparison with state-of-the-art:
- ON-DPM 0. Durand and M. Pantic, "Image Sequence Deformable part model for face alignment in the wild", CVPR, 2016.


Acknowledgments

Mesopotamia Project

http://www.mesopotamia.org