Face Detection under Variable Lighting
Based on Nine Point of Light

Yuemin Li  Jie Chen  Laiyun Qing  Wen Gao  Baocai Yin

Presented by Jie Chen
Outline

• Face detection survey
• Existing problem of the system
• Our solution
• Experiments
• Conclusion
Face detection survey

- Face detection:
  - any faces??
  - the location and extent??
Face detection survey

- Data-driven learning-based techniques.
- Boosting:
  - AdaBoost,
  - FloatBoost,
  - KLBoost,
  - RealBoost,
AdaBoost

P. Viola and M. Jones “Rapid object detection using a boosted cascade of simple features” CVPR 2001
Existing problem of the system

- Different environment illumination
Our solution

• Nine Points of Light
  – a convex Lambertian object
  – under all lighting conditions
  – approximated by nine “harmonic images”,
  – formed by the first nine spherical harmonics.
First nine spherical harmonics

\[ Y_{l m}(\theta, \varphi) \]
Linear subspace $R$

- $C$ : illumination cone.
- $H$ : linear subspace generated by the harmonic images
- $R$ : 9-dimensional linear subspace.
The nine points of light

- 200 samples on the hemisphere;
- These directions are \{(0, 0), (68, 90), (74, 108), (80, 52), (85, 42), (85, 137), (85, 146), (85, 4), (51, 67)\}
The schematic of the universal configuration of nine light source directions with all 200 sample
Experiments

• Face-Samples Preprocessing by 9PL:
  – a **training** set of 6,977 images (2,429 faces and 4,548 non-faces)
  – a **test** set of 24,045 images (472 faces and 23,573 non-faces).
  • available on the CBCL webpage.
Experiments

- The nine images should be real;
- Lack of samples, opt for rendering;
- Construct a linear subspace for each of the 2,429 faces.
Some generated face samples
The ROC curves on the test set
Evaluation of the generated samples

- The face images consist of 6,000 faces (collected from Web).
- preprocess, get 12,000 face images.
- The second group is doubled the number of the latter training set by a linear subspace of the nine directions.
The ROC curves on the MIT+CMU frontal face test set.
Discussion

\[ PE(C) = PE(C^*) + Bias(C) + Var(C) \]

- **\( PE(C) \)**: The error rates
- **\( PE(C^*) \)**: limited learning ability of the classifier
- **\( Bias(C) \)**: the noised training set
- **\( Var(C) \)**: the finite training sample
Discussion

• the original training set
  – noise
  – not capture fully the target distribution.

• By the means the error rate of the trained classifier can be decreased.
Thank you very much!