Quality-driven Fusion

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Adaptive Fusion Schemes

- Adaptive super-resolution of video frames in a face recognition system

- Quality and Fusion

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Two types of image quality measures:

- Univariate and Bivariate

Univariate measures:

- these measures assess the quality of the target image without the explicit use of a reference image

Bivariate measures:

- these measures use a reference image in order to assess the quality of the target image
Univariate Measures

- Defocus blur
- Motion blur
- Off-angle
- Occlusion
- Specular reflection
- Lighting
- Pixel Count
Blur Assessment

- Ratio between energy of low resolution wavelet coefficients to energy of high resolution wavelet coefficients

\[ Q = \frac{\sum_{w_{low}} |W_{low}|^2}{\sum_{w_{high}} |W_{high}|^2} \]

- Daubechies wavelets used to compute the energy coefficients at different resolutions

*Krichen et al. A new probabilistic iris quality measure for comprehensive noise detection. BTAS 2007*
Bivariate Measure

- The availability of a reference image is assumed
Examples

- Average Difference
- Structural Content
- Normalized Cross Correlation
- Correlation Quality
- Maximum Difference
- Image Fidelity
- Weighted Distance
- Laplacian Mean Square Error
- Peak Mean Square Error
- Normalized Absolute Error
- Normalized Mean Square Error
- $L_p$ Norm
Fusion in Face Recognition

- Given a low resolution face video identify a set of frames that have:
  - Maximal facial information
  - Are of good quality

- Develop a method that categorizes frames based on
  - Frame quality
  - Pose or scene changes
  - Motion blur

- Simultaneously drop poor quality frames and fuse information content in good quality frames

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Super-resolution (SR) of face images

- Process of generating an image with higher resolution than its source

- Source
  - **Single image**: interpolation of information
  - **Multiple images**: fusion of information
Artifacts in SR

- Artifacts: noisy pixels due to estimation errors

- Caused by large displacements of objects in the scene in a short duration.

LR frames used for fusion

Super-resolved output showing artifacts or motion degradation

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The proposed technique computes an inter-frame motion parameter $\beta$.

This parameter is used to determine if adjacent frames have to be combined or not in order to generate a super-resolved image.
Frames $f_k$ and $f_{k+1}$ with resolution $M \times N$

Optical flow matrices $u_{k,k+1}$ and $v_{k,k+1}$

Flow magnitude matrix

Using the $L2$ norm of the displacements along both axes at each pixel

Mean of top $k$ values of the flow magnitude matrix sorted in descending order represents $\beta$
Adaptive Frame Selection (AFS)

(Resolution 160X120)

(Resolution 319x239)

SR3  SR5  AFS
The performance improvement due to the proposed technique (AFS) is observed to be pronounced in those videos where the inter-frame motion is large.
Quality can be used to facilitate adaptive fusion

Proposed technique - based on Kanade and Baker’s SR method (1999) - is useful in processing face video streams

Computation of optical flow field can be expensive:

- Investigating computationally efficient methods to approximate this field