Digital Perception Lab.

Dept. Electrical and Computer Systems Engineering
Monash University
Research Covers Areas Such as:

- Computational Mathematics
  - Novel Splines and Fast Approximation of Splines (related to Radial Basis Functions, Support Vector Machines)
  - Finite Element, Wavelets, Multi-pole Methods
- Image Processing
  - Restoration of Historical Film
  - Biomedical Image Processing
- Computer Vision/Robotics
  - Optic Flow
  - Motion Segmentation
  - Tracking
  - 3-D structure modelling

A common thread is: Motion/Displacement Estimation from Images

Common techniques are robust statistics, model selection, model fitting....
Current (and New) Projects

- Robust Model Fitting and Model Selection (with Wang, Bab-Hadiashar, Staudte, Kanatani…..)
- Subspace Methods for SFM and Face recognition (with Chen) (soon to be postdoc with PIMCE)
- Biomedical: Microcalcification in breast X-rays (with Lee, Lithgow), Knee cartilage segmentation (with Cheong and Ciccutini)
- Invariant Matching/Background Modelling (with Gobara)
- Historical Film Restoration and Film Special Effects (with Boukir)
- Wavelet denoising (with Chen)
- (new) Geometric aspects of tracking (ARC 2004-6)
  - Postdoc Wang
- Human motion Modelling and Tracking (with U)
- Visualisation (Monash SMURF vizlab)
- (new) Urban Scanning (Monash NRA – soon to be postdoc Schindler)
- (new) 4-D Recorder Room
  (+Tat-jun Chin + Tk – soon to start phd students)
Advance on Previous Restoration Work (with Boukir)

Can’t capture distortion – e.g., rotation

Can try to use 3-D projective geom. – below

Symmetry in (Robust Fitting)

Actually, the assumption that median belongs to “clean” data is false sometimes even when outliers < 50%!


55 inliers – 45 *clustered* outliers
Symmetry in (Robust Fitting)

about 45% clustered outliers
Very Robust Fitting – Mean-shift

about 95% outliers!

H. Wang and D. Suter.

Large Grant 2000-2
Very Robust Fitting
about 95% outliers!
Very Robust Fitting

How does it work?

Essentially – not just dependent upon a single stat (the median or the number of inliers) but on the pdf about the chosen estimate.

Uses Mean Shift and maximizes a measure roughly

\[
\frac{\text{sum of inlier pdf – as defined by mean shift window}}{\text{bias – mean residual - centre of mean shift window}}
\]
USF Noisy Points

WSU Missed Surf.

UB – distorted edges

Large Grant 2000-2
<table>
<thead>
<tr>
<th>Technique</th>
<th>Avg. error (degree)</th>
<th>Std. dev. (degree)</th>
<th>Density (%)</th>
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<tbody>
<tr>
<td>Black (1994)</td>
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**Large Grant 2000-2**
Imputation\Subspace Learning
(Hallucination if you prefer)

P. Chen and D. Suter.
Recovering the missing components in a large noisy low-rank matrix:
Application to SFM.

What you start with:

Low rank, large noisy matrix with "holes"

\[ M = \begin{pmatrix}
\times & 0 & \cdots & \times \\
\times & \times & \cdots & 0 \\
\cdots & \cdots & \cdots & \cdots \\
\times & \times & \cdots & \times \\
\end{pmatrix}_{m \times n} \]

We want to fill in and de-noise
Why?

- Data Mining – on line recommender systems
- DNA
- Etc……
- Structure From Motion
  \[ M = RS \]
  (M- location of features in images
  R – camera motion – S – structure)
- Face Recognition – other learning and classification tasks.
36 frames and 336 feature points – the most reliable by our measure
4983 points over 36 frames

2683 points (those tracked for more than 2 frames)
SUBSPACE-BASED FACE RECOGNITION: OUTLIER DETECTION and A NEW DISTANCE CRITERION FOR MATCHING

P. Chen and D. Suter.
Subspace-based face recognition: outlier detection and a new distance criterion.

Yale B face database
Outlier detection
(Iterative reweighted least square: IRLS)
7D eigenimages
Subsets 1-5
**Comparison of the error classification rate (%) on Yale-B face database**

<table>
<thead>
<tr>
<th>Method</th>
<th>Subset 1-3</th>
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