Data corruption

- Noise e.g., from capturing devices
- Missing data e.g., due to transmission
- Outliers e.g., occlusion, specular reflection

Disadvantage: Incorporation of robustness???

Our proposed method:

- What we gain: easy incorporation of robustness

\[ \arg\min_z \| \phi(z) - P\phi(z) \|_2^2 \]

- Robust measure

Kernel PCA & Pre-image

- Mapping to feature space is implicit, non-reversible.
- Feature mapping is non-reversible. How to find pre-images?

The pre-image problem:

\[ \arg\min_{z} \| \phi(z) \|_2 \text{ s.t. } \phi(z) \in \mathcal{P}S \]

Robustness

Dealing with missing data:

\[ E_0(x, z) = -\exp \left( -\gamma \sum \delta(x_i \text{ not missing}) \right) \]

Dealing with intra-sample outliers:

\[ E_0(x, z) = -\exp \left( -\gamma \sum \delta(x_i \text{ not missing}) \right) \]

Optimization

- Fix point update

KPCA reconstruction revisited

Traditional approach:

\[ \begin{align*}
\text{arg min}_z \| \phi(z) - P\phi(z) \|_2^2
\end{align*} \]

Experiments

RKPCA for intra-sample outliers

<table>
<thead>
<tr>
<th>Occ:Size</th>
<th>Region Type</th>
<th>Base Line</th>
<th>Mika et al.</th>
<th>Kowk &amp; Tsang</th>
<th>Robust PCA</th>
<th>Ours</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Whole facet</td>
<td>10.4±2.1</td>
<td>12.6±2.2</td>
<td>13.3±2.3</td>
<td>16.1±2.3</td>
<td>10.5±2.5</td>
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<tr>
<td>30</td>
<td>Whole facet</td>
<td>14.3±2.4</td>
<td>16.2±2.5</td>
<td>20.3±2.6</td>
<td>16.2±2.3</td>
<td>15.5±2.4</td>
</tr>
</tbody>
</table>

RKPCA for denoising

- Image denoising on Multi-PIE database

- Image denoising on Multi-PIE dataset: a) original image, b) corrupted by Gaussian noise, c) denoised using PCA, d) using Mika et al., e) using Kowk & Tsang method, f) result of our method.

RKPCA for incomplete training data

- Reconstruction errors for 5 different methods and 10 probabilities of missing values for the Oil Flow dataset.
- Our method outperforms others at all levels of missing data.