Detailed 3D Reconstruction from Multiple Views

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The Problem

Multiview Stereo

Problem with textureless surfaces

Photometric Stereo

Requires single viewpoint

Detailed 3D Reconstruction
Approach

Match Image 1 and Image 2

Match Image 1 and Image 3
Approach

- Find affine transformation for each match using
  \[ H = T_2 T_1^{-1} \]
  \[
  T_i = \begin{pmatrix}
  s_i \cos \theta_i & t_i \sin \theta_i & x_i \\
  -s_i \sin \theta_i & t_i \cos \theta_i & y_i \\
  0 & 0 & 1
  \end{pmatrix}
  \]

- From H, estimate pixel wise transformations as
  \[
  \begin{pmatrix}
  x_2 \\
  y_2 \\
  1
  \end{pmatrix} = \left( \sum_i w_i H_i \right)
  \begin{pmatrix}
  x_1 \\
  y_1 \\
  1
  \end{pmatrix}
  \]
Approach

Image 1

Image 2

Image 2 Aligned

Image 3

Image 3 Aligned

Photometric Stereo

+
Evaluation

Ground Truth

Direct Approach (W/O warping)

Proposed Method

Color Map

Depth Map

Normal Field
Evaluation

Input Images

Warped Images
Evaluation

Ground Truth

Direct Approach (W/O warping)

Proposed Method

Color Map

Depth Map

Normal Field
Evaluation

Relative error of color and depth maps as compared to Direct Method

<table>
<thead>
<tr>
<th>Images</th>
<th>Color Map</th>
<th>Depth Map</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box</td>
<td>0.3968</td>
<td>0.2675</td>
</tr>
<tr>
<td>Bunny</td>
<td>0.4916</td>
<td>0.1640</td>
</tr>
</tbody>
</table>
Discussion

• Proposed method works better than direct method

• Sensitive to the quality of alignment

• Alignment issues
  o Lack or wrong feature matches
  o Distance in the image vs. distance on the surface