Automatic Keypoint Detection on 3D Faces Using a Dictionary of Local Shapes

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3DIMPVT, Hangzhou, China, May 2011
Aim

- Keypoints detection (NOT LANDMARKS)
- Similar to any of 14 learnt features
  (Dictionary of local shapes)
Part of a bigger project

Long Term Objective
Gap in Research
How
Results
Conclusion

Landmarking

Positions + Labels

Landmarking
Part of a bigger project

What
Why
Long Term Objective
Gap in Research
How
Results
Conclusion

Keypoint Detection
Labeling

Part of a bigger project

Landmarking
Positions + Labels
Keypoint Detection
Labeling
Most literature:

- 3 points max or single-point-of-failure design
- Weak features often discarded
- Almost no work on combining more than 2 descriptors
- Little literature that examine multiple descriptors over multiple scales
- Most people focused on landmarking, without giving the intermediate results on candidate detection (keypoints)
Workflow

- What
- Why
- How
- Results
- Conclusion

OFFLINE

Train Meshes → Descriptor Maps

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Workflow

OFFLINE

Statistical Distributions

Landmarks

Train
Meshes

Descriptor Maps

What
Why
How
Results
Conclusion
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OFFLINE

Statistical Distributions

Landmarks

Train Meshes

Descriptor Maps

Score Maps

What
Why
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OFFLINE

Statistical Distributions

Descriptor Weights

Landmarks

Train Meshes

Descriptor Maps

Score Maps

LDA

Statistical
Distributions

Descriptor
Weights
Workflow

ONLINE

Dictionary of local shapes

Test Meshes → Descriptor Maps → Score Maps

Statistical Distributions

Descriptor Weights

Dictionary of local shapes

What
Why
How
Results
Conclusion
Workflow

ONLINE

Dictionary of local shapes

Test Meshes → Descriptor Maps → Score Maps → Mixed Maps

Statistical Distributions
Descriptor Weights

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Workflow

- Statistical Distributions
- Descriptor Weights

Dictionary of local shapes

Test Meshes → Descriptor Maps → Score Maps → Mixed Maps → Final Map → Keypoints
Results

- Sparse selection (max 1%)
- Reapeatable (same subject registration)
  - $\sim 75\%$ (at 10 mm)
- Close to human hand-placed landmarks
  - average All: $\sim 85\%$ (at 10 mm)
  - average Nose: $\sim 99\%$ (at 10 mm)
  - average Eyes: $\sim 90\%$ (at 10 mm)
- High proportion of the local shapes retrieved
  - $\sim 11.88/14$ (at 10 mm)
Conclusion

○ Good points:
  ○ Detects "weak" features
  ○ No single-point-of-failure design

○ Limitations:
  ○ Can be time consuming
    article: 7s, now: 0.5s (8 desc.)
  ○ Linear combination of scores

○ Future Work:
  ○ Non linear methods (boosting, kernel methods)
  ○ Structural matching to deduce correspondences
  ○ Comparison with a new clustering technique for keypoint detection
Conclusion

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- Structural matching to deduce correspondences
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Thank You For Listening!

http://www.cs.york.ac.uk/~creusot