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# Towards Stable and Salient Multi-View Representation of 3D Shapes

H. Yamauchi, W. Saleem, S. Yoshizawa,

Z. Karni, A. Belyaev, H.-P. Seidel

*MPI Informatik, Saarbrücken, Germany*

# Introduction

- 3D Shapes

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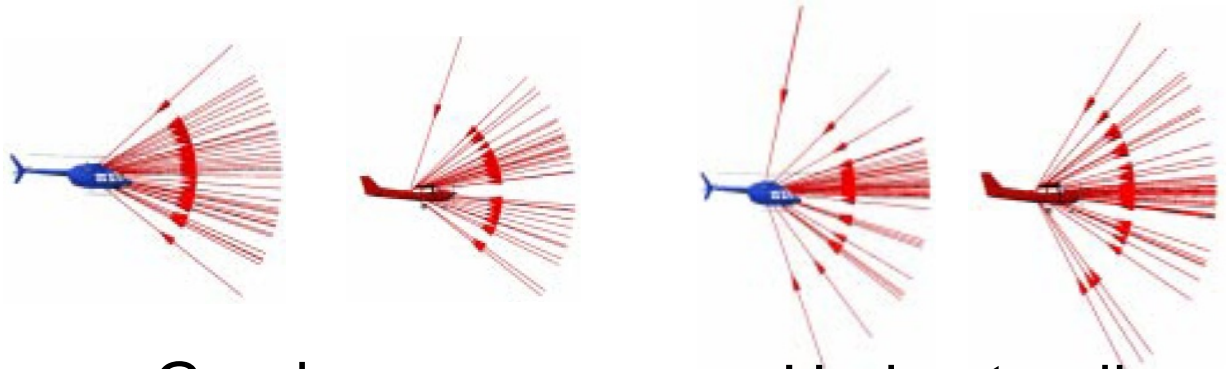
- 3D Shapes are observed by many views

# Introduction (Motivation)

- 3D Shapes are observed by many views
- Which view will be the best?
  - In the sense of shape understanding
  - Application: information filtering for a large 3D shape repository (e.g., automatic 3D thumbnail image generation)

# Related work

- Canonical view (psychology) [Cutzu and Edelman 94][Blanz et.al 99][Denton et.al 04][Hall and Owen 05]



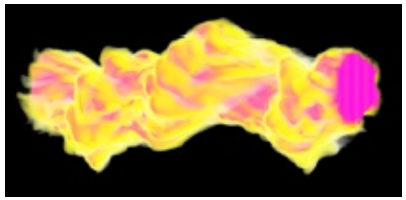
[Blanz et.al 99]

Goodness Understanding

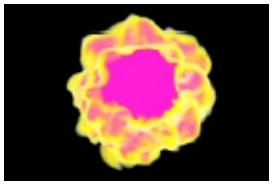
- Human Perception (Hard to classify)
  - [Tarr and Kriegman 91][Shacked and Lischinski 01][Todd 04][Lee et.al 05][Podolak et.al 06]
    - Object visibility, Mesh Saliency, Symmetry ....
- Information retrieval: E.g., [Chen et.al EG06]

# Related work

- Stable view [Seibert and Waxman 92] [Mokhtarian and Abbasi 04]
  - Object recognition: to recognize an object, how many and which views are necessary?
- Entropy based [Gumhold 02] [Vázquez et.al 03] [Bordoroi et.al 05] [Takahashi et.al 05] [Polonsky et.al 05]



Large entropy



Small entropy

Entropy + importance [Bordoroi et.al 05]

Large entropy

Small entropy

Entropy + topological analysis [Takahashi et.al 05]

# Our idea: Filter out and select

- Sample the views on a view sphere
  - e.g., # of samples = 162
- Filter out unnecessary views by classification
  - Similar views don't give us new information
  - Similarity based graph partition to obtain stable view
  - => Stable view
- Select a view/Order views
  - By importance measurement ... View Saliency
  - => Salient view

# Terminology

- View
  - An image defined by a viewpoint and view direction
  - Comparison is possible by an image comparison method

View

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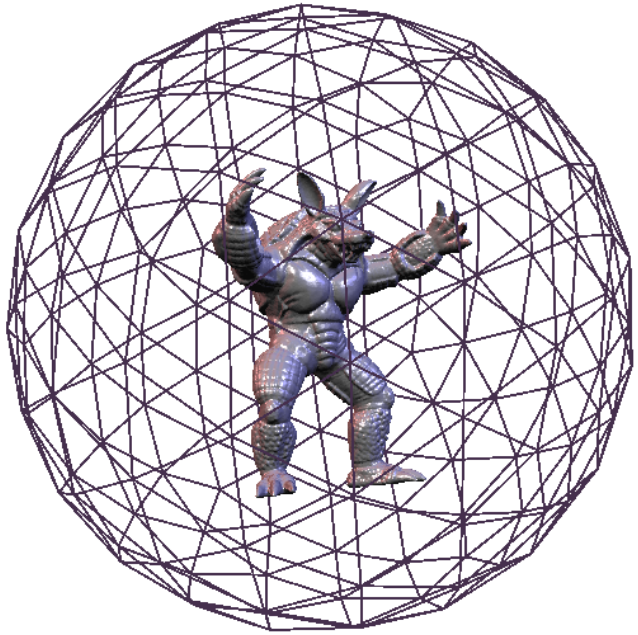
  - Comparison is possible by an image comparison method
- View Sphere
  - Set of view points

View



Object + View Sphere

# Terminology

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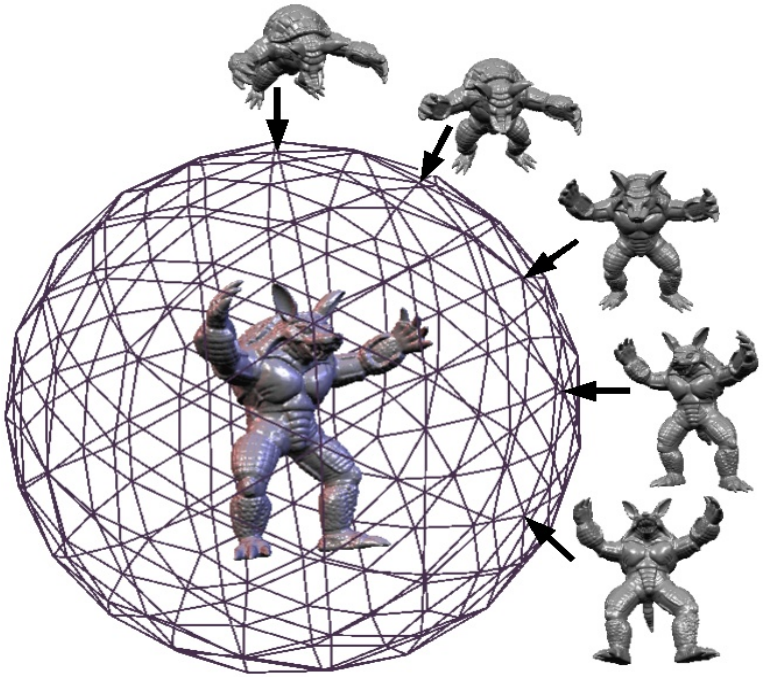
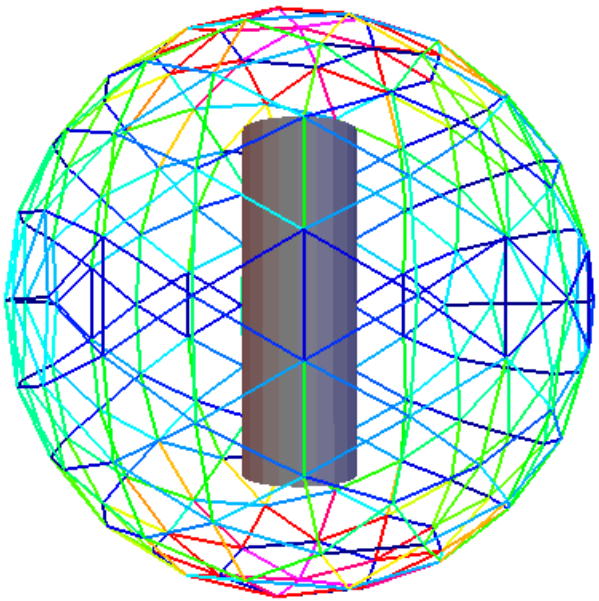
View



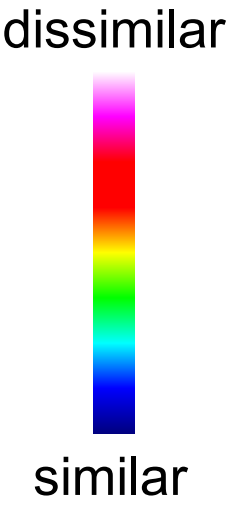
Views: Object + View Sphere

# View similarity

- Difference of two adjacent views
  - Measured by Zernike moments between views
  - Construct similarity weighted spherical graph
  - View: binary image to avoid lighting effect (silhouette)

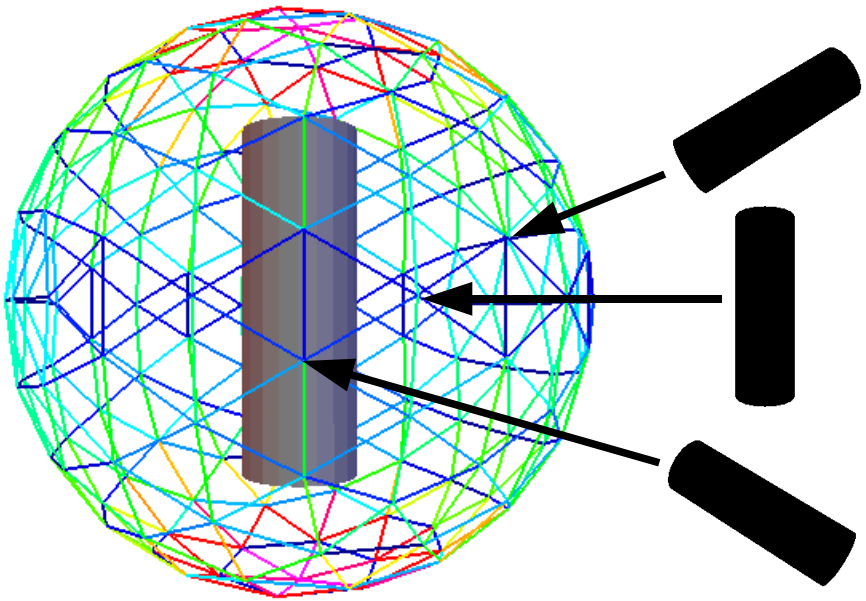


Similarity between two adjacent vertices is assigned to the incident edge



# Similar view example

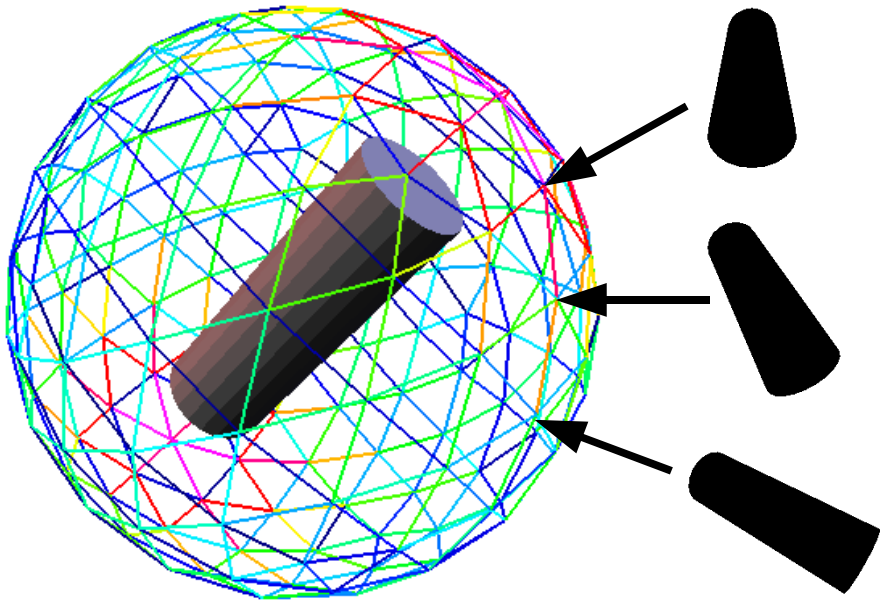
- Blue edge represents the incident views are similar
- Zernike moments are rotational invaliant



These views are similar

# Dissimilar view example

- Red (to white) edge represents the incident views are dissimilar

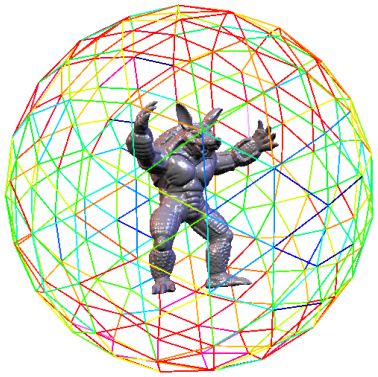


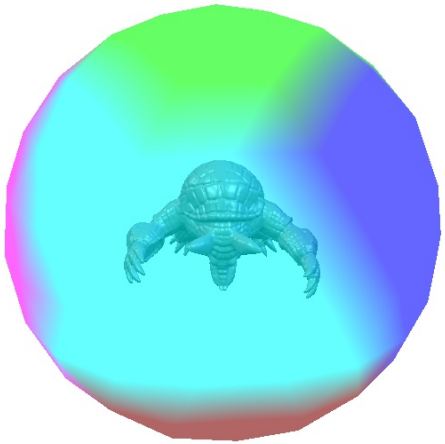
These views are dissimilar

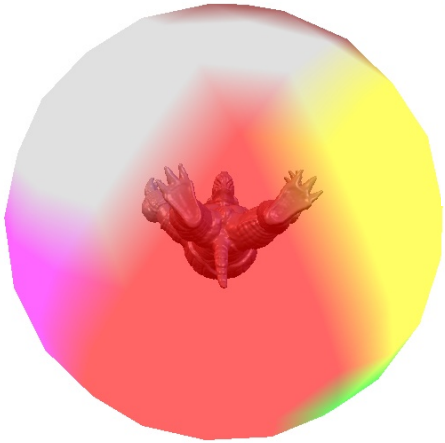
Demo

# Stable view partitioning

- Similarity weighted spherical graph partition
  - Find stable view region by graph partition tool (Metis)
  - Views are similar in each region







8 colors
8 partitions

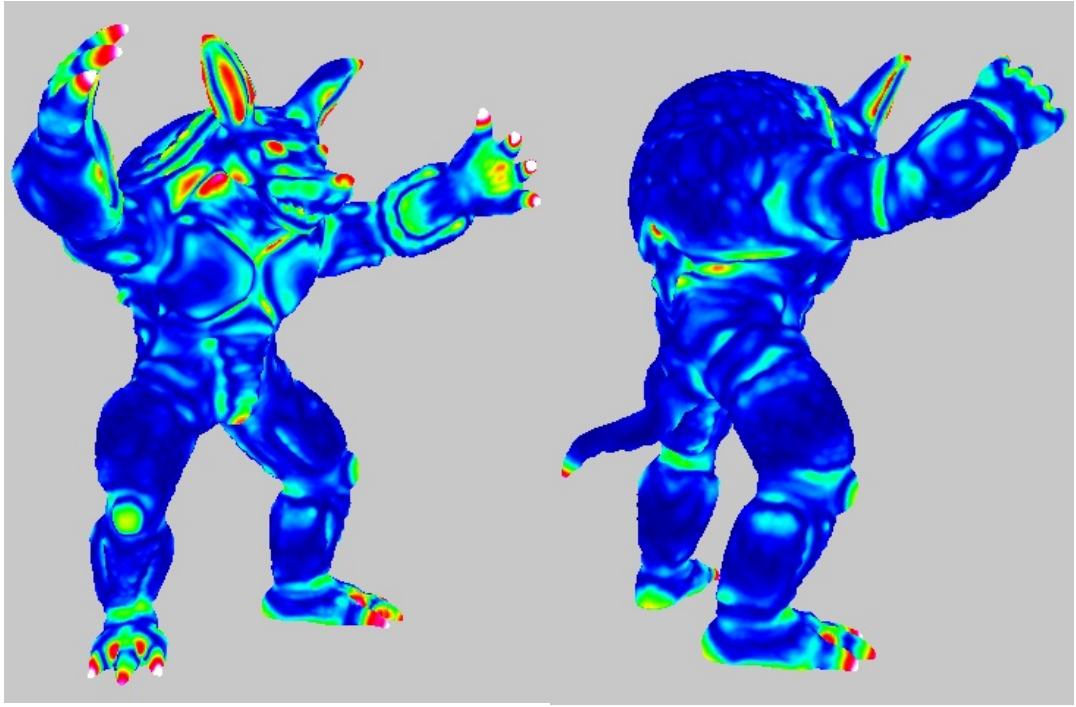
Demo

# Selecting a region (1)

- Which stable view partition should be selected?
  - Inside the region, views are similar
  - However, view stability does not give the importance
    - So which partition is more important?
- Other criterion is necessary to select it
  - View importance?

# Selecting a region (2)

- Mesh Saliency [Lee et.al 2005]
  - Apply Itti's [Itti 1998] visual perception model to mean curvature of an object



Mesh Saliency

High

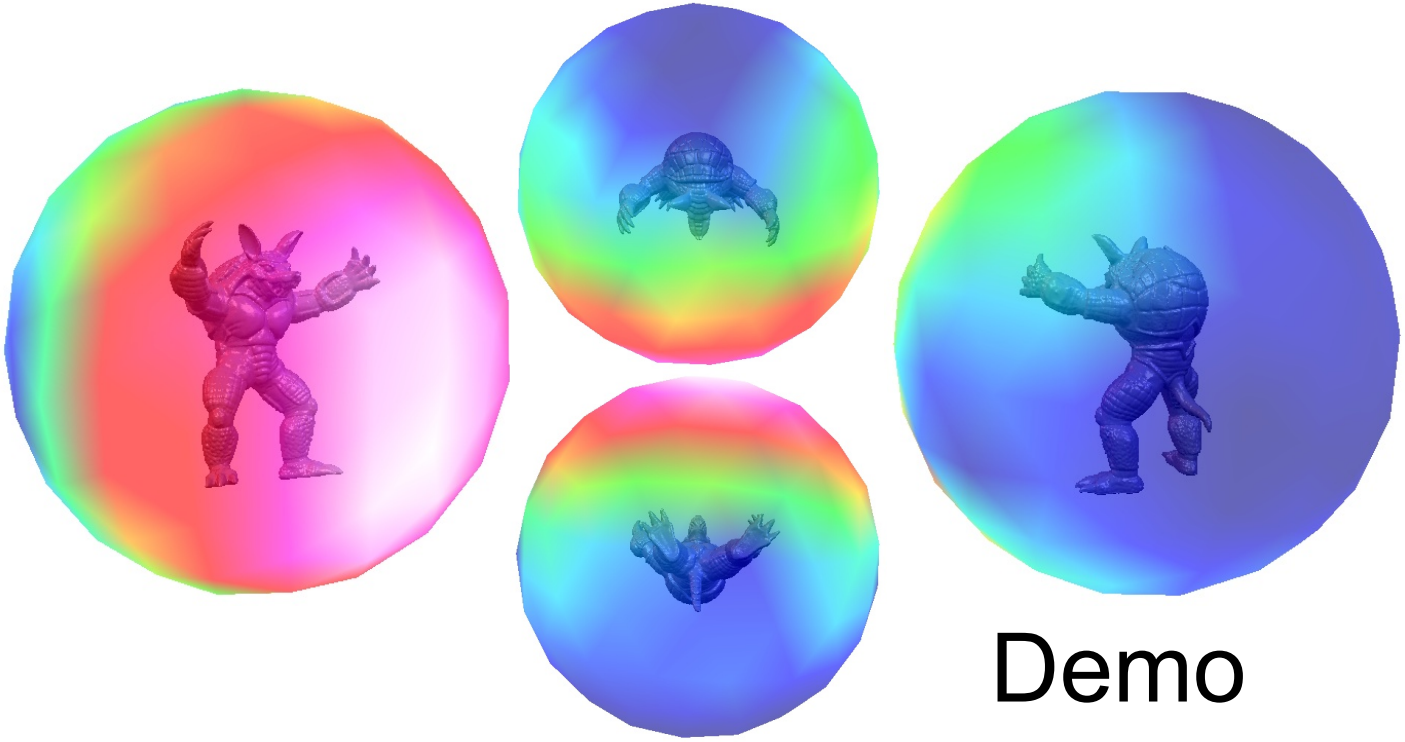
Low

Note: Mesh saliency is defined on vertices

# Salient view

- Generate salient views
  - Use the view sphere and sample views
  - integrate the visible saliency value

Note: View saliency is defined by image and on view sphere vertices



Demo

Color = View Saliency

High

Low

# View selection

- Select stable and high salient partition
  - If we use the high saliency only, we can not select second informative view
  - Unstable view but high saliency view is filtered out
    - Following the recognition criterion
    - (However, unstable view may be an interesting view)
- Choose the salient view weighted centroid of the partition as a viewpoint
  - Viewpoint will be:
    - stays inside the stable region
    - is attracted by more salient view

# Results: Best three views (1)

# Results: Best three views (2)

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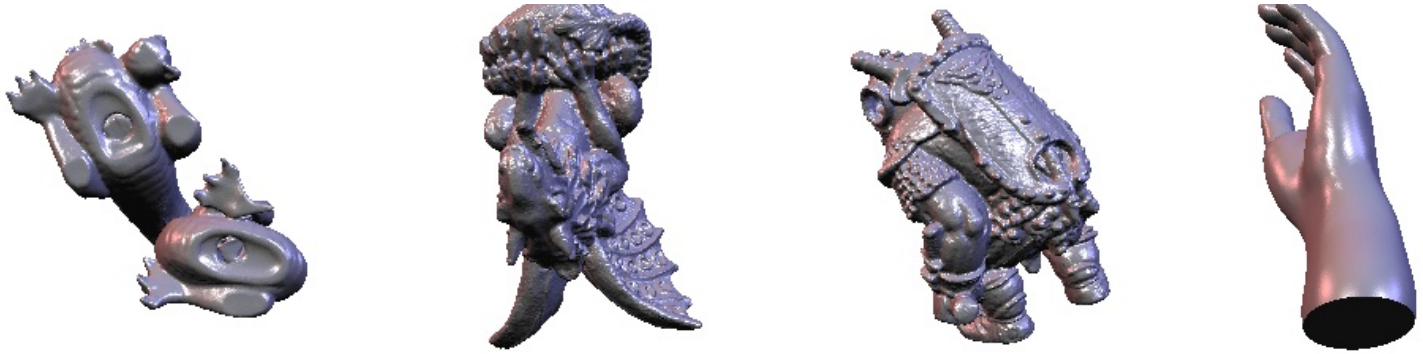
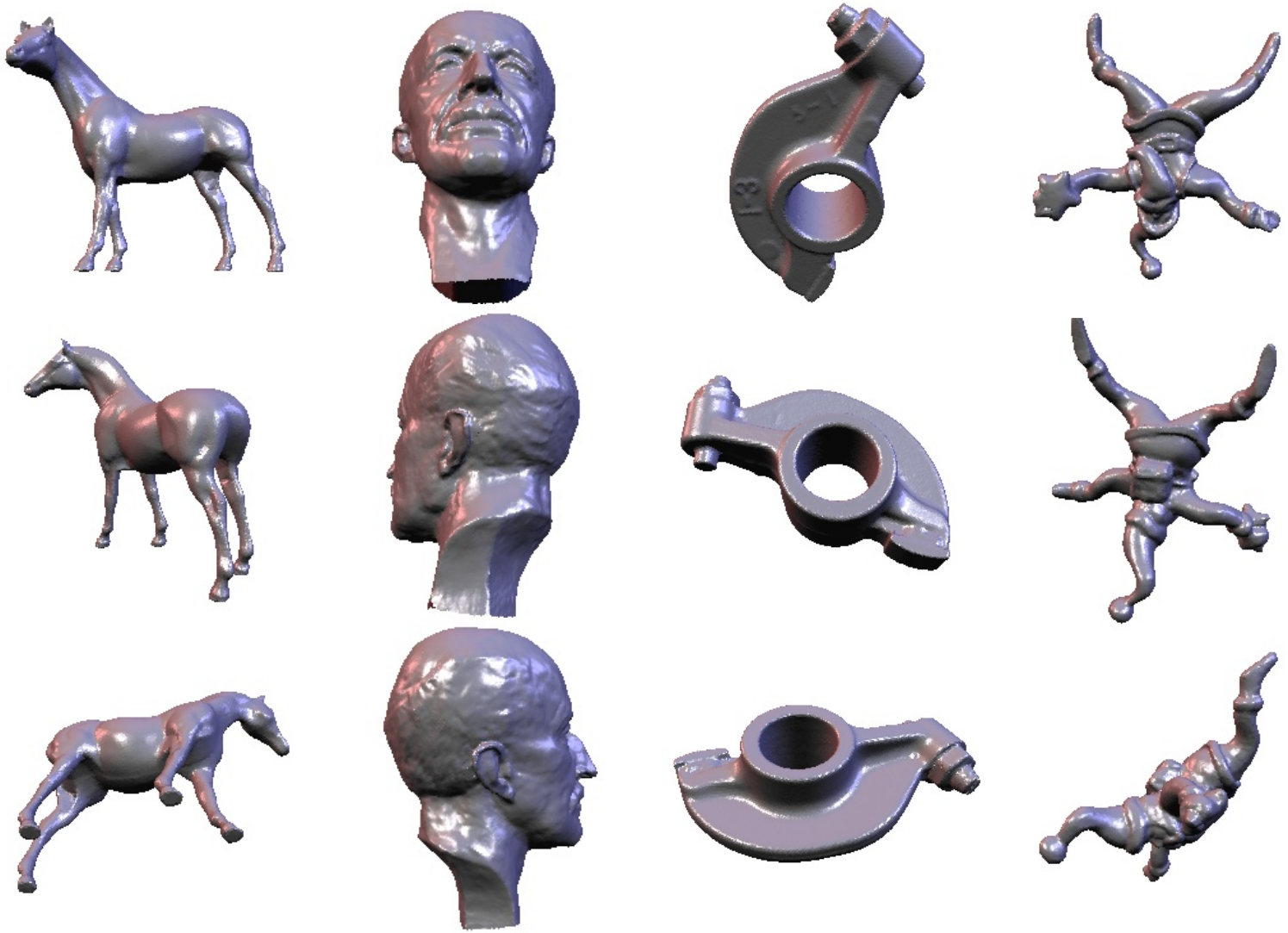
Best View

2nd

3rd



# Results: Best three views (3)



# Conclusion & Future work

- Conclusion
  - View selection by stable and salient view
  - Filter out and Select
    - Filter out the unnecessary views by view stability
    - Salient partition is selected by salient view
- Future work
  - Optimize speed
  - Up vector suggestion
  - Perception, semantics, learning...
    - W. Saleem will present this direction in aim@shape symposium

# Thank you

- Questions?
- How do you see the talk?
  - Unstable
  - Salient
  - Good/Bad view

- Acknowledgments
  - 3D models: Stanford Data Archives, Farfield Technology, Cyberware, CNR/CNUCE, CNR/IMATI/GE, AIM@SHAPE Shape Repository
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