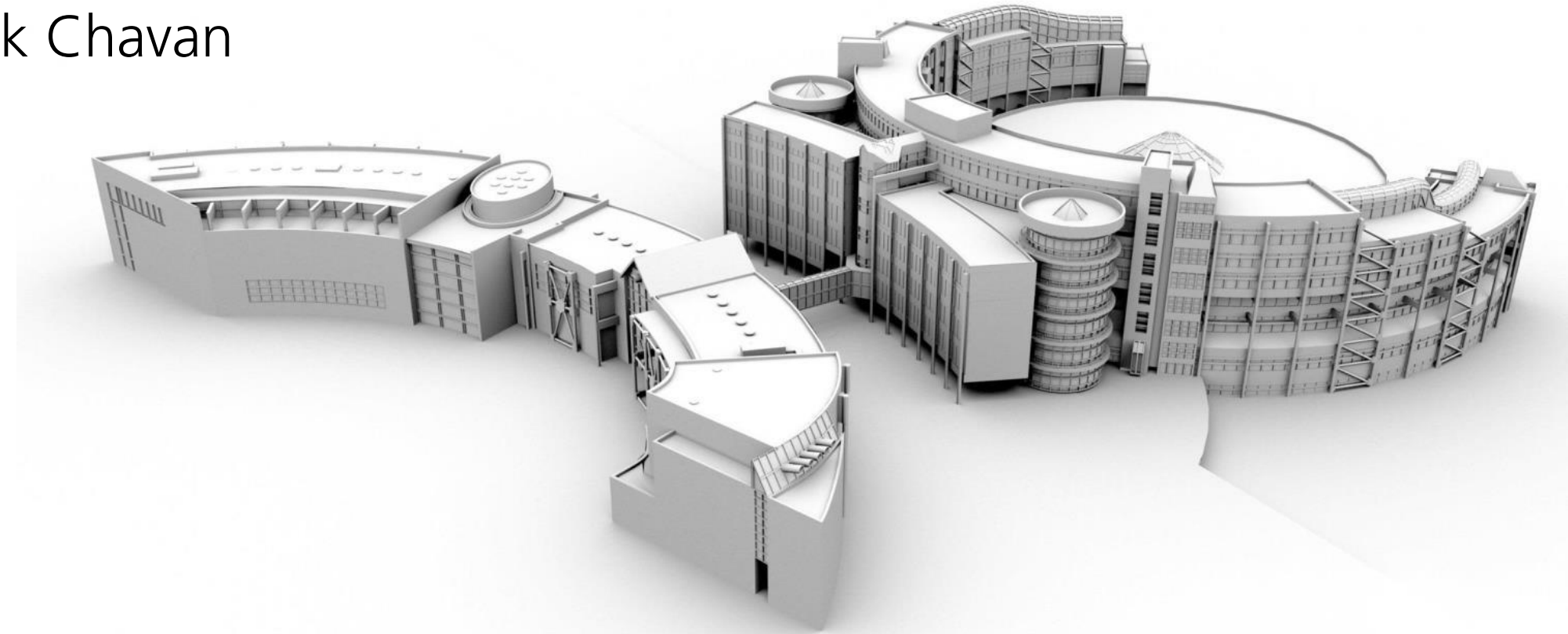
GREEN INCREMENTAL LEARNING

EIBA 10 Camera System: Dataset Sampling

-Vivek Chavan



Fraunhofer IPK
INSTITUT PRODUKTIONSANLAGEN UND KONSTRUKTIONSTECHNIK

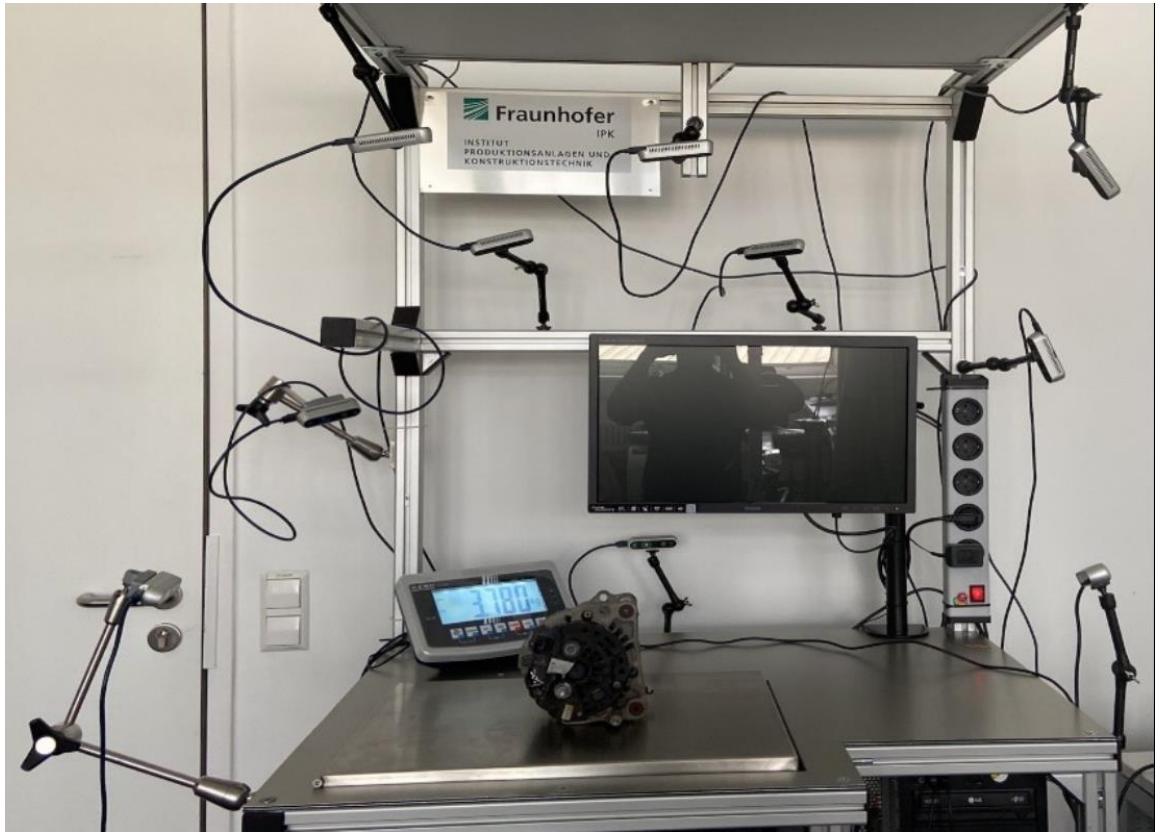
INSTITUT WERKZEUGMASCHINEN UND FABRIKBETRIEB
TECHNISCHE UNIVERSITÄT BERLIN

AGENDA

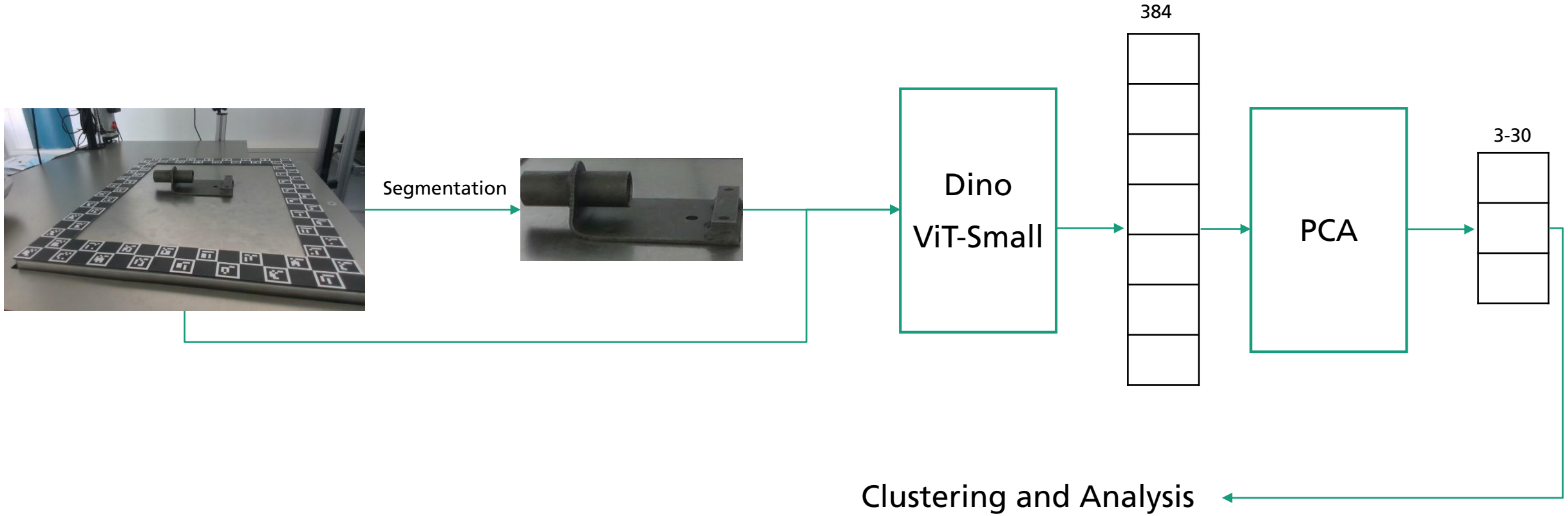
I. 10 Camera & 12 rotation system
II. Uncropped Image Analysis
III. Segmented Image Analysis
IV. Inferences for the Camera positions
V. Inferences for the rotations
VI. Outlier detection
VII. Further work

10 CAMERA & 12 ROTATION SYSTEM

- (10 cameras) x (12 rotations) = 120 images per object (only the primary orientation was considered)



APPROACH

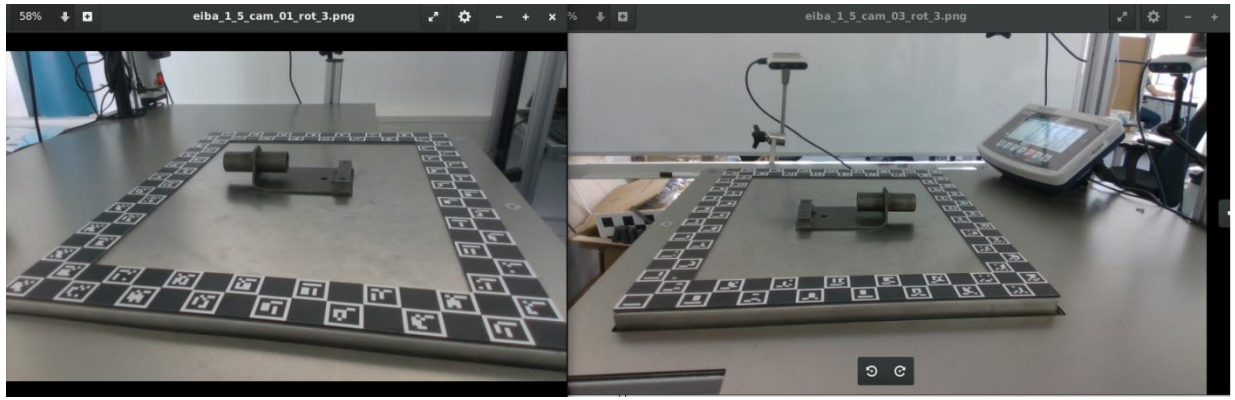


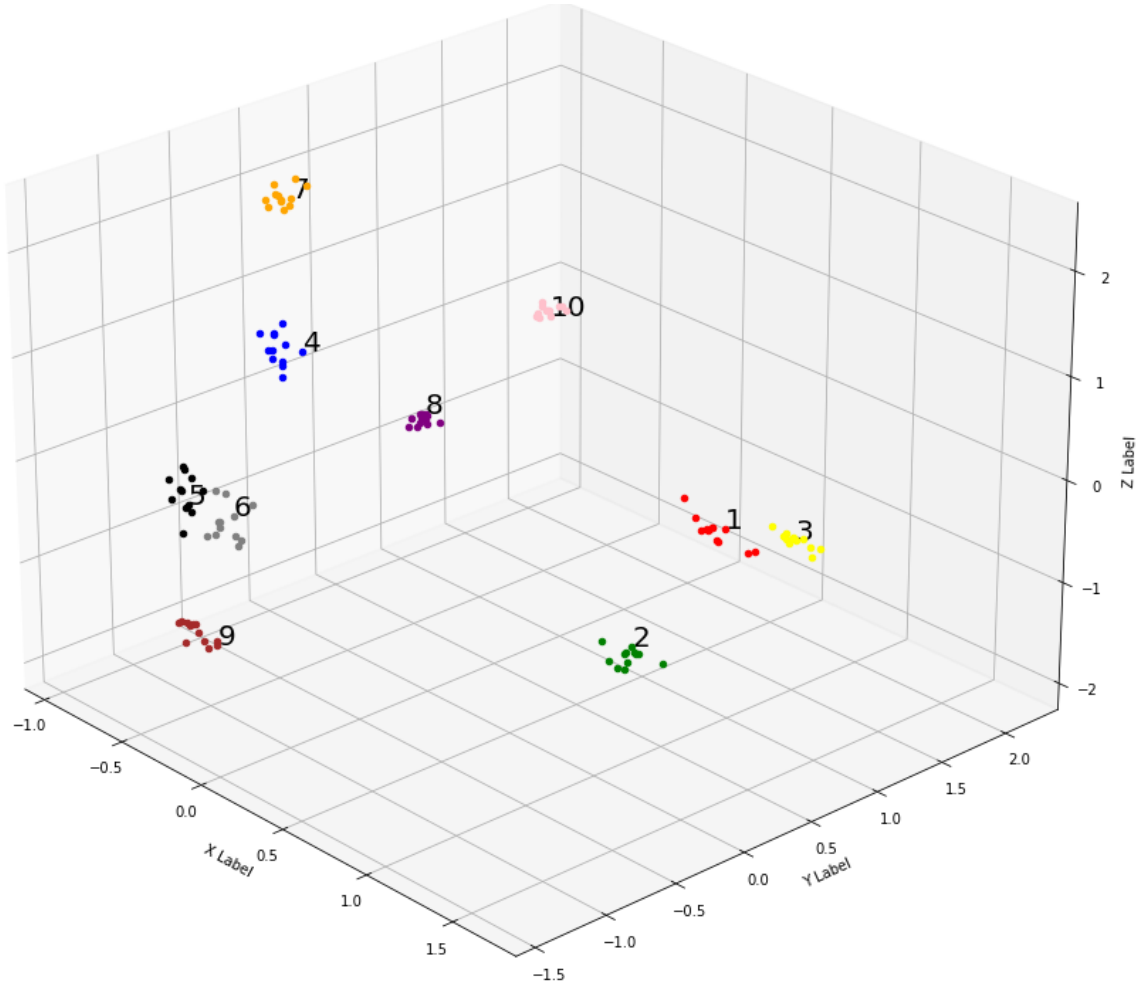
Fraunhofer IPK
INSTITUT
PRODUKTIONSANLAGEN UND
KONSTRUKTIONSTECHNIK

INSTITUT
WERKZEUGMASCHINEN UND FABRIKBETRIEB
TECHNISCHE UNIVERSITÄT BERLIN

UNCROPPED IMAGE ANALYSIS

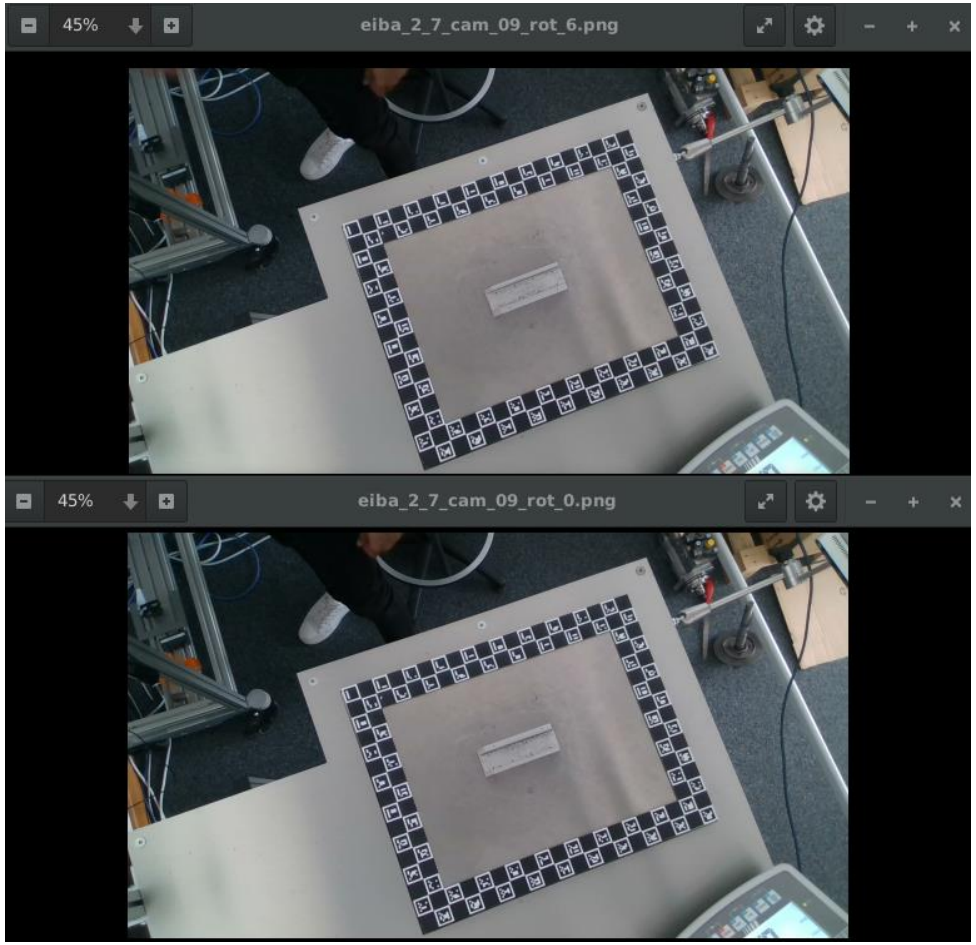
- Clear separation between the camera positions can be seen
- Cameras 1 and 3 produce close embeddings, along with cameras 5 and 6
  - Closer clusters correspond to similarity in the images and features represented





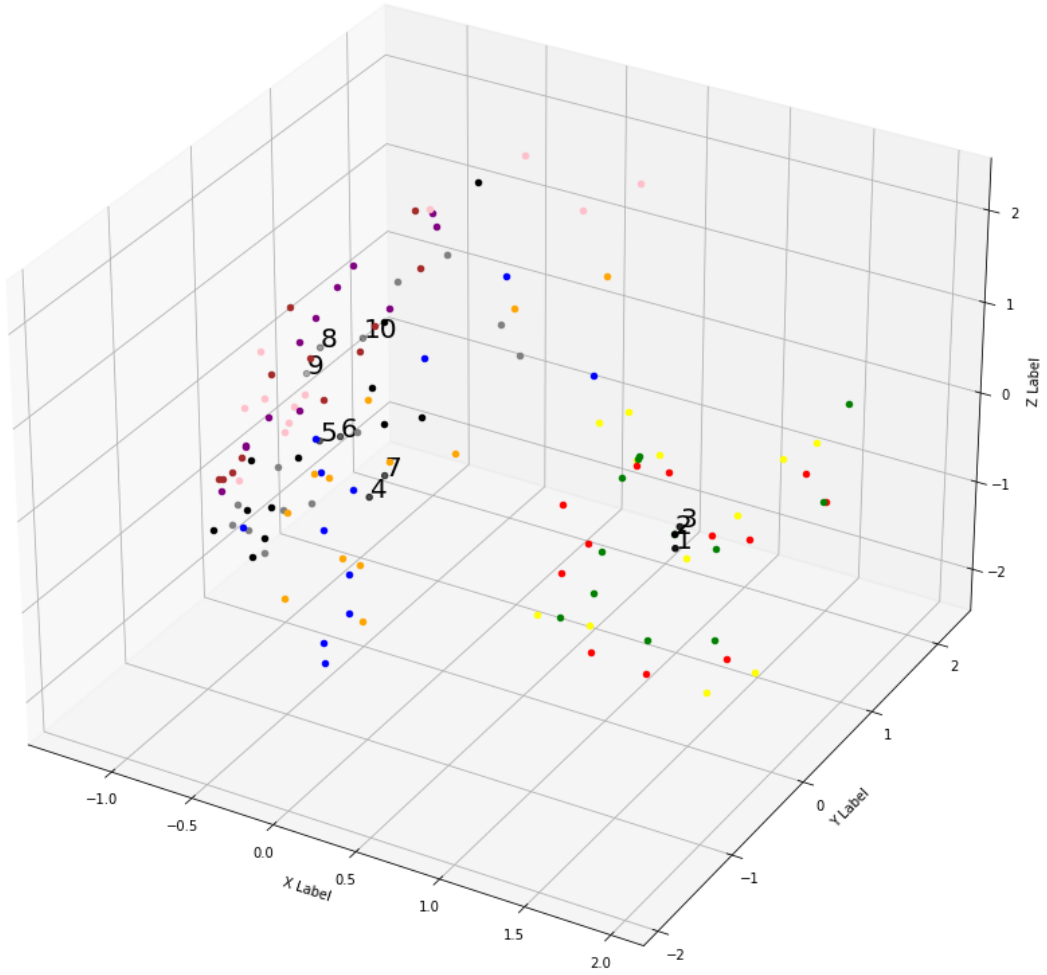
UNCROPPED IMAGE ANALYSIS

- Applications:
  - Finding and eliminating duplicate camera representations
    - E.g.: Only 1 camera could be selected out of Cameras 1, 2 and 3. All features are still captured given that the object is rotated 12x
    - E.g.: For symmetrical/axisymmetric objects, 12 rotations produce multiple duplicate images
  - Selecting a few cameras for maintaining maximum variance
    - Only 4 cameras: 1, 4, 6, 10
    - 7 cameras: 1, 4, 6, 7, 8, 9, 10



SEGMENTED IMAGE ANALYSIS

- The separation between different camera locations is less prominent
- The relative locations of different embeddings remains the same
- In the figure we see the labels at the center of the different camera locations
- Cameras 1, 2 and 3 are very close, which means that they produce very similar images (considering all 12 rotations)
- Cameras 5 and 6 are also close



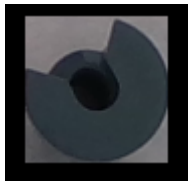
Fraunhofer IPK
INSTITUT PRODUKTIONSANLAGEN UND KONSTRUKTIONSTECHNIK

IWF
INSTITUT WERKZEUGMASCHINEN UND FABRIKBETRIEB TECHNISCHE UNIVERSITÄT BERLIN

SEGMENTED IMAGE ANALYSIS APPLICATIONS:

- Embeddings that are very close to each other signify very similar images.
- These can belong to the same camera or different cameras
- Image 1: Cameras 1 and 3
- Image 2: Different rotations of camera 9



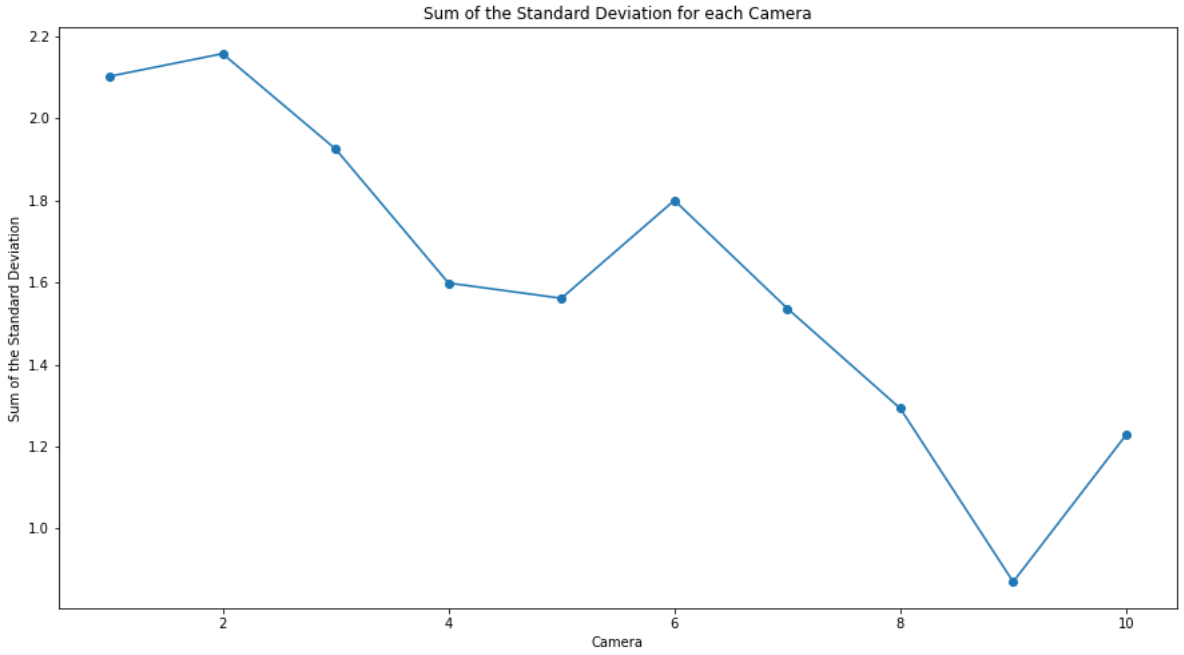



Fraunhofer IPK
INSTITUT PRODUKTIONSANLAGEN UND KONSTRUKTIONSTECHNIK

IWF
INSTITUT WERKZEUGMASCHINEN UND FABRIKBETRIEB TECHNISCHE UNIVERSITÄT BERLIN

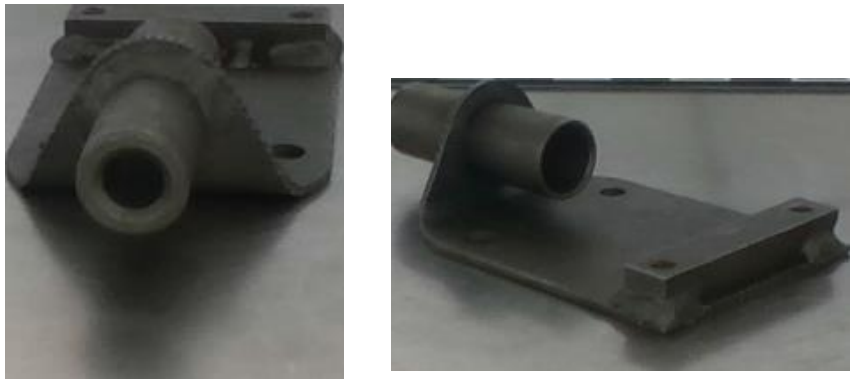
SEGMENTED IMAGE ANALYSIS ROTATIONS AND FEATURE VARIANCE

- The plot shows the sum of the Standard Deviation for different camera locations
- Hypothesis:
  - A high score means that the 12 rotations of the object add a lot of variation to the captured features
  - A low score means that the 12 rotations do not add much in terms of new features.
  - The cameras with low scores (8, 9, 10) are located at the top of the setup, which is why more rotations often do not expose new features of the object



SEGMENTED IMAGE ANALYSIS ROTATIONS AND FEATURE VARIANCE

- Explanation:
  - Sum of std is just reducing the 384 dim to 3 using PCA
  - The standard deviation along the three dimensions is then summed up (for each camera) to get a single value.
  - It is a hypothesis, that clusters with low std are closer together and have less variance in the data. Hence, rotating the object 12x did not add more variation to the images.
  - We also know this instinctively that cameras using the top view will see the same perspective with each rotation

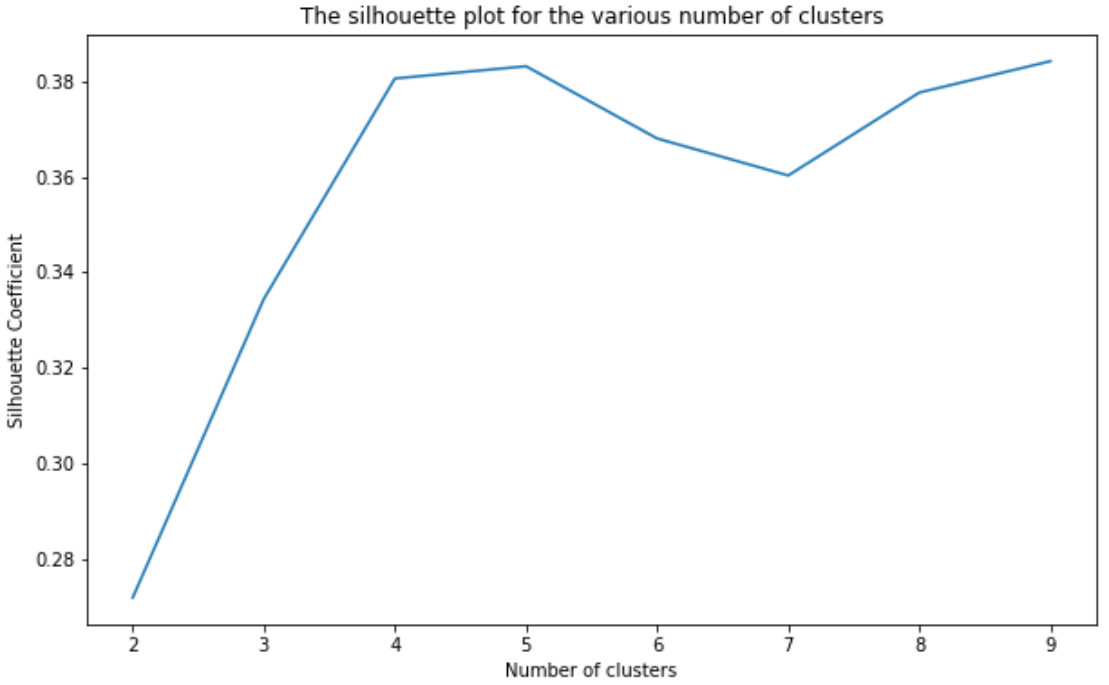


Rotations for camera 1

Rotations for camera 9

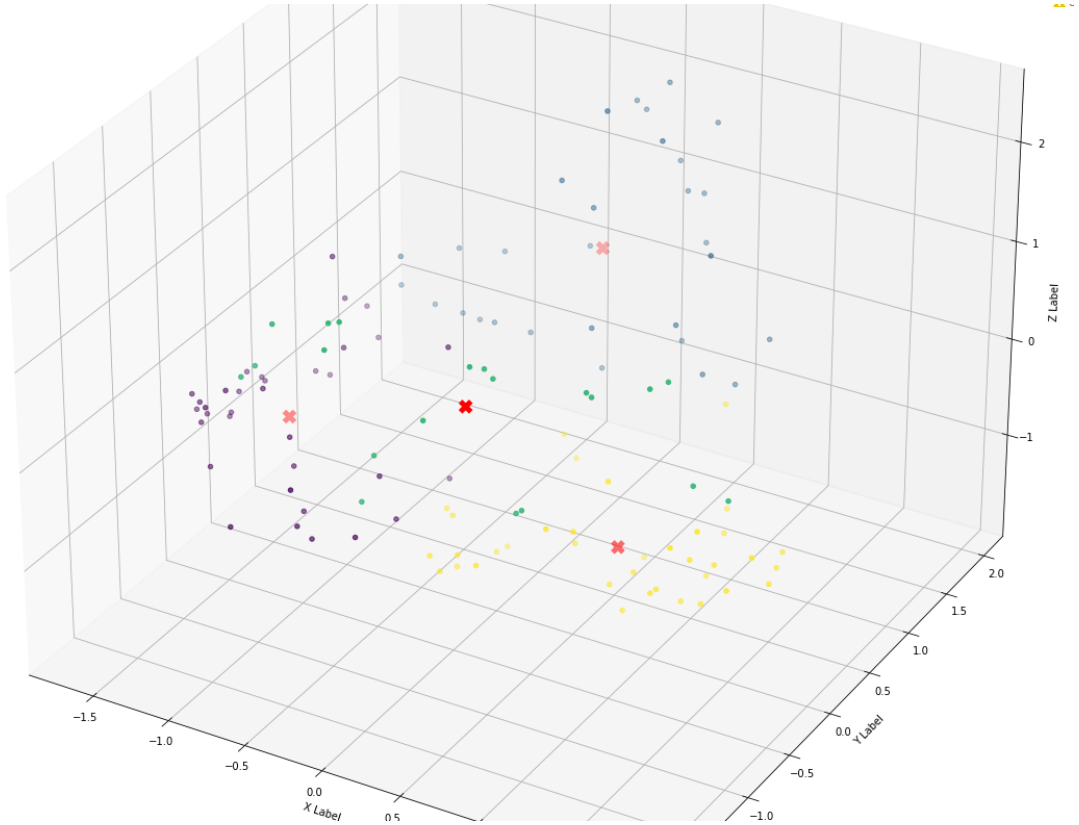
SEGMENTED IMAGE ANALYSIS
SILHOUETTE SCORE

- The Silhouette score indicates the best possible number of clusters
- Hypothesis:
  - It can also be used to get the optimal number of camera configurations to ensure the same feature representations with less cameras
  - E.g. For this object, 4/5 cameras can be used to get the same feature space representation
- The score distribution varies across different objects
- The hypothesis needs to be proven and verified



SEGMENTED IMAGE ANALYSIS
SILHOUETTE SCORE

- Explanation
  - Silhouette score is meant to get the optimal number of clusterings,
  - We used it predict the minimum number of camera 'clusters' to still get the same variation with fewer cameras
  - Silhouette score can potentially also be used to cluster images along rotation angles to derive further insights. This needs to be investigated using a larger dataset.



Only 4 clusters = Cameras: 1, 4, 6 and 10

Fraunhofer IPK
INSTITUT PRODUKTIONSANLAGEN UND KONSTRUKTIONSTECHNIK

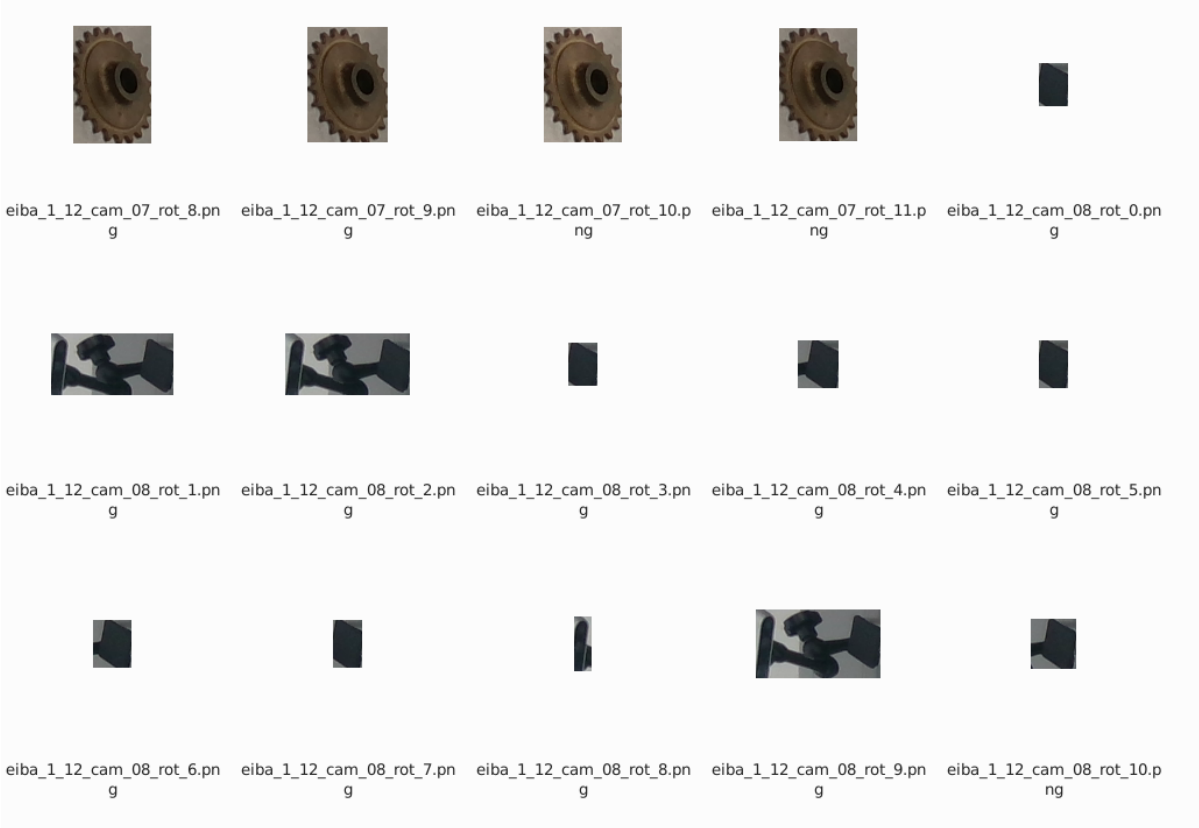
INSTITUT WERKZEUGMASCHINEN UND FABRIKBETRIEB TECHNISCHE UNIVERSITÄT BERLIN

SEGMENTED IMAGE ANALYSIS

- Outlier identification: Gave accurate results for some objects
- The image below does not show the cutouts in the surfaces like other images

SEGMENTED IMAGE ANALYSIS

- Outlier identification: Was not accurate for other objects. The segmentations were also not all accurate and may have contributed to this



FURTHER WORK

- Testing out the hypothesis
- Studying the approach on properly segmented images (many objects had incorrect segmentations)
- Deriving more insights