INT3404E 20 - Image Processing: Mid-term Phase 2 - Planning and Proposal Development

Group 11

1 Tested Approaches

1.1 Preprocessing

- 2D queries
  - Convert the color space of queries to grayscale, and then apply a threshold to generate binary images.
  - These images are resized from 512x512 to 256x256 based on the bounding box of letters, generated with contours.
- 3D Database
  - Each STL model is loaded, then cut at a plane perpendicular to the z-axis at 6/7 of model's height. In other words, all vertices above the cutting plane are used for the processed mesh.
  - The processed meshes are then plotted from a specific angle to generate a 2D version of the database, which are also preprocessed with the 2D procedure above.

1.2 Feature Extraction and Matching approaches

We tried several different feature extraction and matching algorithms after processing the data. These algorithms are as follow:

- Histogram of Oriented Gradients (HOG) and Cosine Similarity
  - The HOG feature descriptor counts the occurrences of gradient orientation in localized portions of an image. The output images from HOG are compared using cosine similarity.
  - HOG is predefined in a function called **hog** in the **skimage.feature** library, and cosine similarity is imported from **sklearn.metrics.pairwise**.
- Template matching
  - We used **cv2.matchTemplate** to compare the 2D processed versions of queries against the database
- Structural similarity index measure (SSIM)
  - SSIM is used to measure the similarity of two images based on **luminance**, **contrast** and **structure**
  - SSIM comparison is provided in the **skimage.metric** library in the form of **compare_ssim**
- Oriented FAST and Rotated BRIEF (ORB)
  - ORB is basically a combination of Features from accelerated segment test (FAST) keypoint detector and Binary Robust Independent Elementary Features (BRIEF).
  - ORB is included in **cv2** library.

- Scale-Invariant Feature Transform (SIFT)
  - SIFT works by identifying key points based on their local intensity extremes and computing descriptors that capture the local image information around those key points
  - SIFT is included in **cv2** library.

1.3 MRR Results

Approaches	Database	Pairs
HOG + Cosine	0.89345	0.7507
Template matching	0.89	0.7787
SSIM	0.8731	0.75504
ORB	0.7603	0.7617
SIFT	0.7743	0.7145

2 Task Assignment

Member	Tasks Assigned	Percentage
Vũ Thành Long (21020647) (Team-leader)	Research 2D image preprocessing methods Preprocess 2D queries Use **SSIM** for matching Write reports	33%
Dương Quang Minh (21020219)	Research feature extraction and matching methods Preprocess 3D database Use **HOG + Cosine** and **SIFT** for matching	33%
Dương Bảo Long (21021514)	Research 3D preprocessing methods and libraries Preprocess 3D database Use **Template matching** and **ORB** for matching	34%