IMAGE PROCESSING - FINAL REPORT

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I. Introduction

This report deals with the problem of Sino-Nom character retrieval. In the database for sets of 3d models and queries are 2d images. The goal is for each input query for a 2d image, find the 5 images most similar to it and put it into the csv file. Results will be ranked based on Mean Reciprocal Rating (MRR) on the private dataset.

My method focuses on processing 3d models to 2d images as well as image comparison algorithms. I use a number of algorithms such as (HOG, Template matching, HIST) to match 2 images together.

This report includes an introduction to the problem, characteristics of the data input, data output results, proposed methods for use, results on each data set, analysis results and conclusions.

II. Data Characteristics

a. Input

- The data file contains a 3D stl model: Extracted from 3d scan, The model has many defects (blurred, unclear, blurred grooves, difficult to detect depth)

Figure 1: Example of a 3d model

- The data file contains a 2D image query : Photo with black text on gray background, very poor quality, blurry, not clear, some lines are cut off, located on the border of the photo...

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Figure 1: Example of a 2d query

b. Output

The output is formatted as a csv file containing the name of 5 best matches from the 3D database for each 2D queries, the format as required in the document. And this result will be used for scoring and evaluation.

III. Proposed Method

a. Pretreatment

- Crop Image: Function used to crop and resize an image based on the contours found in the image
- Convert 3D model to 2d image: The 3D models are uploaded, then I will calculate the bounds of the box containing the 3D model, followed by selecting the cutting axis (z axis). I then identify the cutting plane that is near the model's maximum along the z axis, then I Partition the model along the cutting plane and create a new mesh object from the vectors above the cutting plane. Create and display 3D models. Finally, Convert 3D images to 2D.
- Process 2D : The function takes as input a color image and performs the following steps to process and return a cropped version of the binary image: convert the image from the BGR (Blue-Green-Red) color space to a grayscale image. Use cv2.threshold to convert grayscale images to binary images. Pixels with a value greater than 150 will be set to 255 (white), and the remaining pixels will be set to 0 (black).

b. Feature extraction method

- Template matching algorithm : The Template Matching algorithm is an image digital processing technique used to search and locate a smaller sample within a larger image. This is one of the basis of methods for identifying and detecting objects in images. Here I used an algorithm to get the path to an input image, process that image to turn it into a binary image, then search and match the pattern with images in a directory contains other binary images. The result is a list of filenames of the 5 most similar images.

Steps:

1. Read and process input images: Use cv2.imread(img_path): Read input image from img_path path. Use process_2d(...): Process the input image by converting it to a binary image.

2. Browse all files in the directory containing the image binary

3. Match the input image pattern with each image in the folder: Use cv2.matchTemplate(...) uses the standardized correlation coefficient Method. Use match.max(): Get the highest correlation value from the matching result.

4. sorted( ): Sort the list by correlation value from high to low.

- Histogram of Oriented Gradients algorithm (HOG): Histogram of Oriented Gradients (HOG) is a feature extraction algorithm in image processing and computer vision, used primarily for object detection. HOG analyzes how pixel intensity changes with direction in a neighborhood of an image. This helps capture the object's shape and edge characteristics, thereby aiding in object detection and recognition.

Steps:

1. feature_matching_HOG_similarity(imagel, image2): Extracts distinctive HOG from two images and calculates the cosine similarity between them. Use hog from skimage.feature library to extract features. Use cosine_similarity from sklearn.metrics library pairwise to calculate cosine similarity.

2. feature hog(image): Extract HOG features from an image. Returns the reshaped HOG feature into a 1-dimensional vector.

3. feature_matching_HOG(features1, features2): Calculate the cosine similarity between two HOG feature vectors.

- Histogram algorithm (HIST): The histogram algorithm is a statistical analysis technique used to describe the distribution of data. In the field of image processing, the histogram algorithm is often used to analyze the distribution of gray levels (or colors) in an image. Here are some basic concepts about histograms in image processing. Histogram is an important tool in image processing, helping to analyze and improve image quality through techniques such as equalization and contrast adjustment.

Steps:

1. calculate_histogram(image): This function calculates the histogram of an image. Use the cv2.calcHist() function to calculate the histogram.

2. calculate_similarity(hist1, hist2): This function calculates the similarity between two histograms using the Bhattacharyya coefficient. Use thefunction cv2.compareHist() and cv2.HISTCMP_BHATTACHARYYA to calculate the similarity

3. find_similar_hist(img_path): This function searches for 5 images similar to the input pattern based on histogram. Read and process input images. Loop through all the images in the directory and calculate the similarity between each image's histogram and the input image's histogram. Sorts images based on similarity and returns the 5 images with the highest similarity.

IV. Results

I calculated the MRR for the results using the data in the selected folders in the dataset. Use appropriate extraction methods and specific methods. Output the results in the table below.

Method	Database	Pair
Template Matching	0.8005	0.7671
HIST	0.7613	0.7225
HOG	0.7533	0.7589

I appreciated the algorithm for template matching and I chose it to run with the hidden dataset

V. Conclusion

The problem of extracting sino nom characters from a 3d tissue database using a 2d query is a very interesting and useful problem, however it also has many difficulties when developing, requiring the use of Advanced techniques in image processing due to degraded and inaccurate input data, as well as limited historical documents about the sino nom character. I have implemented the problem based on some algorithms feature extraction for pattern matching like template matching, hog, hist. After running on the input data, I found that the template matching algorithm is the most optimal and effective. Future work should focus on implementing these improvements and further optimizing feature extraction and matching processes. By improving these techniques, we aim to enhance the accuracy and robustness of SinoNom character retrieval, contributing to the preservation and digital accessibility of this historical text system.