

Usage Manual for the MATLAB Code: Object Detection with Kimia99_DB Dataset

Purpose:

The MATLAB script processes the Kimia99_DB image dataset for object detection using region-based image properties. It extracts features, performs training, testing, and evaluates object recognition accuracy.

1. Requirements:

- MATLAB software with the Image Processing Toolbox.
- Kimia99_DB directory containing image files for training and testing.
- Binary images (.png, .jpg, etc.) with white objects on a black background.

2. Functional Workflow:

2.1. Initialization

- **Code Segment:**

matlab

```
clc
clear all
close all
```

Clears the workspace, command window, and closes all figures.

- **Purpose:** Prepares the environment for the script execution.

2.2. Reading Dataset

- **Code Segment:**

matlab

```
listing = dir('Kimia99_DB');
num_rec = zeros(9,11);
```

Scans the Kimia99_DB directory for image files and initializes num_rec for tracking recognition results.

3. Training Phase

- **Loop:** Iterates through all images in the dataset for each class.

matlab

```
for train_no = 1:11
    for class_indx = 1:9
```

- **Reads an image:**

matlab

```
filename = listing(tmp_indx).name;
bw = im2bw(imread(sprintf('Kimia99_DB/%s', filename)), 0);
```

Converts the image to binary format and resizes it to 64x64 pixels.

- **Feature Extraction:**

matlab

```
s = regionprops(bw1{class_indx}, {...});
```

Extracts properties like centroid, major and minor axis lengths, orientation, and pixel area.

- **Ellipse Selection:** The ellipse with the largest area is selected to mitigate noise effects.
- **Vertex Calculation:** Computes the vertices of the ellipse's major and minor axes.

4. Testing Phase

- **Loop:** Tests images not used in the training phase.

matlab

```
for class_indx = 1:9
    for tst_indx = 1:11
```

- **Reads and resizes test images.**
- Extracts features using regionprops.
- **Transformation Matrix Calculation:**

matlab

```
M = coor_im1 * pinv(coor_im2);
```

Computes the transformation matrix for mapping test image vertices to training image vertices.

- **Overlap Rate Calculation:** Measures the ratio of overlapping white pixels between test and training images.

5. Recognition and Evaluation

- **Recognition Index:**

matlab

```
rec_indx(class_indx, tst_indx) = max_cls_indx;
```

Assigns the test image to the class with the highest overlap rate.

- **Accuracy Tracking:**

matlab

```
num_rec(class_indx, train_no) = num_rec(class_indx, train_no) + 1;
```

Updates recognition count for correct classifications.

6. Key Features and Outputs

- **Vertex Coordinates:** Major and minor axes coordinates for each ellipse.
- **Transformation Matrix (M):** Aligns test image with training image.
- **Overlap Rate (overlap_rate):** Quantifies pixel alignment between images.
- **Recognition Accuracy (num_rec):** Tracks correct classifications for each class.

7. Visualizations

- **Plotted Results:**

matlab

```
plot(tmp_coor(:,1), tmp_coor(:,2), 'bp', 'Linewidth', 2);
```

Displays test image vertex alignment and projections.

- **Overlapping Pixels:**

matlab

```
plot(PL_pro_2(:,1), PL_pro_2(:,2), 'r.');
```

Shows the projected overlapping points on the test image.

8. Execution Time

- **Timer:**

`matlab`

```
elapsed_time = toc;
```

Measures and outputs the total execution time for each training-test loop.

9. Practical Applications

- Object detection and classification tasks in image datasets.
- Benchmarking recognition systems with synthetic datasets like Kimia99_DB.

10. Notes

- Ensure images in Kimia99_DB are compatible with MATLAB's `im2bw` function.
- Modify the loop parameters (`train_no`, `class_indx`) based on dataset structure.

This manual explains the steps and purpose of each section of the script for efficient use and adaptation to similar object detection tasks.