Project Report

Cairo University - Faculty of Engineering

CMPS446 Image Processing

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The project idea and need

This project aims to detect and identify road signs using classical image processing techniques. Road sign detection is crucial in autonomous driving, driver-assistance systems, and traffic management. By using classical methods, the project targets efficient processing without the need for high computational power, which makes it suitable for embedded or low-power systems.

Project Workflow

Dataset Manipulation

Combined 2 datasets with different annotations and extracts labels from the images names. (links are provided in the reference section).

Data Preprocessing

Training Preprocessing

- Cropping image to the bounding box
- Convert to grayscale
- Apply gaussian filter
- Perform opening Morphology
- Resize image to fixed size (256, 256)
- Crop the region of interest (Circles & Triangles w.r.t shape)
- Augment images with a low number of samples.

Testing Preprocessing

- Resize image to fixed size (256, 256)
- Convert to grayscale
- Apply gaussian filter
- Perform opening Morphology

Feature Extraction

HOG: we used HOG because of its robustness, efficiency, and ability to capture important edges and shape information in an image. This helped us detect signs whether they are far, near, in good or bad quality.

Training Model

SVM: We used SVM to classify different signs (7 signs). Passed the HOG features to the SVM classifier.

Parameter:

- c = 0.001
- Kernel = “linear”

Prediction

In prediction, we preprocess data then apply HOG features and then predict using the model trained earlier.

GUI

We used Tkinter to make the GUI

- Load image
- Display image
- Make a prediction

Experiment results and analysis

Test Accuracy: 93.63%

	precision	recall	f1-score	support
22	0.95	0.89	0.92	92
24	0.81	0.98	0.89	106
25	1.00	0.92	0.96	66
26	0.93	0.96	0.95	216
27	1.00	0.98	0.99	47
55	1.00	0.91	0.95	141
56	1.00	0.83	0.90	23
accuracy			0.94	691
macro avg	0.96	0.92	0.94	691
weighted avg	0.94	0.94	0.94	691

We cared about accuracy and recall at the same time (f1-score). This is because there may be some images that have many false positive, but we would get high accuracy.

Previous Trials

Preprocessing

- **Histogram Equalization:** Applied for grayscale image and each RGB channel. The problem was the image was very noisy and came up with accuracy > 50%
- **Increasing saturation:** We increased saturation to apply color segmentation but it came up with bad accuracy and images introduced to the model were very hard to distinguish.
- **Getting dominant color:** we had an approach that we get the dominant color for each sign (Red or Blue). This will make them classified more and then we could apply classification on them separately making the model train on fewer sign types but we didn't have accuracy at all.

Feature Extraction

Sift: Getting key points and descriptors for each image and clustering the similar key points using KMeans clustering with the number of clusters equal to the average key points in the samples. BOW is applied to deal with different lengths of descriptors.

Classifiers

KNN: Applied KNN classifier to classify road signs. Accuracy was accepted but the problem was the high computation of the prediction phase, and no training phase.

Work division

- Ahmed Gaber: GUI, preprocessing
- Osama Yousef: Dataset Manipulation, Preprocessing, SVM Model
- Ziad Mohamed: nn model, feature extraction
- Mohamed Ahmed: nn model, feature extraction

Conclusion and references

- https://link.springer.com/article/10.1007/s11042-014-2293-7
- https://jq0112358.medium.com/traffic-sign-segmentation-with-classical-image-processing-methods-canny-edge-detection-color-8ff1096535db
- https://www.sciencedirect.com/science/article/pii/S1474667016416009

Datasets

- https://nlpr.ia.ac.cn/pal/trafficdata/recognition.html
- https://universe.roboflow.com/usmanchaudhry622-gmail-com/traffic-and-road-signs