

Vehicle Recognition Based on Fourier, Wavelet and Curvelet Transforms - a Comparative Study

Farhad Mohamad Kazemi
Islamic Azad University
Department of Artificial
Intelligence
Mashad , IRAN,
fmkazemi@ieee.org

Saeed Samadi
Khorasan Science and
Technology Park (KSTP)
Department of Electronic
Mashad ,IRAN
samadi@kstp.ir

Hamid Reza Poorreza
Ferdowsi University
Department of Computer
Engineering
Mashad , IRAN,
hpourreza@um.ac.ir

Mohamad-R. Akbarzadeh-T
Ferdowsi University
Department of Electrical
Engineering
Mashad, IRAN,
akbarzadeh@ieee.org

Abstract

This paper proposes the application of 3 different kinds of feature extractors to recognize & classify 5 models of vehicles. These feature extractors contain of Fast Fourier transform, discrete wavelet transform & discrete curvelet transform. To justify the correct amount of each feature extractor, we perform per of the mentioned transforms to input images, precisely.

The used classifier in this paper is called k nearest-neighbor. The results of this test show, that the right recognition rate of vehicle's model in this recognition system, at the time of using curvelet transform (Notice, all curvelet coefficients) is 100%.

For decreasing the dimension of feature vectors more & choosing the best features we've used of interclass variance criteria to intraclass variance criteria. As a result of this performance, the size of feature vectors will be extremely decreased. Then, we perform our final impact feature vectors (The best Curvelet coefficients or the best wavelet coefficients or the best Fourier coefficients) to the KNN Classifier. Also, the results of this test show, the right recognition rate of vehicle's model in this recognition system, at the time of using 0.1 of all curvelet coefficients is 100%.The comparison of the 3 proposed approaches for identifying the kind of vehicles showed that curvelet transform can extract better features among the proposed dataset.

1. Introduction

Although classification of road going vehicles has been a subject of interest in the past, e.g. traffic control systems and toll levy automation, vehicle type recognition has not hitherto been considered at this level of accuracy [1]. Instead, Most of the systems either detect (classify vehicle or background) or classify vehicles in broad categories such as cars, buses, heavy goods vehicles (HGVs) etc.

This paper proposes the application of 3 different kinds of feature extractors to recognize & classify 5 models of vehicles. To justify the correct amount of each feature extractors, we perform per of the mentioned transforms to input images, precisely. The comparison of the 3 proposed approaches for identifying the kind of vehicles showed that curvelet transform can extract better features from the proposed dataset.

2. Feature extraction

2.1. Curvelet transform

Curvelets as proposed by E. Candes and D. Donoho , constitute a relatively new family of frames that are designed to represent edges and other singularities along signed curves much more efficiently than the traditional wavelet based transforms. Compared with wavelets, curvelets can sent represent a smooth contour with much fewer coefficients for the same precision [2,3].

3. Classification

In this here, the obtained features from stage 2 are used for intelligent classification. The related feature vector in each picture enters to the related classifier.

The k nearest-neighbor is used for classification [5].

4. Experimental results

For testing the right performance of our proposed algorithm, we've examined 5 common classes of vehicles in Iran, that include of PEUGEOT 206, PEUGEOT 405, Pride, RENAULT5 and Peykan. Our total data set used in this study is a set of 300 images from the backward view of the mentioned vehicles. Our training data set include of 230 images from the backward view of the mentioned vehicles, while our test data set include of 70 images from the backward view of the mentioned vehicles. The size of all test & train images must be normalized to 128*128 pixels.

4.1. The comparative analysis of FFT, wavelet & curvelet transforms

In this paper, we've proposed a comparative analysis of 3 different transforms that contain of: *Fourier transform, Wavelet transform and Curvelet transform.*

The obtained details of performing the achieved coefficients from these transforms are designed when they would be used as feature vector.

To justify the correct amount of obtained features from the transforms, In each recognition algorithm, we've

used of all achieved coefficients from it's related transform as feature vector.

In this experiment, we've used a kind of wavelet (haar) up to 3 levels of resolution & our recognition rate was 92%.

By performing curvelet transform to each of input pattern, 119448 curvelet coefficients achieved. All of these coefficients in different scales & angels performed to their related classifier as feature vector. In this case, coefficients obtained in 4 different scales with various angels, & recognition rate became 100%.

Table 1. The recognition rates with different lengths of 3 various feature vectors.

| Number of features (coefficients) | All coefficients (FFT=16384, Wavelet=16384, curvelet=119449) | 13130 | 10000 | 9000 | 8000 | 6000 |
|-----------------------------------|--|--|-------|------|------|------|
| Recognition rate using FFT | 97% | 90% | 87% | 85% | 85% | 70% |
| Recognition rate using Wavelet | 92% | 89% | 89% | 87% | 90% | 85% |
| Recognition rate using Curvelet | 100% | 100% | 97% | 97% | 95% | 95% |
| | | we used 10 percent of the most important curvelet coefficients | | | | |

3.2. Reducing the dimension of feature vectors (curvelet coefficients, wavelet coefficients, Fourier coefficients)

As it is proved, the kinds of features and the sizes of feature vectors are so important in our recognizing process. On the other hand, Because of existing a large number of curvelet coefficients from backward view of vehicles if these coefficients be performed to our classifier, the speed of our recognition system will be decreased. To solve this problem, we reduced the dimension of feature vectors with using of interclass & intraclass variance criteria [4]. We continued our work with reducing the vector dimension and eventually results showed, in spite of decreasing the vector's dimension, the recognition rate which is based on curvelet transform will propose the best recognition rate in comparison with 2 other systems which are based on FFT and wavelet transforms.

4. Conclusion

This paper represents the efficiency comparison of 3 different structures which are based on Fourier transform in pattern recognition. These 3 kinds of structure are based on Fast Fourier transform, Wavelet transform and Curvelet transform. The features, on the basis of the recognition is made, have been obtained using Fourier, wavelet & curvelet transformations.

The performed numerical experiments for the recognition of the vehicles backward view have shown the superiority of the curvelet transform in comparison with 2 other ways, for extracting features from images. During the next works, we will use of the other classifiers to improve our system recognition rate.

5. References

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