On the Study of Rotation Invariant Object Recognition

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회전불변 객체 인식에 관한 연구

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ABSTRACT

This paper presents a new feature extraction technique, correlation coefficient and Manhattan distance (MD) based method for recognition of rotated object in an image. This paper also represented a new concept of intensity invariant. We extracted global features of an image and converts a large size image into a one-dimensional vector called circular feature vector's (CFVs). An especial advantage of the proposed technique is that the extracted features are same even if original image is rotated with rotation angles 1 to 360 or rotated. The proposed technique is based on fuzzy sets and finally we have recognized the object by using histogram matching, correlation coefficient and manhattan distance of the objects. The proposed approach is very easy in implementation and it has implemented in Matlab7 on Windows XP. The experimental results have demonstrated that the proposed approach performs successfully on a variety of small as well as large scale rotated images.

1. Introduction

Analysis with a large number of variables generally requires a large amount of memory and lengthy computational time. It is easily to adopt a classification algorithm which overfits the training sample and generalizes new sample data poorly. When the input data to an algorithm is too large to be processed, it is often necessary to extract features of the data as a form of feature vector. The feature vector should represent characteristics of original data accurately, such that the results using it are identical as ones from original data. Transforming the input data into the set of features is called a *feature extraction.* Feature extraction is a general term for methods of constructing combinations of the variables to get around these problems while still describing the data with sufficient accuracy.

Best results are achieved when an expert constructs a set of application-dependent features. Nevertheless, if no such expert knowledge is available general dimensionality reduction techniques may help. These include: Principle components analysis (PCA), Kernel PCA, Support vector machine (SVM), Independent component analysis (ICA),Isomap, Partial least squares etc. In our paper we are presenting an existing algorithm as CFE tool.

The main objective of this thesis is to propose a new approach for object detection where the system is rotation invariant. Our propose algorithm is used for reducing the feature from the observation. Then Midpoint Circle Drawing algorithm is used for extracting the circular features (CFs).One dimensional feature vectors are generated from CFs for each object is called *circular feature vectors (CFVs).* In the recognition phase we used histogram matching, correlation coefficient, and also calculated the *Manhattan Distance (MD)* for recognized object perfectly [4][5][8].

2. Related works

Our contribution on this field is developing a Rotation Invariant Object Recognition(RIOR) system using Circular features extraction where the system is not a specific detector like face, character or texture detection system. Our system is capable of detecting any specific object in a large input image that may contain simple or complex background.

To get our system successfully realized, we have tried to use very simple matching technique, and finally, selected template matching after a broad study of various methods. Then we observed that we need to work with large image and deal with a large amount of data. Therefore, we developed an algorithm for compacting image data so that we get faster system with not deteriorating accuracy to an unacceptable level. We successfully implemented the algorithm proposed. Then we realized that if we rotate every template from 1 to 360, and then match, amount of data will be so large. And so, we tried to find out an idea of extracting feature so that we need not rotate the template. After a long study ([1], [2], [6], and [7]) we got an idea that extracts CFs. We use a very easy technique to implement that idea. At the final stage of our work, we were in trouble of setting threshold value (Th). Finally, we successfully develop an idea for setting threshold for the system. For this we use observation from output of various steps of our system. After a great endeavor, we were able to develop a RIOD system using CFs that we claimed. Our system can find rotated objects both image with complex and simple background, and rate of success is satisfactory.

3. Methods

Let $f_o(x,y)$ be the object image then the system can dimensionally reduce by using the following algorithm:

1 The size of the $f_o(x,y)$, $M \times N \times C$;

2. if reduce 3X3 for a single value then we get new $f_{no}(x,y)$: $M_n \times N_n \times C$

3. *for i=1 to .*M_n

    for j=1 to N_n

        for k =1 to .C

$$Temp = \sum_{i}^{Mn}\sum_{j}^{Nn} f_{no}((i*3-2:i*3),(j*3-2:j*3),4-k);$$

$$f_{new}(i,j,4-k) = \sum Temp;$$

        End

    End

End

4. Stop.

Circular features (CFs) are extracted by applying the mid-point circle drawing algorithm on the f_{new} . The circular feature vectors (CFVs) calculated by from the circular values of the f_{new}. Each element of the CVFs calculated from the f_{new} with respect to the radius of the circle on f_{new}. The average values of the pixels on the radius with respect to the RGB are the elements of the CFVs. According this away the propose system calculated the CVFs for the individual objects. The propose system aim to reducing processing time and provide the accurate result very firstly.

4. Results and Discussions

The propose system recognized the object by using histogram matching algorithm first. The propose system also calculated MD to recognize the objects from database. This section shows the CFVs for the following templates and a similarity graph. Here the templates 1 and 2 are same with different angles. The similarity displays that lines for templates 1 and 2 are the most similar. This similarity is mathematically described by the MD.

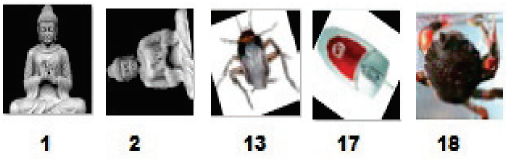

Fig. 1: Templates for feature comparison.

We already have described that the similarity between the CFVs (hence the CFs) is mathematically described by the Manhattan Distance. The MD for the CFVs shown in Fig.03 is displayed. Among the distances, the second one is the minimum. This minimum distance indicates that the object template associated with the distance is more similar than any other templates stored in the database to the test template.

The figure displayed bellow shows the similarity curves among the templates.

1.116732026	0.517254902	0.316431373	0.267394958	0.203551198	1
1.118300654	0.484901961	0.317921569	0.238487395	0.186840959	2
0.916862745	0.560117647	0.796313725	0.670532213	0.5391939	13
1.060980392	0.695882353	0.768235294	0.652408964	0.554684096	17
0.334444444	0.198823529	0.321647059	0.361008403	0.417254902	18

CFVs for the templates marked by No.

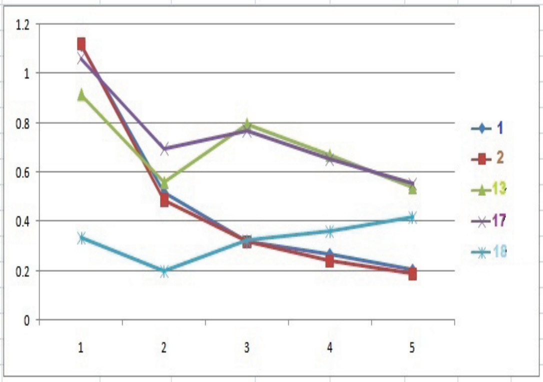

Fig.02: Similarity Curves.

The Fig.03: displayed bellow shows the MDs among the templates.

Another observation came from this system that the propose system provide best result for the circular shape objects. Fig.01. represented the entire template object. The Fig.02 represents the similarity curve for the object templates. For template the similarity curve showing the similar

Manhattan distance

	1	0.955356
MMD	2	0.08103
	3	0.802476
	4	0.161966
	5	0.986346
	6	0.870651
	7	0.553676
	8	0.61685
	9	1.258583
	10	0.584971
	11	1.384888
	12	1.522316
	13	1.461394
	14	0.496872
	15	0.869049
	16	1.363749
	17	1.42233
	18	1.413252
	19	1.40477
	20	0.867359

This value indicates the most similar CFs

CFV for the Test Template	1.116732	0.517255	0.316431	0.267395	0.203551

Fig.03: Manhattan Distance.

curve for template 1 and template 2.The propose system provides best result with respect to different object in different angles. The Fig.03 represented the MD for final recognition of the objects for the database.

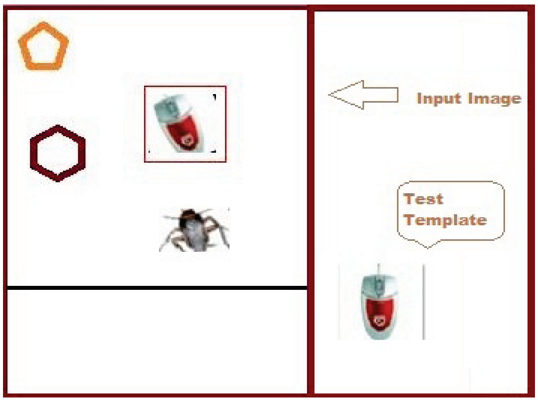

Fig.04: Sample output.

Finally, the system can detect rotated objects successfully. Though the system shows poor accuracy (80%) because of complex background, but gives 94.54% correct output for simple background image. It takes 8s to 9s for input image of size 527X370 and 2s for input image of size 210X210.

5. Conclusion

This paper presented a method for describing the rotation-invariant circular features of f(x,y)s. However, there is still room for improvements. The performance of the proposed approach is batter for the simple background images for any types of objects. We also tested the system for intensity invariant, in that case our system shows accurate result most of the cases. The propose system tried to remove the limitations of the existing system. In the future we will try to evaluate the performance with respect to other existing systems. And also try to remove all the limitations of the propose system. Through our propose system not totally depend on the intensity variation. We will apply new concept to make our propose system intensity invariant as well as rotation invariance.

6. References

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