

CHARACTERS CLASSIFICATIONS BY RADON TRANSFORM

CERVINKA, L[udek]; CIP, P[avel] & HORAK, K[arel]*

Abstract: This article describes method of optic character recognizing. Characters are uppercase of alpha-numeric type. For characters identifications is using Radon transformation. Advantages of identification by Radon transformation is rotated and mirrored invariable. Next advantage of Radon transformation is noise resistivity. Classification characters with noise are stay possible. Similar problem is with non-complete character. Radon transformation can identify little damaged characters.

Key words: Computer vision, OCR, Radon transform, noise

1. INTRODUCTION

Recognizing of alpha-numeric characters is almost resolved problem. But in specific application we need used different approach. Specific problem may be rotated or mirrored characters or combination of these problems.

Random angle of rotation need any preprocessing method, because input data for classification must be in correct format. But disadvantage of using preprocessing is error of method. Error of preprocessing algorithm debases classification accuracy. Radon transformation offers principles of identification characters that are invariable on rotation and mirroring.

2. RADON TRANSFORM

Possible solution these problems is transformation x and y coordinate to polar or semi polar coordinate. Radon transform is good for transformation to semi polar coordinate. For computation Radon transform is using next formula:

$$R(L) = \int f(x)dt(x) \quad (1)$$

when L is trajectory of integration

Classification of character directly from polar coordinate has many advantages and couple disadvantages. Mainly advantage Radon transformation is irrelevant on rotation of character. Rotation of character in semi polar coordinate is only shift in axes x . Next advantage is irrelevant of mirrored character. Mirrored character in Radon space (semi-polar space is called sinograph) is visualized as inverted data on axis y . But in the Radon space this inversion is irrelevant.

3. PRICIPLE OF CLASSIFICATION

3.1 Transformation basic elements

Typical property of Radon transform is specific representation mathematical basic elements. Transformation of line is show as point. Angle of line is value on axis x . Transformation of circuit is show as area with same value.

For classification characters from sinograph is necessary thresholding sinograph. Find optimal value of threshold is very difficult. Threshold value must representations variance of shape in every step. Threshold value must be higher than mean

value because higher value give better resolution of maximum peak, but too high value of threshold removes short lines and circuit. On next picture is example of characters "A"



Fig. 1. Character "A"

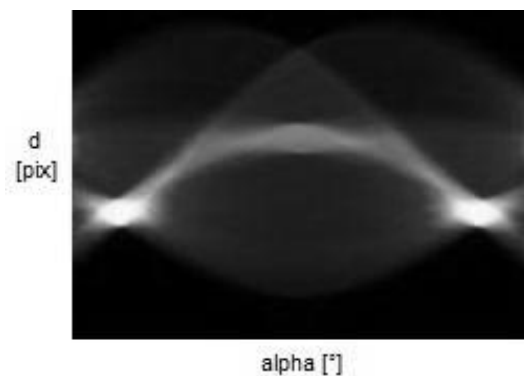


Fig. 2. Sinograph "A"

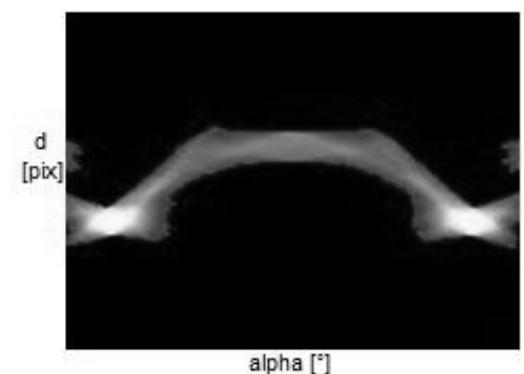


Fig. 3. Thresholded sinograph "A"

3.2 Principle of classification

Thresholded sinograph contains all important data. For the best classification is good to make projection of sinograph to axis x and y . Projection in axes x describes angle of rotation character. If character is rotated than position of maximum in sinograph is shift. For recognizing character is good using modified correlation with model of each character. Modification of this function is very simple. Because sinograph is periodical that correlation must connected input data to loop. The last value in projection continues first value in projection.

After correlations we get one vector for every character. Vector of abstained values includes concordance rate. Maximum value in all vectors designates type of character. For better resolutions is good use correlation for axes x and y .

4. CLASSIFICATION ACCURACY

4.1 Classification accuracy rotated and mirrored characters

Classification accuracy depends on the quality input data. If input data are rotated or mirrored than classification accuracy drops down. Characters shape has influence on accuracy. For example, character “ T ” or “ O ” is same for every rotation and mirroring. But same characters are more asymmetrical as characters “ P ” or “ K ”. Accuracy of the classification shows tab. 1.

Data in tab. 1 are in percent. Each value shows concordance rate of mirrored characters. If character consists of only lines that classification is very high. Similar values we get if characters are mirrored and rotated.

A	B	C	D	E	F	G
99	94	96	96	94	86	95
H	I	J	K	L	M	N
100	100	93	95	92	100	93
O	P	Q	R	S	T	U
99	97	91	93	91	100	96
V	W	X	Y	Z		
99	96	99	93	81		

Tab. 1. Concordance rate of mirrored characters in percent

4.1 Input data with noise

Characters classification is depending on quality input data. Data without noise and damage are classification always correctly. But ideal data don't exist. Picture is usually with noise. This noise is created by method error. Classification of the data with noise is no problem, because noise is distributed to all sinograph area. This noise is transformed by Radon transform as pixel “offset”. After thresholding is major part of noise removed from image.

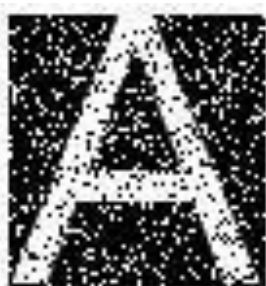


Fig. 4. Character “A” with noise

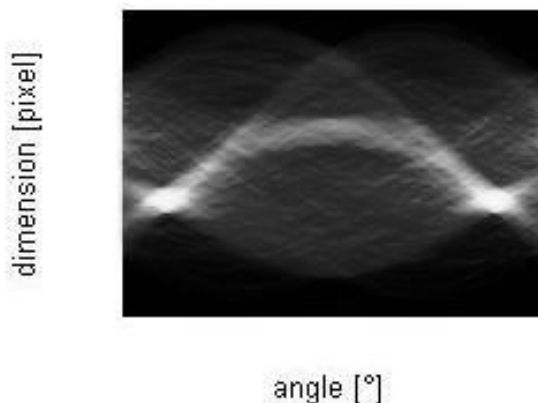


Fig. 5. Sinograph “A” with noise

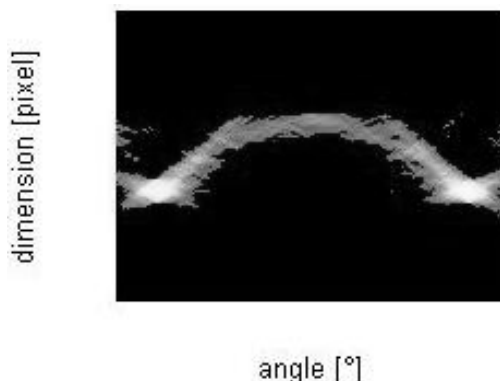


Fig. 6. Thresholded sinograph “A” with noise

Shape on figure 4 is same as shape on figure 2. Selecting of threshold is little more difficult. Value of threshold must take out noise, but value mustn't damage specific shape of the character in sinograph. Good result gets selection threshold in every column in the sinograph. These unique threshold representing specific conditions in every steps of Radon transform.

5. CONCLUSION

Recognizing character with using Radon transformation has good possibility for classification a characters on microdots. Main advantage of Radon transformation is classification rotated character and tolerant of damaged shape.

Classification accuracy is very accuracy. For input data without noise is classification in all case correct. Classification characters with noise accuracy drop down.

Classification method is stay in research. Future work is develop on classification various character noise and independent on font characters.

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