HANDWRITTEN CHARACTER RECOGNITION USING METHOD FILTERS

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Abstract

Handwritten character recognition is an emerging and a very challenging field of research as the handwritings vary from person to person. In this paper we have focused on some of the existing methodologies of character recognition and come up with some new methodologies. A system which encompasses different character recognition methods as filters is proposed in this paper. The methods are prioritized based on their result efficiencies and applied on the input. As we pass through the process, the number of possible results in the solution set keeps decreasing steeply. Using a combination of methods as a filter for recognition yields more accurate results than using a single method and also decreases the space and time complexity of the algorithm. Finally, further scope of development of this model is discussed.

Keywords *–Glyph, Character recognition, handwriting recognition, space time complexity, filter process.*

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1. INTRODUCTION AND CURRENT SCENARIO

Today, handwritten character recognition has achieved some success but awaits major research to witness 100% practical application in various fields.

Various approaches currently used for character recognition are briefly described below.

1.1 Matrix Matching

Every character is converted into a pattern within a matrix and then compared with a pattern in an index. Its recognition is strongest on monotype and uniform single column pages. [1]

1.2 Feature Extraction

Each character is defined by the presence or absence of key features like height, width, density and number of loops etc. It is a perfect approach for OCR of magazines, laser print and high quality images. [2], [3]

1.3 Neural Networks

The working of neural networks is a replica of human neural system. It samples the pixels in each character and matches them to a known index of character pixel patterns. The ability to recognize characters by abstraction is great for damaged text. [4], [5]

Though these methodologies have succeeded partially but their individual application leads to very complex and inefficient computations resulting in greater time and space complexity and lesser accuracy in results, since applying any one methodology on an input handwritten character leads to its comparison with the rest of twenty six English alphabets.

2. PROPOSED MODEL

Along with the Matrix Matching method being used currently, three new character recognition methods namely intersection count method, shape enclosed method and centroid based method are proposed to work together as layered filters in this system.

2.1 Intersection Count Method

This is a very simple yet an effective method of character recognition, in this method we count the number of intersection points made by intersecting edges in a character. Though handwriting varies from person to person, the basic way of writing an alphabet remains the same as in shown in figure 1.

Fig 1

In all the above glyphs of letter A, though the way they are written varies, yet the intersection count remains almost the same. It is three for letter A. For convenience we give a relaxation of ±1 for the number of intersections. A table giving details of intersection count for all the twenty six English alphabets is given in table 1.

Table 1

Alphabet	No. of intersections	Alphabet	No. of intersections
A	3	N	2
B	4	O	0
C	0	P	2

D	2	Q	1
E	3	R	3
F	2	S	0
G	1	T	1
H	2	U	0
I	0	V	1
J	0	W	3
K	2	X	1
L	1	Y	1
M	3	Z	2

Case – We assume the handwritten input character to be very similar to an ideal C. The intersection count method is applied and the count comes as zero. So, from table 1 it can be C, I, J, O, S or U . Thus, the comparison is reduced from twenty six to only six. This result is then passed through the next method called Shape enclosed method described next.

2.1 Shape-Enclosed Method

The isolated end point of a character is joined with another adjacent isolated end point with dotted straight lines. Then, we consider all the shapes enclosed within the alphabet and make a list of encountered shapes.

The following geometric shapes are considered in this method.

Table 2

Name of shape	Shape
Circle	
Semi-circle	
Triangle	
Rectangle	
Trapezium	

The shapes enclosed by all the twenty six English are given in table 3.

Table 3

Alphabet	**Shapes enclosed**	**Alphabet**	**Shapes enclosed**
A	1 triangle 1 trapezium	N	2 triangles
B	2 semi-circles	O	1 circle
C	1 circle	P	1 semi-circle
D	1 semi-circle	Q	1 circle
E	2 rectangles	R	1 semi-circle 1 trapezium
F	1 triangle 1 trapezium	S	2 semi circles
G	2 semi-circles	T	2 triangles
H	2 rectangles	U	1 semi-circle
I	None	V	1 triangle
J	1 triangle	W	3 triangles
K	2 triangles 1 trapezium	X	4 triangles
L	1 triangle	Y	3 triangles
M	3 triangles	Z	2 triangles

Case – The input handwritten character is A in this case. The isolated end points are joined at the base of the character so two enclosed areas are extracted namely, a triangle and a trapezium which is recorded.

2.3 Centroid Based Method

The glyph is divided into grids. The grids are taken as points.

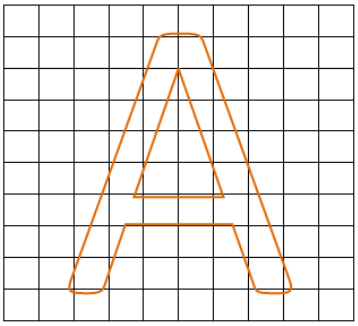

Fig 2

These points are located in the x-y Cartesian coordinate system. The grid blocks with black pixels are considered points.

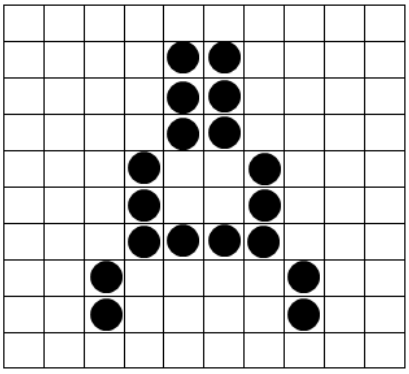

Fig 3

Since the x-y coordinates of the points are known, the centroid of the black points is obtained. The coordinates of the black points are (x1, y1), (x2, y2), (x3, y3) and so on

The centroid will be obtained by the expression.

$$(xc, yc) = [\frac{(x1+x2+x3+\cdots)}{k}, \frac{(y1+y2+y3+\cdots)}{k}] \qquad (1)$$

Here,
x1 , x2, x3… are the X coordinates of the black points and,
y1, y2, y3… are the Y coordinates of the black points.
k is the number of black points obtained.

Once the centroids are obtained, they are compared to the values of centroids for standard alphabets from the database.

If the obtained centroid of an input character is (x, y) then all the standard characters with centroid [(x±2),(y±2)] are selected. The two point relaxation is given to compensate the errors and irregularities which handwritten characters possess.

Case – Let the input be X then the input handwritten character will be divided into grids, 11*11 in this case. The centroid will be calculated. Next, the centroids of the output characters of the previous filters are calculated. One of the outputs from the previous methods will be X. Both the results are matched. Clearly, the centroid will be in the middle i.e., (5, 5).

3. WORKING: METHOD FILTERING

This paper has introduced three new methodologies of handwritten character recognition. These are in turn combined with the matrix matching method. All the methods are used sequentially and as the process continues, the number of possible matches keeps decreasing steeply and this makes the process fast and efficient.

The process to be used first is relatively less efficient than the next ones. Hence, the priority table is given by table 4.

Table 4

Priority	Method
1	Intersection count
2	Shape enclosed
3	Centroid based
4	Matrix matching

If only Matrix matching method were to be used, a given input would have been matched to all the other twenty six stores parameters. But in this process, the number of comparisons decreases when the next method is used and the combination of four different methods acts as a filter.

The working of the model can be easily understood by considering the following case.

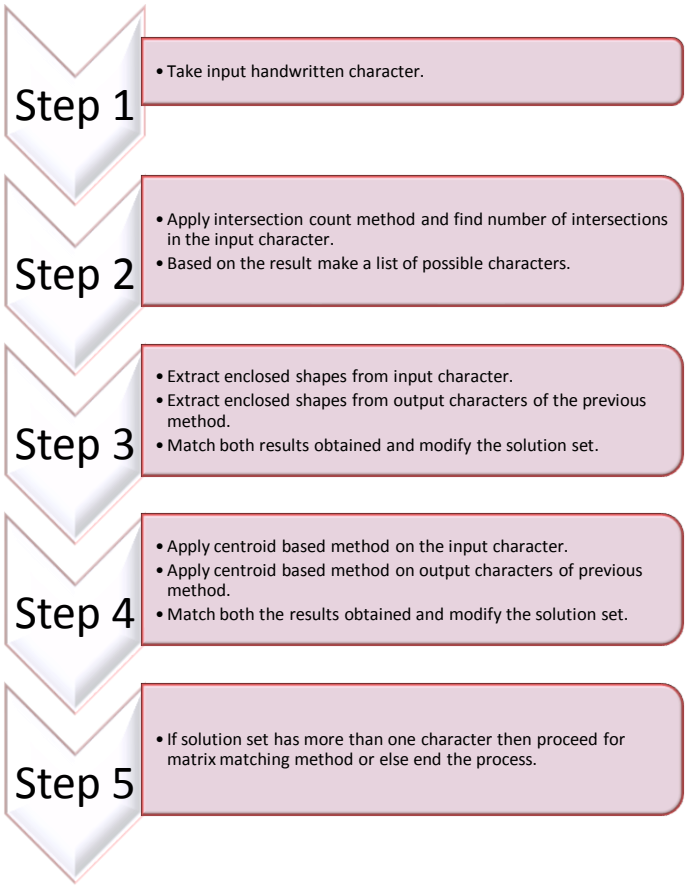

Fig 4: Flow of the process

Case – Handwritten input character is P.

First, number of intersection points is obtained by using the intersection count method which is two for this case.

According to the results of intersection count test and using the table 1, the following possible input characters are obtained. D, F, H, N, K, P and Z. As we go into the next filter, only seven possible characters remain in the solution set.

Second, the enclosed shapes from the handwritten input character are obtained using the shape enclosed method. For P, one semi-circle is obtained from table 3. The enclosed shapes for output characters of intersection count method are extracted using table 3. The solution set is modified accordingly and contains only P and D.

Third, the centroid based method is applied on the handwritten input character as well as on the output of the shape enclosed method, i.e. P and D. The result i.e. centroid for the handwritten character is matched with the centroids of output characters and the solution set is modified accordingly.

If the solution set has more than one element remaining then the matrix matching method is applied. And if only one element remains after applying the three methods then matrix matching method is not applied and the process ends recognizing the character.

4. FUTURE SCOPE

This paper focuses on these character recognition techniques for Majuscule form of the English alphabet.

It can be extended for Minuscule forms and also other languages and scripts with mere modifications.

5. CONCLUSIONS

It is described and justified that applying a filter based process that encapsulates different simple methodologies is much efficient both with respect to time as well as space and leads to greater accuracy than applying just one complex method.

Also, the filter is stopped as soon as the number of possible character is reduced to only one thus saving resources.

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