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Characters recognition using keys points and convolutional neural network

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ABSTRACT

In this paper, the convolutional neural network (CNN) is used in order to design an efficient optical character recognition (OCR) system for the Tifinagh characters. indeed, this approach has proved a greater efficiency by giving an accuracy of 99%, this approach based in keys points detection using Harris corner method, the detected points are automatically added to the original image to create a new database compared to the basic method that use directly the database after a preprocessing step consisting on normalization and thinning the characters. Using this method, we can benefit from the power of the convolutional neural network as classifier in image that has already the feature. The test was performed on the Moroccan Royal Institute of Amazigh Culture (IRCAM) database composed of 33000 characters of different size and style what present the difficulty, the keys points are the same in the printed and handwritten characters so this method can be apply in both type with some modifications.

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1. INTRODUCTION

One of the most leading field of research is the optical character recognition, however the majority of research are targeting the popular language such as others languages like Latin and Arabic and ignoring others languages speaking by minority like amazigh which is a homito-semitic language coming from ancient Berber language. this language have so many variety of dialects from Morocco, Libya, Egypt, Tunisia and Mali. This language is spoken today by about 14 million people, mainly in the Maghreb. The tifinagh characters is normally written left to right and from top to bottom, it is a non cursive writing simplifying the segmentation of characters in a text image Amazigh. because of the similarity in shape of the characters and the there number (33 characters) the preprocessing time is very high, those characters present a challenge to research to create an efficient system for optical character recognition.

In this current paper, we first give a review of others proposed tifinagh characters recognition systems developed by others searchers such as, Bencharef *et al.* [1] used in feature extraction the riemannian metric these metric descriptors are reliable toward change scale. Boutaounte *et al.* [2] are using the simplest possible geometric elements (segments and key points) to create the graph and extracting the impact matrix [3] for recognition. Essaady *et al.* [4] who give a proposition used an analytical method used freeman coding for feature extraction and finite automation in recognition step. Ayachi *et al.* [5], [6] gived two methods for

optical character recognition (OCR) system which used Moments invariants and Walsh transform for feature extraction, and the multilayer neuron networks and dynamic programming for the classification. In their work neural networks combined with walsh transform showed quite interesting results. Oujaoura *et al*. [7] proposed a system based on three features extractor GIST descriptors, texture, walsh, and bayesian networks in the classification for tifinagh characters recognition, but they have some problems in term of central processing unit (CPU) time and recognition rate. Amrouch *et al*. [8] used a directional feature vector sequence and continuous hidden markov models and these models are not a favoritism since each hidden markov models uses the learning of a single character, Zhiyi *et al*. [9], used Fuzzy pattern recognition in which they mainly classified each characters by methods according to maximum membership which posed a problem of recognition effecacity and in terms of processing time because of the descriptor vector size. Boutaounte *et al*. [10] presented an approach based on characters decomposition into multiples geometric shapes (segment, arc) by detecting the points of branch and end and using a comparison between different methods of classification such as neural network (NN), k-mean and support vector machines (SVM). Other work such as Wardani, [11] and Aharrane *et al*. [12] are based in the power of the convolutional neural network to build the OCR system, so the application of the convolutional neural network (CNN) or the deep learning in general are direct as other work in other language as the work of Finjan *et al*. [13] or El-Sawy *et al*. [14] applied in arabic language, Kadir *et al*, [15] used the CNN for number recognition in comparison with bag of features, Sadouk *et al*. [16] used a handwritten database but the recognition rate were between 95% and 98% but Benaddy *et al*. [17], used the CNN as a feature extractor and achieve a rate of 99%.

All the realized works are using the features extraction and with a classifier like neural network or support vector machine, others are using the convolutional neural network as feature extractor or as classifier that gave good results, but the problem are the time to extract the features and to do the leaning phase and the rate of recognition that why we chose to create a new method that use directly image with keys points as features and the power of CNN as classifier to decrease the time and increase the rate. This paper is organized as follows: section 2 presents the techniques used to detect the keys points in each characters. The used CNN is presented in section 3. In the section 4 the experimental results and discussions are mentioned and then the conclusion.

2. PROPOSED METHOD

The preprocessing consists on binarization, normalization and thinning [18] the image in order to reduce the number of data used in the recognition section by keeping only the important information. Since our database is composed of monochrome images. The harris method [19] are used to detect the keys points which are added directly to the image before using a convolutional neural network (CNN) [20] to classify them.

2.1. Normalization and thinning

Normalization is a first step of pre-processing to remove the unwanted area and put the character in the center of the image. To do it, the vertical and horizontal histogram of the image are calculated to find the border of the character, (Figure 1). The horizontal and vertical histogram are scanned to find the corners of the characters Figure 2 illustrate an example of character image normalization.

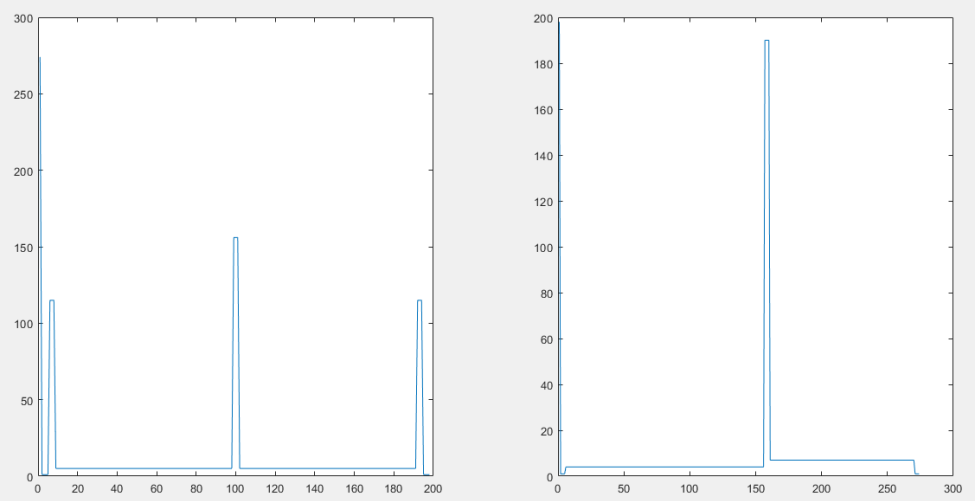

Figure 1. Vertical and horizontal histogram of the image

Due to its robustness and speed the Zhang and Wang [21] algorithm is adopted. Which is a parallel algorithm that produces a perfect skeleton 8-connected in a single iteration and which operates the collisions. The proposed system for recognition is made up of three main phases in Figure 3, the pre-processing phase the normalization and thinning, the isolation of the character block by elimination of unused information and then the character recognition block. In other words, the preprocessing step, feature extraction and the recognition.

The this work the skeleton of the characters with the keys points is presented in the first step, and thereafter it will be transformed to geometric simple shape such as lines or arcs [22]. The goal is to provide a structural description of the character. First, the key points of the character are extracted using harris corner detector in Figure 4.

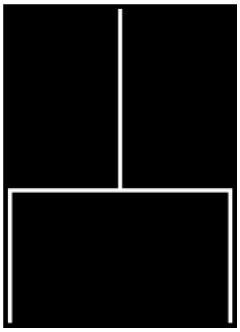

Figure 2. Result of normalization and thinning

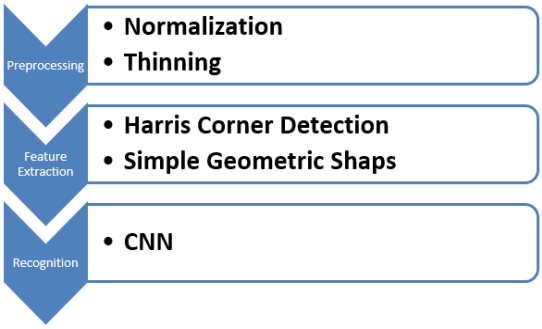

Figure 3. Tifinagh character recognition system

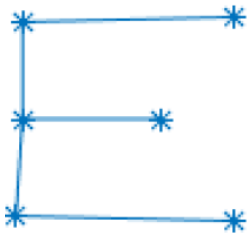

Figure 4. Key points detecter by harris method

The harris algorithm is an improvement of the moravec corners detector [23]. The principle of moravec algorithm is to consider a rectangular local window in the image to determine the average of the changes in the intensity in image by moving it to several directions .When the window undergoes a large sequence of change the minimum of it, is the corner or the point of interest. Assume that I is the intensity of the image, the changing E produced by the movement (x, y) is given by:

$$E_{x,y} = \sum_{u,v} w_{u,v} |I_{x+u,y+v} - I_{u,v}|^2 \quad (1)$$

where,

$$w_{u,v} = exp - (u^2 + v^2)/2\sigma^2 \quad (2)$$

The next step is distinct between the arc and segment, so for each two key points that are connected in the character, a segment is drawing between thereafter the distance among the drawing segment and the black pixels of the character that connect the two points in image is calculated. If the distance is equal to 0 it means that the geometric shapes between the two points are a simple segment, if not two possibly cases can be, first a simple geometrical shape in form of arc connected them or more than one connected segment due to an error in the method of segmentation in Figure 5.

In order to resolve this issue, the angle Y between the two key points and the point that have the biggest distance between the drawing segment and the black line that connect the key points is calculated and we set a threshold for this angle to determine the type of that geometric shapes. The Figure 6 shows the process of problem detection from the start to extracting the key points and also the simple geometric shapes [24]. The information collected in this step will be used to help the CNN in recognition step, a comparison was done between simple images and others with keys points to determine the utility of our method.

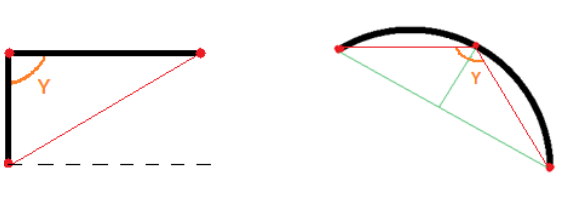

Figure 5. Determination of the Y angle to detect the segmentation error

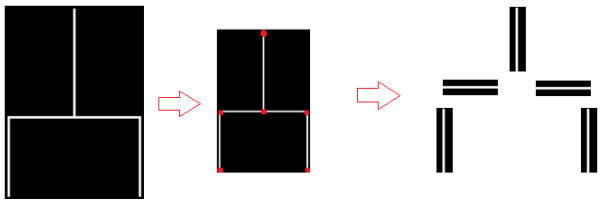

Figure 6. Extracting key points and simple geometric shape

3. EXPERIMENTAL RESULTS

We tested our approach of Tifinagh character recognition on the database of IRCAM. This database includes 33000 characters printed in different sizes and writing styles. In Figure 7 each character will be treated to detect the keys points using haris corner method, the identification effected by a convolutional neural network. To improve the efficiency of our method, we use a CNN white two convolution layers and 2 pooling layers, the training process is performed on a personal computer (PC) equipped with Intel UHD Graphics 620 and a processor i7 8th generation, the accuracy obtained of training and testing is showed in the Table 1.

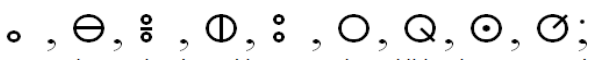

Figure 7. Similare character

Table 1. Accuracy

Variable	Accuracy (%)	Loss (%)
Simple method	96.12	3.88
Keys point method	99.39	0.61

The old method that uses feature extraction in tifinagh character recognition have several problems specially with character in Figure 7 that have a similarity of 80% or more, and to resolve the problem we need an additional treatment such as our previous work [25] or the recognition rate will be inferior to 95%. In this paper this kind of problem was solved by adding key points. The difference between the simple method and the new method using the key points is close to 4% with an accuracy of 99%. The Figures 8 and 9 are completing the table and showing the training progress of our CNN using the two methods.

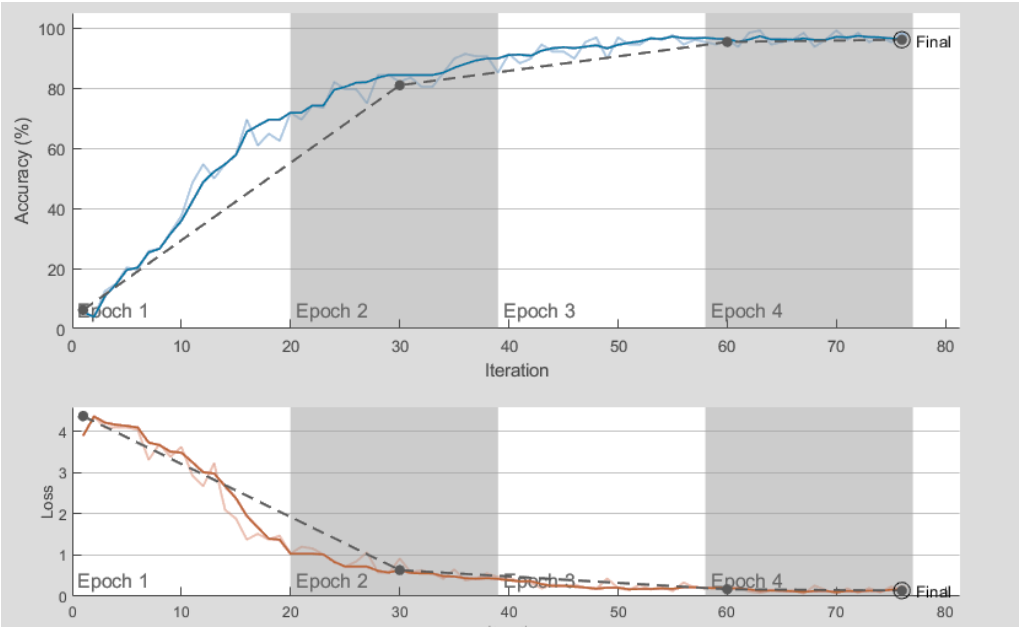

Figure 8. Accuracy and loss using the simple database

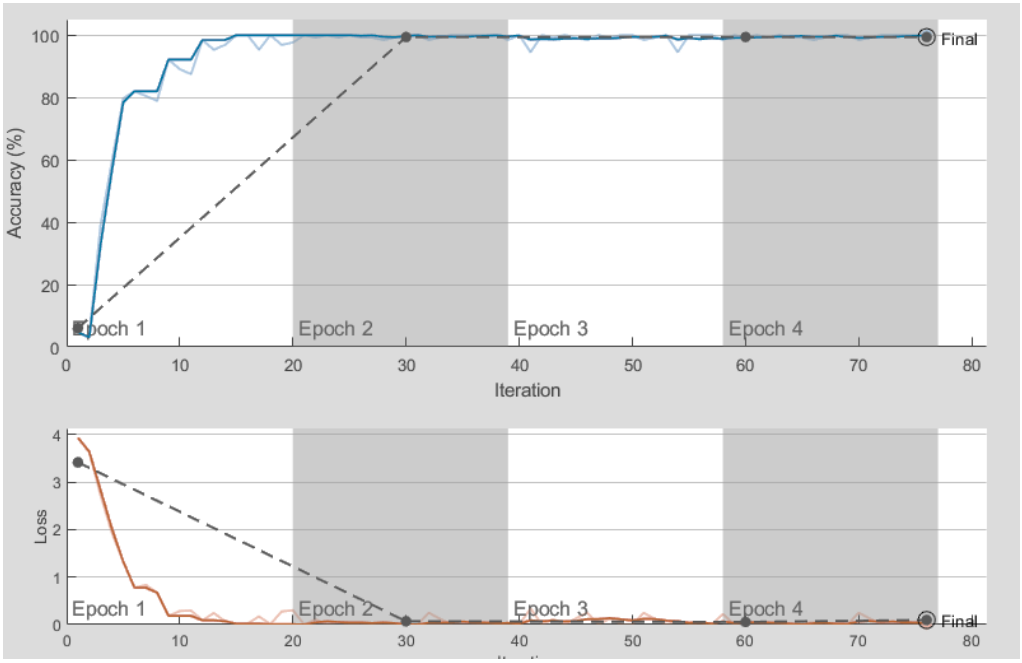

Figure 9. Accuracy and loss using the keys points database

4. CONCLUSION

In this work we presented a new technique for Tifinagh character recognition, using the key points and the geometric to correct the points detection error. The obtained results confirms that we have implemented an efficient method for characters recognition that can be used with other classifier , in future we can add more details to the characters image to improve the efficiency of the CNN, such as key points and types geometric shapes orientation. The obtained result are encouraging us to try this method on handwritten characters that need more preprocessing steps.

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