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딥러닝 기반 미얀마 문자의 특징 추출 및 인식

옴마킨* · 이성근*†

Feature Extraction and Recognition of Myanmar Characters Based on Deep Learning

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요 약

최근 동남아시아의 경제발전에 따라 정보기기의 활용이 광범위하게 확산되고 있으며, 지능적 문자인식을 이용한 응용서비스에 대한 수요가 증가하고 있다. 본 논문은 동남아시아 국가 중 하나인 미얀마 문자에 대한 딥러닝 기반 특징 추출 및 인식에 대해 논한다. 특징 추출에는 미얀마 알파벳(33자)과 숫자(10자리)를 사용한다. 본 논문은 9개의 특징을 추출하고 3개 이상의 새로운 특징을 제안한다. 각 문자와 숫자의 특징을 추출하여 성공적인 결과로 표현하였다. 인식 부분에서는 합성곱 신경망을 사용하여 문자 구분에 대한 실행을 평가한다. 제안한 알고리즘은 캡처된 이미지 데이터 세트에 구현되고, 이에 대한 성능을 평가한다. 입력 데이터 세트에 대한 모델의 정밀도는 96%이며 실시간 입력 이미지를 사용한다.

ABSTRACT

Recently, with the economic development of Southeast Asia, the use of information devices is widely spreading, and the demand for application services using intelligent character recognition is increasing. This paper discusses deep learning-based feature extraction and recognition of Myanmar, one of the Southeast Asian countries. Myanmar alphabet (33 letters) and Myanmar numerals (10 numbers) are used for feature extraction. In this paper, the number of nine features are extracted and more than three new features are proposed. Extracted features of each characters and numbers are expressed with successful results. In the recognition part, convolutional neural networks are used to assess its execution on character distinction. Its algorithm is implemented on captured image data-sets and its implementation is evaluated. The precision of models on the input data set is 96 % and uses a real-time input image.

Keywords

Deep learning CNN, Feature Extraction and Recognition, Myanmar Characters, Orientation, Texture, Skeleton

Ⅰ. Introduction

This paper discusses feature extraction and recognition of Myanmar, one of the Southeast Asian countries. Myanmar character originated in Indian Sanskrit. There are 33 letters and 10 numbers. These alphabet and numerals consist of curves and straight lines. They are extensively used and the Myanmar language is major. Myanmar alphabet and numerals are shown in

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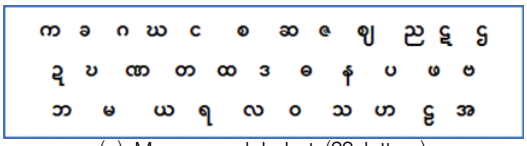
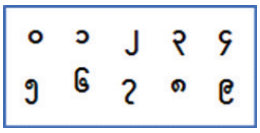
Figure 1. In this paper, we propose feature extraction and recognition for the Myanmar alphabet and numbers. Myanmar language includes 10 digits and 33 basic characters. This paper described the nine structural feature extractions for Myanmar character recognition. The nine features of the alphabet and numbers are extracted. It is very supportive of Myanmar characters recognition. In the previous paper, many previous kinds of research have been done in the field of feature extraction. The current method can be compared with the previous researches and new features are extracted in this research. CNN (Convolutional Neural Network) is used for identification and assess its execution on character recognition[1]. This paper is executed on image datasets and its performance is evaluated. Feature extraction is the vital process of character recognition. This paper presents more than three new features are extracted from Myanmar characters. These extractions can act as supporting material for those character recognition. Nine structural features are extracted and character recognition are represented in the methodology section and the experimental results are displayed in results and discussion.

The rest of the paper is structured as follows. In Section II, we present a related literature review. In Sections III and IV, we consider the method and results. Finally, in Section V, we conclude the paper.



(a) Myanmar alphabet (33 letters)



(b)Myanmar numerals (10 numbers)

Fig. 1 Myanmar letters and numbers

II. Literature Review

Zaw et al. show the signboard images that are captured by a phone camera for Myanmar text recognition[2]. Character recognition, line segmentation, and text extraction are essential steps for these signboard images. The experiment is investigated by template matching. The accuracy is 83.15% for character recognition from 150 captured images and 2854 characters are extracted correctly. The Myanmar printed old characters' recognition is described for feature extraction method in the paper [3]. This method is matched without extraction of feature and with extracted feature strategy. Optical Character Recognition (OCR) converts many documents of printing text or handwritten into machine encoded text. Myanmar old, printed characters' recognition is restricted in that case. The authors describe OCR that is applied in many applications[4]. Myanmar's OCR system is vital for journals, newspapers, and books. The various number of membership functions is operated to get the minimum mean absolute percentage error between recognized alphabets and actual alphabets. The research [5] is applied in data processing such as text-to-speech, examination question papers, postal address reading, reading aid for the blind, bank checks, etc. OCR is vital to alter numerous and journals, newspapers, and published books of Myanmar into readable computer files. This task is very supportive of Myanmar Character Recognition. Much previous research has been done in the field of OCR. The overall system architecture of pre-processing, post-processing, feature extraction, and classification are included in this research. Araújo et al. focus on the character segmentation and license plate recognition[6]. To recognize the vehicle by license plate numbers, License Plate Recognition (LPR) is used. Several phases such as license plate location, vehicle identification, and license plate interpretation are consisting in the automatic vehicle identification system. Vehicle number plate detection and number extraction is a combination of localization and OCR techniques. Currently, vehicles are a vital part of transportation. Vehicle controlling can solve a huge problem. They propose a character segmentation

method and a character recognition method based on the Harsdorf Distance algorithm. Plate localization is one of the most essential types of the transport system[7]. The license plate identification system is applied in many areas such as traffic monitoring systems, highway electronic toll collection, access control, public parking, etc. License plate localization and recognition (LPLR) is described in this paper. This work focus on Tanzanian license plates recognition. To get the good plate number accuracy, the image was enhanced, smoothing median filter and noise removal are used due to easy development. Automatic License Plate Recognition (ALPR) systems are used in the license plate of vehicles detection and recognition systems[8]. The vertical edge detection algorithm is used for the unwanted edges that are removed by the image normalization technique in this approach.

III. Methodology

The overall system architecture is shown in Figure 2. The image processing's processes such as input image data-sets, pre-processing, feature extraction, character classification using CNN, and experimental results are essential for the system architecture. Each alphabet is extracted for features and deep learning CNN is used to recognize characters. In this section, two main parts of feature extractions and recognition are expressed.

3.1 Extracted Letter and Number Features

The feature extractions are the most critical part for every recognition system because the character distinction accuracy depends on these. In this part, region, aspect ratio, horizontal strokes, vertical strokes, orientation, termination points, bifurcation points, texture, and skeleton are extracted. These nine structural features are investigated below.

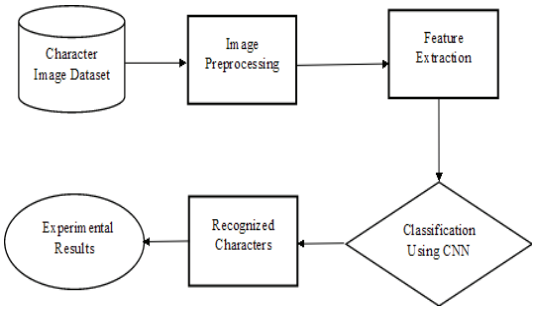


Fig. 2 The overall process for feature extraction

3.1.1 Region

It measures the total number of pixels of the character and can be calculated by:

$$R = \sum C(x, y) \qquad (1)$$

Where R is the region and C(x,y) the Myanmar character image.

3.1.2 Aspect ratio

It can be calculated the ratio between width and height of character.

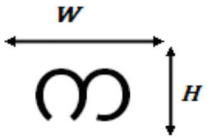


Fig. 3 Aspect ratio of a character

$$AR = \frac{W}{H} \qquad (2)$$

Where AR is the aspect ratio, W is the width and H is the height of the character image.

3.1.3 Horizontal stroke

It counts the number of binary points in the middle row of the character.

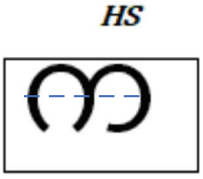


Fig. 4 Horizontal stoke of a character

$$HS = \sum_{j=1}^{n} C_{mrj} \quad (3)$$

Where HS is the horizontal stoke, C is the Myanmar character image, mr is the middle row of the C and n is the number of pixels in the middle row respectively.

3.1.4 Vertical stroke – It counts the number of binary points in the middle column of the character.

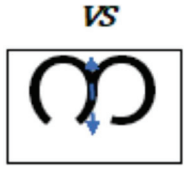


Fig. 5 Vertical stoke of a character

$$VS = \sum_{j=1}^{n} C_{mn} \quad (4)$$

Where VS is the vertical stoke, C is the Myanmar character image, m is middle column of the C and n is the number of pixels in the middle column respectively.

3.1.5 Orientation

It measures the angle be tween the x axis and major axis of the character.

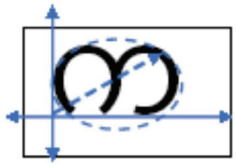


Fig. 6 Orientation of a character

3.1.6 Termination

Myanmar characters include termination points and they can be counted as below:

Fig. 7 Termination points of a character

$$SN = \sum_{i=1}^{8} \ni$$

$$TP_{(i,j)} = \begin{Bmatrix} 1, \text{ if } SN_{(i,j)} = 0 \\ 0, \quad Otherwise \end{Bmatrix} \quad (5)$$

Where TP is the termination point, N is the neighborhood pixel of and TP and SN is the sum of eight neighborhood pixels

3.1.7 Bifurcation

Bifurcation features are included in some of Myanmar characters and they can be counted as below:

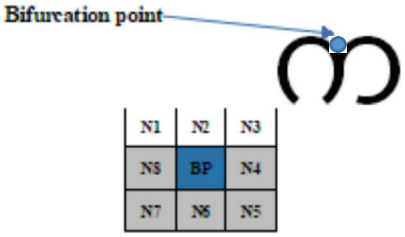


Fig. 8 Bifurcation points of a character

$$SN = \sum_{i=1}^{8} \ni$$

$$BP_{(i,j)} = \begin{Bmatrix} 1, \text{ if } SN_{(i,j)} \geq 3 \\ 0, \quad Otherwise \end{Bmatrix} \quad (6)$$

Where is the bifurcation point, N is the neighborhood pixel of BP and SN is the sum of eight neighborhood pixels.

3.1.8 Skeleton

It is useful feature for character recognition by a computer. It extracts the basic line types that form the character skeleton.

Fig. 9 Skeleton of a character

3.1.9 Texture

It is an important feature in the image and it is used to describe the contents of the region of image.

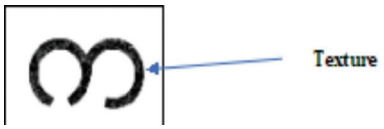


Fig. 10 Texture of a character

3.2 Myanmar Character Recognition

There are many advantages to recognition accuracy. All letters and numbers are experimented for recognition. They contain many curves and similar in shape to each other. In this research work, all of Myanmar letters and numbers have been investigated with the proposed method because English alphabets have already been completed in many previous works. In addition, most algorithms are not consistent with Myanmar characters because of the differences in shape and size. Accordingly, a powerful set of deep learning techniques, the CNN was designed.

3.2.1 The procedure of CNN model

CNN is one of the deep learning algorithms that accept information images and convolve them with filters or kernels to pull features[9][10]. 100 captured images are used for character recognition. The captured images are color images with 43 classes (33 letters and 10 numbers). The dataset has 100 images that are applied to train and test this model. The training images have 80 and the testing images have 20. Individually class includes 3 images for the test batch that are haphazardly picked. In this proposed method, each image size is 4288*2848 pixels and 300 dpi resolution which are provided as intake to the procedure. An N×N image is convolved with a f×f filter and this convolution process comprehends the same feature on the whole image. The window drops after each process and the features are retained by the feature maps. The feature maps catch the local sensory field of the image and operate with shared weights and biases. The deep learning, CNN neural network is explained with Figure 11 and step by step as process is as follows: For the input layer, set the same weight value to the input neurons. The inputs of the two hidden networks and calculate the error′s gradients concerning the renewed neurons weights onward with the network. This step frequently reworks the neuron value and their weights to adjust the activation procedure and the incorrect error managing procedures. Consequently, the recognition mistakes of the outcome are reduced. The outcome layer retains the neurons to pay the characteristic effects to be identified.

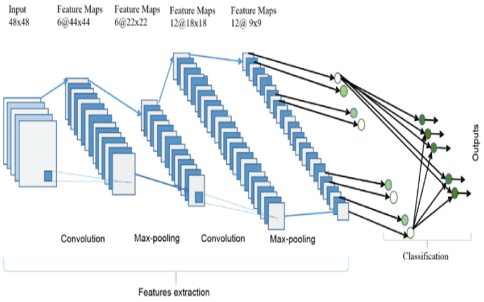


Fig. 11 CNN procedure for character recognition

IV. Result and Discussion

The system has experimented with Myanmar letters and numbers. It is the offline analysis. In this paper, nine features are extracted such as region, aspect ratio, horizontal strokes, vertical strokes, orientation, termination points, bifurcation points, texture, and skeleton. We tested to demonstrate the usefulness of the presented

approach. The proposed technique is executed on Jupyter Notebook 6.3.0 and experimented with captured images by the phone camera and online photos to test distinct forms of images. Totally there are 100 images with JPEG formats. Nearly all images are satisfactorily recognized. The results of feature extraction of the 10 numbers are displayed in Table 1. Table 2 shows the feature extraction results for some Myanmar characters. The successful character recognition results are illustrated in Table 3. Table 3 shows the successful results. Only 4 out of 100 images could not be recognized because of the blur and similar shape of that character input images. This incorrect rate is (100-96)/100 = 0.04.

Table 1. Extracted Features for Numbers

Class (10 Numbers)	Extracted Features								
	Region	Aspect Ratio	Horizontal Stoke	Vertical Stoke	Orientation	End points	Branching Point	Skeleton	Texture
๐	2767	0.10	101.46	100.96	56.66	2	2	205.00	0.92
๑	2478	0.48	105.74	93.00	86.32	5	3	195.00	0.93
๒	2625	0.89	174.39	81.18	63.12	5	3	219.00	0.94
๓	3303	0.84	154.76	83.42	81.27	7	5	274.00	0.93
๔	3336	0.84	154.06	83.50	-81.11	5	3	259.00	0.93
๕	4816	0.80	173.97	105.51	-87.72	6	6	379.00	0.92
๖	4613	0.82	175.14	99.64	-87.68	10	8	370.00	0.93
๗	3344	0.83	168.51	92.86	-74.29	5	3	268.00	0.92
๘	3031	0.38	97.21	90.09	9.51	4	4	243.00	0.90
๙	4617	0.83	175.69	99.13	87.41	9	7	374.00	0.93

Table 2. Extracted Features for Letters

Class (33 Letters)	Extracted Features								
	Region	Aspect Ratio	Horizontal Stoke	Vertical Stoke	Orientation	End Points	Branching Point	Skeleton	Texture
ก	4500	0.85	189.93	99.01	-1.99	9	7	353.00	0.92
ข	3070	0.36	96.97	90.45	78.69	6	6	251.00	0.91
ค	2462	0.52	107.23	91.85	1.34	6	4	187.00	0.91
ฆ	5042	0.84	188.60	101.60	-1.17	9	7	379.00	0.92
ง	2482	0.47	105.56	93.19	-85.41	5	3	198.00	0.92
จ	3269	0.05	95.33	95.20	-37.50	2	4	252.00	0.91
ฉ	5417	0.81	173.30	101.46	2.19	6	8	420.00	0.92
ช	3282	0.27	97.78	94.25	3.25	8	8	280.00	0.90
ฯ	6078	0.76	167.71	108.90	-60.72	7	9	493.00	0.92
ญ	7363	0.35	194.78	182.22	42.10	10	8	579.00	0.95

Consequently, the accurateness rate is good and gives the best experimental results even taking the inaccurate recognition of the image. The research results of this paper are expected to be utilized in various application services based on Southeast Asian character recognition that have similar characteristics.

Table 3. Accuracy result for Letters and Numbers

Input Characters	Total Images	Successful Images	Successes Ratio(%)
Letters	70	67	95.7%
Numbers	30	29	96.6%
Average Accuracy			96%

Ⅴ. Conclusion

This paper presents the nine structural feature extraction of Myanmar characters such as region, aspect ratio, horizontal strokes, vertical strokes, orientation, termination points, bifurcation points, texture, and skeleton. Each of these feature extraction contributes directly to the accuracy of the recognition part. The uniqueness feature extraction is very supportive of character recognition. The recognition role has its unique accuracy, but many input character images need to have been experimented for future development. The precision of models on the input data set is 96 % and uses a real-time input image. In addition, the current method is compared with the conventional method[11] in which the recognition of character is executed using the partially cut character structure. In the conventional method, 93% of license plate characters are recognized. So, our method is better performance and success rate than the conventional method.

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