Identity Card Number Recognition System using Artificial Neural Network

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Abstract

This paper proposes a system for recognizing the identity card number. The quality of the color image of identity card is enhanced by image filtering technique. Color sensing is carried out to get the image portion of the identity card number. Noise canceling is performed to remove the unwanted pixel areas. The characters and digits are segmented out individually by horizontal and vertical Histogram projections. The individual images of printed Myanmar characters and handwritten Myanmar digits are resized into predetermined size to get uniformity. These preprocessed images are applied into the ANN of the proposed system. The ANN is designed with three layers; input, hidden and output layer. The output values of the output layer are the certainty values of digits and characters. The highest certainty output value is the digit or character that is recognized by the network. After all the digits and characters are recognized, the proposed system identifies out the identity card number.

1. Introduction

Optical character recognition (OCR) techniques become the overwhelming techniques of today's world. In the real world applications, sometimes, the need often arises that the printed documents have to be entry into the computer. In such situation, character recognition is very well suited. The character recognition system identifies out the scanned image of the printed document. Not only in the data entry, but also in other certain applications, the OCR techniques can effectively be utilized. OCR can be divided into two types of recognitions: printed character recognition and handwritten character recognition.

Handwritten character recognition is more heuristic approach since it contributes a very large number of variations and styles of digit and character patterns written by different people. Handwritten Character Recognition Systems have been developed for many languages and character sets. Several methods for recognizing Latin, Chinese, Japanese, Greek characters have been proposed, while the recognition of Myanmar characters and digits has been relatively sparse. Therefore, this paper proposed a recognition system for printed Myanmar characters and handwritten Myanmar digits representing the identity card number on an identity card. Image processing techniques together with ANN have to be applied to implement the system. Primarily, the image of an identity card is pre-processed by means of the image processing techniques to get the individual noise-free, uniform-sized digits and characters in order to use for the ANN to train as well as to identify the identity card number. The ANN is trained repeatedly till the recognition of the various printed Myanmar characters and handwritten Myanmar digits concerned is achieved. Hence, the proposed system can be seen to be composed of two major portions; the image processing portion and the ANN[2].

The next section, Section (2), highlights the image processing stages needed in this proposed system. The design of the ANN of the proposed system is discussed in Section (3) with step by step manner. The conclusions and further extensions of the proposed system are stated in the Section (4).

2. Image processing portion

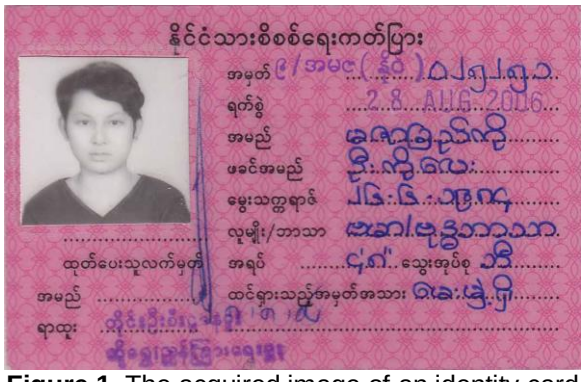

Figure 1. The acquired image of an identity card

The color images of the identity cards with different printed Myanmar characters and handwritten

Myanmar digits representing the identity card numbers are acquired by means of a digital imaging device. The acquired images are stored in the bitmap file format with the resolution of 300 dpi.

2.1. Mean filtering stage

Figure 2. The mean-filtered image

The acquired color image of the identity card is poor at quality and does not fit for the next image processing steps as well as for the ANN. Therefore, to enhance the quality of the image, mean filtering technique is applied. Mean filtering is the most common process used extensively in smoothing and denoising applications. The mean filter considers each pixel in the image in turn and looks at its nearby neighbors to decide whether or not it is representative of its surroundings. The mean color value is calculated from all the pixel values from the surrounding neighborhood. The pixel being considered is then replaced with the calculated mean pixel value. If the neighborhood under consideration contains an even number of pixels, the average of the two middle pixel values is used to replace the pixel being considered [4].

2.2. Color sensing stage

The area of the image containing only identity card number must be extracted from the entire in order to get the printed Myanmar characters and handwritten Myanmar digits representing the identity card number.

The color sensing method is applied in this system to extract the area of interest since this area conveys certain distinct color different from all other portions on the identity card. Unfortunately, there are also certain image portions with the similar color of area of interest. But, fortunately, even though there are similar colors, the area of interest is at the first portion of the entire image. With careful analysis with trial and error approach, to extract the area of interest optimally, the threshold values are achieved as follows:

If Red value of a pixel is greater 40 than Green and Blue value is greater 55 than Green, then this pixel is taken as printed Myanmar characters portion.

If Blue value of a pixel is greater 20 than Red and Blue value is greater 20 than Green, then this pixel is taken as handwritten Myanmar digits portion.

Actually, the color sensed images are of binary images with the detected pixels marked as binary 1 and the other marked as binary 0; black for the area of interest containing the identity card number and white for the background.

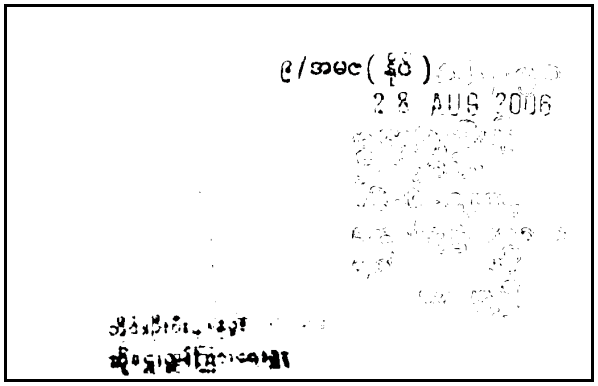

Figure 3. Color sensed portion of the image containing area of printed Myanmar characters of identity card number

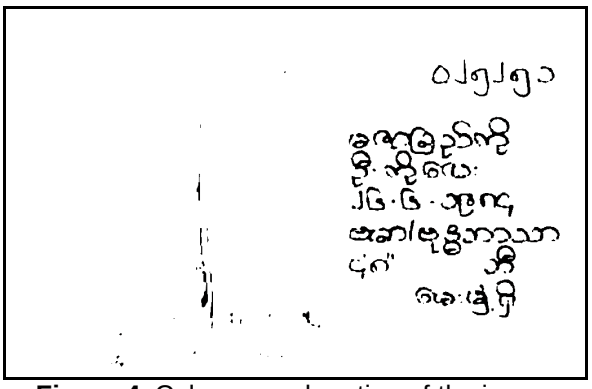

Figure 4. Color sensed portion of the image containing area of handwritten Myanmar digits of identity card number

2.3. Noise canceling stage

Depending on the quality of the identity card and the quality of service in the image acquisition stage, there may certainly be noises on the resultant color sensed binary image. Even thought the filtering stage is implemented to enhance the quality of image, some areas on the identity card may not be necessarily smoothen out and give binary '1s' as if such areas are area of interest in the color sensing stage. But, the point here is that, those areas are of very small sizes (under 30 pixels) and can be eliminated out by filtering with object size; this stage is said as the noise

canceling stage in the image processing [6].

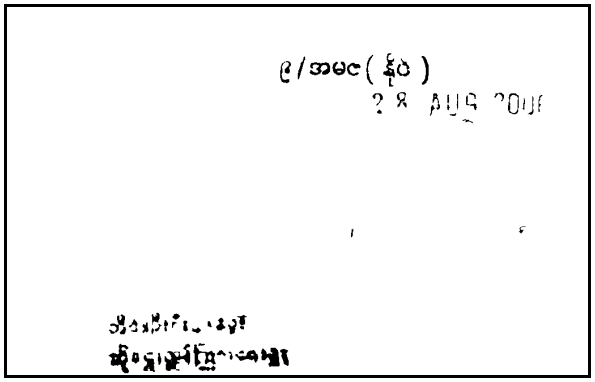

Figure 5. Noise canceled binary image of figure 3

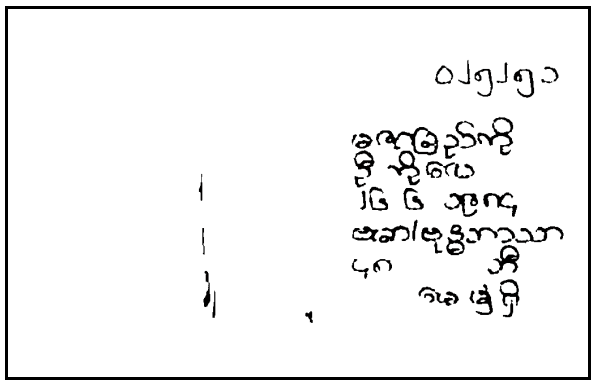

Figure 6. Noise canceled binary image of figure 4

2.4. Segmentation stage

The noise canceled binary images contain many other areas those are not concerned with identity card number. Primarily, these binary images have to be segmented out horizontally to get the digits as well as characters row by row. After row by row segmentation, each row is then again segmented vertically to get individual characters and digits separately. As discussed in the previous section, even though there are certain other image portions with the colors similar to the area of interest, the area of interest is at the first portion of the entire image. Therefore, after the horizontal segmen-tation, only the first segmented row is taken as the only portion of the area of interest and all other rows are discarded.

For both horizontal as well as vertical segmentation, the histogram projection is applied. As can be seen from Figure 7 to 10, in both horizontal and vertical histograms, the smallest histogram values are indicating the place to be segmented. There must be certain histogram values at the characters as well as digits areas in both horizontal and vertical Histograms. Therefore, by means of Histogram projection, after horizontal as well as vertical segmentation, individually cropped binary images of printed Myanmar characters and handwritten Myanmar digits representing the identity card number are obtained [1].

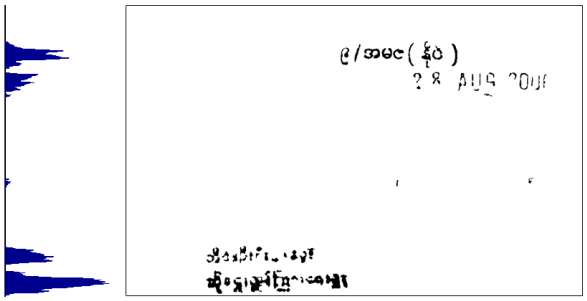

Figure 7. Horizontal Histogram projection upon figure 5

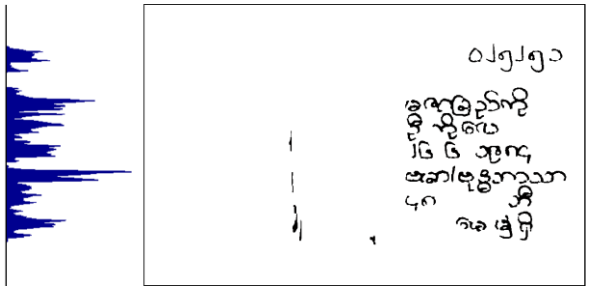

Figure 8. Horizontal Histogram projection upon figure 6

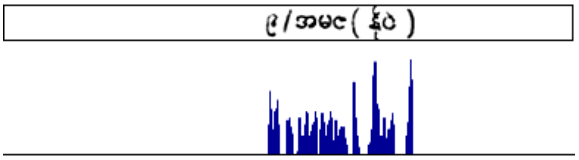

Figure 9. Vertical Histogram projection upon printed Myanmar characters

Figure 10. Vertical Histogram projection upon handwritten Myanmar digits

Figure 11. Individually segmented printed Myanmar characters of identity card number

Figure 12. Individually segmented handwritten Myanmar digits of identity card number

2.5. Resizing stage

The Myanmar characters and digits of identity cards of various people are certainly of various sizes. In order to not only be easy to learn by the ANN but also to get higher accuracy in the recognition by the ANN, the sizes of the individually cropped digits and characters are resized into the predetermined size of the matrix area, 32 x 32 for this system. Resizing stage makes the sizes of individual digits and characters to be uniform. The predetermined size has to be adjusted between the speed and accuracy of the ANN.

This stage is the last stage of the image processing portion of the system. After this stage, the individual noise-free uniform-sized binary images of the printed Myanmar characters and handwritten Myanmar digits representing the identity card number suitable for the input to the ANN are obtained.

Figure 13. The uniform sized characters and digits as the result of resizing stage

3. ANN of the proposed system

The whole character or digit itself is used as the neural network input. The network that has been used is a three layer feed forward neural network. Feed forward networks may have a single layer of weights, where the inputs are directly connected to the outputs, or multiple layers with intervening sets of hidden units. Neural networks use hidden units to create internal representations of the input patterns. In fact, it has been shown that with hidden units, it is possible to approximate any characters and digits. Therefore, this proposed system uses three-layered feed forward architecture, containing input layer, hidden layer and output layer, to get more and more generalization upon Myanmar characters and digits.

In the feed forward architecture, the activations of the input units are set and then propagated through the network until the values of the output units are determined. The network acts as a vector-valued function taking one vector on the input and returning another vector on the output. For instance, in case of this system the input vector might represent the characteristics of one of the Myanmar characters (say 'ma') and the output might be a prediction of whether that character is likely to be 'ma' [3].

The network functions as follows:

1. Each neuron receives a signal, x_j, from the neurons in the previous layer, and each of those signals is multiplied by a separate weight value, w_{kj}.
2. The weighted inputs are summed, v_k, and passed through a limiting or activation function, φ, which scales the output to a fixed range of values, that is in this case, within 0 and 1.

$$v_k = \sum_{j=0}^{m} w_{kj} x_j$$

$$\varphi(v) = \frac{1}{1+\exp(-av)}$$

3. The output of the limiter is then broadcast to all of the neurons in the next layer [5].

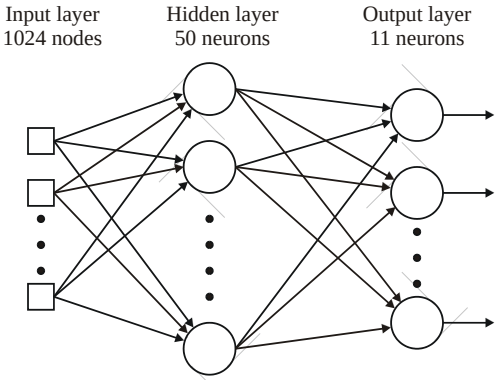

Figure 14. The architecture of ANN for printed Myanmar characters

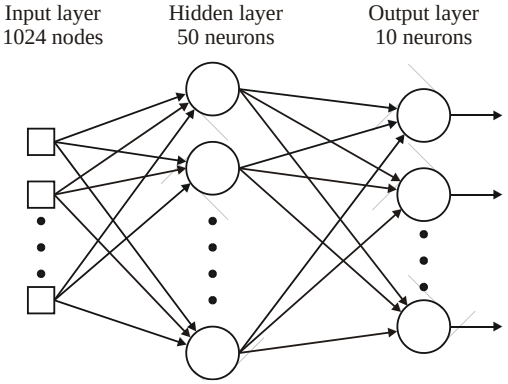

Figure 15. The architecture of ANN for handwritten Myanmar digits

Values acquired after image processing portion are fed into the layer downstream the input layer (the hidden layer). Once the neurons for the hidden layer are computed, their activations are then fed downstream to the next layer, until all the activations eventually reach the output layer, in which each output layer neuron is associated with a specific classification category. In a fully connected multi-layer feed forward network, each neuron in one layer is connected by a weight to every neuron in the layer downstream it. A bias is also associated with each of these weighted sums. Thus in computing the value of each neuron in

the hidden and output layers, first, the sum of the weighted sums and the bias is taken, and then f(sum), the sigmoid function, is applied to calculate the neuron's activation.

Training basically involves feeding training samples as input vectors through a neural network, calculating the error of the output layer, and then adjusting the weights of the network to minimize the error. Each "training epoch" involves one exposure of the network to a training sample from the training set, and adjustment of each of the weights of the network once layer by layer. Selection of training samples from the training set has been taken in random. Training can stop when the network error dips below a particular error threshold (a threshold of 0.001 squared error has been chosen in this case) [3].

Table 1. Summarization of the architectures of two ANNs of the system

Architectures of the two ANNs of the System					
	Input Layer (nodes)	Hidden Layer (neurons)	Output Layer (neurons)	Transfer Function	Training Algorithm
Character	1024	50	11	Log-Sigmoid	Back-Propagation
Digit	1024	50	10	Log-Sigmoid	Back-Propagation

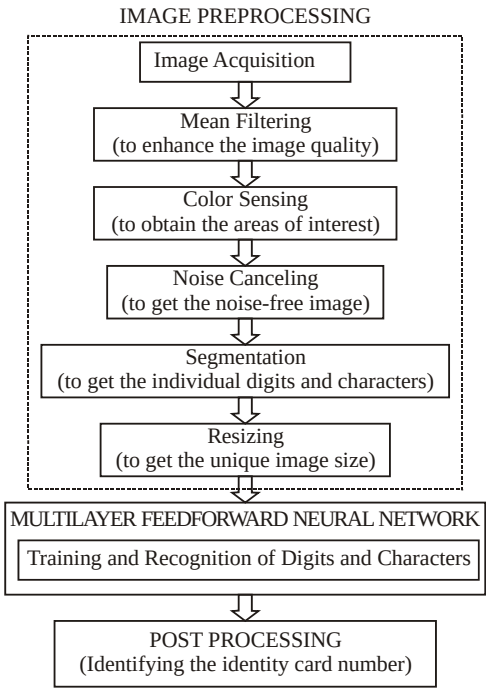

Figure 16. The flowchart of the system

Architecture of the printed Myanmar characters of identity card number recognition network is as follows:

- Input layer: 1024 nodes
- Hidden layer: 50 neurons
- Output layer: 11 neurons (for each character of "ကခဂဃငစဆဇဈဉ")
- Transfer function: log-sigmoid
- Incremental training algorithm, standard back-propagation method

Architecture of the handwritten Myanmar digits of identity card number recognition network is as follows:

- Input layer: 1024 nodes
- Hidden layer: 50 neurons
- Output layer: 10 neurons (for each digit of "၀၁၂၃၄၅၆၇၈၉")
- Transfer function: log-sigmoid
- Incremental training algorithm, standard back-propagation method

In the proposed system, only the identity cards of Mandalay are carried out, and so, common digits and characters, ဓ/ and (နိုင်), are set as default without the ANN. To get high accurate result, fifty training sets are used to train the two ANNs of the proposed system. Hundred testing is performed to find out the accuracy in % for both digits and characters, the resultant accuracy values are listed in Table 2.

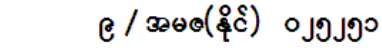

Figure 17. The recognized printed Myanmar characters and handwritten Myanmar digits

Table 2. Accuracy of the system in percentage

Accuracy in Percentage			
Character	Accuracy	Digit	Accuracy
က	80	၀	80
ခ	70	၁	70
စ	80	၂	90
ဇ	90	၃	80
ဈ	70	၄	90
ဉ	90	၅	80
ဝ	80	၆	70
ဗ	70	၇	90
ရ	90	၈	80
ဟ	70	၉	70
အ	70		

4. Conclusion, limitations and further extensions of the system

Many experiments and testing have been made

related to this system and achieved certain amount of satisfactory accuracy rate. In this system, it is needed to recognize the limited printed Myanmar characters (က, ခ, စ, ဇ, တ, နှ, ပ, မ, ရ, ဟ, and အ). The area of interest on the identity card is also limited at identity card number position. However, all the handwritten Myanmar digits (၀ to ၉) have to be recognized by this system. Hence, it is found that the system is of lesser accuracy for the handwritten Myanmar digits than the printed Myanmar characters.

It is found that when developing this system, the system recognizes only one type of printed Myanmar characters and handwritten Myanmar digits if the system is trained with a single set of printed Myanmar characters and handwritten Myanmar digits repeatedly. To be more intelligent, the system is trained with a single set of printed Myanmar characters and handwritten Myanmar digits; and after that, the system is trained with another sample of printed Myanmar characters and handwritten Myanmar digits without using the prior sample. When all the training sets are learned by the ANN, to get more and more intelligibility, the whole training process is repeated. After a certain number of training iterations, the ANN of the system is of well trained with printed Myanmar characters and handwritten Myanmar digits. In the proposed system, the number of training sets is limited.

The more number of images of printed Myanmar characters and handwritten Myanmar digits should be used to train the ANN as the further extension of the system. This system can extract and recognize printed Myanmar characters and handwritten Myanmar digits by sensing only on the predetermined threshold colors. Therefore, the system that can extract and recognize printed Myanmar characters and handwritten Myanmar digits with any color should be extended in future works.

It is found that this system may fail to recognize when the image of the identity card is skew or distorted. So orientation adjustments as well as certain image enhancements should be added as the future analysis. The system cannot accurately crop row by row when the scanned image size of identity card is not unique. Therefore, the image size of identity card should be exactly cropped before applying into the system.

The system also fails to recognize the closely written digits according to method of segmentation used in this system. This fact becomes a limitation of this system and should be materialized as future work.

Another techniques, such as, Fuzzy logic should also be applied in the future system in order to get more accurate recognition of printed Myanmar characters and handwritten Myanmar digits. A separate Fuzzy logic system as well as ANN associated with Fuzzy logic should be developed for further analysis.

5. References

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