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Currency Recognition System Using Image Processing: Libyan Banknote as a Case Study

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ABSTRACT

Banknote recognition in the field of image processing is used to distinguish between banknotes of different countries and determine their values. One of the problems that emerged with this process is the recognization of the banknote. The recognition operations for Libyan currency denominations comprise six stages: image capturing, preprocessing, target region extraction, number segmentation, currency value recognition, and output with screen displaying and voice. The currency recognition system is implemented by comparing the similarity of each banknote value template via image processing steps in the Matlab environment. To prove the effectiveness of the proposed system, the number of banknote images with two types (new and medium) from each of the four types of denominations were tried.

Key words: Currency recognition, Image processing, Libyan currency, Matlab.

1. INTRODUCTION

Recognition of a currency is generally known as a classification Denomination banknote that mean value Currency note from different countries. Rating and calculation all banknotes on hand will be boring, long and error prone. Therefore, it is an automated and reliable currency Recognition and counting are good options for transactions Handle different types of tasks such as selling merchandise to the public Transportation, gas stations, banks, etc. Until now, there Many works have been developed to identify the single currency (currency for a specific country) for example Bangladeshi currency [1], Mexican currency [2], US dollar [3], Indian currency [4] Although a lot of research is working to identify currencies For different countries, there is little work done on paper Getting to know the Libyan currency The benefit of this work is the design and development of a framework Four types of. Recognizable Libyan currency denominations that are currently circulating in everyday life (5, 10, 20, 50). The first table shows the four types of The Libyan banknotes used in this work. In addition to organizing the rest, the sections are as follows: The second section is for the creation form database. Suggested approach as for the recognition of the Libyan currency, it is discussed in the third part of this paper.

Table I: Libyan currencies

Currency Value	Obverse	Reverse
5 Dinar		
10 Dinar		
20 Dinar		
50 Dinar		

2. LIBYAN CURRENCY SPECIFICATION

Features of the Libyan currency

There are many features in the Libyan currency; the Libyan Bank decided it. Figure 1. Give an idea about the features of the currency denomination 20 dinars.

Figure 1: Security Features 20 Dinar.

The height and width of the currency

Currency notes have distinct widths calculation of diagonal values (See the following formula) Due to the high circulation of currency notes, boundaries of notes are folded or damaged easily and the size of the note will get change. Hence, considering only the width and height of the notes, are not enough to identify currency notes

$$R = \sqrt{w^2 + h^2} \quad (1)$$

R : the diagonal of the currency
w : the width of the currency
h : the height of the currency

Average the color values of the currency

Each pixel has a red component, a green component, and a blue component called RGB value so, given an image, we can calculate the average value of red, blue and green according to the formula that gives values very close to each denomination of banknotes. The color contrast on the note of the captured banknote would give fair accurate results for new banknotes. Old currency notes, due to frequent circulation and excessive use, the colors of some categories of notes tend to overlap each other. Then use RGB only Values to distinguish or identify observations will not be sufficient.

$$\text{Mean(Red)} = \frac{\Sigma\text{Values of red color of pixels}}{\text{total number of the pixels of image}} \quad (2)$$

$$\text{Mean(Blue)} = \frac{\Sigma\text{Values of red color of pixels}}{\text{total number of the pixels of image}} \quad (3)$$

$$\text{Mean(Green)} = \frac{\Sigma\text{Values of red color of pixels}}{\text{total number of the pixels of image}} \quad (4)$$

The Blind Recognition (BR) currency

Above-mentioned features will not always give accurate results for used currencies. Hence additional methods need to be used to identify currency notes. One solution to identified issue is to get the Blind Recognition value (Figure 2). Image processing methods like Feature extraction and Edge Detection have been used for this purpose. Similarly, several image processing filters has been used without effecting the basic features of an image

Figure 2: Blind Recognition Circles

The Read Serial Prefix and Artistic impression

Another parameter that we can use is reading text and words which is unique to each denomination of currency note. Serial Prefix (4) and text which describes the Artistic impression (2) on currency image (Figure 1) are some of the unique characters that can be used.

3. PROPOSED SYSTEM

The system proposed here works here on the image of the paper currency obtained by the scanner. The algorithm implemented here is as follows

1. Get a picture of the paper currency from a scanner.
2. The obtained image is an RGB image and is now converted to a grayscale image.
3. Edge detection of full gray scale image.
4. The features of the paper currency properties will be cropped and split.
5. After the split, the characteristics of the banknotes are extracted.
6. The intensity of each feature is calculated.
7. If the condition is met, the currency denomination will be recognized.

In this system, the characteristics of banknotes that are used by the common people are used Differentiate between different denominations of banknotes that were discussed in the previous section Figure 3 given below describes flowchart for currency Recognition.

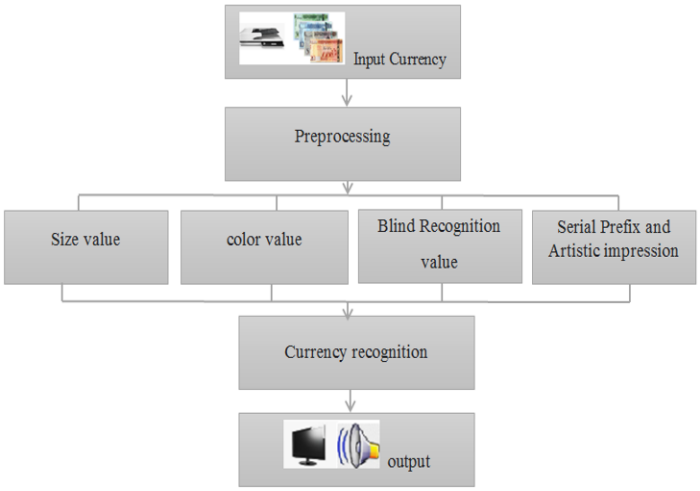

Figure 3: The architecture of proposed system.

1. **Image Acquisition**: Performing image acquisition in image processing is always the first step in the workflow sequence because, without an image, no processing is possible. After the image has been obtained, various methods of processing can be applied to the image to perform the many different vision tasks. There are various ways to acquire image such as with the help of camera or scanner. Acquired image should retain all the features [5]. The following figure shows the image acquisition of Libyan banknote from the denomination of fifty dinars.

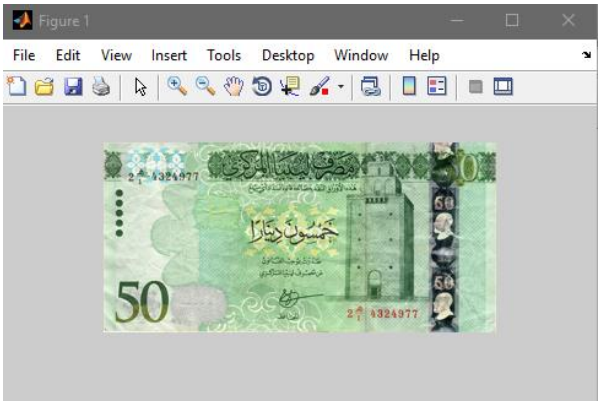

Figure 4: Input Image.

2. Preprocessing: serves as the front end for recognition system, which transforms the coarse image data into a suitable format. In the preprocessing of the images, the following process steps are needed: gray scale converting, image binarization, noise filtering, morphological operation, and black area extraction for all types of currency images.

2.1. Gray scale conversion: Images from your camera or scanner are usually in the form of 24-bit true color images. Therefore, the image is first converted to grayscale and resized as shown in figure 5 that will be processed more easily and efficiently for successive steps.

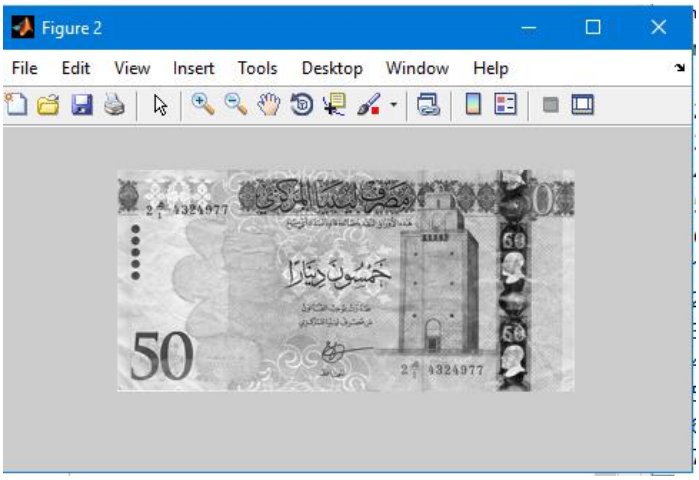

Figure 5: Gray Scale Image.

2.2. Binarization: The grayscale image is further processed into a binary image as illustrated in figure 6 that will reduce storage space and fast process speed. For this process, Otsu's method [6] is used. Otsu's method finds the threshold level of image and then the calculated threshold that minimizes the variance within the classes, i.e. black and white. Each black pixel is assigned value to 0 and each white pixel is assigned value to 1.

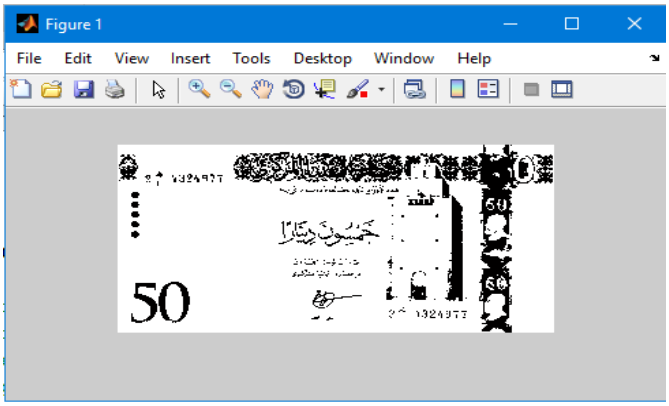

Figure 6: Binary Image.

2.3. Noise filtering: Various noises can appear in digital images during capturing and transmission due to environmental condition and the quality of sensors. Noise may affect segmentation and pattern matching. Hence, we want to eliminate salt and pepper noise and we work with non-linear filter known as median filter. They are also called order-statistics filter, because their response is based on the ordering or ranking of the pixels contained within the mask. It preserves edges while removing unwanted noise [7]. In our system 5x5 size of mask is used.

3. Edge Detection: Because of circulation, edges of the currency notes are usually worn and torn when they get old. Therefore, to overcome the problem of recognizing noisy currency notes, need to apply a suitable pre-processing step. Edge detection is a fundamental tool in image processing and computer vision, particularly in the areas of feature detection and feature extraction, which aim at identifying points of a digital image. Edge detection reflects sharp intensity changes in colors of the image as shown in figure 7. There are many ways to perform edge detection. Gradient and Laplacian are the mostly used methods. Since there are lots of objects and shapes on Bank notes, which are unique to each denomination, the use of edge detection techniques will be helpful to success the research in terms of accuracy.

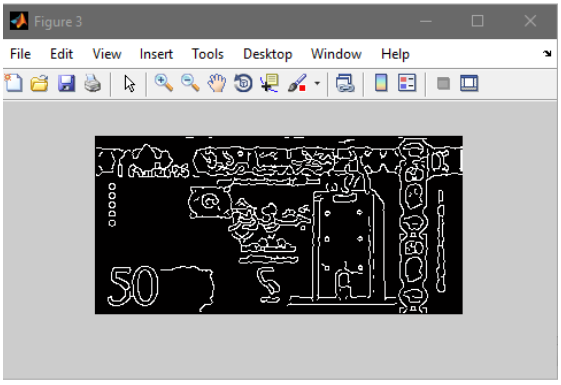

Figure 7: Edge Detection Image.

4. Image Segmentation: Image segmentation such illustrated in the figure below is the process of partitioning a digital image into multiple Segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze.

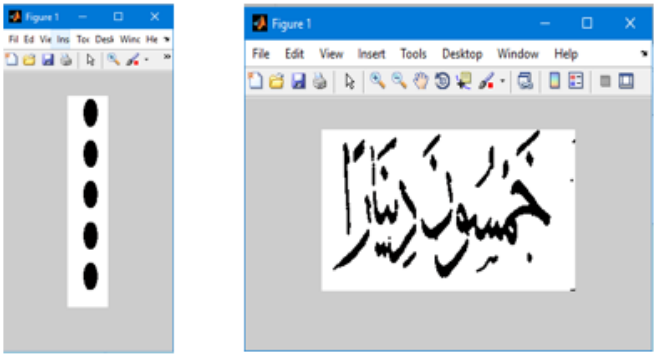

Figure 8: Segmentation Image

5. Feature Extraction: Feature extraction is a special form of dimensional reduction. When the input data to an algorithm is too large to be processed and it is suspected to be very redundant then the input data will be transformed into a reduced representation set of features. Transforming the input data into the set of features is called feature extraction. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of the full size input [5].

4. RESULTS AND DISCUSSION

In this section, the results are obtained after performing the morphological image processing process. The results are displayed in a GUI made in MATLAB as shown in figure 9 that displays the extracted features (color value, size value for observation, blind recognition value,and artistic impression.) of a given currency note and those features extracted are used in an intelligent banknote recognition system. The accuracy and reliability of the system were measured by individually considering the results obtained for serial prefix, blind recognition value and technical impression.

Figure 9: Currency Recognition system via Matlab.

Table 2: Statistics for Accuracy and Reliability.

Currency Value	colour Value	Artistic Impression	Size Value currency	Blind Recognition Circles value	Overall Ratio %
5 Dinar	11/11	11/11	11/11	10/11	97%
10 Dinar	12/12	12/12	10/12	12/12	95%
20 Dinar	12/12	11/12	11/12	12/12	95%
50 Dinar	10/10	9/10	8/10	8/10	92.5%

According to the results in the table (Table 2), system has correctly identified the blind recognition value of 10 out of 10 notes of each denomination, where the maximum success rate has a value of 100%. The value of 8 out of 10 banknotes of each denomination, where the minimum success rate is 80%. According to the results in the table (Table 2), system has correctly read the serial prefix of 12 out of 12notes of each denomination, where the minimum success rate has a value of 100%.The value of 9 out of 10 banknotes of each denomination, where the minimum success rate is 90%. However, the success rate and rate are low. The main reason for this is being traded the edges and borders of the coin are easily bent, torn or frayed due to high circulation of the currency in the open. The reason is that there is writing on the currency, which causes distortion and change of its shape.

5. CONCLUSION

Currency denomination detection was implemented using image processing using MATLAB. Currency features observation such as color value, size value for observation, blind recognition value and artistic impression were extracted. The process is started from image acquisition to calculating the intensity of each extracted feature. The system can extract features even if the banknote has scribbles. The processing algorithm here works suitable for the newly introduced class 5, 10, 20 and 50. The system not only determines the denomination of the banknote, but also gives the result in the form of an audio output.

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