Multiple Segmentation Methods for Iraqi Paper Currency (IPC)

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Abstract

The segmentation of images is a vital topic in the field of image processing. It depends on a series of subsequent operations and process. The subsequent processes in this research reviewed three methods of segmentation: Adaptive thresholding, Fuzzy C mean, and k-mean for currency image segmentation. The three methods applied on the IPC and the results in subsequent operations can be important in the extract features that will be useful in different approach such counterfeit currency. The three methods were applied to the paper currency (PC) images with a dependence on two layers (K =2) and the value of the number of layers was increased with Fuzzy C-mean and K-mean segmentation Such as five layers, for example. A convergence of the results of the three methods was observed and it can be used in the case of two layers with a better Adaptive thresholding segmentation. If you choose more than two layers, we notice a Fuzzy C mean that gives better results.

Keywords: K-Means, Fuzzy-C-Means, Adaptive thresholding, Segmentation

1. Introduction

Image processing usually refers to the operation of images by the computer in order to find the displayed objects. One of the most valuable functions in image analysis is the segmentation which includes dividing the image into constituent parts and extract the interest parts (objects). In recent decades, many algorithms have been developed for segmentation, and this number is constantly increasing each year. Numerous papers have been presented for the methods of division in literature. Since none of the proposed algorithms is applied for all images, so these algorithms are not equally suitable for a specific application. The valuation of the performance of segmentation algorithms is indispensable and therefore it considered as an important subject to study. In general, performance evaluation is critical to all quantum vision algorithms [1].

One of the most important techniques of image processing is the currency recognition which used to determine the currency of different countries. Thus, the odds that PCs in different countries are likely to be increasingly intertwined.

PCRSs systems would be able to identify banknotes both sides in every direction. Meanwhile many observations are distorted during circulation. The design systems have to be precise in discovering torn notes or worn. 50 currencies all over the world with each of them are looking quite different. For example, the PC with the same color but different in size and style. Employees who work for money exchange have to distinguish various types of currencies which is not easy task as they have to remember the code of each currency. Therefore some problems are presented, so they need an effective system to solve these problems [2].

2. Literature Review

Analyze currency crises within the decision theory framework. The system's work includes Fuzzy C-means (FCM) clustering with fuzzy system modeling to improve a perception based on decision matrix and try to build a prescriptive model in order to decide the best estimated reasoning schemes. The fundamental behavior of the market participants through the crisis has been obtained in [3].

Automated PCRS has a very good effectiveness in banking systems and commerce system. For many years, simulating of PC challenges the financial system of each country within various sectors; PCRS with the help of digital image processing techniques are defined. Three characteristics of Indian PC is selected for counterfeit detection included security thread, watermark and identification mark. Extraction the characteristics is performed on the currency's image and matched with the characteristics of the genuine currency which has been presented [4].

Sobel operator with gradient magnitude is employed to extract the characteristic. PCR with great processing speed and decent accuracy has a great significance to the banking system [5].

Target selection is considered as data mining problem in direct marketing. Fuzzy modeling can be used to solve these problems. A comparison between several fuzzy modeling techniques is applied to target selection based

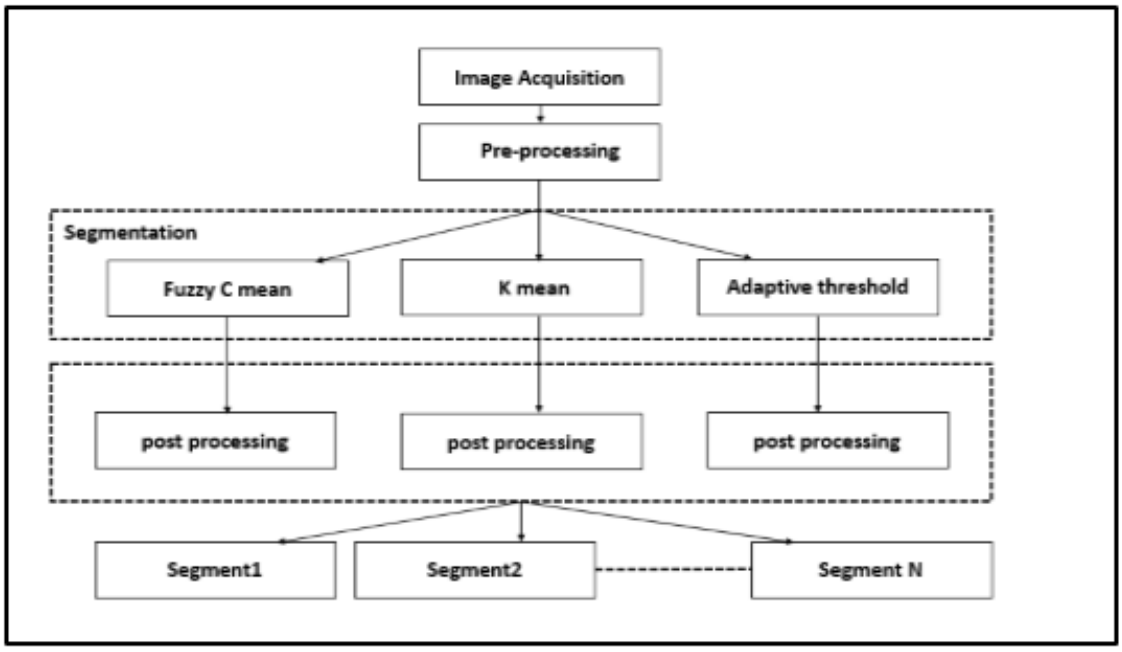

Figure 1: Block diagram of multiple segmentation

on monetary value, frequency, recency measures. The comparison depends on cross-validation which applied to mailing campaigns of a charity organization [6].

A robust algorithm for 3D image segmentation based on a new combination of knowledge-based morphological and adaptive K-mean clustering operations. The proposed algorithm is capable of segmenting the sections of smoothly changeable intensity distributions. The clustering algorithm are incorporated with spatial constraints through the modeling of the regions by using Gibbs random fields.

The segmented regions used Knowledge-based morphological operations to identify the chosen regions according to the earlier anatomical knowledge of the region-of-interest [7].

The currencies in different countries are differentiated by their size, shape, and color. There are multiple people who work for money exchange requires correctness of this varied quantity of currencies. Also, there is a problem of fake currency notes. Almost each country suffers from the problem of fake notes but India has been hit really hard and has become a very acute problem [8].

3. Methodology

A block diagram for this method is shown in the figure (1): Shown in the block diagram of figure 1, first the pre-processing step performed from input image then converting

grayscale image or contrast. After that performed from multiple segmentation for the paper currency will be cropped, finally, use a validation for this segmentation and find the best segmentation of paper currency.

4. Image Acquisition

Image acquisition is generally well-defined as an image retrieval action from a source, usually a device-based source. In the workflow sequence, the performance of getting images is always considered as a first step because without an image. Digital images are usually created from the physical scene. The image for the currency note is generally obtained from using a digital camera then the stored image used for further pre-processing.

5. Pre-processing

The purpose of improving the image and giving the best results is the preprocessing because some of the images content noise or the pixels are unnecessary. In the proposed technique for image enhancement, the contrast method used the image for the purpose of displaying the details of the image well because sometimes the image capture process is taken not suitable for conditions that can be interpreted simply as the difference between the maximum and minimum pixel density in the image. Some image needs color conversion in order to facilitate the work where the whole work on the luminance component with the retention of chromatography components better than working on a color image. Here we have converted to the color image to gray image Here we have converted the color image to gray image.

6. Image segmentation

The image split into distinct areas is called a segmentation. Each segment contains pixels with similar attributes. The segment can be called regions. In image analysis and interpretation, regions should be powerfully associated with entities that have been photographed or features of interest. Significant segmentation is consider as the first step of processing low-level images convert a gray image or a color image into one or more other images to a high-level image description in terms of features, objects, and scenes. The reliability of fragmentation is the main factor in the success of image analysis. The main goal is to split a useful part of the picture and a lot of things are different in appearance than others and

change the image representation. Image segmentation is usually used to locate objects and borders in images.

7. Adaptive Thresholding Technique

Each pixel is compared with the mean of the neighboring pixel in the adaptive threshold technique. In particular, an approximate moving average is calculated for the last pixel viewed as the image passes. If the current pixel-list value is above the average and is set to white, otherwise it is set to black. This method works because pixel comparison to the near-by pixel medium discards soft gradient changes and maintains constant contrast lines. The benefit of this method is that it takes only one pass through the image. Moreover, the moving average is not a good demonstration for the ocean pixel at each stage because the live samples are not equally distributed in all the ways. By using the integrated image (and sacrificing additional iterations through one image), is applied as a solution to solve these problems.

The proposed technique produces the same output independently of how the image is processed and is clean, clear, and easy to code. Instead of calculating the average running of another pixel s, the average six window is calculated for pixel-centric pixels. This is the best average for comparison because it looks at the adjacent pixels from all the directions. The average in linear time is calculated using an integrated image.

Adaptive Threshold Algorithm

Step 1: calculate the integrate image through the input image.

Step 2: Calculate the average (S×S) using the integrated image per pixel at a fixed time and make comparison.

Step 3: if the current pixel percent value is greater than the average then it is set to white otherwise it is set to black.

8. K-mean segmentation

The clustering algorithm is applied in computer vision as a form of image segmentation. K -means clustering is an unsupervised algorithm and it is used to divide the interest area from the background. Partial stretching enhancement is applied to the image to improve the quality of the image before applying K -means algorithm, Data clustering is employed subtractive clustering technique where the centroid is generated based on the potential value of the data points. The initial

centers which generated by subtractive cluster are used in k-means algorithm for the segmentation of image.

K-Means Algorithm
Step 1: randomly choose the initial centroid to produce clusters which vary from one run to another.
Step 2: the mean of the point in the cluster is typically the centroid.
Step 3: Euclidian distance is applied to measure the closeness, correlation, cosine similarity... Etc.
Step 4: K-means will converge for common similarity measure.
Step 5: frequently the stopping condition is changed to until relatively few point change clusters.

9. Fuzzy C–mean (FCM) segmentation

The fuzzy c-mean algorithm is one of the common algorithms used to segment the image by dividing the image area into different cluster areas with similar pixel image values. For medical image segmentation, the appropriate assembly type is a vague compilation.

The FCM can be seen as the opaque version of the k-means algorithm. It is a clustering algorithm that enables the data element to obtain a degree of belonging to each group according to the degree of membership. The algorithm is the iterative cluster method that produces the optimal c division by minimizing the probability within the total set of the target quadratic error function. It is widely used in image fragmentation and pattern recognition. The following are the steps of the traditional c fuzzy means:

Fuzzy C-Means Algorithm
Step 1: Choose random centroid at least two and put values to the randomly.
Step 2: compute membership matrix:

$$U_{ij} = \frac{1}{\sum_{k=1}^{c}\left[\frac{|x_i - c_j|}{x_i - c_k}\right]^{\frac{2}{m-1}}}$$

Where m>1, c: Cluster's No.
Step 3: calculate the clusters centers

$$C = \frac{\sum_{i=1}^{n} u^{m_{ij}} \times x_j}{\sum_{i=1}^{n} u^{m_{ij}}}$$

10. Experimental Results

The three methods proposed for segmentation process were applied on Iraqi currency paper (250 ID, 500 ID, 1000 ID, and 5000 ID) using adaptive thresholding shown in figure 2, segmentation using Fuzzy C mean shown in figure 3 where number of segments equal to two, and segmentation using K-mean shown in figure where number of segments is equal to two. The fuzzy C-Means and K-Means method applied with more

than two segments. K-means method applied with number of

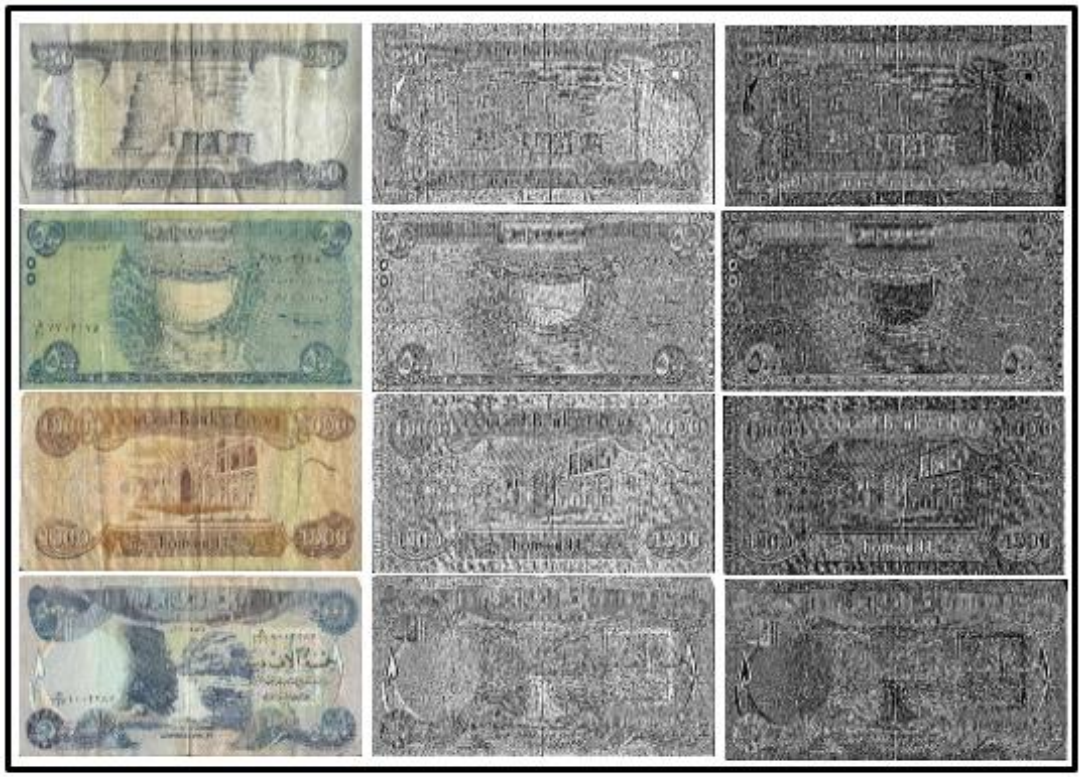

Figure 2: segmentation using adaptive thresholding

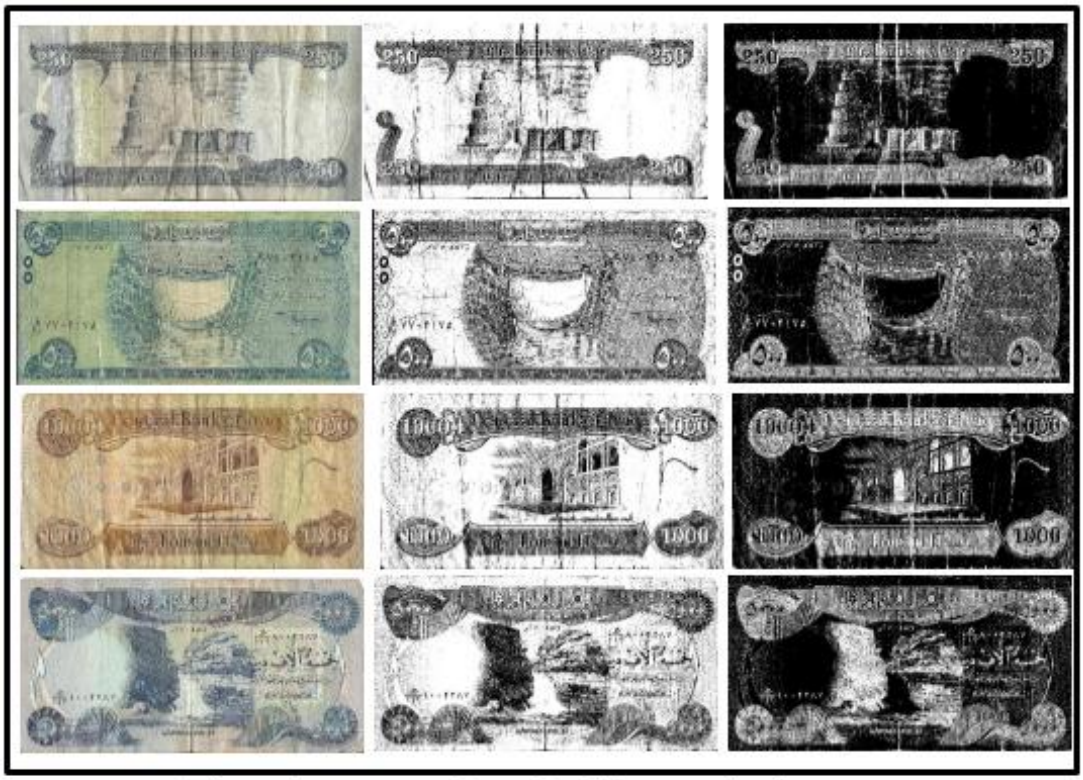

Figure 3: segmentation using K-means (k=2)

The results denote the convergence and it is possible to perform some post-processing

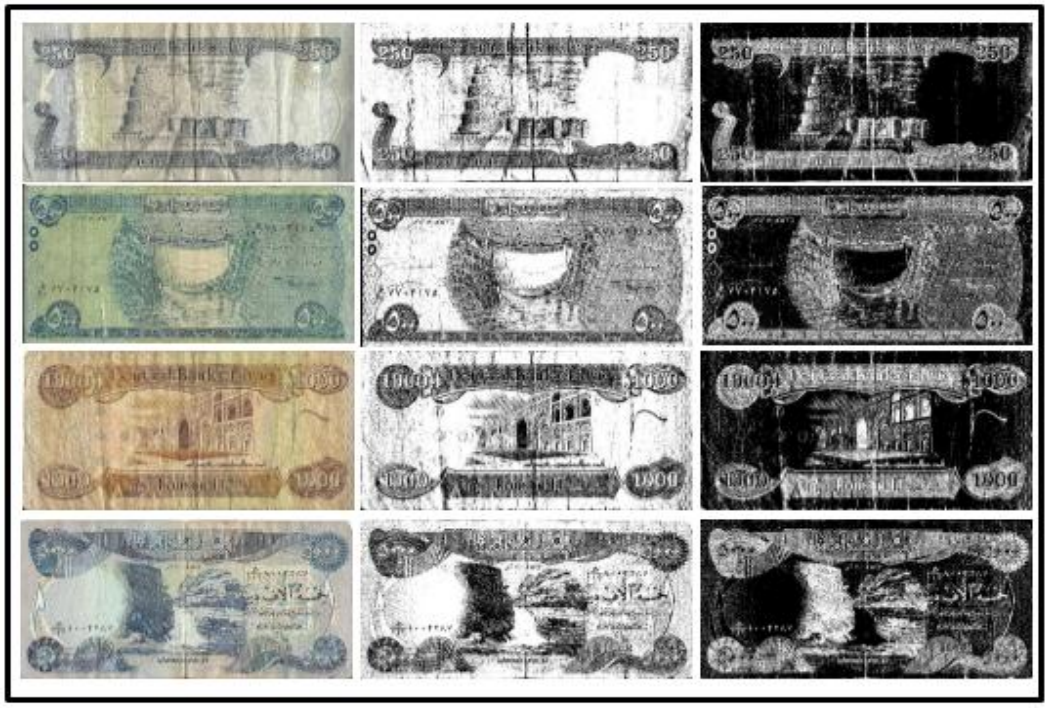

Figure 4: segmentation using Fuzzy C-means (k=2)

operations on results such as morphology operations for the purpose of achieving results. The size of images used in experiments as follow: 509×996 for 250 ID, 508×1115 for 500 ID, 515×1115 for 1000 ID and 509×996 for 5000 ID showing in table 1 that used for counting the white and black pixels with two segments (black and white).

equal to five as shown in figure 4 for 250 ID, figure 5 for 500 ID, figure 6 for 1000 ID, figure 7 for 5000 ID. Fuzzy C-means method applied with number of segments equal to five as shown in figure 8 for 250 ID, figure 9 for 500 ID, figure 10 for 1000 ID, figure 11 for 5000 ID.

Table 1: Counting Segmentation Result for two segments

adaptive Thresholding			Fuzzy C-Means			K-means		
Image Currency	No. of White pixel	No. of Black pixel	Image Currency	No. of White pixel	No. of Black pixel	Image Currency	No. of White pixel	No. of Black pixel
250 ID	307570	199394	250 ID	384121	122843	250 ID	395884	111080
500 ID	334978	231442	500 ID	379612	186808	500 ID	379612	186808
1000 ID	350431	223794	1000 ID	164979	409246	1000 ID	415941	158284
5000 ID	321075	202686	5000 ID	250940	506122	5000 ID	513452	243610

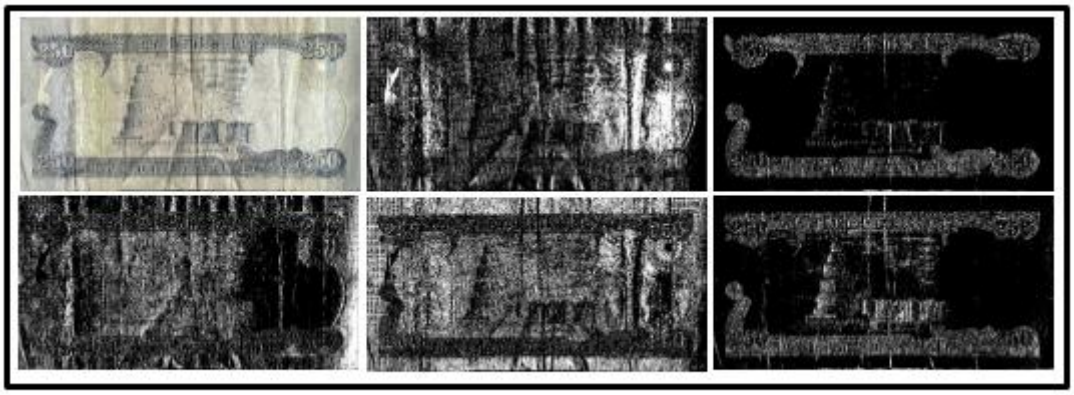

Figure 5: segmentation using K-means for 250 ID (k=5)

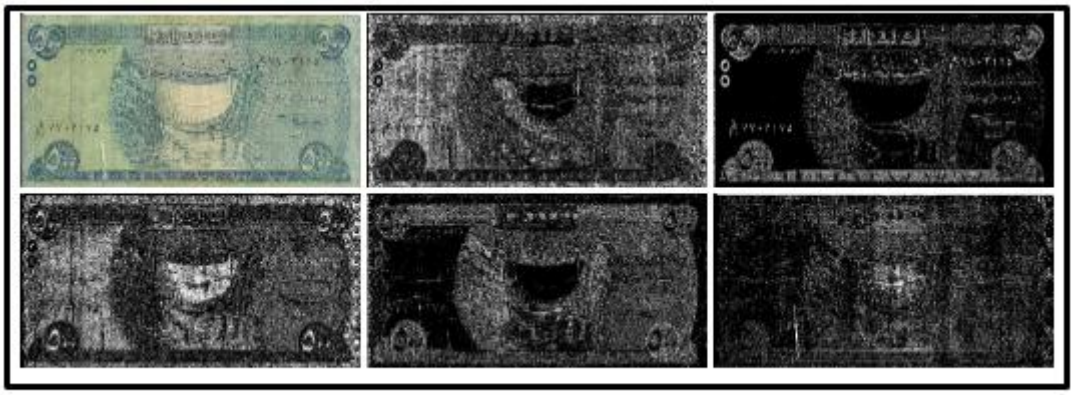

Figure 6: segmentation using K-means for 500 ID (k=5)

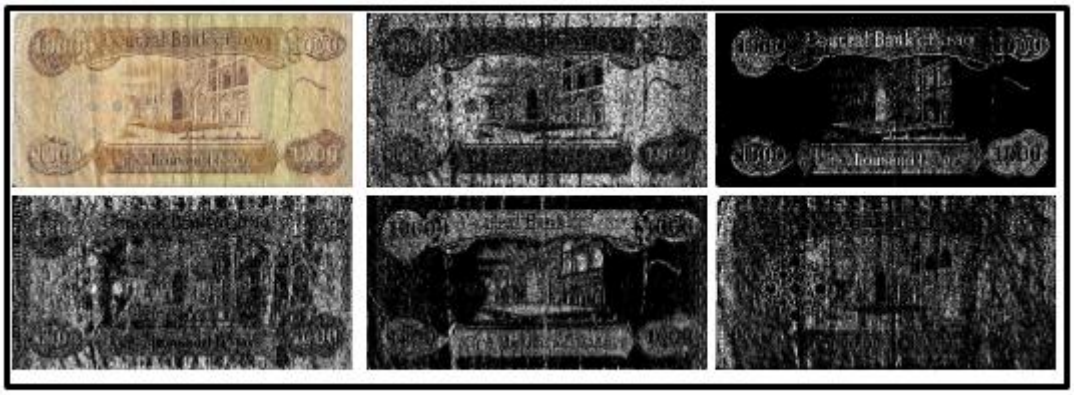

Figure 7: segmentation using K-means for 1000 ID (k=5)

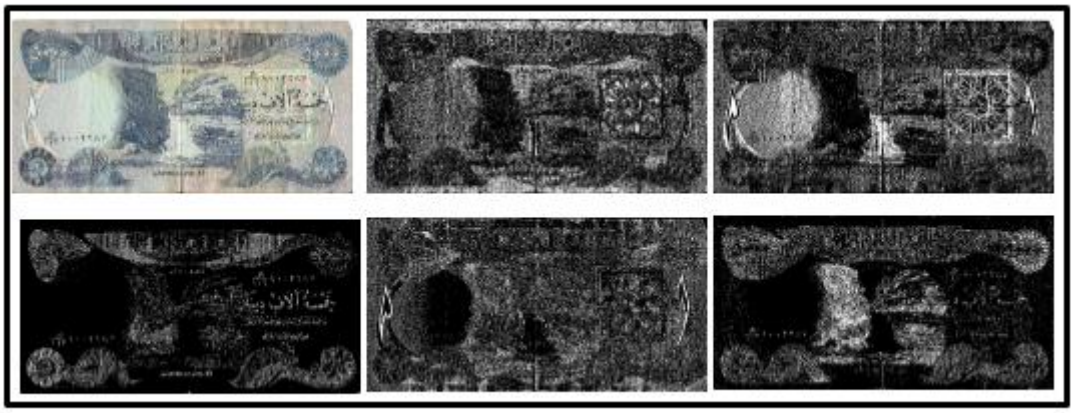

Figure 8: segmentation using K-means for 5000 ID (k=5)

the previous figures (5, 6, 7 and 8) explain the segmentation methods using K-means for five segments. The counting of white pixels in each segments shown in table 2.

The currency paper used for segmentation in previous method (k-means) are applying in fuzzy C-means method as shown in figures 9, 10, 11, and 12 respectively.

Table 2: counting Segmentation Result for Five segments using K-Means				
Segmentation using K-Means				
segment 1	134809	159844	178770	395884
segment 2	33719	59013	52781	111080
segment 3	116946	164749	162646	62907
segment 4	51255	101650	87658	162975
segment 5	170235	81164	92370	106873

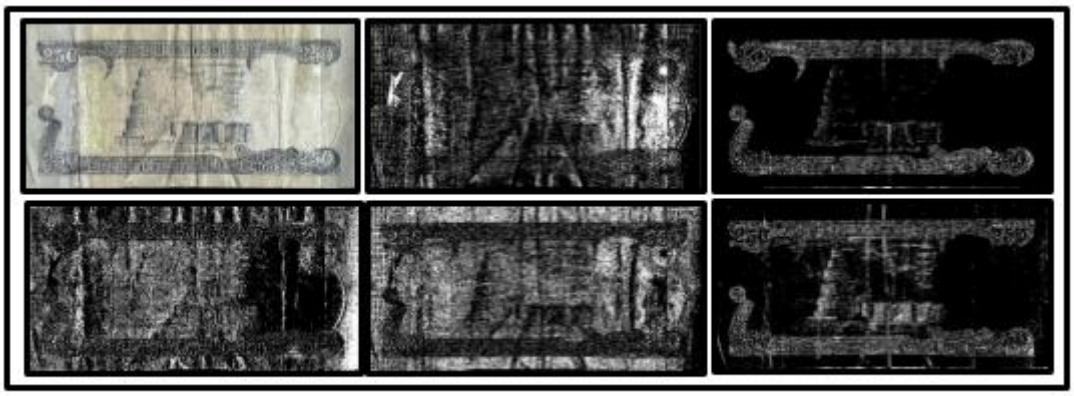

Figure 9: segmentation using Fuzzy C-means for 250 ID (k=5)

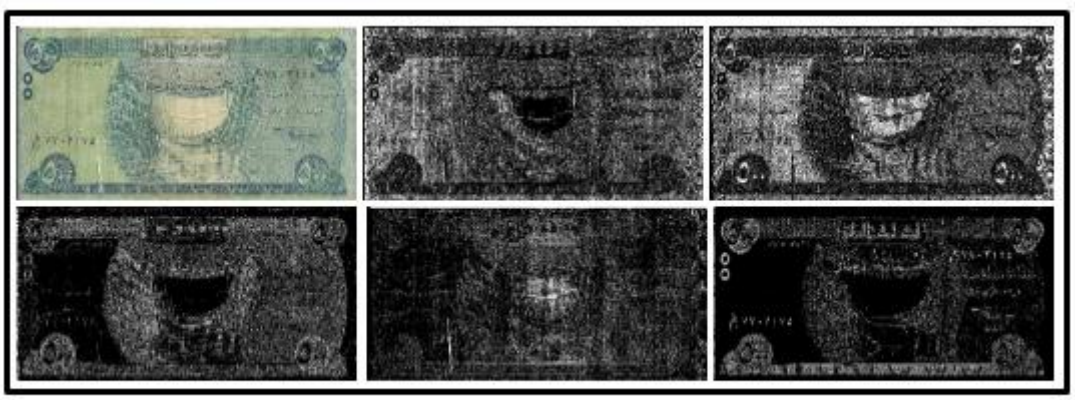

Figure 10: segmentation using Fuzzy C-means for 500 ID (k=5)

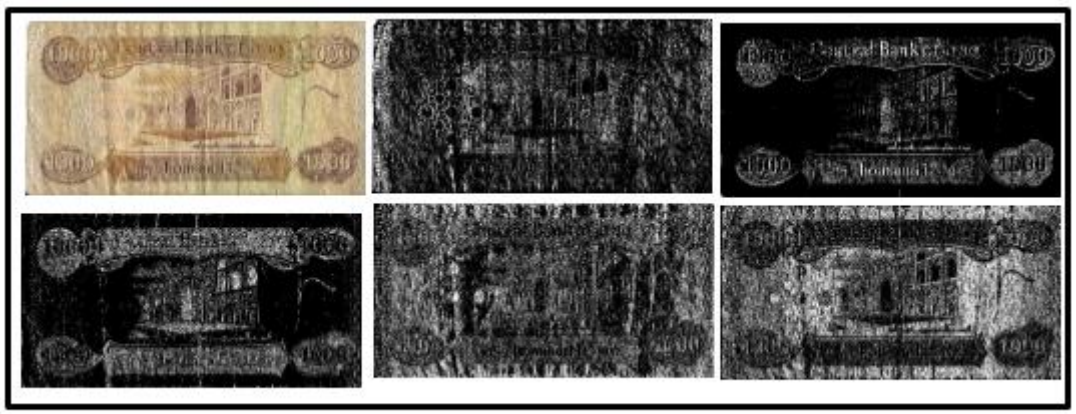

Figure 11: segmentation using Fuzzy C-means for 1000 ID (k=5)

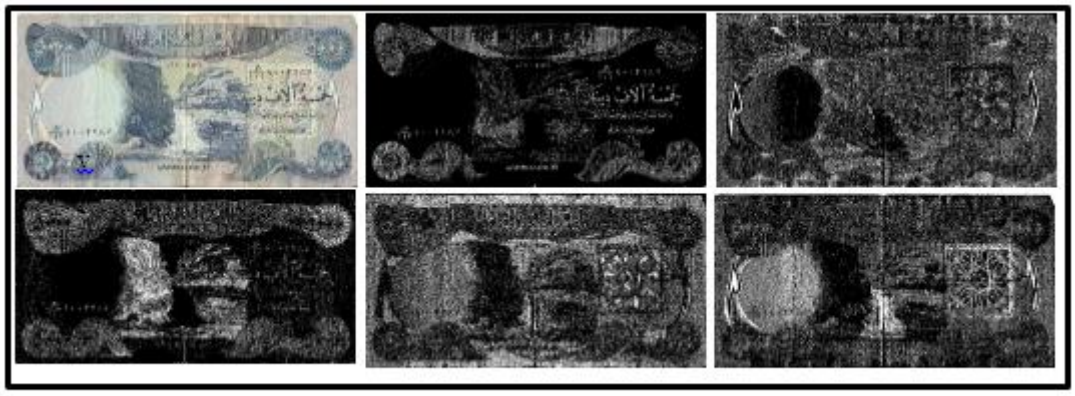

Figure 12: segmentation using Fuzzy C-means for 5000 ID (k=5)

Table 3: Counting Segmentation result for five segment using Fuzzy C-Means				
Segmentation using Fuzzy C-Means				
Segments	250 ID	500 ID	1000 ID	5000 ID
segment 1	56571	155137	100945	122843
segment 2	165275	172905	47347	384121
segment 3	131899	97204	82781	117997
segment 4	35222	88057	154161	165275
segment 5	117997	53117	188991	131899

Conclusion

The various methods of segmentation applied during this work on the Iraqi currency images and these methods are important for the purpose of using in the process of finding the characteristics of the currency and later identify the real currency of the counterfeit currency as well as benefit from more than one method and the comparison between them. And showed images convergence

between the three methods with the preferred method of Adaptive thresholding segmentation and when choosing more than two segments note that the fuzzy C-means segmentation method has a preference over K-mean segmentation. It is possible to conduct other operations on the currency images for the purpose of studying the characteristics of the currency and the possibility of identifying a set of characteristics are more effective in the classification and detection of counterfeit. The proposed system has used three method of segmentation above to the features extraction. Table 3 shows computational time in seconds' of three methods on five databases of images paper currency which were (250 ID, 500 ID, 1000 ID, and 5000 ID). In this stage, the result show that fuzzy C-means segmentation method has a preference over than Adaptive thresholding segmentation and K-mean segmentation while time consuming for adaptive thresholding method less than other two methods (fuzzy C-means segmentation and k-means).

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