Intensification of Old Documents and Photos by Digital Image Processing Techniques

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Abstract— Historical writings are a beneficial source for derivation of information but they frequently undergo quality depreciation, such as impedance, blurriness, yellowing due to transfer, undistinguishable text, uneven lighting etc. Condition and visibility of these archives can be restored applying a methodology known as Binarization. Binarization (Otsu's) is divided into global and local thresholding. Moreover, morphological functions like, erosion and dilation are used. The above mentioned techniques toil on the intensity of the scanned images and breaks down each pixel into phases (segmentation) according to their respective threshold values. At first, global thresholding is applied on the image as a whole. Segments of the image often have lingering distortion. Therefore, these parts undergo local thresholding, after which the image goes through a series of histogram functions of brightness, sharpness and contrast. After enhancement of these records they can be reserved in digital libraries for everyone to view. Further, text from text documents can be retrieved using OCR to encapsulate and save essential data.

Key words: Image Enhancement, Historical Documents, Binarization, Thresholding, Background Noise, Otsu's Method, Morphological Techniques, Histogram, OCR, Image Segmentation

I. INTRODUCTION

There are archives that have collections of old & antique documents which are of immense scientific & constructive importance. Degradation problems are quite typical in them. To preserve the element of the original documents & photos, it is important that the findings are reconstructed to a digital form. Then, it is important to remove noise from these document & images and revise their state using appropriate digital processing methods. The image processing methods that have been used in this paper are Binarization & Morphological techniques with the usage of Histograms. OCR acts as an additional feature for extracting knowledge from these old documents and storing them in a required file format.

A. Binarization

Binarization is a preprocessing task, very useful to document image analysis. It converts the document images in a bi-level form in such way that the foreground pixels are represented by black pixels and the background by white ones. Thresholding methods (Global & Local) are used for image segmentation wherein a set of pixel with common characteristics is divided. In Global Thresholding, the threshold value is held constant throughout the image and is independent of the neighboring pixels. On the other hand, in Local Thresholding, the threshold value is applied on the distinct individual pixels. Basically, Thresholding is the simplest image segmentation method used to achieve Binarization.

B. Morphological Operations

Morphological Operations refer to a set of operations that process images based on shapes. Morphological operations apply a structuring element to an input image and generate an output image. There are basically 2 morphological operations, namely, Erosion and Dilation. These methods are used for defining the objects and their boundaries. Morphological operations have a wide range of applications that are:

1) Removing noise from an image.
2) Isolation of individual elements and joining disparate elements in an image.
3) Finding intensity of bumps or holes in a picture.

C. Otsu's Method

Otsu's method is an automatic thresholding method, i.e., it calculates the Threshold value automatically by analyzing the current state of Histogram. Thresholding usually involves analyzing the histogram. There are several reasons why automatic thresholding is preferred over manual thresholding. It should be noted that Otsu's method applies image thresholding globally, i.e., it can be thought of as an automatic global thresholding method.

D. Histogram

Histograms have various uses in image processing. Firstly, by analyzing the image, we can be informed about an image by just looking at its histogram. It is just like viewing the x ray of a bone in a body. Histograms, like a graph, show intensity values of a particular image. The histograms have operational value in image brightness, sharpness and contrast adjustment. Another important use of histogram is to standardize an image. Histogram is a graphical representation of the distribution of intensity of an image. It calculates the no. of pixels for each intensity value that is being considered.

E. OCR

OCR stands for Optical Character Recognition wherein handwritten, typewritten texts from scanned images are converted into digital format. With the help of OCR, people no longer need to manually retype important documents when entering them into electronic databases. Instead, OCR extracts relevant information and enters it automatically. Mostly, the result is accurate, efficient information processing in less time.

II. SYSTEM ARCHITECTURE

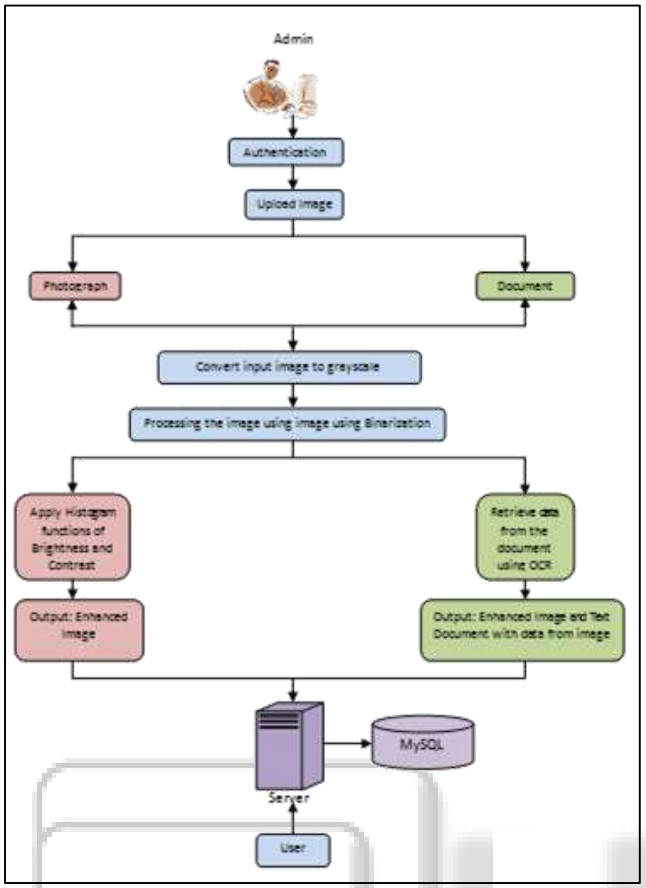

Fig. 1: Architecture

III. PROPOSED IMPLEMENTATION

In this paper we have implemented the above mentioned functions. Firstly, we created an online digital library wherein an admin controls the operations of all the uploaded documents and users. The admin has the choice of uploading the scanned image for photograph related processing or document related processing. When the admin uploads an image he checks whether the uploaded file is a document image or an old photograph. Depending on the file, it is processed for enhancement. Further, for a photograph it performs histogram functions to adjust the values of brightness by Gaussian formula and contrast.

Further, we discuss the working and implementation of the algorithms of the methods used.

A. Histogram Implementation

Fig. 1: Image converted to grayscale

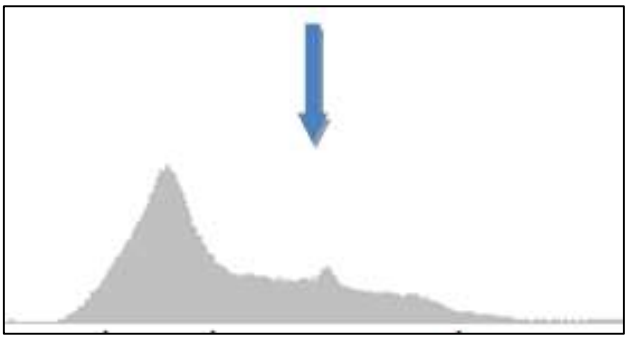

Fig. 2: Histogram of grayscale image

In the above, the pixels are clustered around the center of the image where the intensity is high and slowly reduces through. The histogram stretches out this graph. Adjusting these values gives us a proper equalization of the image and differentiates between various pixels.

For the histogram $H(i)$, its cumulative distribution $H'(i)$ is:

$$H'(i) = \sum_{0 \le j < i} H(j)$$

Our idea is to normalize the image to the correct values between 0 to 255.In our paper we apply histogram equalization with the function "equalizeHist":

```
equalizeHist( src, dst );
```

B. Binarization & Morphological Operations Implementation

1) Binarization:

In Binarization thresholding is used to extract an object item from its background by allotting a threshold value T for individual pixel so that each pixel is either differentiated as an object point or a background Otsu's Binarization works directly on the gray level histogram of the image and globally performs thresholding. Otsu's method is based on a very simple idea of finding the threshold that minimizes the weighted within-class variance.

Fixed thresholding is of the form: g(x, y) =>f(x, y) <T or f(x, y)>=T

It also considers high-intensity pixels of interest, and low intensity pixels of no interest.

2) Morphological Operations:

The general structure of the program is:

- Load an image.
- Create a set of two track-bars for each operation:
- The first trackbar "Element" returns either erosion_elem or dilation_elem
- The second trackbar "Kernel size" returns erosion_size or dilation_size for the corresponding operation.
- The user's function Erosion or Dilation will be called and it will update the output image based on the current trackbar values.

The two functions are as shown below:

a) Erosion

```
/** @function Erosion */
void Erosion( int, void* )
{
  int erosion_type;
  if( erosion_elem == 0 ){ erosion_type =
MORPH_RECT; }
  else if( erosion_elem == 1 ){ erosion_type =
MORPH_CROSS; }
  else if( erosion_elem == 2) { erosion_type =
MORPH_ELLIPSE; }

  Mat element = getStructuringElement( erosion_type,
                       Size( 2*erosion_size + 1,
2*erosion_size+1 ),
                       Point( erosion_size,
erosion_size ) );
  /// Apply the erosion operation
  erode( src, erosion_dst, element );
  imshow( "Erosion Demo", erosion_dst);
}
```

The function that performs the erosion operation is erode. As can be seen, it receives three arguments:

- src: The source image
- erosion_dst: The output image
- element: This is the kernel we will use to perform the operation. If not specified, the default is a simple matrix. Otherwise, its shape can be specified. For this, the function getStructuringElement is used:

```
Mat element = getStructuringElement(
erosion_type,
      Size( 2*erosion_size + 1,
2*erosion_size+1 ),
      Point( erosion_size, erosion_size ));
```

Any of three shapes can be used for our kernel:

1) Rectangular box: MORPH_RECT
2) Cross: MORPH_CROSS
3) Ellipse: MORPH_ELLIPSE

Now, we are ready to perform the erosion of our image.

b) Dilation**:**

The code for dilation is given below. As you can see, it is completely similar to the code for **erosion**. Here we also have the option of defining our kernel, its anchor point and the size of the operator to be used.

```
/** @function Dilation */
void Dilation( int, void* )
{
  int dilation_type;
  if( dilation_elem == 0 ){ dilation_type =
MORPH_RECT; }
  else if( dilation_elem == 1 ){ dilation_type =
MORPH_CROSS; }
  else if( dilation_elem == 2) { dilation_type =
MORPH_ELLIPSE; }

  Mat element = getStructuringElement( dilation_type,
                       Size( 2*dilation_size + 1,
2*dilation_size+1 ),
                       Point( dilation_size, dilation_size
) );
  /// Apply the dilation operation
  dilate( src, dilation_dst, element );
  imshow( "Dilation Demo", dilation_dst);
}
```

Fig. 3: Document before processing

Fig. 4: Document after processing

Fig. 5: Photograph before processing

Fig. 6: Photograph after processing

C. OCR Implementation

Optical character recognition (OCR) is a process of remodeling a printed or scanned document into ASCII characters that a computer can identify. The application mentioned in this paper is equipped with an OCR system to fasten the speed of input operation, decrease human errors and enable storage, fast recovery. The main functional modules in our OCR systems are: feature extraction module and pattern recognition module. The system is equipped with an existing template that contains the matrix values of all characters (A-Z), special characters, numbers, etc.

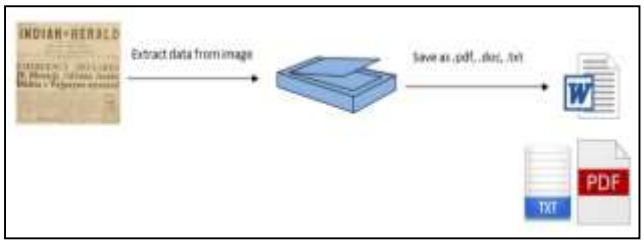

Fig. 7: System Process

The following steps are carried out during the OCR process:

1) The image which is a document is initially scanned for dark and light pixels. Next, the space between words and characters as well as the next blank line is detected.
2) The obtained stream of characters is then scanned further to identify the right and left part of the character.
3) The character is scanned from top to bottom to identify the leftmost dark pixel and then left to right until a space to find the rightmost dark pixel
4) The found character is then cropped and saved in a matrix denomination
5) The matrix consists of binary digits. The character scanning creates the matrix such that all the light pixels are numbered '0' and all dark pixels '1'.
6) This matrix is then matched with the existing template and compared with each track sector value obtained to find exact or nearest existing matrix and hence the nearest character.

IV. Conclusion & Future Prospects

Therefore, by combinative techniques of Binarization (Global & Local Thresholding), Otsu's method and Morphological Techniques imposed using the histogram of the image and adjustment of the brightness levels, contrast and sharpness, old documents and photos have been ENHANCED. Since, only a fixed number of areas are processed because Otsu's is a global technique, therefore, the time and cost of the system reduces. The mathematics used in this project realizes the requirement of segmentation & elevates the quality of the image but various algorithms have different computational time. OCR gives an additional feature of knowledge extraction.

We further propose the idea of generating a module wherein we dynamically change a grayscale picture into a colored picture modifying it pixel by pixel and selecting appropriate coloring so as to produce desired results

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