



# **Real Time Arabic Translation System For Signboard Images Based on Printed Character Recognition**

نظام الترجمة العربي الآني لصور اللوحات الإعلانية بالاعتماد على تمييز الحروف المطبوعة

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**A Thesis Submitted in Partial Fulfillment of the**

**Requirements for the Master Degree in**

**Computer Science**

**Faculty of Information Technology**

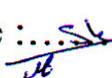
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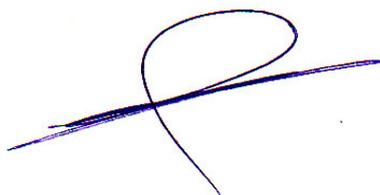
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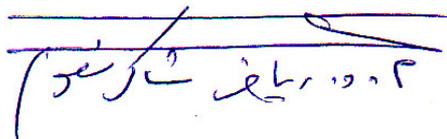
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## DEDICATION

سورة إبراهيم (7) (وَإِذْ تَأْتِنَ رَبُّكُمْ لَئِن شَكَرْتُمْ لَأَزِيدَنَّكُمْ)

Almighty Allah says “And remember! Your Lord caused to be declared (publicly): "If ye are grateful, I will add more (favours) unto you”.

So all praise is for Allah, the exalted, for his favours that cannot be counted.

I dedicate this work to my parents, my husband, my brothers, my sisters, my beautiful son , my relatives, my friends, and all those who helped, supported, and taught me.

## **ACKNOWLEDGMENTS**

I would like to thank my husband and my parents for their continuous support during my study.

I also would like to thank my great supervisor Dr. Rafeeq Abdul Rahman A. Al-Hashemi for his support, encouragement, proofreading of the thesis drafts, and for helping me throughout my studies. I would like to thank the Information Technology Faculty members at the Middle East University. I would also like to thank all of my family members specially my sister Reham, my brother Rashid and all of my friends specially Enas Abu jri and Heam Alsanat .

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## List of Abbreviations

DTW	Dynamic Time Warping
HMM	Hidden Markov modeling
Matlab	Matrix Laboratory
OCR	Optical Character Recognition
PDA	Personal Digital Assistant
RGB	Red, Green, Blue colors
ROIs	Regions of interest
SVM	Support Vector Machine

## Abstract

In spite of the diversity in products of translation text embedded in images for many languages but for Arabic texts there are problems seem to be not yet well solved to address this problem. In this thesis we developed a new system that will automatically translate Arabic text embedded in images into English. This system consists of four subsystems: preprocessing, segmentation (text detection), character recognition and translation.

Dealing with Arabic language was the most important problem faced by the proposed system because it has a set of characteristics makes the identification very difficult, such as words interrelated. In addition there are more than one form character and although the system achieve satisfactory results in dealing with the Arabic language and get an excellent translation through improving the quality of the entered image to the system. The system automatically detect the text in the image and we applied Template matching algorithm to recognize the Arabic character. Our proposal system works good with different backgrounds, rotated images, skewed, font sizes and blurred images.

The proposed system has been tested on samples of 25 images selected from signboard in street and showed promising experimental results within the limits of the system, which is the font size 40, font type (ALNSKH). The system was assessed using recall measurement to evaluate the performance of the developed system and the experimental results of character recognition show a rate of 81.82%, the word recognition subsystem gave a rate of (94.44%) and the word translation was about (83.33%).

## الخلاصة

نظام الترجمة العربي الآني لصور اللوحات الإعلانية بالاعتماد على تمييز

### الحروف المطبوعة

بالرغم من التنوع في منتجات ترجمة النصوص الموجودة في الصور للكثير من اللغات إلا أن ترجمة النصوص العربية ما زالت تحتوي على كثير من المشكلات التي لم تحل . في هذه الأطروحة طورنا نظام قادر على أن يترجم النص العربي الموجود في الصور إلى الانجليزية بشكل تلقائي ، يتألف هذا النظام من أربعة أنظمة فرعية : معالجة الصورة ، التجزئة (تحديد النص)، تمييز الحروف والترجمة .

أن التعامل مع النص العربي من أهم المشكلات التي واجهها هذا النظام لان النصوص العربية تحتوي على مجموعة من الصفات التي تجعل تحديد النص صعبا جدا مثل تداخل الكلمات بالإضافة لذلك وجود أكثر من شكل للحرف الواحد لكن النظام حقق نتائج مرضية في التعامل مع اللغة العربية و حصل على نتائج ممتازة من خلال تحسين نوعية الصورة المدخلة إلى النظام وتحديد النص بشكل تلقائي في الصور ثم تنفيذ خوارزميات مناسبة لتمييز الحروف العربية . يعمل نظامنا المقترح جيدا مع خلفيات مختلفة ، صور مائلة ، صور مشوشة وأحجام خطوط مختلفة .

لقد تم اختبار النظام المقترح على عينة بلغت 25 صورة تم اختيارها من لوحات إعلانية في الشوارع وحقق النظام نتائج واعدة في ظل محدودية النظام والتي تكمن في حجم الخط (40) وخط النسخ لكتابة النصوص و تم تقييم هذا النظام باستخدام مقياس معتمد ( Recall) من اجل قياس أداء النظام المطور حيث كانت النتائج التجريبية لتمييز الحروف معدل ما قيمته 81.82% ، في حين اظهر النظام لتمييز الكلمة معدل 94.44% أما ترجمة الكلمة فقد كانت 83.33%.

# **Chapter One**

## **Introduction**

# Chapter One

## 1.1. Overview

daily lives contain many of the maps, menus and signboards which carry important information that helps, but sometimes it may cause problems when we cannot understand it . This problem is facing tourists especially because they are unable to read the text they see. The proposed system comes to solve this problem through using Image translation system by Optical Character Recognition OCR.

An image translation system generally consists of three core techniques : text extraction, OCR, and translation. The procedure of image translation is as follows: extracting text from an image taken by camera .After selecting the text through the previous steps, the text is entered to OCR system Finally translating the results into target language(Yan, Gao, Zhang, &Waibel, (2001)).

### 1.1.1 Optical Character Recognition (OCR).

OCR converts printed images captured by a camera to machine editable characters. (Almohri, Gray, & Alnajjar, (2008)).

There are two main areas of interest in character recognition namely:

- Printed Character Recognition
- Handwritten Character Recognition.

The study will focus on Printed Character Recognition most of the signboard printed.

The basic steps in the Optical Character Recognition are:

- Image Acquisition
- Preprocessing: The preprocessing stage is a set of operations on image and improves it by removing the distortions and noise.
- Feature Extraction: it analyzes a text and extracts the most representative information from the image then is used as input to the character classifier.
  
- The classification stage: it is the main decision-making stage of an OCR system which uses the features extracted in the previous stage to identify the text segment according to preset rules. (Almohri, Gray, & Alnajjar, (2008), Siddhartha, Jangid, Dhir, & Rani, (2011)).

The Arabic characters recognition has received less attention than Latin character recognition so our scope thesis focuses on Arabic OCR.

### **1.1.2 Arabic characters recognition:**

Many works have been undertaken in the area of Arabic character recognition but with limited success, due to the nature of Arabic characters and other problem such as the Arabic alphabet consists of 28 basic characters. Some characters may have different shapes depending on their position within a word (beginning, middle, end) and their different size (height and width).

Furthermore, 16 Arab characters have one dot or two dots or three dots, or are zigzag, which are used to differentiate between characters.

A review of the research letter that Arab recognition of advanced techniques for the recognition of the Latin text cannot be directly applicable to the recognition of Arabic text. (Amin, (1998), Gazzah, & Amara. (2008))

## **1.2. Problem Definition**

Research papers concerning with the image translation system, have been published in different natural languages such as English ,European languages Japanese and Chinese, But the Arabic characters recognition has received less attention than others languages.

There are many problems related to image translation system:

- Automatic text detection: Image acquisition through a video camera has many challenges which lie in it. Changes in the text: it can vary in font, size, direction, and position of the text. Therefore, detection of the text is one of the problems facing the system.
- Problems which occur during image capture, such as skew of the image that occur when the sign is not parallel to the imaging and the vibration of the camera during the Imaging.
- Translation of the text from the signboards is very difficult because the signboards depend not only on domain but also on functionality of the sign.

So according to these points,, the following problems have been identified:

- Can we improve the image for good results?
- How can we determine the text automatically without the user intervention?
- Is it possible to get a good translation of the text?

### **1.3. Objectives**

The main objective of this research is to design effective Real translation text embedded in images system based on Arabic OCR:

To achieve the above mentioned objective ,the following specific tasks must be performed:

- Improve the image through preprocessing steps which include correction the skew and removing the vibration.
- Locate the text automatically, where the system will extract the text area of the image automatically without the user's intervention
- Build customized Offline dictionary that contains terms related to tourists.

### **1.4. Significance of the Problem**

Throughout our studies that focused on image translation system, we found that the languages of Latin, Indian and Japanese got a great attention and effort, but for the Arabic language ,the efforts are still limited and very little. Therefore, our duty towards the Arabic language was motivating us to provide a scientific research concerned with Image translation system based on Arabic OCR which reduces the time and effort on the tourist to understand the billboards written in Arabic, to activate tourism in the Arab countries.

## **1.5. Thesis Organization**

In addition to this chapter, the thesis includes four other chapters:

Chapter 2 provides an overview of the image translation system listing and explaining different related works in the area about the developed system. Chapter 3 explains in detail the proposed system architecture and the different models and algorithms that are used in all parts of the proposed system. Chapter 4 represents a complete experimental result. Finally, the conclusion and the future works, including recommendations, are presented in chapter5.

# **Chapter Two**

**Literature Survey**

**and Related Works**

## Chapter Two

The proposed system spans several areas of study including: Image processing ,segmentation and OCR. The following is a brief literature survey of the areas covered in this thesis.

### 2.1 Overview

In this research, we have proposed image-based system that translates Arabic text embedded in images into English which consists of many stages and works as follows. After an image is captured from camera, the system detects the text automatically. Then it preprocesses the image for skew, and performs OCR by using off-the-shelf OCR algorithms on the text regions. Finally it translates the text into the English language.

#### 2.1.1 Image Preprocessing

The preprocessing stage is concerned with processing the input data to produce the output data that is used as input to another stage. The importance of the preprocessing stage lies in preparing the character to be in its final shape before entering the recognition stage. The preprocessing stage makes it easy for the pattern recognition system to remove the noise instead of leaving everything to the recognition system to deal with (Sivanandam, Sumathi & Deepa, 2006). Since the images will be coming out from the camera, the images will contain too many

problems. These problems will affect the recognition rate negatively. These problems are: noise, size, color and others. The preprocessing stage is important because it fixes all the previous problems and makes the images ready to other stages.

### **2.1.2 Segmentation**

Image segmentation is the process of partitioning the digital image into multiple regions that can be associated with the properties of one or more criterion. These properties are gray level, color, texture shape, and others. In mathematical sense the segmentation of an image which is a set of pixels, is the partition of the image into  $n$  disjoint sets  $R_1, R_2, \dots, R_n$ , called segments or regions where the union of all regions equals the image.

Examples of the segmentation techniques are those which used in the state of art. One example, in Parisi, Claudio, Lucarelli & Orlandi, (1998), where they segmented the car plate numbers and characters by finding white areas between columns with higher density of black pixels. Isolated black pixels are wiped out and the characters are segmented.

Another example, in Palacios, Sinha & Gupta, (2002). Their approach for segmentation is based on a recursive function that uses splitting algorithms to divide blocks into isolated digits. Their system starts the segmentation process by

making a few obvious separations of characters. The primitives obtained are pre-classified as digit, fragment, multiple, or delimiters. Then the fragments are merged with digits or other fragments and analyzed again.

### **2.1.3 Character recognition**

Digits and character recognition have been recently an interesting domain for researchers who were interested in recognizing characters and digits in many languages.

A recognition system uses a mechanism to extract features, and a classification scheme to determine the character based on the extracted features.

Character recognition includes the following three procedures:

- 1- Character acquisition and preprocessing.
- 2 -Feature extraction that gets the most useful information from the pool of the input data and gets rid of the irrelevant information.
- 3-Classification of the extracted features with specially designed algorithms .Those are usually task-oriented or general-purpose-based in some cases.

### **2.1.3.1 Feature Extraction:**

This stage is a process of extracting the objects from images. In the case of characters extraction, it is the process of extracting the character area from an image.

The area of characters should be the foreground of an image which must be extracted from the background. Feature extraction plays the most important role in character recognition Choudhari,(2006). After characters are extracted, they will be ready for recognition.

### **2.1.3.2 Classification:**

OCR systems extensively use the methodologies of pattern recognition, which assigns an unknown sample to a predefined class. Numerous techniques for classification are investigated by the researchers such as : DTW algorithm, Support Vector Machine (SVM) algorithms, Neural Networks and Template matching , was used Template matching for ease application.

## **2.2 Related works:**

Bousslama & Kishibe, (1999) proposed a new recognition method for machine printed Arabic characters that combined the structural and statistical for feature extraction and used fuzzy rules for classification. The character is

segmented into main and a complement part .Then the features are extracted from the main character and their projection profiles for classification .The system is tested on three different fonts ,and the recognition rates achieved are very high.

Hamid & Haraty, (2001) proposed algorithm that segments handwritten Arabic text. Through the segmentation of the text into blocks of characters ,it generates pre-segmentation points for these blocks, and then it uses a neural network to verify the accuracy of these segmentation points.

Klassen, (2001) introduced a novel Arabic letter recognition system that was adapted to the demands of hand-held and digital tablet applications. Their system uses neural networks for feature extraction and classification. Linear networks are employed as classifiers because of the low computational overhead during training and recall.

Pilu & Pollard, ( 2002) this paper describes the image processing used to process, enhance and binarize raw text images captured by a hand-held camera, and a fast text detection method. The method performs well with text of ordinary size and it has extremely good time performance, and negligible memory use it may mistake parts of oversized fonts as background, it cannot deal with reverse text i.e. light texts on dark background. The main advantages of the approach are its speed and relative robustness under focus conditions.

Yamaguchi, Nakano, Maruyama, Miyao & Hananoi, (2003) designed a system to recognize telephone numbers on signboards. The system extracted the regions of digits in image through edge extraction. Then the skew and slant are calculated and corrected by using Hough transform and a method of circumscribing digits with tilted rectangles. After skew and slant of input image were corrected, telephone numbers were recognized using the results of digits classification. The experiments were tested 1,332 images of signboards with 11,939 digits were obtained: a digit extraction rate of 99.2% and a correct digit recognition rate of 98.8%.

Nagy & Sarkar, (2004) have proposed four methods of converting paper documents to computer readable forms which were compared with regard to hypothetical labor cost: keyboarding, omni font OCR, style specific OCR, and style constrained or style adaptive OCR. According to them, the best choice was to determine primarily by i) the reject rates of various OCR systems at a given error rate, ii) the fraction of the material that must be labeled for training the system, and iii) the cost of partitioning the material according to style.

Nakajima , Matsuo, Nagata & Saito ,(2005 ) present a system which recognizes characters on signboards and translates them into other languages. The user takes an image by the camera of a PDA; then the image is sent to a server. On the server side, the image is sent to the OCR unit that usually outputs many of the character candidates. Next, the word recognizer determines the word sequences in the candidates and sends it to the language translator.

Shaolei & Manmatha, (2006) have proposed a hierarchical, HMM- based automatic evaluation of OCR accuracy for digital library of books. They proposed a Hidden Markov Model (HMM) based hierarchical alignment algorithm to align OCR output and the ground truth for books.

Safronov, Wörn & Tchouchenkov ,(2007) developed a new hierarchical character recognition algorithm to optical character recognition which uses optimization methods basis on the pattern character recognition algorithms . The main idea of this method consists of the following: different characters on one image can be recognized correctly on pre-processing of this image using filters with different parameters .The presented algorithm possesses high recognition accuracy and high speed, which enable their use in industrial systems.

Park, Dinh & Lee ,(2008) present a system for automatic detection of signboard texts which are captured from a mobile phone. The proposed system can detect and binarize texts from images. Firstly, it performs detection of main text region using edge histogram method with horizontal and vertical direction in edge map image. After the text region verification, the detected region is segmented by fuzzy, c-mean clustering .Each region is distinguished as text region (black) and background region as (white) by boundary histogram in detected text region. Experimental results show that the method can be successfully applied to detect main text in signboard images captured under various conditions.

Nandini ,Srikanta & Kumar ,(2008) This paper presented two techniques for skew estimation of binary images. These methods are based on connected component analysis and Hough transform .The first method is based on finding centroids of all words to estimate skew angle, namely the word centroid approach .The second method identifies each word as a single blob and finds the orientation of different blobs ,and namely dilate & thin approach. The approach is robust for machine printed documents containing only text but it fails for document, containing pictures.

Palkovic, (2008) Optical character recognition programs suffer from problem focus on speed and accuracy so this paper analyzed six different algorithms for optical character recognition programs to increase the speed of Optical Character Recognition programs without decreasing accuracy. For instance, binarization and thinning reduce each letter to the minimum amount of information necessary to be able to recognize the letter. The algorithms improve accuracy in two ways. Firstly, algorithms, like noise reduction and skew correction can reduce the chance of an incorrect match. Secondly, the n-gram algorithm provides a means to compensate for errors when searching through documents after the optical character recognition.

Mollah, Basu & Nasipuri ,(2010) developed a text/graphics separation methodology for camera captured business card images and implemented a fast skew correction technique for the text regions extracted from business card image. At first, the background based on intensity variance is eliminated. This makes the foreground components distinct from each other. Then the non-text components are removed using various characteristic features of text and graphics. Finally, the skew text regions are corrected .The developed technique is computationally efficient and consumes low memory so as to be applicable on mobile devices. Through the experiment on business card images of various resolutions have found an optimum performance of 98.25% (recall) .

Jagannathan & Jawahar ,(2005) used two Indian languages – Hindi and Tamil to demonstrate such a system. At first, the image is sent to a server, which detects and corrects the perspective distortions. And then translates the text .Finally, the translated text is send back to the user in a suitable form. The system was tested with 30 images of city names in both Hindi and Tamil. The city names were printed with a font size of 120. When images were taken from various angles close to the frontal view the results were for angles approximately up to 60 and, the recognition accuracy was close to 100% And for angles more than 60 from the frontal view, the results were not consistent. This was because the quality of the rectified images was not suitable for recognition.

Kumar & Gopinath ,(2011) The Two - phase method reduces the skewed data before applying the skew detection and correction methods of accuracy and speed .This technique helps in reducing the computational time required for Hough Transform considerably with less compromise on the accuracy front and speeds up it.

Our study focused on finding an efficient translation system based on Arabic OCR in addition to preprocessing stage to improve the image in order to get better results in translation compared to previous systems.

# **Chapter Three**

**Image translation system based  
on Arabic OCR**

## Chapter Three

### 3.1 Introduction

The system is designed to translate different signboards from the Arabic language into the English language. The system starts in taking the image and ending up with translation the text. The image translation system is divided into four subsystems: image processing, segmentation, character recognition and translation.

### 3.2 The System Framework

The Image translation system based on Arabic OCR architecture is shown in figure 3.1 and it follows description in details for each stage.

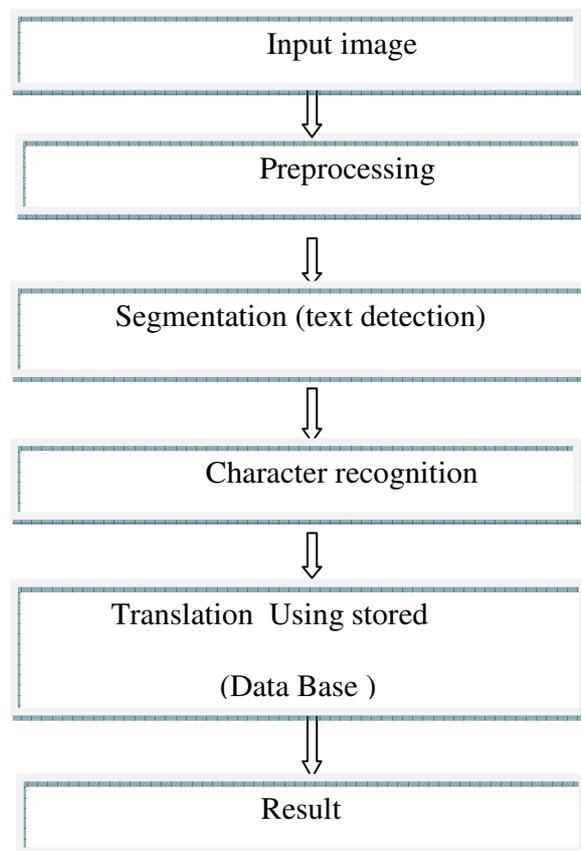


Figure (3-1) steps of the proposed system

**- Image Input :**

This stage is considered as a source of input to the system and it's the only one that requires user intervention.

**- Segmentation :**

It's system which identifies the image area that contains the text. It is the most important process that decides the effectiveness of the system because when the system selects the text area very well, the process of identifying words becomes easier and therefore gives the system strong results.

Segmentation is implemented in two levels: On the first level, text, graphics and other parts are separated On the second level, text lines, words and characters in the image are located.

**- Preprocessing :**

The goal of preprocessing is to simplify the image without ignoring any important information in order to have more accurate representation for others subsystem. At this stage the system is trying to improve the image to make it ready and appropriate for Character recognition by Skew detection, Binarization, Noise removing, and inversing the binary image through using the proposed algorithms.

#### **- Character recognition :**

The recognition step is based on the use off-the-shelf OCR algorithms on the text optimized. OCR contains two main step feature extraction and classification; these steps are closely related to each other as output of earlier step is inputted to later step.

#### **-Dictionary – Text translation:**

To translate the Arabic text into English we use a database search method to deal with names, phrases, and symbols related to tourists through building customized Offline dictionary.

### **3.3 Image translation system based on Arabic OCR**

The aim of this work is to translate the Arabic text into English by implementing Optical Character Recognition on printed Arabic characters.

#### **3.3.1 Image preprocessing subsystem**

The preprocessing stage is a very important step in image processing. The importance of the preprocessing stage lies in preparing the words to be in their final shape before entering the recognition stage. After the image is captured, a number of preprocessing steps are performed for these images. These steps are:

- 1- Binarization.
- 2- Noise removing.
- 3- Inversing the binary image
- 4- Skew detection and correction. The block diagram of preprocessing steps is shown in Figure 3.2

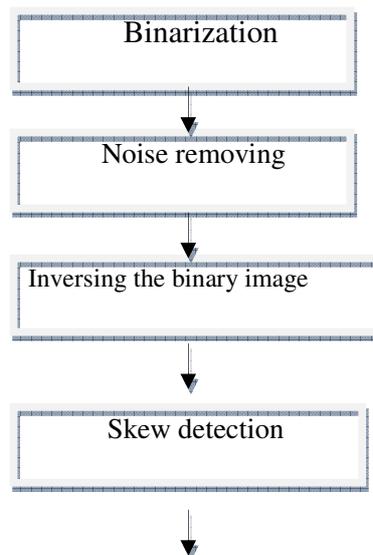


Figure (3-2) Preprocessing module

- **Binarization**

This process, which aims to convert the image into binary image, means to make all pixels zeros and ones. In this step we first convert the image into gray scale by `rgb2gray` command. The `rgb2gray` converts the RGB image or color map into grayscale then converts the gray values into the binary values. This step is done by comparing the gray values of an image with a given threshold. This threshold value is measured by finding the dominant gray value in the input image, and then choosing the threshold value to be the center point between the dominant value and the maximum gray value.

After determining the threshold value, each pixel in the image is compared with the threshold value. If the value of the pixel is less than the threshold reset the pixel to zero. Otherwise, reset the pixel to one as in equation 3.1.

$$P(x,y) = \left. \begin{array}{l} 0 : P(x,y) < \text{threshold value.} \\ 1 : P(x,y) > \text{threshold value.} \end{array} \right\} \dots\dots\dots 3.1$$

Where  $P(x,y)$  is the pixels of the image and the threshold is the value between the dominant and the maximum value and in this stage threshold = .80%.

- **Noise Removal:**

The image always contains noise that usually appears as an extra pixel (black or white) in the character image. If the noise is not taken into consideration, it could subvert the process and produce an incorrect result, so we use the median filter and fspecial filter to remove the noise from the image.

- **Image Inversion:**

Image inversion means inverting the pixels of an image: the zeros pixels to ones and vice versa. Inverting the Image is necessary since after applying the binarization, the background of the image takes the ones pixels and the foreground of the image takes the zeros pixels. As known in Image Processing using matlab, they

deal with image as ones pixels. Therefore, inversion is necessary to give the objects or digits in the image the ones and give the background the zeros. In this stage the inversion function is applied to the image for this purpose.

- **Skew detection and correction:**

Skew occurs when the Camera is not parallel with the images (Mollah ,Basu, & Nasipuri, (2010)). In this stage, at first system must calculate the amount of skew in the image and then correct skew. It is an important pre-processing step to increase the accuracy of the subsystem processes, such as character recognition.

For skew correction, we will implement vertical histogram algorithm because it is a popular method for skew detection. . Figure 3.3 shows algorithm for preprocessing subsystem .

```

Algorithm Preprocessing
input: image
output: Processed_image
if image_dim >1 then
    image = convet_image_gray(image)
else
    image = image
end
Processed_Image = image
Threshold=value
for pixel_index =1 to max_pixel_index step 1
    if Pixel_value > Threshold
        Pixel_Value = 1
    else
        Pixel_Value = 0
    end
end
Sum = 0
for pixel_index =1 to max_pixel_index step 1
    Sum = Sum+Pixel_Value
end
Counter_image_row = count(rows)
Counter_image_col = count(cols)
If Sum/(rows*cols) <50%
    for pixel_index =1 to max_pixel_index step 1
        Pixel_Value = Pixel_Value
    else
        Pixel_Value = ~ Pixel_Value
    end
end
vertical_histogram = count(number_of_ones)
best_angle = max(vertical_hist)
Processed_Image = rotate_image(best angle)

```

Figure (3-3) Preprocessing algorithm

### 3.3.2 Segmentation and Text detection subsystem :

Text detection is the process of partitioning the digital image into multiple regions that can be associated with the properties of one or more criterion. These properties are gray level, color, texture shape, and others. In mathematical sense the segmentation of an image, which is a set of pixels, is the partition of the image into  $n$  disjoint sets  $R_1, R_2, \dots, R_n$ , called segments or regions( regions of interest (ROIs) ) where the union of all regions equals the image.

$$\text{Image} = R_1 \cup R_2 \cup \dots \cup R_n.$$

Text detection from scene images handles many challenging. This is because there are variations of text due to differences in font size, style, color, complex background , and the images can be in gray scale or color. These variations make the problem of automatic text detection extremely difficult. Figure. 3.4 show some examples of text in images.



Figure (3-4) Examples of testing images

The system defines the text area (ROIs) by using a horizontal projection profile technique( Almohri, Gray, &Alnajjar, (2008)). A computer program scans the image horizontally to find the first and last black pixels in a line. Once these pixels are found, the area in between these pixels represents the line that may contain one or more character. Using the same technique, the whole image is scanned and each line is detected and saved in a temporary array for character recognition.

The main difference between our method and other methods is that our system dealing with colored background and the system will extract the text area of the image automatically without user intervention. Figure 3.5 shows algorithm for segmentation subsystem .

```

Algorithm: Segmentation

input: Processed_Image

output: Segments, segments_files, word_segments

col_sum=0

for counter_rows = 1 to counter_rows_max step = 1
    col_sum = col_sum + pixel_value
end

Vsum = col_sum

Counter_image_col = cols

for col = 1 to max_col step 1
    if Vsum = cols
        segment_start = col
    else
        break
    end
end

for col = 1 to max_col step 1
    if Vsum ~= cols
        segment_end = col
    else
        break
    end
end

segment = image(segment_start: segment_end)
segment_file = file(segment)

Segment = Rotate_image_(segment, 90 degree)

repeat Segmentation

Word_segments = segments

```

Figure (3-5) Segmentation algorithm

### 3.3.3 Character recognition Subsystem

Character recognition is one of the most critical subsystems in this research because the Arabic CR presents several challenges, including:

- The Arabic script is cursive.
- Connected characters, where characters can have different shapes in different positions of a word.
- 15 of the 28 Arabic letters include dots.
- A word is composed of sub-word (s).

In addition to the above characteristics, the Arabic font is written-read from right to left. These characteristics have made the progress of Arabic OCR more complex and difficult than other languages.

At this subsystem, DTW algorithms was previously suggested ,but the results of recognizing this kind was not clear and didn't achieve the aim of this system which the was process of translating Arabic texts so template matching algorithm was suggested in order to find the similarity between ROI and template of letter. Excellent results were obtained that enabled the system to get excellent translation and the following algorithm is applied in order to recognize all characters in the original image:

- 1- Template character is read to the recognition subsystem.
- 2- Image resize of processed template is applied to normalize size of the template to size of segment.
- 3- Template is passed around the segment and correlation between template and ROI (region of interest) in the segment is calculated.
- 4- Decision is made based on pre-assigned threshold that there is a character similar or not similar to the template. The threshold found to be 85% for acceptable performance. If a character is decided to be in the location a code of the letter is obtained based on the number of the template being recognized.
- 5- A matrix that contains the codes for templates in the specified location in the segment is filled until each segment is finished. For example " محافظة معان " start with letter "م" its code is 094 and this code location is in the matrix. This process is repeated for all letters from the beginning to the end of each segment. Figure 3.6 shows example for this step .

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
097	008	071	094	105	068	078	008	031	094
( Figure (3-6) ) Example for matrix محافظة معان string									

- 6- The process is repeated for all template characters from the beginning to the end of each segment. Notice that after coding the Arabic character in recognition phase, the letter is coded into its similar based letter translation. As an example “هـ” letter in Arabic will be “H” in English. Table3.1. shows the letters in Arabic and their opposites in translation Figure 3.7 Show the result of character recognition subsystem

محافظة معان	MgAN	MhAFeH
-------------	------	--------

Figure( 3-7) Result of character recognition subsystem string for محافظة معان string

- 7- The algorithm is applied for the matrix that reads the matrix from right to left (like Arabic language) and concatenate the codes into single line and multiple lines into one text for further processing.
- 8- The text is divided into multiple words using the space character and fed to the translation subsystem.

Table 3.1 Code of Arabic letter

Arabic letter	Code of letter
و ء ئ أ إ	H
هـ	W
ا ع ي	X
بـ	B
تة	T
ثـ	o
جـ	J
حـ	h
خـ	O
دـ	d
ذـ	c
رـ	R
زـ	Z
سـ	s
شـ	C
صـ	S
ضـ	D
طـ	T
ظـ	e
عـ	g
غـ	G
فـ	F
قـ	Q
كـ	K
لـ	L
مـ	M
نـ	N

It is noteworthy that the process of recognition is time consuming due to the loops carried out to get characters from templates used in the system. This is because the Arabic characters in contrast to English characters have many shapes depending on the location of the character in the word. Figure 3.8 depicts examples of templates used. Total number of templates used is 114 templates. Figure 3.9 shows algorithm for recognition subsystem .

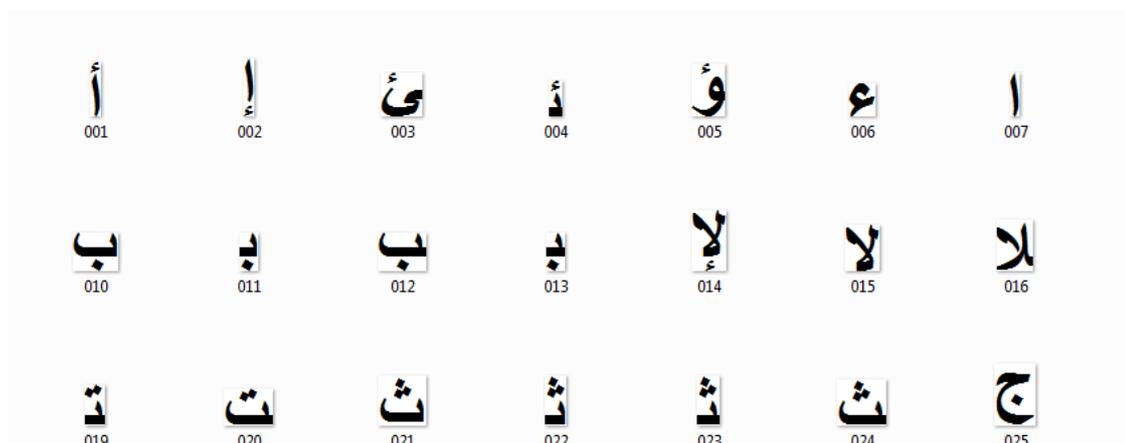


Figure (3-8) Part of Arabic characters shapes used in Recognition

Algorithm : *Recognition*

Input: Segments, templates

Output: text

Letter\_Code = number\_letter\_template

Arabic\_start\_location = Max\_Col, First\_Row

Temp\_image\_segment = Image\_crop (Arabic\_start\_location, Template\_size)

Correlate\_Factor = -1

Sum = 0

for Segment\_pixel\_index=1 to Max\_Segment\_Index step 1

    for template\_Pixel\_index to Max\_template\_index step 1

        Sum = template\_pixel\_Value \* Segment\_Pixel\_Value

    end

end

Correlate\_factor = Sum / (Max\_Segment\_Index \* Max\_Template\_Index)

Threshold = 0.85

for template\_Number = 1 to Max\_Template\_Number step 1

    for segment\_index = 1 to max\_segment\_Index step 1

        If Correlation\_Factor > thr

            Result\_table(letter\_location) = letter\_location, letter\_code

        end

    end

end

Word = ' '

Line = ' '

for Result\_Table\_Rows = 1: Max\_Result\_table\_Rows step 1

for Result\_table\_locations = 1 to max\_Result\_table\_location step 1

    if Result\_table(Result\_table\_locations) ~ = letter\_code(' ')

        Word = Word + Result\_table(Result\_table\_locations)

end

Line = Line + Word

end

Text = Line

### 3.3.4 Translation Subsystem

Figure (3-9) Recognition algorithm

The output is passed to the translation subsystem. The system uses database that contains dictionary of a set of words specified for translation. Database used in the system contains words translated for tourism translation application. The system can easily be applied for other application by feeding the needed words and their matched translation to the database. The recognitions subsystem will recognize the word and attempt to translate it using the same translation subsystem.

The translation subsystem takes the word from the recognition subsystem and searches the database. If the word exists in the table, the translation is obtained and appended to the output string. If the word is not found in the database word, the translation is assumed to be the same word and also fed to the output string . This will be helpful for word that is a name of people or objects and could not be collected in the system. For instance, the line “مطعم أحمد- وجبات سريعة” in Arabic language is recognized as “MTAM AHMD WJBAT SRYAH” and after translation it becomes “Restaurant AHMD – FOOD FAST”. Here “AHMD” is translated also as “AHMD” because it is not found in the database. This will help the user of the system at least to identify the objects by its similar translation in English. Part of the table used for translation is shown in table 3.2.

Table 3.2: Recognition and Translation output of the system

<b>Word</b>	<b>Translation</b>
JAMgH	University
ALHsYN	ALHussein
A"RdN	Jordan
SLAMH	Good bye
Mg	with
ALsXMH	Bye

### 3.4.1 Substitution of letters for translation

Misrecognized characters can be optionally substituted to compensate the recognition process at the last stage of translation.

This substitution is not arbitrary but based on the fact that many characters are very similar to each other in Arabic language, For instance “ح” is very similar to “خ” and “ج”. For certain threshold (85%) was used for recognition subsystem one of these character may be recognized as different one. For the system to substitute a letter for another, they both must be very similar, or the word

recognized with the original character is very similar to one existed in the database. Figure 3.10 depicts an example of using this enhancement.

	MdYNH	City	
	ALBtRA"	Petra	
	ALWRdYH	Rose	
	MWsa	Mosa	
	WAdY	Valley	
	ALtBYQYH	Applied	
	ALtBYQH	Applied	
علا			

Figure (3-10) Substitution for missed character System

In the figure 3.10, the system attempts to recognize the word “التطبيقية” from the Arabic language. now instead of recognizing it completely “ALtBYQYH”, the system recognizes it “ALtBYQH” which misses the character “يـ” in the Arabic language or “Y” in recognition system. Because the system didn’t recognize it well, substitution for this letter could be attempted by inserting another structure for the word “التطبيقية” in the Arabic language, and this will enhance the overall translation process for the English language which will be translated using this method to “applied” word in the English language for better translation.

The substitution is governed by the similarity of length and structure of the translated word and original word and the similarity between substituted characters. Figure 3.11 shows algorithm for translation subsystem .

```
Algorithm for Translation
Input: Text, dictionary
Output: Translation
for Number_text_characters to end text step 1
    Words = Substring (Text, ' ')
end

for Numer_Word =1 to Max_Number_Words
    Word = Words(Number_Word)
    Temp_Translation = English_Translation(Word)
    if Temp_Translation ~= Word
        Translation = Temp_Translation
    else
        if Temp_Word = Similar_to_Temp_Word
            Translation = Temp_Translation
        else
            Translation = Word
        end
    end
end
end
```

Figure (3-11) Translation algorithm

### 3.4 Flow chart for system :

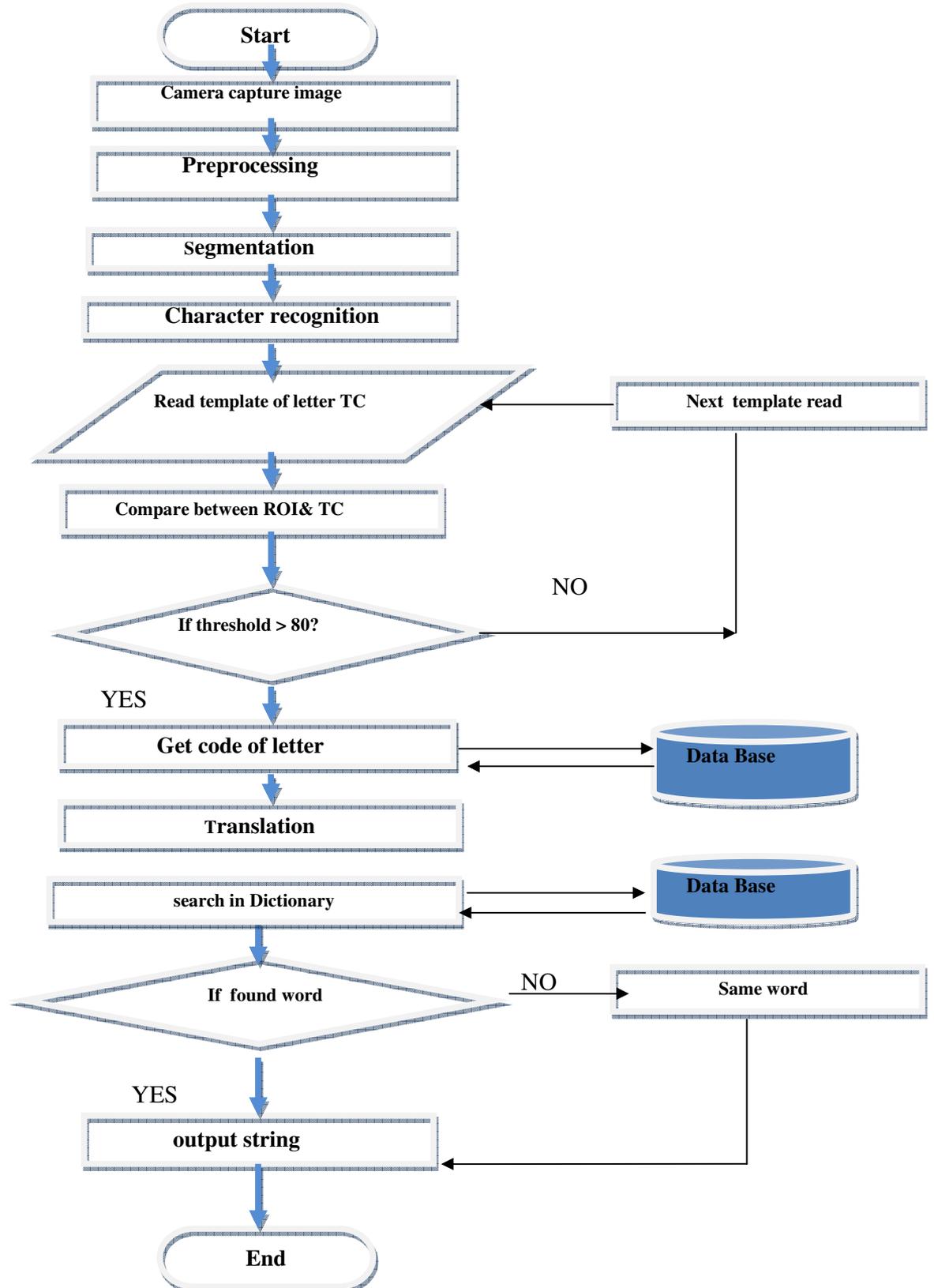


Figure (3-12) Flow chart of the proposed system

# **Chapter Four**

## **Experimental Results and Discussion**

## Chapter 4

### 4.1 Factors measured in the system

Image translation system based on Arabic OCR system has been designed to aid tourists to translate different announcements in Arabic language to help them to identify facilities while they travelling around sightseeing around Arabic places.

The system has been designed and developed totally using Matlab 2008b platform since Matlab provides powerful tools for image manipulation and recognition.

The system has been designed and developed totally using Matlab 2008b platform since Matlab provides powerful tools for image manipulation and recognition.

The Evaluation factors that used for measuring the system performance are as the following:

- Rate of characters recognized.
- Rate of words recognized.
- Rate of words translated.

Rate of characters recognized is obtained by dividing the number of recognized characters through the sample image by the total number of characters that counted in the image by the user of the system. For convenience, the number of total characters are entered the system by a text file assigned with the image file as in equation (4.1)..

$$\text{Recall} = \frac{\text{Number of correctly recognized characters}}{\text{Total number of characters}} \dots\dots\dots(4.1)$$

Rate of word recognized is calculated by counting the combined characters into word from the recognition systems divided by the total number of word that must be recognized by the system entered using text file assigned together with the sample image file as in equation (4.2)..

$$\text{Recall} = \frac{\text{Number of correctly recognized words}}{\text{Total number of words}} \dots\dots\dots (4.2)$$

Rate of word translated is computed by dividing the total number of recognized words that translated successfully by the dictionary by the total number assigned in the text file attached to the sample image. The translation process is dictionary based translation neither lexical nor grammar analysis carried by the system as in equation (4.3)..

$$\text{Recall} = \frac{\text{Number of correctly words translated}}{\text{Total number of words}} \dots\dots\dots(4.3)$$

## 4.2 Experimental results for various font sizes

The system is tested for 5 different images that contain the same text to be translated by the system. The images have different size of the same text. Although the base font is 40 for template characters, the system can recognize and translate other fonts with different rates near the base font. The images that tested in the system are shown in figure4.1 below.



Figure (4-1) : Images samples for 5 different sizes

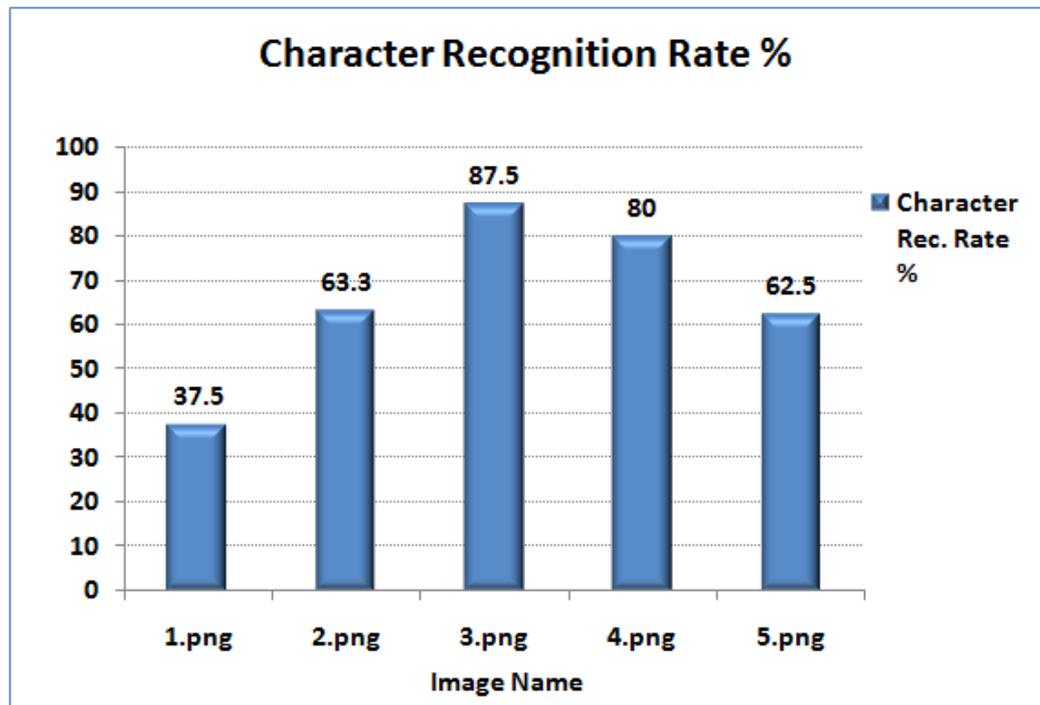


Figure (4-2) : Characters recognition rate for 5 different font size.

The system shows acceptable level of character recognition rates if the text in the image approximated to the base font and degrades gradually for other fonts above or below the base font as shown in figure 4.2.

The translation rate for some font sizes fluctuates between( 50%-100%) because the system recognized either one or two words out of two words existed in the tested images .

### 4.3 Performance of the system for skew detection

The system is tested for sample images with an embedded text that skewed within each image. The text in the image have random angle of skew. The system shows excellent ability to recognize and translate for text of degrees  $0^{\circ}$ ,  $90^{\circ}$ ,  $180^{\circ}$  and  $270^{\circ}$ . for these images the characters recognition rate is the same for the image of  $0^{\circ}$  degree .Images 1.png, 7.png, 8.png and 9.png have the same character recognition. The system also provides different response for skewed texts in the image with different angle of alignment of the text. The images that tested in the system are shown in figure4.3 below.



1.png



2.png



3.png



4.png



5.png



6.png



7.png



8.png



9.png

Figure (4-3) : Sample images for testing.

Word recognition process can detect 75% of the words in the skewed texts, and for most cases 100% is obtained for the system as shown in figure 4.4. Based on the recognition process the words can be translated for the words with highest character recognition and the rate of the word recognition. when substitution of characters is applied high rate of words can be translated in the system for different angle of alignment. Figure 4.5 depicts the result of word translation process in the skewed embedded text in the images under consideration.

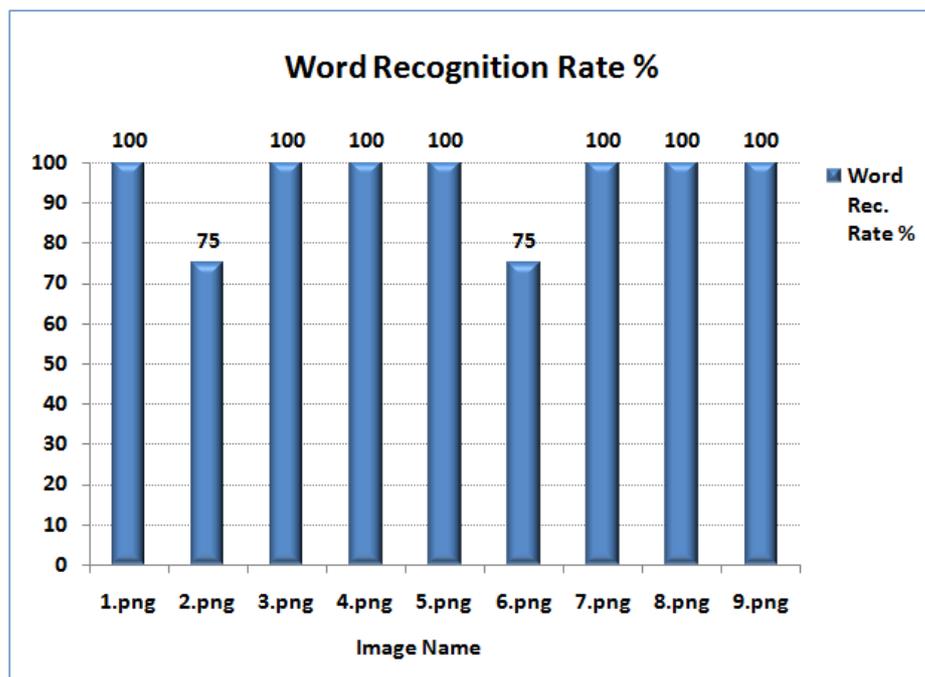


Figure (4-4) : Word recognition rate for skewed texts embedded

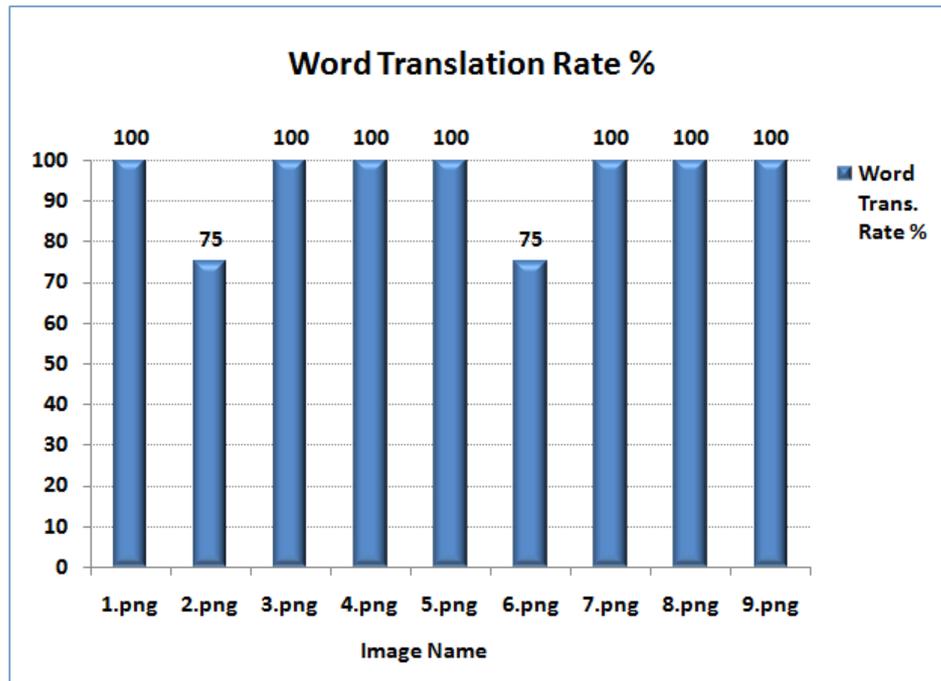


Figure (4-5) : Word translation rate for skewed texts embedded

### 4.3 Experiment Results for General Image Samples

The system tested against different images with various texts within each image, for convenience images of eight of the samples images are shown in figure 4.6. The system is tested against different types of street sign images and computer based sign images. The system deals with different font size, skewed images and noisy images.



17.png



19.png



20.png



21.png



22.png



23.png



24.png



25.png

Figure (4-6) : Sample images for testing

Table 4.1 shows the recognition text versus the translated text for images in the experiment. Recognition text is obtained after the words being combined from the recognized characters. The translated texts are the output of translation system.

Table 4.1: Recognition and Translation output of the system

Image Name	Recognized Text	Translated Text
25.png	MNTQHH gGMLL	'Area' 'Work'
24.png	MRZRKRZRZZ tNMYHH	'MRZRKRZRZZ' 'Development'
23.png	MRZRKRZRRA "LMgRFQHH	MRZRKRZRRA "LMgRFQHH
22.png	ALRWYsdd	'ALRWYSHD'
21.png	AXRZRQQ LMRQQ	'ALARZRAQ' 'ALMAFRAQ'
20.png	MTeTgMM MJOhJOhOhOhMd	'MTeTgMM' 'MOhJOhOhOhMd'
19.png	MOJOhAFTeTeHH A"RBdd tR.Jh"BB BB	MOJOhAFTeTeHH 'Irbid' 'Welcome' 'you'
17.png	MsQAA MgANN	MsQAA maan

The results of the system are depicted in figure 4.7. Note that the recognition rate of the character is measured based on the number of the character

recognized divided by the expected number of characters assumed from the image. The system shows high rate for character recognition. This will aid the translation subsystem to deal efficiently with image contents.

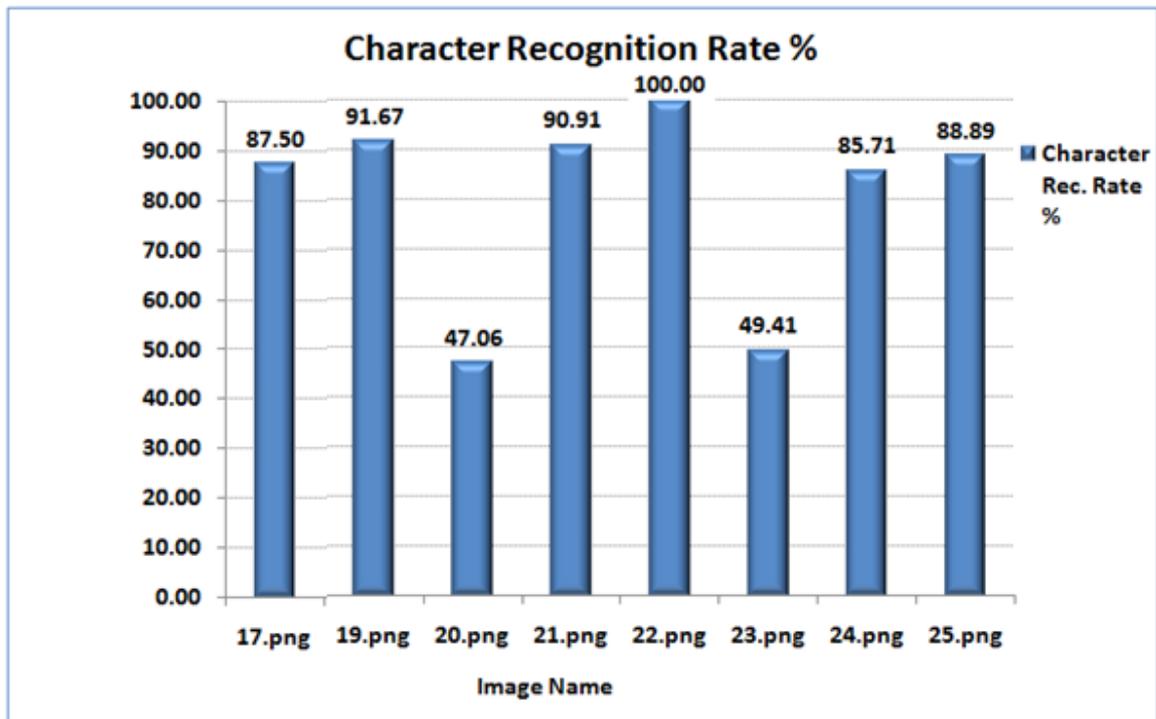


Figure (4-7) : Rate of Recognition of images from 17-25

The rate of word recognition is calculated by dividing the total number of recognized word by the total number of words assumed in the image. Word Recognition rate is shown in figure 4.8. Note that the recognition rate is affected by the number of word in the image. For instance image 22.png contains only the Arabic word 'الرويشد'. the number of words recognized by the system is '1' which is 'ALRWYsdd' and the number of the words in the image also "1" so the rate became 100%. for the image number 23 only one out of two words was

recognized. So the rate became 50%.The system shows stable word recognition rate for images that contains high number of words to be recognized.

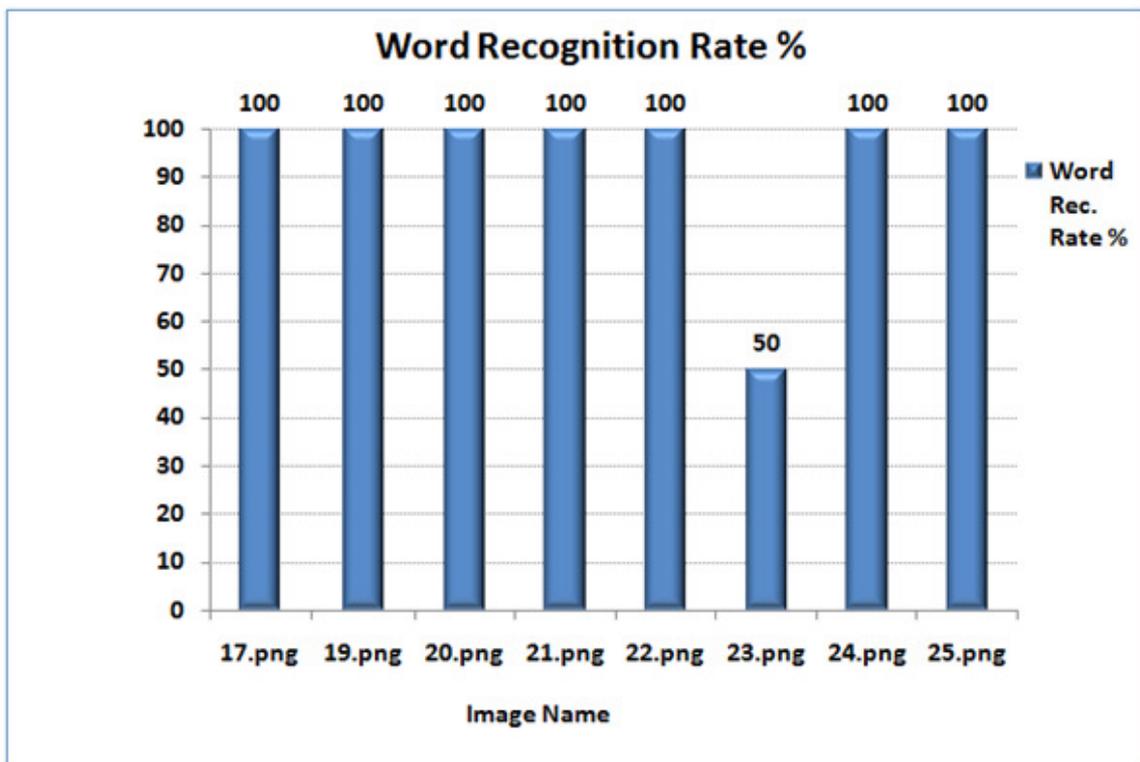


Figure (4-8) : Rate of word Recognition for images from 17-25

Figure 4.9 shows the rate of translation system. This rate is calculated by counting the number of words that correctly translated by the total number of words in the image. Translation rate depends on the rate of character recognition rate and the content of the word recognized against the dictionary in the system.

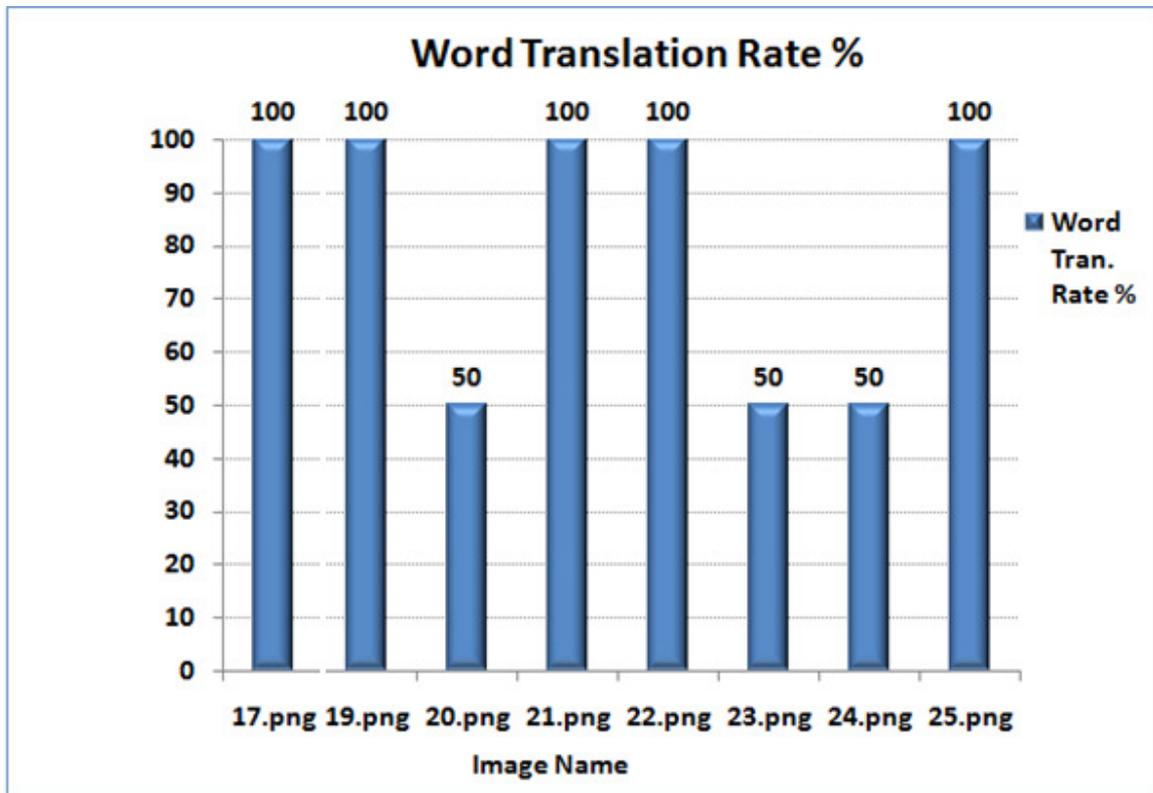


Figure (4-9) : Rate of Word Translation for images 17-25.

The system shows acceptable level of recognition and translation levels. As shown in table 4.2, average of character recognition is 81.82%. This affect together with the accuracy of word segmentation process aided the word recognition subsystem (94.44%). as consequence the word translation also has an acceptable level about (83.33%).( Total statistics obtained in this experiment is tabulated in the table 4.2)

Table 4.2: Rate of Recognition and translation for the system

Image number	Character Recognition Rate	Word Recognition Rate	Word Translation Rate
25	<b>88.89</b>	<b>100</b>	<b>100</b>
24	<b>85.71</b>	<b>100</b>	<b>50</b>
23	<b>49.41</b>	<b>50</b>	<b>50</b>
22	<b>100.00</b>	<b>100</b>	<b>100</b>
21	<b>90.91</b>	<b>100</b>	<b>100</b>
20	<b>47.06</b>	<b>100</b>	<b>50</b>
19	<b>91.67</b>	<b>100</b>	<b>100</b>
18	<b>95.24</b>	<b>100</b>	<b>100</b>
17	<b>87.50</b>	<b>100</b>	<b>100</b>
	<b>81.82</b>	<b>94.44</b>	<b>83.33</b>

# **Chapter Five**

## **Conclusions & Future**

### **works**

# Chapter Five

## 5.1 Conclusions:

After working endlessly and doing unlimited studies on this thesis we can conclude that the thesis objective to develop a system that will automatically translates Arabic text embedded in images into English has been met with success..

The system is designed and positioned to make it easy for tourism to translate Arabic text which could be difficult for them to understand in Arab countries during their trips in Arab world .While the text detection method is robust and accurate, text recognition is good because Arabic character recognition still suffer from some problem however the system was able to obtain excellent results in translation Arabic texts into English.

The test images consists of a variety of variations such as text in different color, light, text on dark background, image with blurring, and image with skew.

We calculate the Recall for characters ,words and translation to evaluate the performance of the developed system and an experimental result shows character recognition is 81.82%, the word recognition subsystem (94.44%) and the word translation also has an acceptable level about (83.33%).

## 5.2 Future Works:

The work of this thesis enables an application that translates text in Arabic Image to English text for other further applications. The software has many features and deals with different backgrounds of the images and enables skew detection of the image.

This application can be further enhanced in the future as follows:

The font size should be adopted for the font size a way larger than or smaller than the base font size. This could be done using normalization techniques which should be studied and developed accurately in Matlab.

The threshold for correlation coefficient is fixed in the system around 85%. This can be enhanced in the future by adjusting the value of the threshold based on the percentage of translation that it obtains from the first phase. This could allow the system to adapt to increase the rate of character recognition and hence the overall image translation system rate.

Smart phone have image enhancement techniques taken in real time system such as especially deblurring techniques. This could aid the system when applying this software in smart phones. Investigations should be carried for this application to be used in smart phone systems for portability. Portability on these devices depends on the phone operating system and hardware device and the application development it used.

# **Chapter Six**

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