

DEVELOPMENT OF IMAGES TO BRAILLE CONVERSION SOFTWARE FOR
SYMBOLS USING TEMPLATE MATCHING WITH RULE BASE
(Images to Editable Text to DeBrailSo)

MOHD SOLAHUDDIN BIN JAAFAR

Report submitted in partial fulfilment of the requirements
For the award of the degree of
Bachelor of Computer Sciences (Computer Systems & Networking)

Faculty of Computer Systems & Software Engineering
UNIVERSITI MALAYSIA PAHANG

MAY 2011

PERPUSTAKAAN UNIVERSITI MALAYSIA PAHANG	
No. Perolehan 069145	No. Panggilan TK 7882 P3 S65 2011 CS B.
Tarikh 30 NOV 2012	

ABSTRACT

The blind people who need to read text always face some problems because they only can read Braille dots. The reading materials for them are very limited as they are unable to read available normal reading materials. Images to Braille conversation Software/hardware (Symbols) is a system that helps Blind people to read available reading materials. The current system only can support upper-case English alphabets from A to Z using six dots. Hence, to complete the current system, we have developed a complete images to Braille conversation system to process and convert the images of normal texts into Braille dots (8 dots) taking into account (i) lower/upper case English alphabets, (ii) numbers and (iii) special characters/symbols all together. Particularly, this research focuses on the part two, which is the processing and conversion of special characters/symbols. The special characters such as (` - = [] \ ; ' , . / ! @ # \$ % ^ & * () _ + etc.). Need special treatment to convert it to Braille. This system is able to convert any scanned, captured or saved image of symbol's into Braille. This system receives the input images, process and compares it with characters templates that have been stored in the database. The processing of image is done into five steps systematically as: (i) binarization and pixel inversion, (ii) noise removal, (iii) segmentation and clustering, (iv) line identification and finally (v) character extraction. A GUI is developed to observe the processed and displayed Braille dots to ensure the accuracy. Followed by a hardware is developed to demonstrate the working ability to display the Braille dots in terms Led. The Blind people only need to capture the text picture using a hardware tool such as camera to get digital image and fed into the system, then the system will convert and display the Braille dot automatically. (This system is targeted to integrate with Alphabets and Numbers and then use with hand phone or camera as a handy plug-in/plug-out device.). So that the blind people can carry

it anywhere any time with them to capture picture and make it readable for them. They also will be able to read the received SMS in their hand phone. The system also will read the material aloud for additional convenience for this group of people so that they can read and listen as per need. The developed integrated system may offer an easy life for the Blind community by widening the reading materials in a affordable and convenient way.

ABSTRAK

Orang-orang buta yang perlu untuk membaca teks selalu menghadapi masalah kerana mereka hanya boleh membaca titik Braille. Bahan bacaan bagi mereka sangat terhad kerana mereka tidak dapat membaca bahan-bahan yang sedia bacaan biasa. Gambar ke perbualan Braille Software / perangkat keras (Simbol) adalah sistem yang membantu orang buta untuk membaca bahan bacaan yang sedia. Sistem saat ini hanya boleh menyokong huruf besar huruf Bahasa Inggeris dari A sampai Z menggunakan enam titik. Oleh kerana itu, untuk melengkapkan sistem saat ini, kami telah mengembangkan suatu gambar yang lengkap untuk sistem perbualan Braille untuk memproses dan menukar imej teks normal menjadi titik-titik Braille (8 titik) dengan mempertimbangkan (i) huruf kecil / huruf besar dalam bahasa Inggeris, (ii) nombor dan (iii) aksara khas / simbol semua bersama-sama. Khususnya, kajian ini menumpukan pada, bahagian kedua yang merupakan pemprosesan dan penukaran aksara khas / simbol. Aksara khas seperti (` - = [] \ ; ! . ' , / ^ @ # \$ % & * () _ + Dll). Perlu perlakuan khusus untuk mengubahnya menjadi huruf Braille. Sistem ini mampu menukarkan semua diimbias, ditangkap atau disimpan gambar simbol ke dalam Braille. Sistem ini menerima input gambar, proses dan membandingkannya dengan watak template yang telah disimpan di dalam database. Pengolahan citra dilakukan ke dalam lima langkah sistematik sebagai: (i) binarization dan inversi pixel, (ii) penghapusan hingar, (iii) segmentasi dan clustering, (iv) pengenalan garis dan akhirnya (v) ekstraksi aksara. Sebuah GUI dibangunkan untuk mengamati diproses dan dipaparkan Braille titik untuk memastikan ketepatannya. Dilanjutkan dengan peranti keras dibangunkan untuk menunjukkan kemampuan bekerja untuk memaparkan titik-titik Braille dalam hal Led. Orang-orang yang buta hanya perlu untuk menangkap gambar teks menggunakan alat peranti keras seperti kamera untuk mendapatkan gambar digital dan dimasukkan ke

dalam sistem, maka sistem akan mengubah dan memaparkan dot Braille secara otomatis. (Sistem ini disasarkan untuk mengintegrasikan dengan Alphabets dan Bilangan dan kemudian digunakan dengan hand phone atau kamera sebagai peranti plug-in/plug-out kepada.). Sehingga orang yang buta dapat membawa di mana sahaja bila-bila masa dengan mereka untuk menangkap gambar dan membuatnya dibaca bagi mereka. Mereka juga akan mampu membaca SMS yang diterima di telefon tangan mereka. Sistem ini juga akan membaca bahan-bahan yang keras untuk keselesaan tambahan untuk sekumpulan orang sehingga mereka boleh membaca dan mendengar sesuai keperluan. Sistem yang terintegrasi yang dibangunkan mungkin menawarkan kehidupan yang mudah bagi masyarakat buta dengan memperluaskan bahan bacaan dengan cara yang berpatutan dan selesa.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	STUDENT'S DECLARATION	II
	SUPERVISOR'S DECLARATION	III
	DEDICATION	IV
	ACKNOWLEDGEMENT	V
	ABSTRACT	VI
	ABSTRAK	VII
	TABLE OF CONTENTS	X
	LIST OF TABLES	XIV
	LIST OF FIGURES	XV

1	INTRODUCTION	
	1.1 Background	1
	1.2 Problem Statement and Motivation	2
	1.3 Aim and Objective	3
	1.4 Scope of The Projects	4
	1.5 Study Module	4
	1.6 Thesis organization	6

2**LITERATURE REVIEW**

2.1	Introduction	7
2.2	Early stages towards the development of a device that eases the reading of blind people (2010)	8
2.3	OCR for printed urdu script using feed forward neural network	9
2.4	An Arabic optical Braille recognition system	9
2.5	OCR error correlation of an inflectional Indian language using morphological parsing	10
2.6	Pattern Recognition	10
	2.6.1 Pattern recognition approaches	11
	2.6.1.1 Template Matching	14
	2.6.1.2 Statistical Classification	15
	2.6.1.3 Syntactic or structural matching	16
	2.6.1.4 Neural network	18
2.7	Optical character recognition (OCR)	20
2.8	Tool of development	21
2.9	Summary	21

3**METHODOLOGY**

3.1	Introduction	22
3.2	3.2.1 Identification	25
	3.2.2 Planning	27
	3.2.3 Analysis	28
	3.2.4 Design	29
	3.2.4.1 Design algorithm for symbols	30
	3.2.4.2 Design interface for symbols	33
	3.2.5 Implementation and testing	34
3.3	Summary	34

4	IMPLEMENTATION	
4.1	Introduction	35
4.2	Flow chart: Module 2	36
	4.2.1 Word extraction by horizontal projection	37
	4.2.2 Character extraction by vertical projection	38
	4.2.3 Rule base for same character	40
	4.2.4 Template matching	42
4.3	Summary	43
5	INTEGRATION	
5.1	Introduction	44
5.2	Module 1: Images capturing and noise removal for symbols	45
5.3	Module 2: Clear images to text conversion for symbols	46
5.4	Module 3: Text to 8-bits symbols	47
5.5	Summary	48
6	RESULT AND DISCUSSION	
6.1	Introduction	49
6.2	Result of the system	50
	6.2.1 Testing	51
6.3	OCR performance evaluation	60
6.4	Summary	60

7	CONCLUSION	
7.1	Summary	61
7.2	Achievement of contribution	62
7.3	Future research directions	62
7.4	Lesson learnt	62
	REFERENCE	64
	APPENDIX A	65
	APPENDIX B	69

LIST OF TABLES

TABLES NO	TITLE	PAGE
2.1	Pattern recognition models	12
2.2	Differentiation of pattern recognition between existing systems	19
2.3	Differentiation between OCR tool and method use in existing system	20
2.4	Development tool use in existing systems	21
3.1	Timeline for first semester	27
3.2	Timeline for second semester	27
3.3	Software requirement	28
3.4	Hardware requirement	28
5.1	List of symbols character	45
5.2	List of conflict character	46
5.3	List of dots, binary and decimal format	47
5.4	List of decimal for each character	47
5.5	List of decimal for each character	47

LIST OF FIGURES

FIGURE	TITLE	PAGE
1.1	Study Modules	5
2.1	Project of Yusor A. Taqi Al-Qazwini (2010)	8
2.2	Example of four object represent by two feature (area and perimeter) in a two-dimensional feature space	13
2.3	A representation of a simple 3-layer feed forward artificial neural network with 4 inputs, 5 hidden nodes, and 1 output	13
2.4	Correlation method used template matching	14
2.5	Statistical PR approach	15
2.6	Structural matching example	16
2.7	Syntactic pattern representation of a sheet metal design	17
2.8	Fully connected multilayer feed-forward network with one hidden layer	19
3.1	Task Distribution by organization	23
3.2	Task Distribution by module	23
3.3	Flow Chart Planning	24
3.4	Required tools and equipment	26
3.5	Data identification for symbols	26
3.6	System flow for OCR	32
3.7	Flow Interfaces for OCR	33
4.1	Flow Chart for Module 2	36
4.2	Flow Chart for Word extraction using horizontal projection	37

4.3	Process for Word extraction using horizontal projection	38
4.4	Flow Chart for Character extraction using vertical projection	39
4.5	Process for Character extraction using vertical projection	39
4.6	Flow Chart for Rule Base	41
4.7	Process for Rule Base	41
4.8	Flow Chart for Template Matching	42
4.9	Process for template matching	42
6.1	Example picture of character for symbol	51
6.2	Result for symbol 1	51
6.3	Result for symbol 2	52
6.4	Example picture of character for symbols with different colour	52
6.5	Result for colour symbol 1	53
6.6	Result for colour symbol 2	53
6.7	Example picture of character for symbol with colour and noise	54
6.8	Result for noise symbol 1	54
6.9	Result for noise symbol 2	55
6.10	Example picture of character for symbol with color and not complete picture	55
6.11	Result for damage symbol 1	56
6.12	Result for damage symbol 2	56
6.13	Example picture of character for symbol with two level character symbols	57
6.14	Result for two level symbols 1	57
6.15	Result for two level symbols 2	58
6.16	Example picture of character for symbol with same shape character symbols that need to use rule base	58
6.17	Result for rule base symbols 1	59

6.18	Result for rule base symbols 2	59
------	--------------------------------	----

CHAPTER 1

INTRODUCTION

1.1 Background

Optical Character Recognition (OCR) is a system to convert scanned printed/handwritten image file into readable/editable text document. OCR system received file as an image and convert it by comparing/matching the characters with the set of OCR stored database. There are many important applications using character recognition nowadays such as speed track that have been used by government to track speeding car. This character recognition can be used for blind people to read text. It has open the new light of life to blind community.

This project aims to develop program that replaced blinded people eye so that they can see the world. They only need a mobile phone with camera, simple easy text to Braille converter and a program. With the program, blind people can read all text, tag and signboard without help from other people.

Other than that, this project also will open a new era of translating image to text. Just imaging when someone go to country that they do not know their language. There are many text, tag and signboard that using the country language. So, with the same

project development, this program can be act as translator by only taking a picture of the text and translate to the known language.

1.2 Problem Statement and Motivation

Blind people cannot see, but they can read by their fingers using Braille. Braille is a system of raised dots that is read with finger. The system was invented by Louis Braille of France in the early 1800s. The systems have helped many blind people to read over the ages. Nowadays, the there are many device such as typewriter and printer to produce Braille text. And they also have OCR software that can scan the text and read the text loudly.

The devices to convert text to Braille nowadays are very rare. The current devices also have limited function, very expensive and depend on speech synthesizer to read the text for blind people. But most blind people prefer using Braille to read and some of them are deaf. Also some of the people cannot buy this device because it is expensive.

Because of that, the demands for easy, cheap and portable system/devices are growing to convert image/test documents into Braille. The device must be small like mobile phone that can be carried anywhere, anytime and for any purpose of reading text. The development process consists of several stages, starting from reading the input which is an image file, processing it, and converting it to an editable format. After that, the process goes through few stages until producing the Braille symbols.

This project is continued from previous project by Yusser A. Taqi Al-Qazwini on "Early Stages towards the Development of a Device That Eases the Reading of Blind People"^[1]. The previous project considered only 6 dot format Braille and it covers only capital letter. There is no function that can support small letter, special symbol and number.

This research upgrades previous project and focuses on developing system/device for Braille using '8' dot formats and covers for special character that usually use in computer symbol. This research divided into 3 part of character such as special character, upper and lower case and numbers.

1.3 Aim and Objective

The aim of this project is to develop a simple and easy OCR system to convert image file into readable and editable format and into Braille. The whole work of the project images to Braille divided into 3 modules as follow:

- (i). Module 1: Image capturing and digitalization to clear images considering of noise removal and angle correction.
- (ii). Module 2: Conversion of clean images to text in terms of character extraction, horizontal and vertical projection, and template matching with rule base algorithm.
- (iii). Module 3: Braille display hardware development and text to 8 bits Braille implementation with sounds.

This project focuses on Module 2. To achieve the aim, the objectives are:

- (i). To investigate about available pattern recognition and images processing approaches and find a suitable one for OCR.
- (ii). To develop an suitable images to text conversion system considering character extraction, horizontal and vertical projection and template matching with rule base.
- (iii). To implement and integrated with Module 1, Module 2, Module 3 and test for special symbols, along with other characters for 8 bits Braille symbols.

1.4 Scope of The Projects

OCR Braille System is developing to face certain scopes of user. The scopes of this project are:

- (i). The system can process image to editable text
- (ii). The system can convert images to editable text using character extraction, horizontal and vertical projection and template matching with rule base.
- (iii). The system can integrated with module 1, module 2, module 3 including upper and lower case, number and symbols.

1.5 Study Module

Study modules in Figure 1.1 showed the part by part of development this system

- (i). Module 1: Image capturing and digitalization to clear images considering of noise removal and angle correction.
- (ii). Module 2: Conversion of clean images to text in terms of character extraction, horizontal and vertical projection, and template matching with rule base algorithm.
- (iii). Module 3: Braille display hardware development and text to 8 bits Braille implementation with sounds.

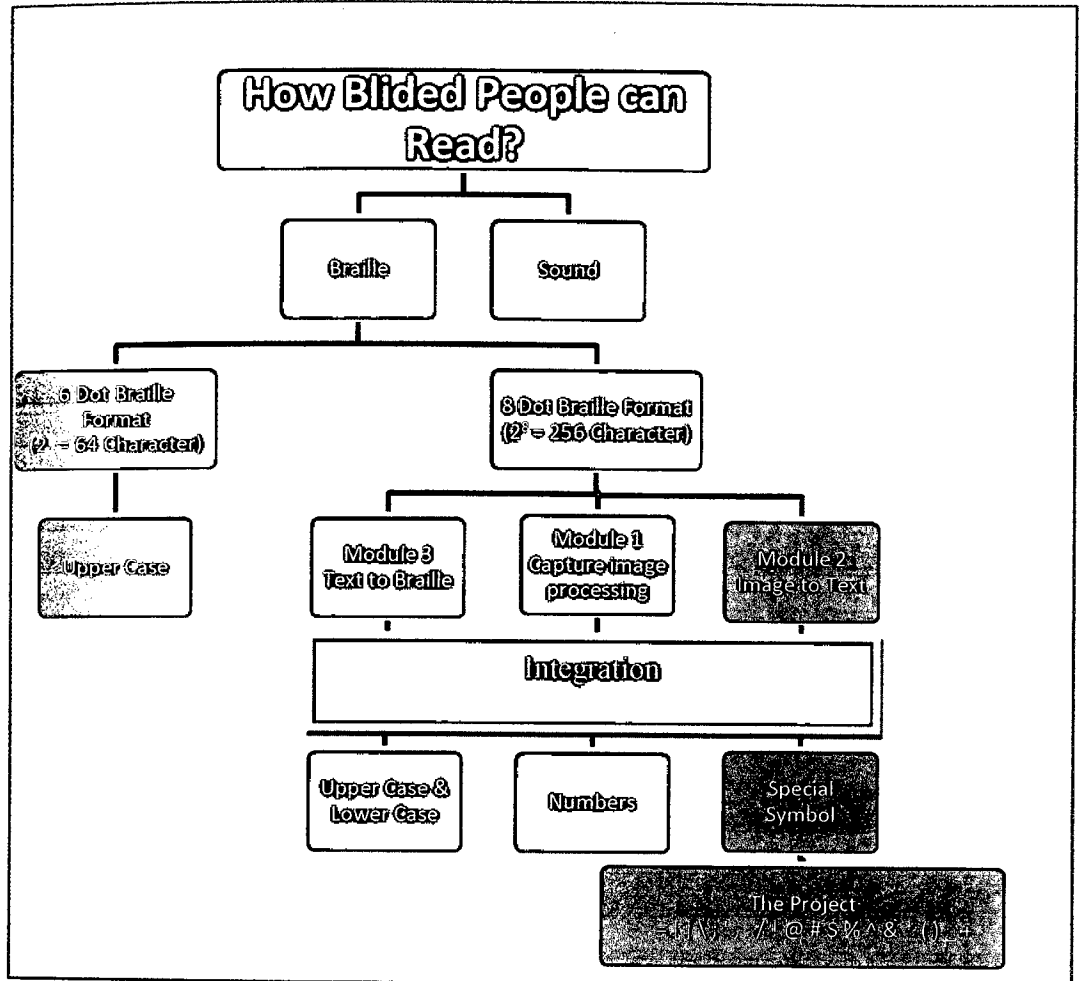


Figure 1.1 Study Modules

1.6 Thesis Organization

Thesis Organization is how to organize the thesis. In this thesis is organized in five chapters. Chapter 1 presented 6 sub-chapter such as background, problem statement and motivation, aim and objective, scope of the project, study module and thesis organization.

Chapter 2 covers the literature review. This chapter needs to make a research about past project that related to this project to make this project better.

Chapter 3 covers the research methodology. This chapter discuss about development phases and what method is suitable to use for this project.

Chapter 4 cover all the result and discussions base on the experimental result.

Chapter 5 covers conclusion and contribution of the thesis. This chapter also discusses and suggests for the future works based on analysis and recommendation what need to be repair in future work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction ^{[1][2][3]}

These chapters describe other people's work that relate to this project. Blind people will remain in the dark when they are unable to read and write. Many researchers have been made to solve this problem. Pattern Recognition is one of the successful researches that help to solve this problem. Character Recognition (OCR) is one of the applications of the Pattern Recognition.

Now days, most of the technology tools built for people with blindness and limited vision. The technology tools are built on the two basic building blocks of OCR software and Text-to-Speech (TTS) engines and any information on these would be invaluable for people with vision impairment.

2.2 Early stages towards the development of a device that eases the reading of blind people (2010)^[1]

Our program prototype is not the first program designed around this concept: in 2010 Yusor A. Taqi Al-Qazwini (Universiti Putra Malaysia) comes out with a program that using this approach but only with limited character. The program only using 6 dot Braille that cover 64 character.

Basically, the program involved in the recognition process was prepared with Paint and imported into the OCR algorithm. So in the program, user can import their text images using scanners, digital camera, or they can make it with Paint. The output such as text document can be printed out or observed on the computer screen. The initial setup of the project with the use of scanner of smart phone for image digitization, personal computer for image processing, and printer for output observation is how in Figure 2.1.

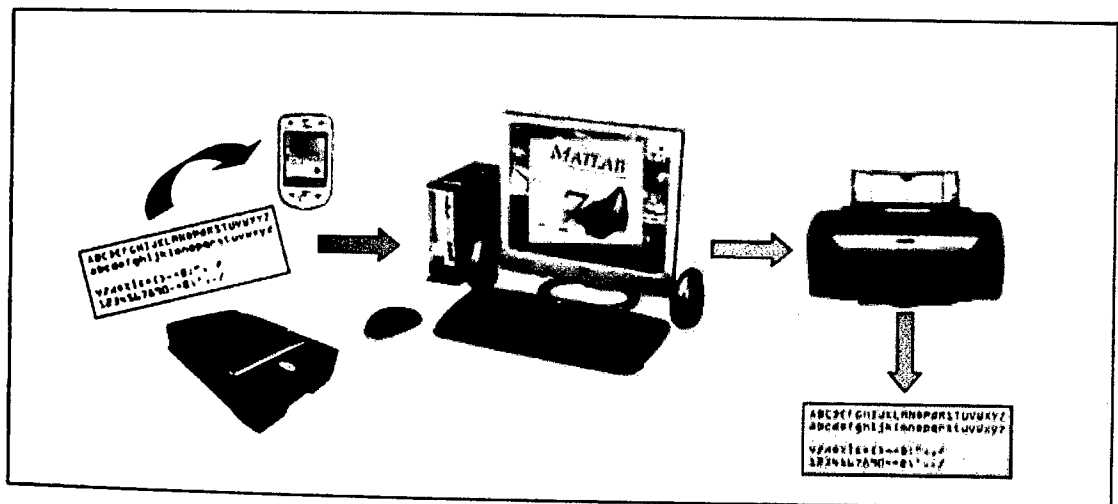


Figure 2.1 : Project of Yusor A. Taqi Al-Qazwini (2010)

This limitation of this project not covers other character such as upper and lower case, number and special symbol. Our approach is to cover that program to add some feature like that.

2.3 OCR For Printed Urdu Script Using Feed Forward Neural Network

This paper deals with an Optical Character Recognition system for printed Urdu, a popular Pakistani/Indian script and is the third largest understandable language in the world, especially in the subcontinent but fewer efforts are made to make it understandable to computers. Lot of work has been done in the field of literature and Islamic studies in Urdu, which has to be computerized. In the proposed system individual characters are recognized using our own proposed method/ algorithms. The feature detection methods are simple and robust. Supervised learning is used to train the feed forward neural network. A prototype of the system has been tested on printed Urdu characters and currently achieves 98.3% character level accuracy on average .Although the system is script/ language independent but we have designed it for Urdu characters only.

2.4 An Arabic Optical Braille Recognition System

Technology has shown great promise in providing access to textual information for visually impaired people. Optical Braille Recognition (OBR) allows people with visual impairments to read volumes of typewritten documents with the help of flatbed scanners and OBR software. This project looks at developing a system to recognize an image of embossed Arabic Braille and then convert it to text. It particularly aims to build fully functional Optical Arabic Braille Recognition system. It has two main tasks, first is to recognize printed Braille cells, and second is to convert them to regular text. Converting Braille to text is not simply a one to one mapping, because one cell may represent one symbol (alphabet letter, digit, or special character), two or more symbols, or part of a symbol. Moreover, multiple cells may represent a single symbol.

2.5 OCR error Correlation of an Inflectional Indian Language Using Morphological Parsing

This project deals with an OCR (Optical Character Recognition) error detection and correction technique for a highly inflectional Indian language, Bangla, the second-most popular language in India and fifth-most popular language in the world. The technique is based on morphological parsing where using two separate lexicons of *root words* and *suffixes*, the candidate root-suffix pairs of each input string, are detected, their grammatical agreement is tested and the root/suffix part in which the error has occurred is noted. The correction is made to the corresponding error part of the input string by means of a fast dictionary access technique. To do so, the information about the error patterns generated by the OCR system are examined, and some alternative strings are generated for an erroneous word. Among the alternative strings, those satisfying grammatical agreement in root and suffix are finally chosen as suggested words. In the list of suggested words generated by the system, the desired word is available in 84.22% cases.

2.6 Pattern Recognition

Pattern recognition techniques are an important component and rich issue of intelligent systems is usually used to identify an input, such as speech, images, or a stream of text, by the recognition and delineation of patterns it contains and their relationships ^[4].

Pattern recognition can be applied in many areas. But they usually applied in this area ^[5]:

- Image preprocessing, segmentation, and analysis
- Computer vision
- Artificial intelligence
- Seismic analysis
- Radar signal classification/analysis
- Speech recognition/understanding
- Fingerprint identification
- Character (letter or number) recognition
- Handwriting analysis
- Electro-cardio graphic signal analysis/understanding
- Medical diagnosis
- Socioeconomic
- Archaeology
- Data mining/reduction

2.6.1 Pattern Recognition Approaches

The design of a pattern recognition system basically involves four steps that usually involve such as ^[6]:

- i) Data acquisition and pre-processing, e.g. capturing a picture of an object or scan a text and removing the irrelevant noise ^[6]
- ii) Data representation, e.g. deriving relevant object characteristics (like its size, shape, and colour) which efficiently offer germane information needed of pattern recognition ^[6]
- iii) Training, e.g. imparting pattern class definition into the system ^[6]
- iv) Decision making that involves finding the pattern description of new, unseen object based on a training set of characters ^[6].