CHAPTER 1

INDTRODUCTION

This chapter provides the background of the study, describes the problem situation, and identifies the research objective and hypotheses. It also explains research scope and significance of the study.

1.1 Rationale

The fast advancement of technology has made the world going more digitally in most aspects. Data and documents are considered more flexible and easier to use in digital form. In this form, data and documents can be shared and distributed easily on the network. In addition, if properly stored and cared, data and documents in digital form relatively are more durable than in physical form. This phenomenon motivates people to convert physical data and documents into digital form.

Despite the fact stated earlier, there are some cases which digital data or documents require their physical form to be included for certain purpose, e.g., the validation process. Because of that, for some occurrences people still need their data and documents both in physical form and in digital form. There are two approaches for doing this: (a) taking a picture of the physical documents or scanning them into images; or (b) manually submitting the document's contents into some standard digital format, e.g., ASCII. In practice the first approach is relatively easier than the second one. However, the second approach provides more possibilities in data processing and information extraction of the contents of the documents.

Automatic character recognition can overcome the gap between these two approaches. Automatic character recognition is a field of research which aims to translate handwritten or printed text into machine-editable text format [13]. Printed character recognition is considered as a solved problem, while handwritten character recognition is still comparatively difficult because of the gap between human reading capabilities and recognition systems [6, 13]. In printed character recognition, the involved characters usually have an approximately normal type. This type has the shape or design that tends to be unchanged and standardized, so the issues are narrowed into the variations of character orientation, e.g., slant, skew, and rotation. On the other hand, human writings are nearly impossible or at least very difficult to be standardized. Human writings tend to be unique and no one has the same handwriting, they are always different. This makes handwritten character recognition challenging in coping with variation in individual writing styles [8].

The automation process of character recognition is very useful in any activity where a large mass of documents must be interpreted or analyzed [4]. Accurate automatic character

recognition can save time required to transform the documents content into digital form. Also, automatic character recognition can cut labor cost because there is no human involved in the process. Those two advantages motivate researchers all over the world to build an optimum character recognition system.

In general, there are two main tasks in character recognition: (a) representing the character as a form of features and (b) classifying the characters using the feature representation. These two main processes usually done in two approaches: (a) statistical or (b) structural [13]. In statistical approach, objects or patterns are represented as measurements or values, and understood as a point in the n-dimensional space. Because of its trait, statistical approach offers a number of useful properties for mathematical operation and eventually resulted in rich repository of algorithmic tools. However, there is no direct possibility to describe relationship that might exist among different part of a pattern. Also, statistical feature usually represents a predefined set of features regardless of the size or complexity of the corresponding objects. These drawbacks of the statistical approach can be overcome by structural approach which use graph representation. Graphs are not only able to describe properties of an object, but also relationships among different parts of an object. Moreover, the graph representation is not constrained by default, making it suitable for recognizing patterns with complex relationships. Despite of its superiorities stated earlier, graph actually has no standardized way in classification and clustering operation. This makes it more difficult to develop algorithmic tools to process graph represented features than the statistical features. Unconstrained graph representation of a large complexity objects may also result in high computational cost and slow computational speed [2, 12].

1.2 Theoretical Framework

This research represents input character images as graphs. Using graph as a feature, input character images will be represented in accordance to its complexity. This graph representation categorized the edges into structural types which are loop, line, and curve. These structural types are used to create hierarchical classification.

The proposed method does not follow the common model estimation process that employ learning method and concludes one representative model for a certain class. Instead, more than one representative model can exist and can be defined as references in a certain class.

1.3 Conceptual Framework

Character recognition systems have two core processes: (a) feature extraction; and (b) classification [13]. Characters are transformed into feature representation in the feature

extraction. These features will represent the characters and will be used as a decisive attributes in the classification process.

There are two phases in character recognition: (a) model estimation; and (b) recognition. Model estimation aims to get the understanding of a particular character about its common feature and conclude a model based on it [9]. The model was compared with the feature of the test input in recognition process. The result then returned by the recognition process by using discriminate function.

1.4 Statement of the Problem

Recognizing handwritten character images which have wide variation in writing styles have become a challenge. Individual handwriting also has varying shape details and complexity among individual styles.

Statistical approaches in character recognition use pre-defined length feature representation and ignore the differences in character's complexity. Besides, this information can be used to enhance the classification mechanism e.g. selective classification. The recognition procedure which is demonstrated in [13] use point features which sampled from the foreground pixel of the character. This feature representation is required to have uniform length for all character regardless of the character's complexity, so all characters are forced to have the minimum number of points required to represent the most complex character. For instance, character 'O' required a minimum of 4 points to represent the loop of the character. Therefore, a relatively simpler character 'I' is forced to have exactly 4 points to maintain the same feature length with 'O' even though character 'I' is only consisted of single line structure that could be represented by only 2 points. This result in unnecessary additional feature elements which could be eliminated to reduce the feature size and give optimum representation for each character.

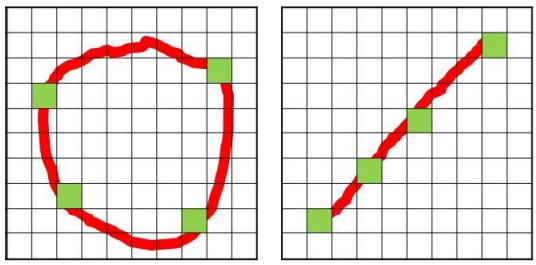

Figure 1.1: Feature representation with forced uniform length

Moreover, the information about character's complexity can also enhance the recognition process by building selective classification mechanism. For example, given model class 'I', 'O', and 'D' represented by 2, 4, and 4 points respectively, an unknown character which is represented by 4 points can automatically marked as non 'I' character because of the different complexity which is depicted in the number of points. Therefore, the classifica-

tion is conducted only to the two remaining model 'O' and 'D' instead of all three classes, resulting in more efficient classification procedure.

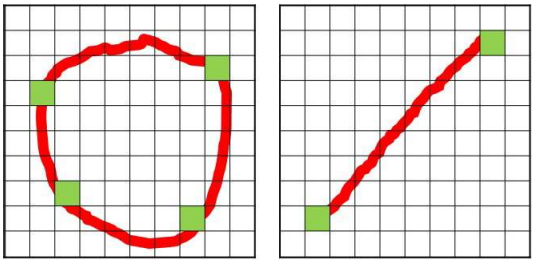

Figure 1.2: Feature representation according to character's complexity

Existing graph matching procedure in character recognition still uses local context in search of graph similarity instead of using global context which actually have the complete relation information of graph's elements. The matching procedure described in [12] still calculate the similarity between graphs by pairing their individual edges, resulting in exhaustive search in feature pairing procedure. Besides, global context of the graph can reduce the number of searching comparison in feature pairing procedure. For instance, using global context by defining subgraphs out of the branch points of the graph, the number of comparisons that are required to pair all the edges of the graph is only two comparisons. This number is fewer than a total of nine comparisons which are required to pair all the edges by using the local context of individual edge.

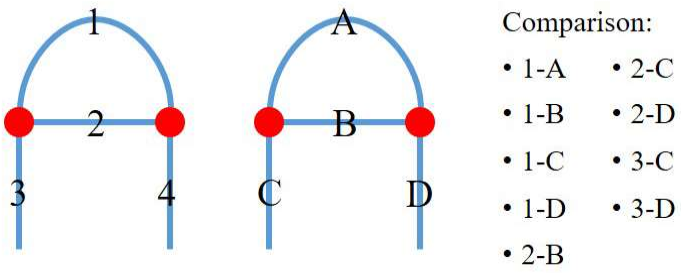

Figure 1.3: Illustration of edge-wise pairing comparison

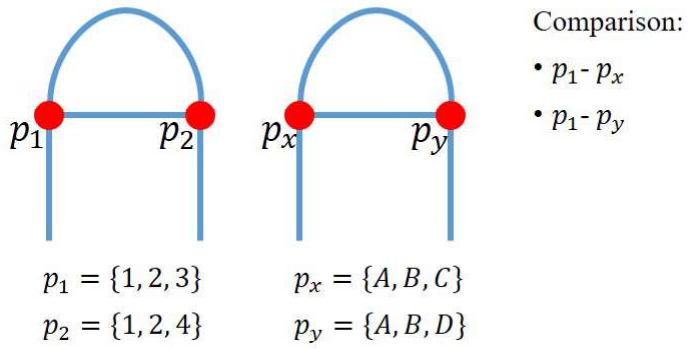

Figure 1.4: Illustration of branch-wise pairing comparison

1.5 Objective and Hypotheses

In line with the problem, the objective of this research is to provide a character recognition system using graph which represents structural elements of the character. Graph is capable of representing character in accordance to its complexity. The structures complexity information can also be exploited to build selective classification scheme. Hierarchical specification of graphs also reduce unnecessary comparison by preventing calculation of graph with different geometric features, thus reducing computational cost.

1.6 Scope and Delimitation

In this research, the scope and delimitation of the study are:

1. This research uses CEDAR CD-ROM 1 Handwritten Character Image dataset.
2. This research is evaluated based on all-caps Latin character (A-Z).

1.7 Significance of the Study

The automation process of character recognition is very useful in any activity where a large mass of documents must be interpreted or analyzed. Not only can it save the time required to do the task in a large scale, but it can also cut the labor cost spent when this task is done using human labor. Automatic character recognition makes data processing and information extraction possible for a large scale of documents in an efficient way.