Crow Search Freeman Chain Code (CS-FCC) Feature Extraction Algorithm for Handwritten Character Recognition

Muhammad Arif Mohamad
Faculty of Computing,
Universiti Malaysia Pahang Al-Sultan Abdullah,
26600 Pekan, Pahang, Malaysia
arifmohamad@ump.edu.my

Zalili Musa
Faculty of Computing,
Universiti Malaysia Pahang Al-Sultan Abdullah,
26600 Pekan, Pahang, Malaysia
zalili@ump.edu.my

Amelia Ritahani Ismail
Kulliyyah of Information and Communication Technology,
International Islamic University
Malaysia, Kuala Lumpur, Malaysia.
amelia@iium.edu.my

Abstract— **With so many algorithms developed to improve classification accuracy, interest in feature extraction in Handwritten Character Recognition (HCR) has increased. In this research, a Crow Search Algorithm (CSA)-based metaheuristic strategy for feature extraction in HCR was developed. The data representation method employed was Freeman Chain Code (FCC). The fundamental issue with using FCC to represent a character is that the outcomes of the extractions depend on the starting points that changed the chain code's route length. The shortest route length and least amount of computational time for HCR were found using the metaheuristic technique via CSA, which was suggested as a solution to this issue. The suggested CS-FCC extraction algorithm's computation durations and route lengths serve as performance indicators. The algorithm experiments are carried out using the chain code representation created from previous research of the Centre of Excellence for Document Analysis and Recognition (CEDAR) dataset, which consists of 126 upper-case letter characters. According to the results, the proposed CS-FCC has a route length of 1880.28 and only takes 1.10 seconds to solve the entire set of character images.**

Keywords— *Handwritten Character Recognition, Feature Extraction, Metaheuristic Algorithm, Crow Search Algorithm, Freeman Chain Code*

I. INTRODUCTION

The sensitivity of selected characteristics influences the accuracy of handwritten character recognition (HCR). As a result, a variety of feature extraction approaches may be found in the literature [1]. Feature extraction is the process of extracting the most representative information from raw data in order to reduce within-class pattern variability while increasing between-class pattern variability. To that end, for each class, a set of features is retrieved that helps differentiate it from other classes while staying insensitive to characteristic differences within the class [2]. [3] has an excellent survey of feature extraction approaches for character recognition.

Chain code is one of the boundary-based feature representations that can be used for image processing, shape analysis, and pattern identification. The original chain coding technique, known as Freeman Chain coding (FCC), was presented by Freeman in 1961 [4]. There are numerous types of chain code algorithms that have been developed through FCC extension and chain code enhancement. Previous work on chain code representation in the literature may be found in [5-7]. The difficulty of the chain-coding procedure would be based heavily on how the image would be traversed and the starting point of the traversing method [8]. Even if the image is the identical, the start point of the image character will yield a distinct chain code direction. The starting point in a character

is chosen at random, and then the best solution is sought. Unfortunately, research into FCC construction using a single continuous route and minimizing chain code length has not been actively investigated [1]. To address this issue, a metaheuristic technique is employed to extract the FCC that accurately represents the characters.

As a result, this research suggested a chain code feature extraction based on a metahueristic algorithm that is investigated utilizing a Crow Search Algorithm (CSA). CSA has been used successfully in numerous fields, including computer science, electrical engineering, civil engineering, mechanical engineering, and biomedical applications. In this paper, CSA is used to shorten the chain code. The fundamental issue with using FCC to represent characters is that the length of the FCC is dependent on the beginning point, the branching node, and the revisited walk. To address these issues, CSA is utilized to generate FCC, which has the ability to construct FCC that accurately represents the image characters.

II. RELATED WORK

HCR is a computer's capacity to accept and comprehend intelligible handwritten input, which is then analyzed by numerous automated process systems. The main issue with the HCR system is the diversity of handwriting styles, which can be drastically different for different writers [9]. HCR is often divided into three stages: pre-processing, feature extraction, and classification. The goal of the preprocessing stage is to provide a clean character image that the feature extraction stage can use directly and effectively. The purpose of the feature extraction stage is to remove redundancy from data. The classification stage is used to identify characters or words. Various approaches for character recognition are now widely used.

In this work, the Freeman chain code (FCC) is used to represent a character image. FCC is one of the boundary extraction-based representation approaches used for image processing, shape analysis, and pattern identification. Chain code representation provides a character picture border where the codes specify the direction of where the next pixel is located. There are numerous types of chain code algorithms that have been developed through FCC extension and chain code enhancement. Chain code has two directions: 4-neighborhood and 8-neighborhood. This research employs an 8-neighbourhood approach to character extraction. The difficulty of the chain-coding procedure would be based heavily on how the image would be traversed and the starting point of the traversing method [8]. Even if the image is the identical, the start point of a character will yield a distinct