Chapter 6
Bangla Character Recognition Using Optical Joint Transform Correlation

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ABSTRACT

Automatic Bangla character recognition has been a great challenge for research and development because of the huge number of characters, change of shape in a word and in conjunctive characters, and other similar reasons. An optical joint transform correlation-based technique is developed for Bangla character recognition which involves a simple architecture, but can operate at a very high speed because of optics, and offer a very high level of accuracy with negligible false alarms. The proposed correlation technique can successfully identify a target character in a given input scene by producing a single correlation peak per target at the target location. The discrimination between target and non-target correlation peaks is found to be very high even in noisy conditions. The recognition performance of the proposed technique is observed to be insensitive to the type and number of targets. Further improvement of the technique is made by incorporating a synthetic discriminant function, which is created from distorted images of the target character and hence can make the system efficiently recognize Bangla characters in different practical scenarios.

INTRODUCTION

Optical Character Recognition (OCR) represents the technique of automatically detecting the alphanumeric characters from a given document and translating them into computer encoded character data (Mori, Nishida & Yamada, 1999). Research interests in Bangla character recognition is relatively new and its associated challenges are both many and complex (Chaudhuri Pal, 1998). First, the number of characters in Bangla language is significantly larger than that in most

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other languages. In addition, there are several sets of characters that have nearly similar shapes, some characters extend beyond the average span, and the language also includes many conjunctive characters. Then, within the context of a word, characters are often interconnected. Recognition of handwritten Bangla characters is a rather challenging task also in part because the written form varies rather widely from person to person.

Digital character recognition techniques have inherent limitations arising from more processing steps and slow speed because of serial processing. Real time character recognition requires a very high processing speed so that instantaneous detection of characters and translation to computer characters can be achieved (Dong, Wejinya, Zhou, Shan & Li, 2009). Additional requirements are efficient recognition of characters in a given input document/scene where characters might also have variations in scale, rotation, and font style.

Optical image processing-based techniques can be applied to real-time character recognition applications, which would recognize a character based on shape and size. Optoelectronics-based image processing techniques employ optical light source, Fourier lenses and other optical components to process the given images in parallel, which implies a very fast operation and provides with almost instantaneous output (Weaver & Goodman, 1966). Optical pattern recognition systems are mainly based on either VanderLugt filter (VanderLugt, 1964) or Joint Transform Correlation (JTC) (Perez & Karim, 1989; Alam, Awwal & Karim, 1991; Alam & Karim, 1993). A VanderLugt correlator as well as its variations such as that involving either phase-only filter (Horner & Gianino, 1984) or amplitude-modulated phase-only filter (Awwal, Karim & Jahan, 1990) necessitate generation of a pre-fabricated complex filter that needs to be accurately aligned with the optical axis in the Fourier plane. When VanderLugt correlator is designed properly, phase of the input and phase of the complex matched filter cancels each other out at the Fourier plane. Presence of a strong correlation peak at the output indicates the location of a match. In comparison, in the case of JTC technique, the reference image and the given image are introduced simultaneously before the optical lens thus eliminating the requirements of complex filter and optical alignment sensitivity issues.

Optical JTC-based technique can also be employed for character recognition in real time (Perez & Karim, 1989; Alam, Awwal & Karim, 1991). However, the classical JTC technique has been observed to suffer from a number of problems, including strong but unwanted auto-correlation signals, duplicate cross-correlation signals, and poor discrimination between a target object and any non-target object present in the input scene (Nomani, Bari, Islam, Haider & Islam, 2007). A number of important modifications of the optical JTC technique have been studied in the literature, including binary JTC (Haider, Islam & Alam, 2006), phase-encoded JTC (Javidi & Kuo, 1988), Fourier plane power spectrum subtraction, fringe-adjusted filter (Alam & Karim, 1993), and synthetic discriminant function (Cherri & Alam, 2001; Riasati, Banerjee, Abushagur & Howell, 2000). An efficient phase-shifted and phase-encoded fringe-adjusted JTC technique has been developed, which can successfully detect multiple objects in one processing step and ensures better utilization of the space-bandwidth resource by generating one correlation peak per target object (Haider, Islam, Alam & Khan, 2005; Islam, Purohit, Asari & Karim, 2008).

Optical JTC technique incorporating synthetic discriminant function has been developed to efficiently recognize Bangla characters. The technique has been observed to be capable to detecting characters with scale and rotation variations present in the input. Further research work is being carried out to enhance the technique so that character recognition performance is invariant to handwriting and font-style variations. Optical JTC-based character recognition technique is investigated through mathematical analyses and