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A SURVEY ON OPTICAL CHARACTER RECOGNIZATION SYSTEM

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ABSTRACT

This paper explores various techniques used in Optical Character Recognition (OCR) for character identification and conversion. OCR is a technology that converts scanned images or handwritten notes into a digital format. The OCR process involves multiple stages, including preprocessing, classification, post-acquisition, pre-level processing, segmented processing, post-level processing, and feature extraction.

Index Terms— Optical Character Recognition, Character Identification, Image Processing, Feature Extraction.

I.INTRODUCTION

Optical Character Recognition (OCR) is an advanced technology used to convert handwritten or printed text into a digital format. This process enables digitized text to be electronically edited, searched, stored efficiently, and displayed online. OCR plays a crucial role in various applications, including document digitization, automated data entry, and assistive technologies for visually impaired individuals. The OCR process consists of multiple stages, each contributing to the accuracy and efficiency of character recognition. These stages include preprocessing, classification, post-acquisition, pre-level processing, segmented processing, post-level processing, and feature extraction. By refining the techniques used at each stage, OCR systems can achieve improved accuracy and performance.

Several methodologies have been developed to enhance OCR performance, incorporating advanced computational techniques such as neural networks, fuzzy logic, and machine learning algorithms. These methods help in improving text recognition by reducing errors caused by variations in handwriting, font styles, and image quality. This paper provides a comprehensive literature review of different OCR techniques and their applications. The survey examines various methodologies used in OCR and discusses their effectiveness in different scenarios. The subsequent sections of this paper delve into the detailed literature survey, exploring different approaches and innovations in OCR technology. These techniques are analyzed based on their accuracy, computational efficiency, and adaptability to different types of text recognition tasks.

Finally, the paper concludes by summarizing the findings of the literature survey and highlighting future directions for research in OCR systems. By understanding the strengths and limitations of existing approaches, further improvements can be made to enhance OCR accuracy and usability across various domains.

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II.LITERARTURE SURVEY

A. S. Sawant, "Script Independent Text Pre-processing and Segmentation for OCR" (2015)

Sawant's research focuses on script-independent text preprocessing and segmentation techniques for OCR applications. The paper emphasizes the importance of preprocessing as a critical step in OCR, ensuring that text is cleaned, binarized, and properly segmented before feature extraction. The study explores various methodologies, including thresholding, noise removal, and character segmentation, to improve OCR performance across different languages and scripts. The proposed approach enhances recognition accuracy by addressing script variability and challenges in character connectivity. The findings highlight that efficient preprocessing significantly boosts OCR accuracy, particularly in multi-script environments where text structures vary. The study also discusses how machine learning techniques can further improve segmentation by adapting to different font styles and document layouts.

V. Kieu, F. Cloppet, and N. Vincent, "OCR Accuracy Prediction Method Based on Blur Estimation" (2016)

Kieu et al. propose a novel method for predicting OCR accuracy based on blur estimation. The paper presents a mathematical model that quantifies the level of blur in a scanned or photographed document and correlates it with the expected OCR performance. The study highlights that blur significantly impacts text recognition accuracy, particularly in low-resolution images or handheld device captures. By integrating blur estimation into OCR preprocessing, the system can determine whether an image needs enhancement before recognition. The experimental results demonstrate that using blur estimation for preprocessing adjustments can improve OCR accuracy by optimizing contrast and sharpness. This research provides valuable insights into improving OCR robustness for real-world applications, such as mobile-based document scanning and low-quality image processing.

J. B. Pedersen, K. Nasrollahi, and T. B. Moeslund, "Quality Inspection of Printed Texts" (2016)

Pedersen et al. explore OCR-based quality inspection of printed texts, focusing on defect detection in printed materials. The paper discusses how OCR can be used for quality control in industries where printed labels, barcodes, or official documents require verification. The study integrates image processing techniques with OCR to detect errors such as misaligned printing, faded text, and incorrect character formations. The research highlights the importance of high-resolution imaging and adaptive thresholding to enhance defect detection. By incorporating machine learning algorithms, the proposed method improves text verification accuracy, ensuring reliability in applications such as automated document verification and packaging quality control. The study concludes that OCR-based quality inspection can significantly reduce human error in printed text evaluation while improving efficiency in industrial workflows.

A. F. Mollah, N. Majumder, S. Basu, and M. Nasipuri, "Design of an Optical Character Recognition System for Camera-Based Handheld Devices" (2011)

Mollah et al. present an OCR system specifically designed for handheld devices, addressing the challenges of mobile text recognition. The study focuses on capturing images under varying lighting conditions and perspectives, which commonly affect OCR accuracy in mobile applications. The proposed system incorporates preprocessing techniques such as contrast enhancement, noise reduction, and adaptive thresholding to improve text recognition. Additionally, the research discusses the role of edge detection and feature extraction in enhancing character clarity. The experimental results demonstrate that the system effectively recognizes text from images taken at different angles, making it suitable for real-time applications like mobile document scanning and assistive reading devices. The study concludes that optimizing OCR algorithms for mobile use can greatly improve accessibility and usability in portable text recognition tasks.

B. Jain and M. Borah, "A Comparison Paper on Skew Detection of Scanned Document Images Based on Horizontal and Vertical" (2014)

Jain and Borah analyze different methods for skew detection in scanned document images, a crucial preprocessing step in OCR systems. The paper compares horizontal and vertical projection-based techniques to determine their effectiveness in correcting text orientation. The research highlights that skewed text significantly degrades OCR accuracy, making precise skew correction essential. The study evaluates multiple algorithms, including Hough Transform and projection profile methods, to detect and rectify text misalignment. The results indicate that vertical projection performs better for dense text, while horizontal projection is more effective for sparsely distributed characters. The paper concludes that an adaptive hybrid approach combining both techniques could enhance OCR performance by improving document alignment before text extraction.

III.PROPOSED METHODOLOGY

One of the critical steps in an offline character recognition system is skew detection and correction. This step is essential for scanned documents as part of the pre-processing stage in most document analysis and recognition systems. This paper presents a method for detecting and correcting skew in Assamese language document images using horizontal and vertical projection profile analysis [5].

Background images in OCR often introduce errors. A non-linear transformation technique is applied to enhance the contrast of each image channel, significantly improving recognition accuracy after removing background images [7]. The Fourier Transform is used for pre-processing, decomposing an image into sine and cosine components of increasing frequencies. This transformation converts the spatial domain into the frequency domain, facilitating further processing [1].

Reading text from photographs and natural scenes poses a significant challenge. Recently developed machine learning algorithms have been applied for feature learning from unlabeled data. A scalable text detection and recognition system is

proposed based on automatic feature learning, specifically targeting text in natural scene images [8].

Over the years, researchers have worked on machine-printed Chinese and English character recognition. A high-performance OCR engine was developed using search and fast-match techniques to construct a large vocabulary dataset containing 1,862 text lines sourced from newspapers, magazines, journals, and books [9].

To enhance text extraction from natural scene images, Wang and Kangas [10] proposed a method to identify character-like regions. Connected component extraction is used to verify block candidates, and priority adaptive segmentation (PAS) is implemented to accurately extract the foreground pixels of each character block.

Another system for text extraction from TV screens is presented in [11], utilizing an open-source OCR algorithm for functional verification of television sets. In contrast, Diaz-Escobar [12] introduced a novel technique for recognizing content-less characters in degraded images using phase congruency and a local energy model. The proposed phase features are invariant to non-uniform illumination and geometric distortions, outperforming traditional SIFT-based methods in recognition accuracy.

Extracting scene text from images and videos is particularly challenging due to complex backgrounds, variable font sizes, diverse styles, and poor resolution. To address this, [13] employs region-based and connected component-based methods for text extraction, while an Artificial Neural Network (ANN) classifier filters out non-text components.

Since handwritten text varies significantly, designing a reliable OCR system is a challenging task. This paper presents an algorithm based on the Kohonen Neural Network, a type of self-organizing map. The results indicate that a two-layered neural network significantly reduces system complexity without degrading performance [14].

For historical document OCR, [15] proposes a complete methodology for recognizing printed and handwritten texts without prior knowledge of the font. A robust pre-processing and segmentation approach is applied to detect text lines, words, and characters.

For handwritten character recognition, Yaeger [16] developed a system based on neural networks, using a multi-layer perceptron for improved recognition accuracy. Similarly, Hu et al. [17] introduced a model that combines high-level and low-level features, providing feature invariance for normalization and curvature adjustment.

Another approach by Funada [18] applies Hidden Markov Models (HMMs) for online handwritten recognition. The method significantly reduces memory usage while improving recognition rates.

Text segmentation, a crucial stage in OCR, employs horizontal and vertical projection profile methods [1]. Different methods are applied at various intermediate stages of OCR, including an algorithm designed to correct the skew angle of text documents.

Matas [19] introduced an end-to-end real-time scene text localization and recognition method. The classification process consists of two stages:

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1. Probability estimation of each Extremal Region (ER) being a character using novel O(1) complexity features.
2. Selection of locally maximal probability ERs for accurate text recognition.

Lin and Hsu [20] proposed a neural network-based approach that reduces training time while maintaining high recognition accuracy. A multi-stage pre-processing technique is employed, partitioning training data before the training phase. For license plate recognition (LPR), [21] presents an adaptive image segmentation technique and connected component analysis, forming the core of intelligent infrastructure applications like toll payment and parking fee automation.

IV.COMPARISON

Paper [5] highlights the Projection Profile method as an effective skew detection feature. However, while Vertical Projection Profile Analysis allows minor noise, it may introduce errors, whereas Horizontal Projection Profile Analysis effectively reduces noise impact. Vertical projection methods have higher time complexity compared to horizontal projection methods.

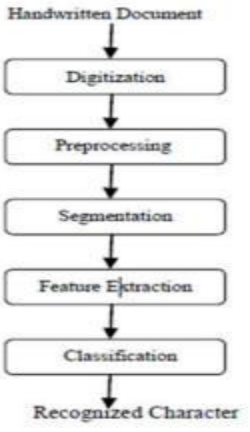
Paper [7] discusses a technique for removing background images to improve OCR accuracy, particularly beneficial in government agencies and organizations where OCR simplifies data collection and analysis. The study evaluates three OCR software tools: HANWANG OCR, ABBYY, and Tesseract. Unlike Tesseract, HANWANG OCR and ABBYY OCR offer built-in pre-processing functions for image enhancement before text extraction.

Paper [8] presents a character classifier trained on 5,198 characters from 62 classes (26 uppercase and 26 lowercase letters). The highest accuracy (81.7%) was achieved using a model with 1,500 features.

Text segmentation is a crucial stage in OCR. Paper [22] reviews various segmentation techniques, categorizing them into three groups:

1. Analytical methods – Assess segmentation algorithms based on their principles and properties.
2. Empirical goodness methods – Measure segmented image properties using predefined quality parameters.
3. Empirical discrepancy methods – Compare segmentation results against reference segmentation outputs.

For pen-input devices like PDAs, online handwriting recognition algorithms are essential. Funada et al. [18] introduced an HMM-based method that efficiently segments and classifies characters, significantly reducing memory usage while enhancing recognition accuracy.



V.CONCLUSION

This paper presents a comprehensive survey of various techniques used in Optical Character Recognition (OCR). Different types of text sources, including handwritten characters, natural scene images, business cards, and TV screen images, have been considered for experimentation. A systematic workflow of an OCR system has been discussed, covering key stages such as preprocessing, segmentation, and classification. The study highlights the use of projection profile-based methods for segmentation, Fourier transform techniques for preprocessing, and the nearest neighbor classifier for character recognition. This survey provides valuable insights for researchers in selecting the most suitable techniques based on specific application requirements and performance parameters. By analyzing the strengths and limitations of different OCR methods, this paper serves as a useful reference for optimizing OCR systems and improving text recognition accuracy.

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