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Systematic Literature Review on Optical Character Recognition Methods for Text Extraction

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Abstract
The development of technology has driven a significant increase in the need for document digitization and automation of text-based data processing. A systematic review is needed to identify progress related to the development of OCR in text extraction. Therefore, this study presents a systematic literature review on the development and use of OCR in text extraction using the PRISMA method. The study began with an initial search of 38 studies, which were then selected based on established criteria. Seven relevant articles were successfully identified through a focused search using the keywords "Optical Character Recognition/OCR." The results of the literature review analysis show that the Convolutional Neural Network (CNN) method is the most widely used approach in the development of OCR for text extraction. In addition, the analysis results also reveal that OCR has been applied in various fields, including healthcare, public administration, government, transportation, and commercial services. This study also highlights the various benefits as well as several challenges that are still faced in the future development of OCR. These challenges include improving character recognition accuracy and handling font variations as well as image quality. Thus, the insights generated by this research contribute to the development of OCR as a more reliable and effective tool in supporting document digitization processes.
Keywords: *optical character recognition, text extraction, prisma, deep learning*

Abstrak
Perkembangan teknologi telah mendorong peningkatan signifikan dalam kebutuhan digitalisasi dokumen dan otomatisasi pemrosesan data berbasis teks. Tinjauan sistematis diperlukan untuk mengidentifikasi kemajuan terkait pengembangan OCR dalam ekstraksi teks. Oleh karena itu, penelitian ini menyajikan tinjauan pustaka sistematis tentang pengembangan dan penggunaan OCR dalam ekstraksi teks dengan menggunakan metode PRISMA. Penelitian diawali dengan penelusuran awal terhadap 38 penelitian kemudian diseleksi berdasarkan kriteria yang ditetapkan. Ada tujuh artikel yang relevan berhasil diidentifikasi melalui pencarian terfokus menggunakan kata kunci “Optical Character Recognition/OCR”. Hasil analisa dari tinjauan literatur ini menunjukkan bahwa metode *Convolutional Neural Network* (CNN) merupakan pendekatan yang paling banyak digunakan dalam pengembangan OCR untuk ekstraksi teks. Selain itu, hasil analisis juga mengungkapkan bahwa OCR telah diterapkan di berbagai bidang, termasuk bidang kesehatan, administrasi publik, pemerintahan, transportasi, dan layanan komersial. Studi ini juga menyoroti beragam manfaat serta sejumlah tantangan yang masih dihadapi dalam pengembangan OCR di masa mendatang. Tantangan ini antara lain berkaitan dengan peningkatan akurasi pengenalan karakter dan penanganan variasi font maupun kualitas gambar. Dengan demikian, wawasan yang dihasilkan penelitian ini berkontribusi terhadap pengembangan OCR sebagai alat yang lebih andal dan efektif dalam mendukung proses digitalisasi dokumen.
Kata Kunci: *pengenalan karakter optik, ekstraksi teks, prisma, pembelajaran mendalam*

1. Introduction

Technological development has triggered a significant increase in the need for document digitization and automation of text-based data processing [1]. One of the key technologies involved in this transformation is Optical Character Recognition (OCR), a system designed to recognize characters or text present in images, photos, or scanned documents and convert them into digital text that can be processed by computer [2].

As the demand for visual data and its complexity grow, various OCR methods and algorithms have been developed to improve the accuracy and efficiency of text extraction. Conventional pattern recognition-based methods are now often combined with modern approaches such as machine learning and deep learning, which can recognize text patterns in various languages, fonts, and image conditions [3].

Conventional OCR methods, which rely on manual features, struggle to recognize variations in fonts, sizes, and complex backgrounds. With the emergence of deep learning capable of mimicking the human visual system, OCR can now handle various fonts, scales, and background conditions with higher accuracy [4].

Although many studies on Optical Character Recognition (OCR) have been conducted and have resulted in significant advancements, this technology continues to evolve alongside the growing demand for reliable and efficient text recognition systems. Various methods and approaches have been proposed to improve the performance of Optical Character Recognition (OCR). Nevertheless, variations in input conditions, such as differences in font type and size, text scale, and image background complexity, remain major challenges that affect the accuracy level of OCR systems.

In addition to these technical challenges, developers and researchers also face difficulties in determining the most appropriate method among the many available approaches. Each method has its own advantages and limitations depending on the context of its application [15]. Therefore, a comprehensive systematic review is needed to identify research trends and evaluate the OCR methods that have been developed. This review is expected to serve as a reference for researchers and developers in choosing the most effective and accurate approach according to the needs and characteristics of the data used.

This study uses the Systematic Literature Review (SLR) method with PRISMA guidelines to identify, analyze, and synthesize existing research on the development of OCR for text extraction. The PRISMA method is applied so that the process of identifying and selecting literature is carried out transparently, allowing the review results to provide a reliable basis for researchers and developers [5]. This research is expected to provide a comprehensive understanding of trends and methods, enabling developers and researchers to determine the most effective and precise approaches in the development of Optical Character Recognition (OCR) for text extraction, while also revealing research gaps that still need to be addressed.

2. Materials and Methods

The Systematic Literature Review (SLR) method used in this research is based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. This method involves the process of identifying, assessing, and synthesizing various scientific works that have been published, including both research results and ideas from researchers and practitioners in the related field. Through a systematic literature review (SLR), this study aims to collect, examine, and evaluate all relevant studies to gain a comprehensive understanding of the topic under investigation [6].

Literature searches were conducted through academic databases such as Scopus, Mendeley, Google Scholar, and Connected Papers because they provide credible scientific publications. By using these platforms, the research ensures that only relevant and academically valid literature is included in the review. This study limits the search to recent publications in order to identify trends and the latest methods in the development of Optical Character Recognition (OCR) and to filter out sources that are no longer relevant.

Table 1. Journal Selection Criteria

Inclusion	Exclusion
Keyword: “Optical Character Recognition/OCR”	Articles published more than 5 years ago
Studies Published Internationally	Studies that are not published in international journals or conferences
Articles Published 5 years	
Studies that apply machine learning, or deep learning approaches for Optical Character Recognition/OCR	

The strategy for selecting literature in this study uses specific keywords, such as 'Optical Character Recognition (OCR)', to identify relevant studies. These keywords were chosen to cover important aspects in the development of OCR for text extraction, including trends and recommendations for the best methods. The identified literature was screened through abstract review and full content evaluation, so that only research relevant to and supporting the understanding of OCR development was selected. A full review was conducted by assessing the relevance, credibility, and methodological quality. Related research on trends

and methods was further evaluated in terms of effectiveness and applicability, to ensure that the selected literature truly provides comprehensive insights for OCR development in text extraction. With this strategy, the resulting review is expected to be richer and support the research objectives.

By using the PRISMA flowchart, this study can show the number of literature identified, screened, and evaluated until they are included in the final review, allowing the selection process to be traced transparently and resulting in a comprehensive literature review.

Based on **Table 1**, inclusion and exclusion criteria are used to screen and select the literature to be used in the Systematic Literature Review. Inclusion criteria include literature that uses the keyword "Optical Character Recognition/OCR," allowing a focus on studies relevant to the research topic. Additionally, only studies published internationally are included, to ensure wide accessibility of information and a global understanding of the context. Articles considered are those published in the last five years, in order to maintain relevance to the latest developments. Studies on trends and methods in OCR development for text extraction are included in the inclusion criteria due to their direct relevance to the research objectives.

Conversely, literature published outside the specified time frame is excluded because its content is likely no longer relevant to current trends and technology, so only sources that truly support the research objectives related to the development of Optical Character Recognition (OCR) for text extraction are included. The following are questions that will answer this study.

RQ1. What methods have been used in Optical Character Recognition (OCR) for text extraction?

RQ2. What challenges or limitations are commonly encountered in OCR applications?

RQ3. What are the benefits of using optical character recognition (OCR) in text extraction?

3. Results and Discussion

Based on the search results and then processed for identification as shown in **Fig. 1**, 38 (thirty-eight) references were found with titles that matched the keywords entered in the query. However, not all of these references could be included in this study. Of this number, 10 (ten) nationally scaled articles were excluded because they did not fit the scope of the research. In addition, there were 7 (seven) journals that were not within the 2021-2025 period, so they were also excluded from the list of references used.

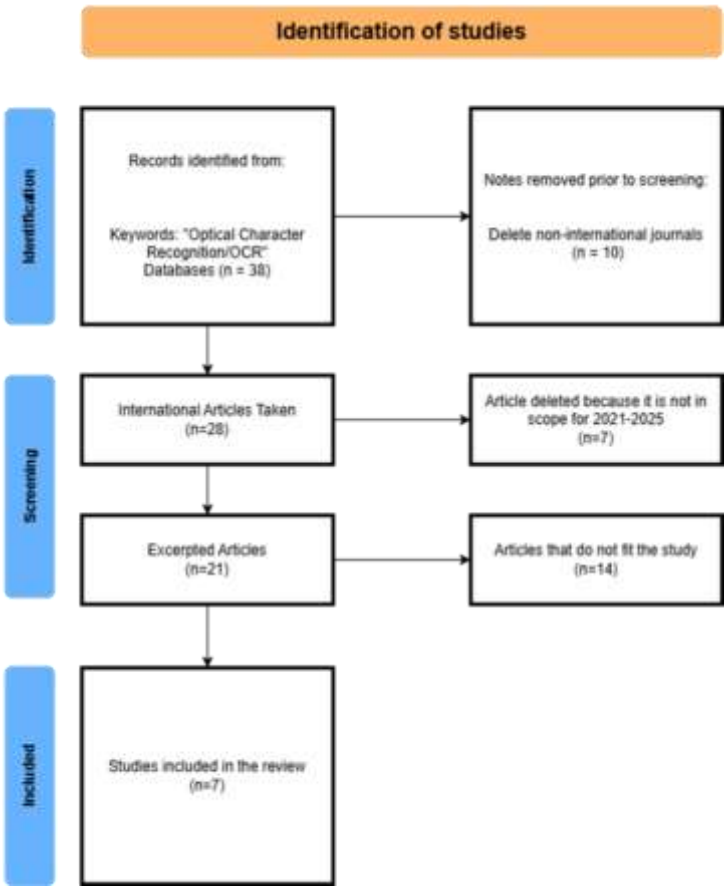

Fig. 1: Items selected for Systematic Review and Meta-Analysis (PRISMA)

Table 2. Research Jurnal

Writer	Year	Title
P. Sharma [7]	2023	Advancements in OCR: A Deep Learning Algorithm for Enhanced Text Recognition
Ç. Sayallar, et al [8]	2023	An OCR Engine for Printed Receipt Images using Deep Learning Techniques
Y. Shambharkar, et al [9]	2023	An Automatic Framework for Number Plate Detection using OCR and Deep Learning Approach
G. Suddul and J. F. L. Seguin [10]	2024	A custom-built deep learning approach for text extraction from identity card images
T. W. Ramdhani, et al [11]	2021	Optical Character Recognition Engines Performance Comparison in Information Extraction
P. Imura, et al [12]	2025	Development of OCR Technology Application System for Health Data Recording
K. Mohsenzadegan, et al [13]	2022	A Smart Visual Sensing Concept Involving Deep Learning for a Robust Optical Character Recognition under Hard Real-World Conditions

In addition to these obstacles, there are 8 (eight) other articles that were excluded because they are not relevant to the research topic focusing on Optical Character Recognition (OCR) and the selected study is listed in **Table 2**. From the mapping of previous research in **Table 2**, it was found that the most frequently appearing keyword in this study is Optical Character Recognition (OCR). This indicates that OCR has become a core technology in various studies focusing on the automation of data extraction from images or photos and scanned results. The widespread application of OCR reflects its important role in supporting digital transformation, data processing efficiency, and the development of text-based artificial intelligence systems. After understanding the concepts used in this study, the next step is to explore the methods applied to develop Optical Character Recognition (OCR). This exploration includes technical approaches such as Convolutional Neural Network (CNN) algorithms and testing techniques to ensure the performance of Optical Character Recognition (OCR) in various usage scenarios.

Table 3. Method

Writer	Method
P. Sharma [7]	Convolutional Neural Network (CNN)
Ç. Sayallar, et al [8]	Convolutional Neural Network (CNN)+Bidirectional Long Short-Term Memory (Bi-LSTM) + Connectionist Temporal Classification (CTC)
Y. Shambharkar, et al [9]	Convolutional Neural Network (CNN)+YOLO
G. Suddul and J. F. L. Seguin [10]	Convolutional Recurrent Neural Network (CRRN) + Long Short-Term Memory (LSTM)
T. W. Ramdhani, et al [11]	Named Entity Recognition (NER)
P. Imura, et al [12]	YOLOv5
K. Mohsenzadegan, et al [13]	Convolutional Neural Network (CNN) + Recurrent Neural Network (RNN)

Based on **Table 3**, it can be seen that research in the development of Optical Character Recognition (OCR) from 2021 to 2025 mostly uses Convolutional Neural Network (CNN) methods. CNN is used for its ability to understand, extract, and analyze visual patterns in images hierarchically, enabling high-accuracy text character recognition without the need for manual feature extraction. Some studies also combine CNN with other supporting technologies, such as Recurrent Neural Networks (RNN), to process

the sequence of features generated by CNN, allowing accurate sequential text recognition, especially in documents or images with complex and varied real-world conditions. There is also research that combines CNN with Long Short-Term Memory (LSTM) to recognize sequences of letters and build words from text regions that have been detected through image segmentation, utilizing LSTM so that the system can consider the sequential context of characters and produce text extraction from identity cards with high accuracy.

Other studies have also combined CNN with YOLO technology to leverage YOLO's capability in fast and accurate object detection, which is useful for locating vehicle license plates. Then, CNN is used to extract visual features from the detected license plate area so that alphanumeric characters can be accurately recognized through the OCR process, thereby forming a robust automatic license plate recognition system that can handle variations in real-world conditions.

From the studies reviewed, almost none explicitly mentioned the programming language used, but it is very likely that the implementations were done using Python. This is considering the rich ecosystem of libraries and frameworks for deep learning and image processing such as PyTorch, TensorFlow, and OpenCV, which support the development of CNN and RNN models, as well as efficient integration with OCR algorithms.

Based on these findings, further research can utilize Python to develop or refine OCR. OCR, as an automatic character recognition system, can effectively process and extract text through CNN. By integrating CNN methods and leveraging Python libraries, an OCR system can be designed to better recognize various types of text. Research can focus on improving character recognition accuracy in complex real-world conditions.

Table 4. Utility

Writer	Utility
P. Sharma [7]	Deep learning-based OCR algorithms improve the accuracy and efficiency of text recognition.
Ç. Sayallar, et al [8]	Deep learning-based OCR on shopping receipts to automate data extraction and improve the efficiency and accuracy of information processing.
Y. Shambharkar, et al [9]	OCR system for detecting and recognizing vehicle license plates based on deep learning.
G. Suddul and J. F. L. Seguin [10]	Automatic and accurate text extraction from identity cards using deep learning.
T. W. Ramdhani, et al [11]	OCR machine for fast and accurate information extraction on government HR documents.
P. Imura, et al [12]	Automatic and efficient health data recording and management using deep learning-based OCR technology.
K. Mohsenzadegan, et al [13]	Accurate and reliable text recognition in various challenging image conditions using deep learning-based OCR.

OCR has been developed for various purposes across different sectors. Shown in the **Table 4**, in the healthcare sector OCR is used to extract and digitize measurement data from various medical devices, such as glucometers, blood pressure monitors, and pulse oximeters, so that health information that was previously only displayed on the device screen can be automatically recorded, stored, and processed in a digital record-keeping system. The use of OCR technology provides significant benefits for various sectors, particularly in terms of automation and the acceleration of data processing, which directly impacts the improvement of operational efficiency and the quality of decision-making.

4. Discussion

RQ1. What methods have been used in Optical Character Recognition (OCR) for text extraction? Based on the results of the table analysis, it was found that various methods are used in the development of Optical Character Recognition (OCR) for text extraction. Among the seven reviewed articles, the most commonly used method is the Convolutional Neural Network (CNN). CNN is used due to its ability to understand, extract, and analyze visual patterns in images hierarchically, enabling it to recognize text characters with high accuracy without requiring manual feature extraction [7].

Not only CNN, several studies also combine CNN with other supporting technologies such as Convolutional Neural Network (CNN), Bidirectional Long Short-Term Memory (Bi-LSTM), and Connectionist Temporal Classification (CTC), which are useful for handling variations in font, text size, noise, and low-quality images on printed receipts, thereby providing improvements in text recognition accuracy and performance compared to conventional approaches [8].

There is also the combination of the Convolutional Neural Network (CNN) method with YOLO. This combined method utilizes YOLO for real-time object detection and the flexibility of CNN + OCR in reading text, resulting in a system that is accurate, efficient, and quite robust for real-world applications [9]. Another combined method is the Convolutional Neural Network (CNN) and Recurrent Neural Network (RNN), this method shows that OCR can be performed reliably even on documents with severe distortions [13].

Another method that is also used is YOLO, designed to perform real-time object detection so that it can locate the screen position or measurement area on medical devices. The use of YOLO adds value in ensuring that the OCR process focuses on the correct area, reduces visual noise, and improves the accuracy of reading medical numbers [12]. In addition, the use of the Named Entity Recognition (NER) method is applied to extract important entities from the OCR text, thereby providing significant value in improving the accuracy of the information extraction process and ensuring that the data extracted is more structured and ready for use in further analysis [11].

RQ2. What challenges or limitations are commonly encountered in OCR applications? From several reviewed studies, challenges in developing OCR for text extraction are still frequently encountered. Common challenges stem from poor image quality, visual variations, and the complexity of document structures. All articles show the same issue: noise, blur, shadows, glare, low lighting, perspective distortion, and low resolution are the main causes of decreased OCR accuracy. In addition, variations in fonts, character sizes, background colors, watermarks, holograms, and other non-text elements (tables, charts, lines, photos) make text detection and segmentation difficult. Moreover, many types of documents have very different structures and layouts, so OCR cannot generalize well without a large and representative training dataset. All articles emphasize that OCR errors directly affect information extraction failures, so robust pre-processing, specialized deep learning models, extreme data augmentation, as well as strict post-processing and validation are required to ensure reliable results.

RQ3. What are the benefits of using optical character recognition (OCR) in text extraction? From a literature review, several advantages of using optical character recognition (OCR) for text extraction have been identified, which have been widely utilized in various sectors, including healthcare, commercial, government, transportation, and many others. OCR is designed to convert image-based information into digital data quickly, accurately, and automatically, thereby enhancing efficiency, accuracy, and reliability in document processing [14].

In the commercial sector, the use of OCR provides significant advantages because it can extract text from printed receipts more accurately, efficiently, and reliably without the need for manual character segmentation, while also being able to handle various real-world receipt conditions, thereby supporting the automation of transaction data digitization and processing [8].

In the transportation sector, OCR provides significant value in license plate detection systems because it can extract characters quickly, accurately, and automatically, thereby enhancing vehicle identification effectiveness and supporting various security and transportation applications [9]. In other sectors, the advantage of OCR on identity cards allows for automatic and accurate text extraction from identity images, making it very efficient for verification, onboarding, or digitizing identity record archives [10].

For the health sector, OCR also provides significant benefits for health data record-keeping and management systems. OCR enables automation of data input, minimizes manual errors, digitizes medical documents, and makes administrative workflows more efficient, thereby helping healthcare facilities handle patient data more reliably and quickly [12].

Based on the findings from the review, future OCR development needs to be more focused on using deep learning methods to improve the system's robustness to real-world conditions. Various articles emphasize that traditional OCR struggles to recognize text in images with noise, blur, glare, shadows, low contrast, or perspective distortion. With deep learning, models can be trained to perform image restoration, contrast enhancement, and noise reduction, so that the input received by the OCR module is cleaner and more consistent, thereby improving the accuracy of character and word recognition.

Further research can focus more on optimizing OCR applications for text extraction, considering the great potential of OCR for various sectors, such as healthcare, public administration, government, transportation, and commercial services. From the various articles reviewed, it appears that modern OCR still faces significant challenges when dealing with low-quality images, perspective distortions, noise, or highly complex document variations.

Therefore, further research needs to strengthen the integration of deep learning methods, particularly by combining text detection models, character recognition, and image restoration into a single unified pipeline so that the system is more stable in real-world conditions. The development of extreme augmentation techniques and multi-domain datasets is also key to improving OCR generalization, enabling it to read various types of documents without requiring specialized training for each case. This approach will open up significant opportunities for the application of OCR across various sectors, ranging from public service automation to real-time large-scale document analysis.

Moreover, the findings emphasize that effective OCR requires the integration of text detection and text recognition, where a combination of deep learning models can enhance this performance. By utilizing a text detection model combined with character recognition models such as CRNN or Transformer-based OCR, this multi-stage approach allows the system to accurately detect text, even in documents with complex layouts, skewed orientations, and non-text elements like watermarks or tables. With this combination, the OCR pipeline becomes more robust against document variations.

The future of OCR requires the integration of deep learning with NLP, intelligent post-processing, and data security, so that the extraction results can be validated and processed automatically. Relying on OCR alone is not enough, as extraction results may still contain character errors or incorrect information. With the integration of deep learning and NLP, the system can perform automatic corrections, format checks, entity identification, and context validation. In addition, data security and privacy protection become an integral part, so that OCR is not only accurate but also safe and reliable in real-world implementations.

5. Conclusion

This study implements the PRISMA method to conduct a systematic literature review on the development of OCR in text extraction. A search using the keyword Optical Character Recognition/OCR identified seven relevant articles sourced from various digital database platforms. Literature analysis revealed that the Convolutional Neural Network (CNN) method is the most frequently used approach as the primary choice in its development due to its ability to understand, extract, and analyze visual patterns in images hierarchically, enabling high-accuracy text character recognition without the need for manual feature extraction. These findings also indicate that OCR in text extraction has been applied across various fields, ranging from healthcare, public administration, government, transportation, to commercial services.

The variety of methods discovered reflects OCR's ability to adapt to the needs of each field. Based on a literature review, we identified key factors in the development and implementation of OCR for text extraction. This study not only highlights the latest trends but also serves as a reference for developers in optimizing the use of OCR to meet user needs to the fullest. This research presents a systematic literature review on the development of OCR for text extraction. A systematic review protocol was applied to analyze seven articles obtained from leading digital databases, including Scopus, Mendeley, Google Scholar, and Connected Papers. The findings of this study illustrate the current state of knowledge regarding OCR development in text extraction, while also identifying various benefits and challenges commonly encountered in its implementation. In addition, this research highlights potential future areas that could further benefit from modern AI technology as recommended by the literature. Finally, the research findings are discussed in the context of their implications for future OCR research and development.

Based on a review of various papers discussing the development of OCR in text extraction, it can be concluded that there are various approaches used in its development process. These methods include the use of Convolutional Neural Networks (CNN), Named Entity Recognition (NER), and YOLO. In addition, some studies propose a combination of methods such as CNN combined with Bidirectional Long Short-Term Memory (Bi-LSTM) and Connectionist Temporal Classification (CTC), or the integration of CNN

with YOLO. Other approaches found include a combination of Convolutional Recurrent Neural Network (CRRN) with Long Short-Term Memory (LSTM), as well as a combination of CNN and Recurrent Neural Network (RNN). Overall, this review provides a structured understanding of current methodologies, identifies key factors affecting model performance, and highlights the challenges and benefits for future exploration. Overall, this review provides a systematic overview of the latest methodologies, highlights their benefits across various sectors, and identifies challenges for further development in the future.

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