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Advances in Optical Character Recognition for Figure Processing: A Review from 2014 to 2020

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ABSTRACT

This research discusses the developments of Optical Character Recognition (OCR) methods for figure processing between 2014 and 2020. The study covered five sub-research questions on text detection, extraction, segmentation methods, state-of-the-art techniques, and their effectiveness in bridging existing research gaps. This is a quantitative method in which electronic data was analyzed systematically, based on independent variables like detection, extraction, and segmentation methods, along with dependent variables like accuracy, efficiency, and applicability. The key findings in this paper include the importance of deep learning to enhance the accuracy of text detection and segmentation, hybrid techniques that can improve text extraction efficiency, and integrated OCR frameworks for processing figures. The outcomes reveal recent trends, gaps in literature, and potential future directions that could further fuel innovation in OCR technology.

Introduction

This chapter establishes the background of the research by taking about the relevance of OCR in document and figure processing, given its practical importance in data analysis, storage, and editing. The main research question revolves around the development of OCR techniques for figure processing from 2014 to 2020. Five sub-research questions steer the research: How has figure text detection developed? What have been the advancements in text extraction techniques? What are the developments in segmentation methods? What are the latest techniques in figure processing with OCR? How would these advancements cover the existing gaps in research? This paper adheres to a quantitative method of analysis of the collected electronic data based on systematic search protocols for independent variables such as detection, extraction, and segmentation methods, and dependent variables such as accuracy, efficiency, and application scope.

This section sets the basis for the research by exploring the critical role that OCR plays in the processing of textual as well as graphical content in a document. It highlights the applied benefits of OCR technology in the areas of data analysis, storage solutions, and document editing. The main research question deals with the development of OCR techniques concerning figure processing in the period between 2014 and (2020) To address this question, five sub-research questions have been designed: First, how has the text detection process in figures changed over time? Second, what are the major developments that have taken place in the text extraction techniques? Third, have improvements in figure segmentation techniques been made? Fourth, what are the state-of-the-art techniques used by contemporary OCR-based applications for figure processing? Last, how do these new inventions adequately fill existing gaps identified in previous studies? This paper adopted a quantitative methodology for research, wherein electronic data were systematically analyzed through established search protocols. The study focuses on independent variables, which include the methods of detection, extraction, and segmentation, while also focusing on dependent variables such as accuracy, efficiency, and the breadth of application.

Literature Review

This section will give a comprehensive review of existing research on OCR figure processing from 2014 to 2020, answering the five sub-research questions identified in the introduction. It will outline the progress and challenges in text detection, extraction, segmentation, and the latest techniques, and it will identify gaps in current research. The section concludes with hypotheses that propose the relationships between the identified variables, suggesting that recent advancements have significantly improved the accuracy and efficiency of OCR methods.

This section provides an extensive review of the literature regarding Optical Character Recognition (OCR) figure processing that occurred between 2014 and 202(0). It addresses the five sub-research questions identified in the introduction systematically, providing an understanding of how methodologies and findings evolve in this field. It draws attention not only to the progress made in areas like text detection, extraction, and segmentation but also to the problems still being addressed by researchers. The discussion also lays emphasis on the latest techniques developed, thus exposing both strengths and weaknesses in detail. In addition, this section identifies gaps within existing literature, which motivates further investigation. Conclusion. Hypotheses are presented in the conclusion as potential relationships between the variables, suggesting that these recent technological breakthroughs have significantly improved both the accuracy and the efficiency of OCR methods.

Progression of Figure Text Detection

Initial studies from 2014 to 2015 focused on simple text detection algorithms that were usually restricted by low accuracy rates. Subsequent research from 2016 used machine learning models that enhanced the precision of detection, although processing complex figures was still an issue. More recent developments between 2018 and 2020 used deep learning techniques to gain higher accuracy in detecting diverse types of figures. Hypothesis 1: Recent deep learning-based text detection methods improve detection accuracy for complex figures significantly.

Advancements in Text Extraction Techniques

Early research in text extraction focused on increasing speed and efficiency but sacrificed accuracy. Mid-term research from 2016 to 2017 introduced hybrid approaches that combined traditional and machine learning methods to improve the quality of extraction. Recent studies in 2019 further improved these techniques with neural networks, achieving higher accuracy. Hypothesis 2: Hybrid extraction techniques that use neural networks significantly improve the accuracy and efficiency of text extraction.

Advancements in Segmentation Techniques

Methods used in the initial stages of segmentation were heuristics. Most of them produced errors, particularly with complicated figures. Improved machine learning-based methods for segmentation became available in 2017 and are less likely to have low adaptability in certain instances. Recent 2020 studies that utilized improved deep learning models considerably enhance the segmentation's accuracy and adaptability for processing figures. Hypothesis 3: Deep models highly improve segmentation's accuracy and adaptability for processing figures.

Improved techniques in Figure processing through OCR

In this period, between 2018 and 2020, integrated OCR frameworks that involve detection, extraction, and segmentation were introduced to improve the methods of processing figures in a more integrated and efficient manner. It therefore solved the earlier integration and application problems in various settings. Hypothesis 4: Integrated OCR frameworks significantly improve overall processing efficiency and applicability across diverse figure types.

Overcoming Gaps in OCR Figure Processing Research

Although many developments exist, the corresponding research on methods often lacked good comprehensive evaluation. Recent work partially filled in some of these holes by offering bigger benchmarks and much more complete assessments. Hypothesis 5: Recent major evaluations substantially improved the understanding about the usability as well as success of OCR algorithms in various types of settings.

Method

This section describes the quantitative approach applied to review OCR developments in figure processing. The data collection procedure is described with a focus on electronic data between 2014 and 2020, along with the variables involved, which include detection, extraction, and segmentation methods. This approach guarantees a comprehensive review of OCR techniques.

This section explains the quantitative methodology applied to evaluate developments in Optical Character Recognition (OCR) specifically about figure processing. It explains the data collection approach, which focuses mainly on electronic data gathered between the years 2014 and (2020) In addition, it identifies and explains the variables involved in the research, including the different techniques that include detection, extraction, and segmentation methods. By using this structured approach, the analysis is expected to provide a comprehensive and detailed understanding of the changing techniques in OCR so that the implications and effectiveness can be discussed in a more informed manner.

Data

Data for this research were obtained from electronic sources using systematic search protocols with specific keywords. The data range is from 2014 to 2020 and includes research articles that focus on OCR figure processing. The collection process involved forward and backward reference searches to ensure comprehensive coverage. Sample screening criteria included studies with a focus on text detection, extraction, and segmentation methods.

Variables

The independent variables in this study are the OCR methods used for text detection, extraction, and segmentation. Dependent variables include accuracy, efficiency, and applicability across diverse figure types. Control variables involve the complexity of figures and the technological context of each study. The reliability of these variables is supported by existing literature, ensuring accurate measurement and analysis.

Results

The results section presents an analysis of OCR advancements in figure processing from 2014 to 2020, structured around the five hypotheses proposed. It includes descriptive statistics and

regression analyses to validate the hypotheses, illustrating how recent OCR techniques have addressed previous challenges and improved figure processing accuracy and efficiency.

Deep Learning-Based Text Detection Methods

This finding supports Hypothesis 1, as it shows that deep learning-based methods significantly improve text detection accuracy in complex figures. The analysis demonstrates increased detection rates and reduced error margins, indicating that these methods address the previous limitations of processing diverse figure types. Empirical significance, therefore, brings out the role of deep learning in enhancing OCR capabilities.

Hybrid Techniques for Enhanced Text Extraction

This result verifies Hypothesis 2 as the hybrid techniques with neural networks considerably enhance text extraction accuracy and efficiency. This study shows quality improvements in extractions and lesser processing time, confirming that the blend of traditional and machine learning approaches indeed has a more significant impact in OCR.

Superior Segmentation via Deep Learning

This finding supports Hypothesis 3, which shows that advanced deep learning models greatly enhance segmentation accuracy and adaptability in figure processing. Analysis of improved segmentation precision and adaptability to varied types of figures reinforce the significance of deep learning in advancing OCR segmentation techniques.

Efficacy of Integrated OCR Frameworks

This result confirms Hypothesis 4, showing that comprehensive OCR systems widely enhance overall processing speed and functionality, regardless of the complexity involved with the various figure types. The analysis gives evidence of heightened processing speeds and enhanced integration levels of detection, extraction, and segmentation, emphasizing the importance of coherent OCR solutions.

Comprehensive Evaluations of OCR Methods

This result confirms Hypothesis 5, emphasizing the importance of recent comprehensive assessments in understanding how well OCR techniques are applicable and effective. Analysis shows that full benchmarking should be done for improving OCR methods and ensuring they are applicable to various contexts.

Conclusion

The conclusion synthesizes the findings obtained from this study on the advancement in OCR for figure processing between 2014 and 2020, mentioning the parts played by deep learning, hybrid techniques, and integrated frameworks in enhancing accuracy and efficiency. Again, theoretical and practical impacts, limitations in terms of data, and potential areas for future work based on new OCR methods and impacts under varying conditions have to be explored. The study underscores the importance of continuous innovation in OCR to meet the evolving needs of figure processing across various fields.

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