

Criticism Title, Abstract, and Introduction

Assignment 1- Literary Criticism 1

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Table of content

1. Introduction
2. Title Criticism
3. Abstract Criticism
4. Introduction Criticism
5. Conclusion
6. References

1

INTRODUCTION

This paper aims to enhance the performance of Printed Arabic Optical Character Recognition (OCR) systems through the application of Deep Learning techniques, specifically by adapting the YOLOv4 model originally designed for Object Detection tasks to perform recognition of individual Arabic characters.

1.1 Clarity and Precision

The title of the paper is clear and precise. It explicitly identifies:

- . The research domain: Arabic Optical Character Recognition
- . The text type: *Printed Arabic*
- . The technical method: *YOLOv4*

Journal of Computer Science

Original Research Paper

A Printed Arabic Optical Character Recognition System using Deep Learning

Salah Alghyaline

Department of Computer Science, the World Islamic Sciences and Education University, Amman, Jordan

1.2 Representativeness of the Research Content

The title accurately reflects the technical core of the paper, particularly the use of a deep learning–based object detection model. However, it does not explicitly indicate the nature of the scientific contribution, such as performance improvement, methodological novelty, or comparative evaluation.

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1.3 Academic Relevance and Appeal

The title is relevant and appealing to researchers in:

- Artificial Intelligence
- Computer Vision
- Arabic Language Processing

Nevertheless, it does not highlight the application context (e.g., printed books or document digitization), which constitutes an important part of the paper's practical relevance.

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1.4 Constructive Critical Remark

The title could be strengthened by emphasizing the research contribution or outcome, for example:

“Improving Printed Arabic OCR Accuracy Using YOLOv4”

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2.1 Inclusion of Core Elements

The abstract includes the essential components of a scientific abstract:

- A general background on Arabic OCR challenges
- The main objective of the study
- The proposed methodology (YOLOv4-based OCR)
- The dataset used
- Quantitative performance results

Thus, it satisfies the structural requirements of an academic abstract.

Abstract: Recognizing Arabic script is challenging for many reasons: The Arabic language is cursive and morphologically rich. There is a high similarity between Arabic letters. Moreover, Arabic has many diacritics and dots, and they change the letter's phonetic transcription. This study proposes a Printed Arabic Optical Character Recognition approach (PAOCR) based on the state-of-the-art You Only Look Once (YOLO) object detector. Four techniques were proposed and implemented to design an end-to-end Arabic OCR system. First, the YOLO4 object detector is customized and trained on deep Convolutional Neural Networks (CNNs) to recognize Arabic characters. Second, the overlapped bounding boxes are processed to keep the most accurate box for each character. Third, the Hunspell library checks the word spelling and corrects the wrong ones. Fourth, edit distance is used to compare OCR misspelled words with Hunspell's suggestions and choose the closest correct word. The experimental results in the Arabic Printed Text Image (APT) dataset showed that the Word Recognition Rate (WRR) of customized YOLO4 Arabic OCR is 66.7%, whereas applying the three proposed techniques with YOLO4 achieved 82.4%. A comparison with two existing OCR systems Tesseract and ABBYY showed that the proposed approach achieved a 95.7% Character Recognition Rate (CRR), whereas Tesseract and ABBYY achieved 92.3 and 84.8%, respectively.

Keywords: Optical Character Recognition, Arabic OCR, Convolutional Neural Network, YOLO4

2.2 Definition of the Research Problem

Although the abstract refers to the difficulty of Arabic OCR, it does not explicitly articulate the research problem in a precise or problem-driven manner. The challenge is described broadly, without clearly identifying a specific gap in prior work.

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2.3 Presentation of Methodology

The abstract mentions the use of YOLOv4 but does not justify its selection over other OCR or sequence-based models. This weakens the methodological argument presented at this stage.

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2.4 Reporting of Results

The inclusion of numerical accuracy results is a strength. However:

- The significance of these results is not discussed
- No comparison with existing state-of-the-art systems is highlighted in the abstract

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2.5 Critical Observation

The abstract is descriptive rather than analytical. It would benefit from explicitly stating the scientific contribution and explaining how the proposed approach advances the field.

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3.1 Thematic Framing and Background

The introduction provides an appropriate background on OCR technology and the linguistic characteristics of the Arabic script. This contextualization is logically structured and academically sound.

Introduction

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This study proposes a printed Arabic OCR approach. YOLO4 is customized and trained to recognize Arabic characters. However, YOLO does not yield a reasonable recognition rate because one character may have multiple recognition results. This study improves the YOLO4 OCR recognition accuracy using three techniques: Removing the redundant recognition results by processing the overlapped bounding boxes and keeping the boxes with the highest accuracy. In addition, a spelling checker with edit distance is used for correcting the wrong words. The experimental results on the well-known database called Arabic Printed Text Image (APT) (Slimane *et al.*, 2009) show that using these techniques significantly improves the OCR for the Arabic language. The proposed approach achieved 82.4% Word Recognition Rate (WRR), whereas the YOLO4 approach achieved 66.7% WRR. Furthermore, a comparison with existing commercial and open-source OCR systems shows that the proposed approach achieved higher WRR and Character Recognition Rate (CRR).

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Stolyarenko *et al.* (2011) used scale Invariant Feature Transform (SIFT) descriptor with sliding windows to solve the Arabic OCR problem. (Addakiri and Bahaj, 2012) proposed an online OCR approach for handwritten Arabic characters. The approach converts the input images into binary images; then, the converted images are used to train a neural network to recognize Arabic characters. The networks include input layer, two hidden layers, and output layer. (Yousefi *et al.*, 2015) proposed system to recognize handwritten script. The approach starts by normalizing the baseline and the position of letters. Long Short-Term Memory (LSTM) network is used for letter classification. (Radwan *et al.*, 2016) proposed OCR for printed text, a neural network with three sliding windows, is used to segment the Arabic characters. Another neural network with two convolutional layers and two max-pooling layers is used for character recognition. (Ahmed *et al.*, 2017) proposed CNNs architecture for Arabic OCR. The method converts the image color into grayscale and then changes its

3.2 Identification of the Research Problem

The paper discusses several known challenges in Arabic OCR (e.g., cursiveness, diacritics, character shape variation). However:

- The research problem is not formulated as a clear research question
- The discussion remains general and descriptive rather than problem-focused

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3.3 Use of Previous Studies

While the introduction references prior work, it:

- Lacks critical comparison
- Does not clearly identify limitations or gaps in existing studies
- Fails to explicitly show how the current study addresses those gaps

This contradicts the lecture's emphasis on critical analysis of previous literature rather than mere review.

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3.4 Statement of Research Objectives

The objectives of the study are implied but not explicitly stated in a structured or numbered form, which reduces clarity regarding the study's direction and scope.

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3.5 Logical Flow and Coherence

The introduction follows a general logical progression; however, the transition from problem description to proposed solution is abrupt and lacks sufficient theoretical justification.

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Stolyarenko *et al.* (2011) used scale Invariant Feature Transform (SIFT) descriptor with sliding windows to solve the Arabic OCR problem. (Addakiri and Bahaj, 2012) proposed an online OCR approach for handwritten Arabic characters. The approach converts the input images into binary images; then, the converted images are used to train a neural network to recognize Arabic characters. The networks include input layer, two hidden layers, and output layer. (Yousefi *et al.*, 2015) proposed system to recognize handwritten script. The approach starts by normalizing the baseline and the position of letters. Long Short-Term Memory (LSTM) network is used for letter classification. (Radwan *et al.*, 2016) proposed OCR for printed text, a neural network with three sliding windows, is used to segment the Arabic characters. Another neural network with two convolutional layers and two max-pooling layers is used for character recognition. (Ahmed *et al.*, 2017) proposed CNNs architecture for Arabic OCR. The method converts the image color into grayscale and then changes its

3.6 Constructive Critical Remark

The introduction would be significantly strengthened by:

- Clearly defining the research gap
- Formulating a main research question
- Explicitly stating research objectives
- Positioning the study more critically within existing literature

Introduction

Optical Character Recognition (OCR) applies image processing technology to convert printed and handwritten text images into editable text. The aim is to use the editable text for further processing (Patel *et al.*, 2012). OCR applications includes automatic cheque recognition (Mehta *et al.*, 2010), handwriting form recognition (Fanany, 2017), Automatic License Plate Recognition (ALPR) (Alghyaline, 2020), text reading for blind people (Liambas and Saratzidis, 2016) and digitization of historical documents (Bukhari *et al.*, 2017). Humans can easily recognize printed and written text with high accuracy, and they do that after years of training during school time. However, they could face some problems recognizing the written text because the handwriting is different from one person to another. Therefore, many efforts were made to develop accurate and fast OCR systems. Each language has its specifications and many OCR approaches were proposed for different languages: English OCR (Mehta *et al.*, 2016; Chaudhuri *et al.*, 2017a; Afroge *et al.*, 2016; Zanwar *et al.*, 2020), Japanese OCR (Srihari *et al.*, 1997; Nguyen and Nakagawa, 2016), Chinese OCR (Yin *et al.*, 2019; Li *et al.*, 2016), Indian OCR (Mathew *et al.*, 2016;

Chaudhuri *et al.*, 2017b) Arabic OCR systems (Al-Amin and Alsaade, 2017; Nashwan *et al.*, 2017). Languages are classified as cursive and non-cursive and it is more challenging to recognize the cursive alphabet. Also, there are handwriting and printed texts OCR, and it is even more challenging to recognize handwriting texts. Arabic is one of the most difficult languages (Boudelaa *et al.*, 2010; Farghaly and Shaalan, 2009; Lu *et al.*, 1999), it is right-to-left script and the letters are joined together (cursive). Most of the Arabic letters in the word are connected and there is a high similarity between their shapes. Some comparative studies (Alkhateeb *et al.*, 2017) show that the word recognition rate of existing Arabic OCR systems is under 75%. Deep learning features showed superior accuracies in the object recognition field (Girshick, 2015; Redmon *et al.*, 2016; Bochkovskiy *et al.*, 2020). The variation in the character's style, size and font type and the cursive nature of the character makes it more challenging to develop an accurate Arabic OCR system. YOLO4 represents the state-of-the-art object detector (Bochkovskiy *et al.*, 2020). YOLO4 runs in real-time with around 65 FPS speed. Many real-time applications adopt YOLO due to its high accuracy and speed (Alghyaline, 2019; 2020; Jiang *et al.*, 2022).



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5. Conclusion

Component	Evaluation
Title	Very Good
Abstract	Good
Introduction	Moderate

6. References

- https://www.researchgate.net/profile/Salah-Alghyaline/publication/365224023_A_Printed_Arabic_Optical_Character_Recognition_System_using_Deep_Learning/links/639a47a4095a6a77742c7f6e/A-Printed-Arabic-Optical-Character-Recognition-System-using-Deep-Learning.pdf



Thank You

التكليف 1

دراسات نقدية 1

Prepared by:
Dr. Nourhan Abdelkerim



فهرس المحتويات

1. المقدمة
2. نقد العنوان
3. نقد الملخص
4. نقد المقدمة
5. الخاتمة
6. المراجع

1

المقدمة

تهدف هذه الورقة إلى تحسين أداء أنظمة التعرف الضوئي على الحروف العربية المطبوعة (OCR) من خلال تطبيق تقنيات التعلم العميق، وبشكل خاص عبر تكييف نموذج YOLOv4 المصمم أساسًا لمهام اكتشاف الأجسام ليقوم بمهمة التعرف على الحروف العربية الفردية.

1.1 الوضوح والدقة

عنوان البحث واضح ودقيق، إذ يحدد صراحة:

- مجال البحث: التعرف الضوئي على الحروف العربية
- نوع النص: العربية المطبوعة
- الأسلوب التقني: YOLOv4

Journal of Computer Science

Original Research Paper

A Printed Arabic Optical Character Recognition System using Deep Learning

Salah Alghyaline

Department of Computer Science, the World Islamic Sciences and Education University, Amman, Jordan

1.2 تمثيل محتوى البحث

يعكس العنوان بدقة الجوهر التقني للورقة، خاصة استخدام نموذج كشف الأجسام المعتمد على التعلم العميق.
إلا أنه لا يوضح صراحة طبيعة الإسهام العلمي مثل:

- تحسين الأداء
- الجِدَّة المنهجية
- التقييم المقارن

Journal of Computer Science

Original Research Paper

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1.3 الأهمية والجاذبية الأكاديمية

العنوان مناسب وجذاب للباحثين في:

- الذكاء الاصطناعي
- الرؤية الحاسوبية
- معالجة اللغة العربية

ومع ذلك، لا يبرز سياق التطبيق (مثل رقمنة الكتب أو المستندات)، وهو جانب مهم من الأهمية العملية للبحث.

Journal of Computer Science

Original Research Paper

A Printed Arabic Optical Character Recognition System using Deep Learning

Salah Alghyaline

Department of Computer Science, the World Islamic Sciences and Education University, Amman, Jordan

1.4 ملاحظة نقدية بناءة

يمكن تعزيز العنوان بإبراز الإسهام البحثي مثل:
“تحسين دقة التعرف الضوئي على الحروف العربية المطبوعة باستخدام
YOLOv4”

Journal of Computer Science

Original Research Paper

A Printed Arabic Optical Character Recognition System using Deep Learning

Salah Alghyaline

Department of Computer Science, the World Islamic Sciences and Education University, Amman, Jordan

2.1 تضمين العناصر الأساسية

يتضمن الملخص العناصر الأساسية للملخص العلمي:

- خلفية عامة عن تحديات OCR العربي
- الهدف الرئيسي للدراسة
- المنهجية المقترحة (YOLOv4)
- مجموعة البيانات المستخدمة
- النتائج الكمية

وبذلك يحقق المتطلبات الهيكلية للملخص الأكاديمي.

Abstract: Recognizing Arabic script is challenging for many reasons: The Arabic language is cursive and morphologically rich. There is a high similarity between Arabic letters. Moreover, Arabic has many diacritics and dots, and they change the letter's phonetic transcription. This study proposes a Printed Arabic Optical Character Recognition approach (PAOCR) based on the state-of-the-art You Only Look Once (YOLO) object detector. Four techniques were proposed and implemented to design an end-to-end Arabic OCR system. First, the YOLO4 object detector is customized and trained on deep Convolutional Neural Networks (CNNs) to recognize Arabic characters. Second, the overlapped bounding boxes are processed to keep the most accurate box for each character. Third, the Hunspell library checks the word spelling and corrects the wrong ones. Fourth, edit distance is used to compare OCR misspelled words with Hunspell's suggestions and choose the closest correct word. The experimental results in the Arabic Printed Text Image (APT) dataset showed that the Word Recognition Rate (WRR) of customized YOLO4 Arabic OCR is 66.7%, whereas applying the three proposed techniques with YOLO4 achieved 82.4%. A comparison with two existing OCR systems Tesseract and ABBYY showed that the proposed approach achieved a 95.7% Character Recognition Rate (CRR), whereas Tesseract and ABBYY achieved 92.3 and 84.8%, respectively.

Keywords: Optical Character Recognition, Arabic OCR, Convolutional Neural Network, YOLO4

2.2 تحديد مشكلة البحث

رغم الإشارة إلى صعوبة OCR العربي، إلا أن المشكلة لم تُصاغ بشكل دقيق أو مدفوع بالمشكلة.

الوصف عام دون تحديد فجوة واضحة في الدراسات السابقة.

Abstract: Recognizing Arabic script is challenging for many reasons: The Arabic language is cursive and morphologically rich. There is a high similarity between Arabic letters. Moreover, Arabic has many diacritics and dots, and they change the letter's phonetic transcription. This study proposes a Printed Arabic Optical Character Recognition approach (PAOCR) based on the state-of-the-art You Only Look Once (YOLO) object detector. Four techniques were proposed and implemented to design an end-to-end Arabic OCR system. First, the YOLO4 object detector is customized and trained on deep Convolutional Neural Networks (CNNs) to recognize Arabic characters. Second, the overlapped bounding boxes are processed to keep the most accurate box for each character. Third, the Hunspell library checks the word spelling and corrects the wrong ones. Fourth, edit distance is used to compare OCR misspelled words with Hunspell's suggestions and choose the closest correct word. The experimental results in the Arabic Printed Text Image (APTI) dataset showed that the Word Recognition Rate (WRR) of customized YOLO4 Arabic OCR is 66.7%, whereas applying the three proposed techniques with YOLO4 achieved 82.4%. A comparison with two existing OCR systems Tesseract and ABBYY showed that the proposed approach achieved a 95.7% Character Recognition Rate (CRR), whereas Tesseract and ABBYY achieved 92.3 and 84.8%, respectively.

Keywords: Optical Character Recognition, Arabic OCR, Convolutional Neural Network, YOLO4

2.3 عرض المنهجية

تم ذكر استخدام YOLOv4، لكن دون تبرير اختياره مقارنة
بنماذج OCR الأخرى أو النماذج التسلسلية، مما يضعف
الحجة المنهجية.

Abstract: Recognizing Arabic script is challenging for many reasons: The Arabic language is cursive and morphologically rich. There is a high similarity between Arabic letters. Moreover, Arabic has many diacritics and dots, and they change the letter's phonetic transcription. This study proposes a Printed Arabic Optical Character Recognition approach (PAOCR) based on the state-of-the-art You Only Look Once (YOLO) object detector. Four techniques were proposed and implemented to design an end-to-end Arabic OCR system. First, the YOLO4 object detector is customized and trained on deep Convolutional Neural Networks (CNNs) to recognize Arabic characters. Second, the overlapped bounding boxes are processed to keep the most accurate box for each character. Third, the Hunspell library checks the word spelling and corrects the wrong ones. Fourth, edit distance is used to compare OCR misspelled words with Hunspell's suggestions and choose the closest correct word. The experimental results in the Arabic Printed Text Image (APT) dataset showed that the Word Recognition Rate (WRR) of customized YOLO4 Arabic OCR is 66.7%, whereas applying the three proposed techniques with YOLO4 achieved 82.4%. A comparison with two existing OCR systems Tesseract and ABBYY showed that the proposed approach achieved a 95.7% Character Recognition Rate (CRR), whereas Tesseract and ABBYY achieved 92.3 and 84.8%, respectively.

Keywords: Optical Character Recognition, Arabic OCR, Convolutional Neural Network, YOLO4

2.4 عرض النتائج

من نقاط القوة تضمين نتائج رقمية.

لكن:

- لم يتم مناقشة دلالة هذه النتائج
- لم تُذكر مقارنة واضحة مع أحدث الأنظمة

Abstract: Recognizing Arabic script is challenging for many reasons: The Arabic language is cursive and morphologically rich. There is a high similarity between Arabic letters. Moreover, Arabic has many diacritics and dots, and they change the letter's phonetic transcription. This study proposes a Printed Arabic Optical Character Recognition approach (PAOCR) based on the state-of-the-art You Only Look Once (YOLO) object detector. Four techniques were proposed and implemented to design an end-to-end Arabic OCR system. First, the YOLO4 object detector is customized and trained on deep Convolutional Neural Networks (CNNs) to recognize Arabic characters. Second, the overlapped bounding boxes are processed to keep the most accurate box for each character. Third, the Hunspell library checks the word spelling and corrects the wrong ones. Fourth, edit distance is used to compare OCR misspelled words with Hunspell's suggestions and choose the closest correct word. The experimental results in the Arabic Printed Text Image (APT) dataset showed that the Word Recognition Rate (WRR) of customized YOLO4 Arabic OCR is 66.7%, whereas applying the three proposed techniques with YOLO4 achieved 82.4%. A comparison with two existing OCR systems Tesseract and ABBYY showed that the proposed approach achieved a 95.7% Character Recognition Rate (CRR), whereas Tesseract and ABBYY achieved 92.3 and 84.8%, respectively.

Keywords: Optical Character Recognition, Arabic OCR, Convolutional Neural Network, YOLO4

2.5 ملاحظة نقدية

الملخص وصفي أكثر منه تحليلي.

ويستفيد لو تم توضيح الإسهام العلمي وكيف يطور المجال.

Abstract: Recognizing Arabic script is challenging for many reasons: The Arabic language is cursive and morphologically rich. There is a high similarity between Arabic letters. Moreover, Arabic has many diacritics and dots, and they change the letter's phonetic transcription. This study proposes a Printed Arabic Optical Character Recognition approach (PAOCR) based on the state-of-the-art You Only Look Once (YOLO) object detector. Four techniques were proposed and implemented to design an end-to-end Arabic OCR system. First, the YOLO4 object detector is customized and trained on deep Convolutional Neural Networks (CNNs) to recognize Arabic characters. Second, the overlapped bounding boxes are processed to keep the most accurate box for each character. Third, the Hunspell library checks the word spelling and corrects the wrong ones. Fourth, edit distance is used to compare OCR misspelled words with Hunspell's suggestions and choose the closest correct word. The experimental results in the Arabic Printed Text Image (APT) dataset showed that the Word Recognition Rate (WRR) of customized YOLO4 Arabic OCR is 66.7%, whereas applying the three proposed techniques with YOLO4 achieved 82.4%. A comparison with two existing OCR systems Tesseract and ABBYY showed that the proposed approach achieved a 95.7% Character Recognition Rate (CRR), whereas Tesseract and ABBYY achieved 92.3 and 84.8%, respectively.

Keywords: Optical Character Recognition, Arabic OCR, Convolutional Neural Network, YOLO4

3.1 التأطير الموضوعي والخلفية

قدمت المقدمة خلفية مناسبة عن OCR وخصائص الخط العربي.

الطرح منطقي وأكاديمي سليم.

Introduction

Optical Character Recognition (OCR) applies image processing technology to convert printed and handwritten text images into editable text. The aim is to use the editable text for further processing (Patel *et al.*, 2012). OCR applications includes automatic cheque recognition (Mehta *et al.*, 2010), handwriting form recognition (Fanany, 2017), Automatic License Plate Recognition (ALPR) (Alghyaline, 2020), text reading for blind people (Liambas and Saratzidis, 2016) and digitization of historical documents (Bukhari *et al.*, 2017). Humans can easily recognize printed and written text with high accuracy, and they do that after years of training during school time. However, they could face some problems recognizing the written text because the handwriting is different from one person to another. Therefore, many efforts were made to develop accurate and fast OCR systems. Each language has its specifications and many OCR approaches were proposed for different languages: English OCR (Mehta *et al.*, 2016; Chaudhuri *et al.*, 2017a; Afroge *et al.*, 2016; Zanwar *et al.*, 2020), Japanese OCR (Srihari *et al.*, 1997; Nguyen and Nakagawa, 2016), Chinese OCR (Yin *et al.*, 2019; Li *et al.*, 2016), Indian OCR (Mathew *et al.*, 2016;

Chaudhuri *et al.*, 2017b) Arabic OCR systems (Al-Amin and Alsaade, 2017; Nashwan *et al.*, 2017). Languages are classified as cursive and non-cursive and it is more challenging to recognize the cursive alphabet. Also, there are handwriting and printed texts OCR, and it is even more challenging to recognize handwriting texts. Arabic is one of the most difficult languages (Boudelaa *et al.*, 2010; Farghaly and Shaalan, 2009; Lu *et al.*, 1999), it is right-to-left script and the letters are joined together (cursive). Most of the Arabic letters in the word are connected and there is a high similarity between their shapes. Some comparative studies (Alkhateeb *et al.*, 2017) show that the word recognition rate of existing Arabic OCR systems is under 75%. Deep learning features showed superior accuracies in the object recognition field (Girshick, 2015; Redmon *et al.*, 2016; Bochkovskiy *et al.*, 2020). The variation in the character's style, size and font type and the cursive nature of the character makes it more challenging to develop an accurate Arabic OCR system. YOLO4 represents the state-of-the-art object detector (Bochkovskiy *et al.*, 2020). YOLO4 runs in real-time with around 65 FPS speed. Many real-time applications adopt YOLO due to its high accuracy and speed (Alghyaline, 2019; 2020; Jiang *et al.*, 2022).

This study proposes a printed Arabic OCR approach. YOLO4 is customized and trained to recognize Arabic characters. However, YOLO does not yield a reasonable recognition rate because one character may have multiple recognition results. This study improves the YOLO4 OCR recognition accuracy using three techniques: Removing the redundant recognition results by processing the overlapped bounding boxes and keeping the boxes with the highest accuracy. In addition, a spelling checker with edit distance is used for correcting the wrong words. The experimental results on the well-known database called Arabic Printed Text Image (APT) (Slimane *et al.*, 2009) show that using these techniques significantly improves the OCR for the Arabic language. The proposed approach achieved 82.4% Word Recognition Rate (WRR), whereas the YOLO4 approach achieved 66.7% WRR. Furthermore, a comparison with existing commercial and open-source OCR systems shows that the proposed approach achieved higher WRR and Character Recognition Rate (CRR).

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Stolyarenko *et al.* (2011) used scale Invariant Feature Transform (SIFT) descriptor with sliding windows to solve the Arabic OCR problem. (Addakiri and Bahaj, 2012) proposed an online OCR approach for handwritten Arabic characters. The approach converts the input images into binary images; then, the converted images are used to train a neural network to recognize Arabic characters. The networks include input layer, two hidden layers, and output layer. (Yousefi *et al.*, 2015) proposed system to recognize handwritten script. The approach starts by normalizing the baseline and the position of letters. Long Short-Term Memory (LSTM) network is used for letter classification. (Radwan *et al.*, 2016) proposed OCR for printed text, a neural network with three sliding windows, is used to segment the Arabic characters. Another neural network with two convolutional layers and two max-pooling layers is used for character recognition. (Ahmed *et al.*, 2017) proposed CNNs architecture for Arabic OCR. The method converts the image color into grayscale and then changes its

3.2 تحديد مشكلة البحث

تم ذكر تحديات مثل:

- الاتصال بين الحروف
- التشكيل
- اختلاف أشكال الحروف

لكن:

- لم تُصغ المشكلة كسؤال بحثي واضح
- الطرح عام وغير موجه نحو المشكلة

Introduction

Optical Character Recognition (OCR) applies image processing technology to convert printed and handwritten text images into editable text. The aim is to use the editable text for further processing (Patel *et al.*, 2012). OCR applications includes automatic cheque recognition (Mehta *et al.*, 2010), handwriting form recognition (Fanany, 2017), Automatic License Plate Recognition (ALPR) (Alghyaline, 2020), text reading for blind people (Liambas and Saratzidis, 2016) and digitization of historical documents (Bukhari *et al.*, 2017). Humans can easily recognize printed and written text with high accuracy, and they do that after years of training during school time. However, they could face some problems recognizing the written text because the handwriting is different from one person to another. Therefore, many efforts were made to develop accurate and fast OCR systems. Each language has its specifications and many OCR approaches were proposed for different languages: English OCR (Mehta *et al.*, 2016; Chaudhuri *et al.*, 2017a; Afroge *et al.*, 2016; Zanwar *et al.*, 2020), Japanese OCR (Srihari *et al.*, 1997; Nguyen and Nakagawa, 2016), Chinese OCR (Yin *et al.*, 2019; Li *et al.*, 2016), Indian OCR (Mathew *et al.*, 2016;

Chaudhuri *et al.*, 2017b) Arabic OCR systems (Al-Amin and Alsaade, 2017; Nashwan *et al.*, 2017). Languages are classified as cursive and non-cursive and it is more challenging to recognize the cursive alphabet. Also, there are handwriting and printed texts OCR, and it is even more challenging to recognize handwriting texts. Arabic is one of the most difficult languages (Boudelaa *et al.*, 2010; Farghaly and Shaalan, 2009; Lu *et al.*, 1999), it is right-to-left script and the letters are joined together (cursive). Most of the Arabic letters in the word are connected and there is a high similarity between their shapes. Some comparative studies (Alkhateeb *et al.*, 2017) show that the word recognition rate of existing Arabic OCR systems is under 75%. Deep learning features showed superior accuracies in the object recognition field (Girshick, 2015; Redmon *et al.*, 2016; Bochkovskiy *et al.*, 2020). The variation in the character's style, size and font type and the cursive nature of the character makes it more challenging to develop an accurate Arabic OCR system. YOLO4 represents the state-of-the-art object detector (Bochkovskiy *et al.*, 2020). YOLO4 runs in real-time with around 65 FPS speed. Many real-time applications adopt YOLO due to its high accuracy and speed (Alghyaline, 2019; 2020; Jiang *et al.*, 2022).



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3.3 استخدام الدراسات السابقة

تم الاستشهاد بأعمال سابقة، لكن:

- دون مقارنة نقدية
- دون توضيح الثغرات
- دون بيان كيفية معالجة الدراسة الحالية لها

Introduction

Optical Character Recognition (OCR) applies image processing technology to convert printed and handwritten text images into editable text. The aim is to use the editable text for further processing (Patel *et al.*, 2012). OCR applications includes automatic cheque recognition (Mehta *et al.*, 2010), handwriting form recognition (Fanany, 2017), Automatic License Plate Recognition (ALPR) (Alghalyne, 2020), text reading for blind people (Liambas and Saratzidis, 2016) and digitization of historical documents (Bukhari *et al.*, 2017). Humans can easily recognize printed and written text with high accuracy, and they do that after years of training during school time. However, they could face some problems recognizing the written text because the handwriting is different from one person to another. Therefore, many efforts were made to develop accurate and fast OCR systems. Each language has its specifications and many OCR approaches were proposed for different languages: English OCR (Mehta *et al.*, 2016; Chaudhuri *et al.*, 2017a; Afroge *et al.*, 2016; Zanwar *et al.*, 2020), Japanese OCR (Srihari *et al.*, 1997; Nguyen and Nakagawa, 2016), Chinese OCR (Yin *et al.*, 2019; Li *et al.*, 2016), Indian OCR (Mathew *et al.*, 2016;

Chaudhuri *et al.*, 2017b) Arabic OCR systems (Al-Amin and Alsaade, 2017; Nashwan *et al.*, 2017). Languages are classified as cursive and non-cursive and it is more challenging to recognize the cursive alphabet. Also, there are handwriting and printed texts OCR, and it is even more challenging to recognize handwriting texts. Arabic is one of the most difficult languages (Boudelaa *et al.*, 2010; Farhaly and Shaalan, 2009; Lu *et al.*, 1999), it is right-to-left script and the letters are joined together (cursive). Most of the Arabic letters in the word are connected and there is a high similarity between their shapes. Some comparative studies (Alkhateeb *et al.*, 2017) show that the word recognition rate of existing Arabic OCR systems is under 75%. Deep learning features showed superior accuracies in the object recognition field (Girshick, 2015; Redmon *et al.*, 2016; Bochkovskiy *et al.*, 2020). The variation in the character's style, size and font type and the cursive nature of the character makes it more challenging to develop an accurate Arabic OCR system. YOLO4 represents the state-of-the-art object detector (Bochkovskiy *et al.*, 2020). YOLO4 runs in real-time with around 65 FPS speed. Many real-time applications adopt YOLO due to its high accuracy and speed (Alghalyne, 2019; 2020; Jiang *et al.*, 2022).

This study proposes a printed Arabic OCR approach. YOLO4 is customized and trained to recognize Arabic characters. However, YOLO does not yield a reasonable recognition rate because one character may have multiple recognition results. This study improves the YOLO4 OCR recognition accuracy using three techniques: Removing the redundant recognition results by processing the overlapped bounding boxes and keeping the boxes with the highest accuracy. In addition, a spelling checker with edit distance is used for correcting the wrong words. The experimental results on the well-known database called Arabic Printed Text Image (APT) (Slimane *et al.*, 2009) show that using these techniques significantly improves the OCR for the Arabic language. The proposed approach achieved 82.4% Word Recognition Rate (WRR), whereas the YOLO4 approach achieved 66.7% WRR. Furthermore, a comparison with existing commercial and open-source OCR systems shows that the proposed approach achieved higher WRR and Character Recognition Rate (CRR).

model to recognize Korean characters based on AlexNet and GoogLeNet CNNs architectures.

Stolyarenko *et al.* (2011) used scale Invariant Feature Transform (SIFT) descriptor with sliding windows to solve the Arabic OCR problem. (Addakiri and Bahaj, 2012) proposed an online OCR approach for handwritten Arabic characters. The approach converts the input images into binary images; then, the converted images are used to train a neural network to recognize Arabic characters. The networks include input layer, two hidden layers, and output layer. (Yousefi *et al.*, 2015) proposed system to recognize handwritten script. The approach starts by normalizing the baseline and the position of letters. Long Short-Term Memory (LSTM) network is used for letter classification. (Radwan *et al.*, 2016) proposed OCR for printed text, a neural network with three sliding windows, is used to segment the Arabic characters. Another neural network with two convolutional layers and two max-pooling layers is used for character recognition. (Ahmed *et al.*, 2017) proposed CNNs architecture for Arabic OCR. The method converts the image color into grayscale and then changes its

3.4 أهداف البحث

الأهداف ضمنية وليست مصاغة بوضوح أو بشكل مرقم.

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3.5 الترابط المنطقي

التسلسل العام منطقي، لكن الانتقال من المشكلة إلى الحل مفاجئ ويفتقر إلى تبرير نظري كافٍ.

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3.6 ملاحظة نقدية بناءة

يمكن تعزيز المقدمة عبر:

- تحديد الفجوة البحثية بوضوح
- صياغة سؤال بحث رئيسي
- ذكر الأهداف صراحة
- وضع الدراسة في سياق نقدي أوضح

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5. الخاتمة

المكونات	تقييم
العنوان	جيد جدًا
الملخص	جيد
المقدمة	متوسط

6. المراجع

- https://www.researchgate.net/profile/Salah-Alghyaline/publication/365224023_A_Printed_Arabic_Optical_Character_Recognition_System_using_Deep_Learning/links/639a47a4095a6a77742c7f6e/A-Printed-Arabic-Optical-Character-Recognition-System-using-Deep-Learning.pdf



Thank You