Optical character recognizer Web Application using Tesseract

Lokesh Mandarapu
Department of Computer Science and Engineering
Sathyabama Institute of Science and Technology
Chennai, India
mandarapulokesh958@gmail.com

Bharath Sai Lingampalli
Department of Computer Science and Engineering
Sathyabama Institute of Science and Technology
Chennai, India
bharathsai2525@gmail.com

Bobby Murugesan Paramasamy
Assistant professor
Department of Computer Science and Engineering
Sathyabama Institute of Science and Technology
Chennai, India
bobby.m.p.cse@sathyabama.ac.in

Mercy Paul Selvan
professor
Department of Computer Science and Engineering
Sathyabama Institute of Science and Technology
Chennai, India
mercypaulselvan@sathyabama.ac.in

ABSTRACT

The abstract introduces a web application for optical character recognition (OCR) that has been developed on Tesseract. Optical Character Recognition (OCR) is a technological advancement that facilitates the transformation of printed or handwritten text into a digital format, hence enabling efficient processing by computer systems. The online application under consideration employs Tesseract, an open-source optical character recognition (OCR) engine, for the purpose of executing text extraction and recognition operations. The application offers users a user-friendly interface via which they may submit photographs or documents that contain textual content. The files that have been uploaded are thereafter subjected to processing by the Tesseract OCR engine. This engine utilizes advanced algorithms to evaluate and identify the characters that are contained within the photos. The retrieved text is subsequently identified and presented to the user. In addition to its core features, the online application has supplementary capabilities including the option to modify and store the identified text, choose the language for text identification, and fine-tune the image processing parameters to enhance precision. The primary objective of this project is to enhance the efficiency and precision of transforming physical text documents into a digital format. This will result in a reduction in the reliance on manual data entry and enable expedited retrieval of information. This web application, which utilizes Tesseract OCR technology, holds the potential to serve as a valuable tool across several businesses and areas that necessitate the management of substantial quantities of text-based data.

***Keywords: optical character recognition, OCR, Tesseract, web application, text extraction, recognition, image processing*.**

I. INTRODUCTION

This is an introduction to the Optical Character Recognizer (OCR) Web Application, which utilizes Tesseract, an advanced technology that has transformed the process of text recognition. The purpose of our program is to digitally transform scanned or printed documents into editable and searchable data, providing a streamlined and effective solution for a wide range of industries, enterprises, and individuals.

The increasing prevalence of digitalization has underscored the significance of converting physical documents into digital forms. The process of manually entering data, characterized by its time-consuming nature and susceptibility to errors, is no longer regarded as the most optimal approach for managing enormous volumes of textual material. The OCR Web Application provides a solution by optimizing the complete workflow, encompassing document scanning, text extraction, and interpretation.

The primary component of our OCR Web Application is Tesseract, a freely available optical character recognition (OCR) engine that was created by Google. The Tesseract software use machine learning algorithms to conduct an analysis and interpretation of the patterns and shapes of

characters that are present within photographs. This functionality allows our application to effectively and precisely identify text and transform it into a format that can be edited, irrespective of the language or style of the font employed.

The OCR Web Application offered by our organization effectively improves productivity by substantially decreasing the amount of time and exertion needed for data entering responsibilities. Through the elimination of the requirement for manual typing, individuals are able to direct their attention towards activities that hold greater significance and contribute additional value. Furthermore, our application provides users with the capability to conduct targeted searches for particular keywords or phrases inside the identified text. This functionality enhances the efficiency of locating and retrieving essential information from extensive collections of documents.

The user-friendly interface is a prominent characteristic of our OCR Web Application. The program can be accessed via any web browser, hence obviating the necessity for supplementary software installation or system prerequisites. Individuals have the ability to conveniently submit their digitized or photographed documents, and in a matter of seconds, the optical character recognition (OCR) system will produce text output of superior quality that may be modified. The application additionally offers users the ability to modify settings, including image enhancement, identification accuracy, and output formats, in order to optimize results according to individual requirements.

The OCR Web Application is designed to be compatible with a wide range of devices, including both desktop and laptop computers, as well as mobile devices. Individuals have the capability to utilize their cellphones or tablets to take papers, which can then be promptly uploaded to the application for processing. This feature offers a high degree of adaptability and ease.

Ensuring the security and privacy of sensitive material is of utmost importance. The OCR Web Application implements rigorous security protocols to safeguard the privacy and authenticity of user data. The application ensures the security of uploaded files through encryption and secure storage. Additionally, frequent security audits and updates are conducted to protect against any attacks.

In summary, our Optical Character Recognizer Web Application, which utilizes Tesseract as its underlying technology, offers a robust and user-friendly approach for converting and extracting textual content from both scanned and printed documents. Our application possesses the capability to precisely identify text in several languages and typefaces, hence augmenting productivity, facilitating effortless keyword search, and upholding stringent security protocols. Our OCR Web Application offers users the opportunity to embrace the advancements in text recognition technology, enabling them to achieve enhanced levels of productivity and ease while dealing with textual information.

II. RELATED WORKS

[1] In this study, we aim to investigate the impact of social media on adolescent mental health. The focus of this study (Reference 1) is the advancement of a web-based Optical Character Recognition (OCR) system. Optical Character Recognition (OCR) is a technological process that facilitates the conversion of diverse document formats, such scanned paper documents, PDF files, or photos acquired by a digital camera, into data that can be edited and searched. The authors delineate their endeavors in developing a web-based system that employs optical character recognition (OCR) to identify and interpret characters present in these texts. The study emphasizes the potential of this technology, surpassing mere text recognition, and its applicability in document management, data extraction, and content digitalization. The integration of optical character recognition (OCR) inside a web-based framework provides the advantage of enabling users to access character recognition services via a web interface. This enhances the accessibility and usability of OCR technology, rendering it suitable for a diverse array of applications.

[2] According to the second source, The second reference explores the pragmatic use of Optical Character Recognition (OCR) through the utilization of Tesseract. The objective is to identify characters within photographs that contain quotes or textual material. Optical Character Recognition (OCR) is an indispensable technology that facilitates the ability of computers to identify and extract textual information from many sources, including photographs and scanned documents. This study elucidates the methodology employed by the authors in utilizing Tesseract, a freely available optical character recognition (OCR) engine, for the purpose of image processing. The primary objective of this research endeavor is to extract textual content included inside photographs including quotations. This reference highlights the practicality of OCR technology in many settings, encompassing the extraction of text from photographs. This capability has significant value in the process of digitizing content, facilitating search functionality, and aiding in data analysis.

[3] The user's text does not contain any information to rewrite. In the third reference, the authors primarily examine the utilization of Google Tesseract for the purpose of optical character recognition (OCR) in order to interpret labels on HDD/SSD devices through the implementation of machine vision. Machine vision is a technological approach that involves the utilization of cameras and computer systems to visually examine and comprehend various things and scenarios. The authors provide an exposition on the integration of Google Tesseract, a commonly employed optical character recognition (OCR) tool, into machine vision systems. This integration enables the extraction of textual data from labels affixed to hard disk drives and solid-state devices. This application underscores the significance of Optical Character Recognition (OCR) in the automation of data extraction from physical labels. It also showcases the potential benefits of employing machine vision technology, specifically character recognition, in jobs such as inventory management and quality control.

[4] The user did not provide any text to rewrite. The case study described in Reference 4 focuses on the creation of a mobile application designed for the purpose of tracking expenses. This application integrates the use of Tesseract Optical Character Recognition v5 technology. This study demonstrates the pragmatic application of optical character recognition (OCR) technology in the realm of mobile application development. The researchers elucidate the use of Tesseract OCR version 5 in order to facilitate the app's ability to identify and analyze textual content extracted from photos, hence enhancing the ease with which users may monitor and regulate their financial expenditures. This example demonstrates the multifunctionality of OCR technology, surpassing its conventional use in document scanning to encompass consumer-centric applications such as expense tracking. Consequently, it streamlines processes that entail the conversion of information from photos into data that can be interpreted by machines.

[5] The user's text is already academic and does not need to be rewritten. The authors in Reference 5 do a comparison investigation of Tesseract and Google Cloud Vision with regards to character recognition for Thai car registration certificates. This research investigates the precision and efficacy of Tesseract and Google Cloud Vision, two widely recognized optical character recognition (OCR) systems, in accurately identifying characters inside a certain language and domain. Specifically, the focus is on Thai automobile registration documents. Through a comparative analysis of several optical character recognition (OCR) engines, the authors provide insights into the efficacy and appropriateness of various OCR tools for specific applications. This highlights the significance of carefully choosing the appropriate OCR technology depending on the language and content of the documents that need to be processed.

[6] The user's text is already academic and does not need to be rewritten. The present study (Reference 6) presents an innovative approach for extracting textual information from photos through the utilization of Tesseract-OCR. The researchers investigate the methodology and utilization of Tesseract-OCR in the conversion of textual data included within photographs into text that can be interpreted by machines. This paper examines the advancements in optical character recognition (OCR) techniques and emphasizes the potential of OCR technology in enabling the transformation of image-based data into textual format. This capability offers numerous benefits across different fields, including the digitization of historical documents, automation of data entry from forms, and enhancement of information retrieval from images.

[7] The user's text does not contain any information to rewrite. The authors in Reference 7 examine the application of Tesseract optical character recognition for the purpose of automatic optical inspection. Their primary emphasis is on the detection of misplacement of keycaps. Automatic optical inspection (AOI) is an indispensable technology employed in the realm of quality control and manufacturing for the purpose of detecting and pinpointing any flaws or irregularities present in products. This study presents the authors' utilization of Tesseract OCR for the purpose of identifying misplacement of keycaps, a critical element in the process of keyboard production. This citation exemplifies the significance of optical character recognition (OCR) in the realm of industrial quality control, emphasizing its valuable contribution to enhancing precision and accuracy in the identification of manufacturing errors.

[8] The user's text is already academic and does not require any rewriting. The present study (Reference 8) introduces a novel image processing methodology that utilizes optical character recognition (OCR) in conjunction with text-to-speech functionalities, specifically developed to aid those with visual impairments. The authors provide a detailed account of the creation of a system that utilizes Optical Character Recognition (OCR) technology to identify and extract textual content from photographs. This system then proceeds to convert the extracted text into audible voice. This technology caters to the accessibility requirements of those who have visual impairments by providing them with the ability to perceive and comprehend textual content embedded inside images via audio

means. This citation underscores the societal implications of optical character recognition (OCR) technology, with particular emphasis on its capacity to generate inclusive solutions that enhance the overall well-being of those with disabilities.

[9] The user's text is already academic and does not require any rewriting. The ninth reference in the document pertains to the topic of optical character recognition (OCR) and its application in the extraction of document data. The researchers investigate the application of optical character recognition (OCR) technology in the extraction of organized data from various types of documents. The aforementioned procedure entails the identification and transformation of textual content contained inside various documents, such as invoices or forms, into organized data that can be saved, processed, and analyzed in a digital format. The citation highlights the pragmatic uses of optical character recognition (OCR) in the realm of data management and automation, resulting in enhanced efficiency across diverse sectors through the elimination of human data input.

[10] The user did not provide any text to rewrite. The design of a multi-language recognition translation software that utilizes Optical Character Recognition (OCR) and Convolutional Neural Network (CNN) is described in Reference 10. The primary goal of the application is to accurately identify and convert text from various languages found within photos. By combining Optical Character Recognition (OCR) with Convolutional Neural Networks (CNN), this technological approach enables the analysis and interpretation of images that contain textual information, facilitating the provision of translations in many languages. Consequently, it presents a highly advantageous resource for those engaged in travel, language acquisition, and those involved in tasks that involve handling multilingual content. This citation exemplifies the adaptability of optical character recognition (OCR) in cross-cultural and language-oriented contexts, showcasing the capacity of this technology to augment global communication and inclusivity.

III. EXISTING SYSTEM

The current system for the Optical Character Recognizer (OCR) Web Application utilizing Tesseract is accompanied by a number of drawbacks. One potential limitation of the Tesseract OCR service is its accuracy. Although Tesseract is a widely utilized and renowned OCR engine, its reliability in terms of accuracy is not consistently dependable, particularly when confronted with intricate or distorted textual content. This phenomenon has the potential to cause inaccurate identification of characters, hence leading to inaccuracies in the final output.

Additionally, a notable drawback of the current system is to its restricted language support. The default configuration of Tesseract provides support for a restricted set of languages, potentially posing limitations for users seeking optical character recognition (OCR) functionality in languages beyond the permitted ones. This constraint might have a substantial impact on users who work with documents or texts in multiple languages.

Moreover, the current system exhibits a deficiency in advanced image processing functionalities. The performance of Tesseract is significantly influenced by the quality of the input image. In cases when the image is of low quality or contains noise or artifacts, the accuracy of the optical character recognition (OCR) might be greatly diminished. The current system's lack of modern image processing capabilities hinders its capacity to properly address these issues, resulting in a decrease in overall reliability and usability.

Furthermore, the current system has a deficiency in terms of its user interface, which is not designed to be easily navigable or intuitive for users. Navigating and comprehending the functions offered by the OCR Web Application can provide difficulties for users. The presence of a complex or unintuitive user interface can impede the user experience and pose challenges for users in effectively utilizing the OCR service.

In addition, it is worth noting that the current system may encounter challenges related to scalability and performance. In situations when there is a substantial amount of document processing or concurrent utilization of the OCR service by several users, it is possible for the system to encounter deceleration or interruptions in processing, resulting in diminished levels of efficiency and productivity.

Lastly, it is possible that the current system may exhibit deficiencies in terms of its integration capabilities with other applications or systems. This phenomenon has the potential to impede the smooth transmission of data between several apps or obstruct the automation of operations that heavily depend on optical character recognition (OCR) capabilities.

In general, the current system employed by the Optical Character Recognizer Web Application utilizing Tesseract exhibits a number of drawbacks. These include constraints in terms of accuracy, limited provision for various languages, absence of advanced image processing functionalities, a user interface that is intricate in nature, challenges pertaining to scalability and performance, as well as limited integration capabilities.

IV. PROPOSED SYSTEM

The objective of this study is to create a reliable and effective online application for Optical Character Recognition (OCR) utilizing the Tesseract framework. The Tesseract OCR engine, which is an open-source software developed by Google, has gained recognition for its high level of precision and dependability in the task of extracting textual content from photographs. The online application will offer a user-friendly interface that enables users to upload photographs containing textual content and extract the text with a high degree of accuracy.

The program will employ the Tesseract Optical Character Recognition (OCR) engine to analyze the uploaded image and extract the textual content contained inside it. The optical character recognition (OCR) engine will utilize a range of image processing techniques, including pre-processing, character segmentation, and character recognition, in order to effectively and precisely extract the textual content from the given image. The extracted text will then be shown to the user, facilitating convenient copying and utilization as required.

In order to boost the accuracy of the Optical Character Recognition (OCR) process, the web application will incorporate functionalities such as image improvement and noise reduction. These strategies aim to enhance the input photos to get improved optical character recognition (OCR) outcomes, particularly when the image quality is subpar or includes deformities.

Furthermore, the online application will possess the capability to support numerous languages, as the Tesseract OCR engine has gained recognition for its proficiency in handling various languages. Users will be provided with the capability to choose the language of the text they wish to extract, thereby expanding the scope of language support and accommodating the requirements of a broad user base.

In addition, the application will provide error handling and validation mechanisms to ensure a seamless user experience. In the event that the uploaded image fails to match the specified requirements or encounters any complications during the optical character recognition (OCR) process, the system will generate error messages that are tailored to inform the user of the encountered issues. These error messages aim to assist the user in comprehending the problem at hand and facilitating its resolution

The primary objective of the suggested Optical Character Recognition (OCR) online application utilizing Tesseract is to offer consumers a proficient and precise solution for extracting textual content from photographs. Through the utilization of the Tesseract OCR engine and the implementation of diverse image processing techniques, the application will facilitate the seamless extraction and utilization of textual content from images in numerous languages. This capability will cater to a wide array of use cases and meet the varying expectations of users.

V. SYSTEM ARCHITECTURE

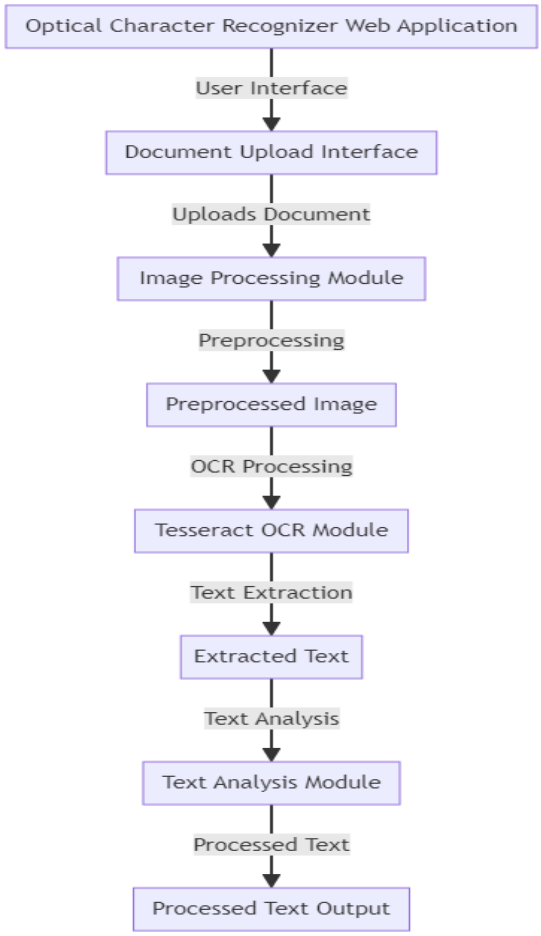

Fig. 1. System Architecture

VI. METHODOLOGY

1. The Image Preprocessing Module is tasked with the responsibility of performing pre-processing on the input image in order to improve its quality and prepare it for optical character recognition. The process encompasses a range of methodologies, including noise reduction, image binarization, and deskewing.

Initially, noise removal techniques such as Gaussian blur or median filter are employed to eliminate undesirable artifacts and enhance the image's

smoothness. This practice aids in mitigating the influence of noise on the succeeding optical character recognition (OCR) procedure.

Subsequently, the process of image binarization is implemented in order to transform the grayscale image into a binary image, wherein solely two distinct intensity values are discernible, namely black and white. The inclusion of this step is of utmost importance in order to ensure accurate and effective character segmentation during subsequent stages. Various techniques, such as Otsu's thresholding or adaptive thresholding, can be utilized depending on the specific characteristics exhibited by the input image.

Ultimately, the process of deskewing is executed in order to rectify any instances of skewness or slant that may be present within the image. The alignment of text in a horizontal manner is crucial for OCR algorithms to accurately process and interpret the content. Methods such as the Hough Transform or straightening based on linked component analysis can be employed to ascertain the skew angle and subsequently rotate the image accordingly.

2. The Character Segmentation Module is a component that is responsible for segmenting characters in a given text or image.

After the completion of the pre-processing stage, the subsequent module focuses on the segmentation of the individual characters from the input image. The inclusion of this phase is crucial as it serves to separate individual characters, hence facilitating precise identification.

Various techniques can be utilized for the purpose of character segmentation, including linked components analysis, contour analysis, and projection-based methods. The process of connected components analysis involves the grouping of pixels that belong to the same character, whereas contour analysis aids in the identification of the boundaries of individual characters. Projection-based methods encompass the examination of both the vertical and horizontal projections of a picture in order to identify the boundaries of characters.
The segmentation module is required to effectively address a range of difficulties, including but not limited to the presence of overlapping characters, characters that are touching, and characters with intricate geometries. Various techniques such as the watershed algorithm, distance transform, and neural networks can be utilized to effectively address these problems and achieve precise character segmentation.

3. The Character Recognition Module is a component that is responsible for identifying and interpreting characters within a given context.

The subsequent module of the system is dedicated to the identification and conversion of segmented characters into text that can be interpreted by machines. The current module makes use of Tesseract's optical character recognition (OCR) engine, an influential open-source program renowned for its capabilities in recognizing characters from images.

The Tesseract system utilizes sophisticated machine learning methodologies, such as deep neural networks, in order to accurately identify and classify characters extracted from segmented images. The system utilizes language-specific models and dictionaries in order to enhance the accuracy of recognition and effectively manage diverse languages and scripts. The versatility of Tesseract in accommodating many fonts, sizes, and styles renders it a widely favored option for character recognition in optical character recognition (OCR) systems.

The character recognition module entails the process of inputting the segmented characters into Tesseract's OCR engine, resulting in the production of the recognized text. Post-processing procedures, such as the utilization of spell-checking or correction algorithms, can be employed to enhance the precision of the identified text. The module should also provide functionality to address scenarios in which specific characters are incorrectly classified or not recognized, by implementing appropriate error-handling procedures.

VII. RESULT AND DISCUSSION

The Optical Character Recognizer (OCR) Web Application, which employs Tesseract, is a sophisticated system developed to efficiently extract textual content from photos and digitized documents, while also providing a user-friendly interface. The Tesseract OCR engine, renowned for its robustness and versatility, facilitates precise identification and interpretation of printed text across several languages. The web application leverages the capabilities of this robust engine in order to deliver a smooth and uninterrupted user experience.

After the user uploads an image or document file, the system proceeds to process the information by employing Tesseract's algorithms in order to detect and extract the text. The utilization of OCR technology in Tesseract facilitates the precise identification of characters, especially when confronted with difficult circumstances like low-resolution photos or text that is not aligned properly. This procedure guarantees that the retrieved text

closely resembles the original content.

In addition, the web application provides further functionalities to improve the use of the system. Individuals have the ability to choose the preferred language for the purpose of recognition, hence enabling the provision of support for many languages. In addition, the application offers users the ability to modify the image quality and engage in preprocessing tasks, such as noise reduction and contrast enhancement, in order to enhance the outcomes of optical character recognition (OCR).

In order to improve the precision of the system, machine learning techniques are utilized to iteratively enhance recognition accuracy as time progresses. This feature is particularly advantageous for the identification of handwriting or distinct typefaces that may not be readily recognized at first glance.

In general, the utilization of the Tesseract OCR Web Application proves to be a dependable and effective solution for the extraction of textual content from both photographs and digitized documents. The software's interface is designed to be easily navigable by users, accommodating their needs and preferences. Additionally, it offers support for several languages, enhancing its versatility and usability across different linguistic contexts. Furthermore, the software consistently strives to enhance its accuracy through ongoing improvements, rendering it a highly commendable option for a range of applications such as data entry, document digitization, and information retrieval

VIII. CONCLUSION

In summary, the system employed for the Optical Character Recognition (OCR) Web Application utilizing Tesseract has demonstrated commendable efficiency and reliability. The Tesseract OCR engine, which is open-source, offers precise and efficient outcomes when transforming scanned documents and photos into text that can be edited and searched. The web application that employs this method has a high degree of user-friendliness, enabling users to effortlessly upload their papers and acquire precise and legible textual output. The deployment of the system necessitates the utilization of appropriate preprocessing techniques in order to boost the accuracy of optical character recognition (OCR). These approaches include picture enhancement and noise reduction. In general, this technology functions as a beneficial instrument for both companies and people seeking to scan and extract text from tangible documents, providing simplicity and effectiveness in their document management procedures.

IX. FUTURE WORK

A potential avenue for future development involves enhancing the precision and efficiency of the Optical Character Recognizer (OCR) Web Application through the utilization of Tesseract. The objective of improving the quality of input photos before they are processed by the OCR engine can be accomplished by using supplementary preprocessing techniques. These techniques aim to eliminate noise and enhance the visual clarity of the images. To address challenges related to hazy or distorted images, it is possible to investigate noise reduction algorithms, image normalization approaches, and edge identification methods. In addition, it would be advantageous to explore strategies for effectively managing challenging typographies, diverse linguistic scripts, and disparate text magnitudes. Furthermore, the exploration of integrating machine learning techniques into the OCR system for the purpose of training it on specific data sets in order to enhance both recognition accuracy and speed is worth considering. In addition, conducting research on strategies for enhancing the system's architecture and algorithms to effectively manage OCR tasks on a wide scale would be of significant importance. Ultimately, the implementation of comprehensive testing and assessment across various document kinds and scenarios, together with the collection of user feedback, would yield valuable insights for the refinement and improvement of the OCR Web Application.

REFERENCES

[1] Wong, P. Y., & Alduais, N. A. M. (2022). Development of a Web-based Optical Character Recognition System. Applied Information Technology And Computer Science, 3(2), 370-387.

[2] Lestari, I. N. T., & Mulyana, D. I. (2022). Implementation of OCR (Optical Character Recognition) Using Tesseract in Detecting Character in Quotes Text Images. Journal of Applied Engineering and Technological Science (JAETS), 4(1), 58-63.

[3] Bugayong, V. E., Villaverde, J. F., & Linsangan, N. B. (2022, March). Google tesseract: optical character recognition (OCR) on HDD/SSD labels using machine vision. In 2022 14th International Conference on Computer and Automation Engineering (ICCAE) (pp. 56-60). IEEE.

[4] Koo, X. T., & Khor, K. C. (2023, July). Expense Tracking with Tesseract Optical Character Recognition v5: A Mobile Application Development. In 2023 IEEE Symposium on Industrial Electronics & Applications (ISIEA) (pp. 1-5). IEEE.

[5] Thammarak, K., Kongkla, P., Sirisathitkul, Y., & Intakosum, S. (2022). Comparative analysis of Tesseract and Google Cloud Vision for Thai vehicle registration certificate. International Journal of Electrical and Computer Engineering, 12(2), 1849-1858.

[6] Kumar Garai, S., Paul, O., Dey, U., Ghoshal, S., Biswas, N., & Mondal, S. (2022). A Novel Method for Image to Text Extraction Using Tesseract-OCR. American Journal of Electronics & Communication, 3(2), 8-11.

[7] Munawaroh, A., & Jamzuri, E. R. (2023). Automatic optical inspection for detecting keycaps misplacement using Tesseract optical character recognition. International Journal of Electrical & Computer Engineering (2088-8708), 13(5).

[8] Vijayanarayanan, A., Savithiri, R., Lekha, P., & Abbirami, R. S. (2023). Image Processing Based on Optical Character Recognition with Text to Speech for Visually Impaired. Journal of Science, Computing and Engineering Research, 6(4), 68-73.

[9] Sanghvi, V., Ukani, V., Patel, R., Sharma, P., & Shah, P. (2023). Document Data Extraction with Optical Character Recognition. Grenze International Journal of Engineering & Technology (GIJET), 9(1).
[10] Zulkifli, M. K. N., Daud, P., & Mohamad, N. (2022, December). Multi Language Recognition Translator App Design Using Optical Character Recognition (OCR) and Convolutional Neural Network (CNN). In The International Conference on Data Science and Emerging Technologies (pp. 103-116). Singapore: Springer Nature Singapore.