# ASSISTING BLIND READERS: IMAGE TEXT-TO-SPEECH CONVERSION IN PREFERRED LANGUAGE

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***Abstract*- In the 2019 survey conducted by the Indian Foundation for the Blind, it was observed that a staggering 6.8 trillion people are visually impaired, facing challenges in their daily lives. Recognizing the importance of enabling them to navigate the contemporary world despite their impairments, it becomes imperative to implement measures leveraging emerging technologies. In this context, this paper proposes a novel approach aimed at supporting the visually impaired population by introducing a self-assisted text-to-speech module. This module not only caters to the visually impaired but is also beneficial for individuals without visual impairments who seek a quick conversion of text to speech. The proposed method involves the use of a finger-mounted camera to capture images of printed text. Subsequently, an Optical Character Recognition (OCR) technique is employed to analyze the captured image, comparing it with a predefined dataset for character recognition. The key advantage of this method lies in its ability to significantly reduce the dataset memory requirements for comparison, as it focuses solely on character recognition. The efficacy of the proposed system is simulated using Python simulator software, employing two classification algorithms—Random Forest (RF) and Convolutional Neural Networks (CNN) in conjunction with OCR. This comprehensive approach aims to address the challenges faced by the visually impaired community, enhancing their accessibility to textual information efficiently and inclusively.**

**Index Terms: Accuracy, Precision, Recall, CNN, RF,OCR, Python.**

## I.INTRODUCTION

The proliferation of the Internet, particularly the World Wide Web, is already reshaping the landscape of science education and is poised to exert even greater influence in the future. This digital realm presents a dynamic medium that holds the potential to be more adaptive to students, fostering increased engagement in their learning process and providing broader access to diverse information sources compared to traditional methods. Envisioning a future where individuals with visual impairments can seamlessly partake in online examinations, our project aims to facilitate real-time accessibility. An automated and instantaneous test grading system relieves faculty members of time- consuming duties. Text-to-speech technology, utilizing natural language processing, allows computers to articulate text. While various text reading applications employ techniques like label reading, voice stick, brick pi reader, and pen aiding, they often involve creating and managing datasets. Addressing this challenge, our developed finger- reading technique eliminates the need for stored datasets, providing prompt responses to any given text captured through image input. The speech synthesizer then transforms the audio input into text, contributing to further advancements in learning modules. Despite the evolution of technology in electronic information storage, textual information remains the predominant mode of information exchange.

The development of assistive reading systems relies on the integration of two crucial technologies: Optical Character Recognition (OCR) for Text Information Extraction (TIE) and Text-To-Speech (TTS) for converting the extracted text into speech. Text Information Extraction serves as the primary and essential function of any assistive reading system, acting as an integral component of OCR, influencing the intelligibility of the output speech. The emphasis on the quality of text-to-speech not only enhances the overall system performance but also extends the capability to generate expressive synthetic speech. The incorporation of automatic video text detection and extraction facilitates the partitioning of video blocks into text and non-text regions. Ongoing advancements in computer vision, digital cameras, and computing have paved the way for the development of camera-based products, seamlessly merging computer vision technology with existing beneficial systems like optical character recognition. OCR, with its high recognition rate, accurately identifies characters, words, and sentences from photographed images of typewritten or printed text, enabling electronic conversion into computer-readable text. These technological developments offer practical solutions, particularly for visually impaired individuals, who require portable assistance in reading printed text. A

camera-based assistive text reading framework has been devised, aiding blind individuals in reading text labels and product packaging from handheld objects, with an extension to the continuous reading of printed text-based books. The device's task involves video processing to extract Regions of Interest (ROI) from videos, automatically setting the video duration to around 5 seconds, and employing boundary detection by comparing pixel counts. The imperative need to simulate the development of a voice-assisted text-to- speech system using optical character recognition, encompassing various input sets and delivering speech output, underscores the significance of this technological advancement.

## II. LITERATURE SURVEY

Language processing typically relies on a left- lateralized network of frontotemporal cortical regions, known for its remarkable consistency across individuals and cultures. However, developmental factors, such as delayed exposure to language, have been shown to influence and modify this network. Recent findings indicate that congenitally blind individuals exhibit an expansion of the conventional frontotemporal language network, incorporating parts of the "visual" cortices. In this study, we present evidence that blindness is associated with reduced left lateralization in frontotemporal language areas. Analyzing fMRI data from congenitally blind adults and children, we computed laterality indices for sentence comprehension compared to various control conditions. Across experiments and participant samples, congenitally blind individuals displayed a less left-lateralized frontotemporal language network when compared to their sighted counterparts. Interestingly, this reduction in left lateralization was not correlated with Braille reading ability or the extent of occipital plasticity. Notably, a positive correlation emerged between the lateralization of the frontotemporal cortex and that of language-responsive occipital areas in blind individuals. Those with right-lateralized language responses in frontotemporal cortices also exhibited right-lateralized occipital responses to language. These findings unveil a modified neurobiology of language in blindness, suggesting that, despite its typical consistency, the neurobiology of language can be altered by nonlinguistic experiences.

The contemporary era's inundation of online information has underscored the critical necessity for a tool adept at condensing lengthy texts into concise and meaningful summaries. This need is particularly pronounced for individuals with specific requirements, such as the visually impaired or the elderly, who benefit from direct access to essential information without navigating through extensive passages. Current research in automatic summarization aims to replicate human capabilities, yet it grapples with both enabling and limiting hypotheses. To achieve a machine's ability to mimic human understanding, access to a broad spectrum of knowledge is imperative, influencing the orientation, argumentation, and subsequent summary of the text. Most Text Summarizers (TS) focus on compressing initial data, leading to inevitable information loss, and emphasizing text features rather than the author's intent or the reader's purpose. This paper addresses this limitation by introducing a system that prioritizes implicit knowledge acquisition, catering to the needs of individuals with special requirements by providing essential data efficiently.

Visually impaired individuals face the challenge of accessing printed or handwritten material, typically requiring Braille to comprehend the content. However, the proposed system innovatively leverages other sensory abilities possessed by the visually challenged, such as auditory perception, by converting textual material into an audio stream. The process initiates with image capture and text recognition using OCR/ICR technology, followed by loading the necessary font templates for printed text into the conversion software. For handwritten documents, sub-stroke matching, segmentation, and merging techniques are employed. The output is an electronic version of the printed media, akin to a text document, cross-referenced with a word repository for optimal accuracy before being transformed into an audio file. The disseminated information utilizes ZigBee or Wi-Fi protocols for broadcast, multicast, or unicast transmission to paired receivers. Designed in the form of a pen, this portable technology offers convenience and serves as a groundbreaking tool, empowering the visually impaired by alleviating the frustration associated with limited reading capabilities, thereby enhancing their overall quality of life.

The proliferation of digital, high-contrast displays in public transport, public spaces, and offices, owing to their dynamic content updating capabilities, underscores the significance of efficiently locating and reading them, especially in the context of the previously proposed Bionic Eyeglass—a mobile navigation guide designed for the blind and visually impaired. This paper introduces a pioneering algorithm tailored for color cellular visual microprocessors, focusing on the localization of displays in image flows, coupled with an enhanced algorithm for the recognition of numbers on these displays. The cellular wave algorithms for sign localization adeptly integrate color information with spatial-temporal logic, considering both inherent properties of color displays and device-specific details in the algorithmic design. This innovative approach aims to optimize the functionality of navigation aids for the visually impaired in navigating through environments equipped with these digital displays.

The advent of computer-based speech synthesis has significantly enhanced communication by enabling automatic speech-conducive interactions. While various assistive technology tools exist, visually impaired individuals still face challenges in achieving complete independence when accessing computer systems compared to their sighted counterparts. Common assistive technologies, such as screen magnifiers and speech-synthesized readers, provide text-to-speech capabilities but do not empower users to navigate systems fully using traditional input devices like mouse and keyboard. To address this limitation, a mouse-controlled assistive technology is proposed, allowing visually impaired users to access their desktops through mouse movements. This innovation aims to provide comprehensive desktop access, ensuring that visually impaired individuals can perform a variety of operations with ease. The incorporation of aural medium and speech elements enhances accessibility and accuracy in navigation, aligning with the visible trend in Assistive Technology. This technology holds the potential to revolutionize access for visually impaired individuals, enabling them to participate in online competitive exams and access previously inaccessible areas.

The global expansion of e-learning has become a prominent mode of education; however, computing and engineering programs face challenges in incorporating visually impaired learners due to the extensive use of graphical representations. Traditional lecture strategies may not seamlessly transition to e-learning, especially with the spatial distance among participants. This paper evaluates learners' perceptions during e-learning lectures focused on software requirements specification using UML/SysML use case models, with a specific emphasis on visually impaired participants. Online lectures were conducted in real-time, utilizing external remote communication tools and Model2gether for collaborative interaction with use case models. Before the lectures, participants completed a pre-survey and interviews. Learning assessment included both group work and exams. Post-lecture, post-survey, and interviews were conducted, with quantitative data subjected to statistical analysis. Results indicate that, with proper tool support, visually impaired learners can be effectively included in e-learning activities based on graphical representations. Additionally, post-survey responses reveal that learners did not distinguish between visually impaired and sighted colleagues while collaborating using Model2gether. This suggests the feasibility of inclusive e-learning strategies for visually impaired individuals incomputing and engineering education.

The emerging trend of online practice and examination systems (OPES) represents a paradigm shift in interactive remote teaching and learning. Operating within the B/S design model, OPES caters to three functional roles: students, teachers, and system administrators. This system introduces a distributed and asynchronous learning environment, emphasizing practice and examination content to enhance student engagement. The practice procedure dynamically adjusts questions to target users' knowledge weaknesses, with OPES generating guidelines summarizing and exporting these weaknesses and blind spots after each practice session. This facilitates focused learning for students, enabling them to delve into detailed knowledge guided by the provided instructions. The examination questions are randomly generated under thematic testing with a scientifically distributed count. To alleviate the clients' burden, all operations are executed on the server side, and clients receive only the execution results through the JSP technique. OPES thus streamlines the learning experience, offering tailored practice and assessment while embracing the flexibility of remote education.

Text classification, the automated process of assigning text to predefined categories based on its content within a given system, involves key steps like word segmentation, feature selection, weight calculation, and performance evaluation. Feature selection, particularly crucial for classification accuracy, aids in indicating the relevance of text contents and significantly influences the classification result. This module is extensively utilized in text processing, playing a vital role in applications such as spam filtering, news classification, sentiment analysis, and part-of- speech tagging. The paper introduces a method for extracting feature words using Chi-square Statistics, recognizing the variability of feature words in different contexts. Notably, the classification employs both single words and double words as features concurrently. Experimental assessments with classical Naive Bayes and Support Vector Machine classification algorithms demonstrate the method's efficiency, showcased through comparative analysis of experimental results. This approach offers valuable insights into enhancing text classification processes with potential applications across diverse domains.

## III. EXISTING SYSTEM

Random Forest (RF):

Random forests, also known as random decision forests, represent an ensemble learning method employed for classification, regression, and various tasks. The approach involves constructing numerous decision trees during training, with the final output being the mode of classes for classification or the mean/average prediction for regression across the individual trees. This ensemble technique addresses the tendency of decision trees to overfit their training set. While random forests typically outperform standalone decision trees, it is essential to note that their

accuracy tends to be lower than that of gradient-boosted trees. Nevertheless, the effectiveness of random forests is subject to the characteristics of the data, impacting their overall performance in different scenarios. Decision trees are a popular method for various machine-learning tasks. Tree learning "come[s] closest to meeting the requirements for serving as an off-the-shelf procedure for data mining", say Hastie *et al.*, "because it is invariant under scaling and various other transformations of feature values, is robust to the inclusion of irrelevant features, and produces inspectable models. However, they are seldom accurate".
In specific scenarios, decision trees that are grown extensively tend to capture highly irregular patterns, exhibiting low bias but very high variance, leading to overfitting of training sets. Random forests address this issue by employing an ensemble approach, averaging multiple deep decision trees trained on different subsets of the same training set. The primary goal is to mitigate variance, even though this comes at the cost of a slight increase in bias and a reduction in interpretability. Essentially, random forests amalgamate the efforts of individual decision trees, functioning as a collaborative team to enhance the performance of a single random tree. While not identical, the ensemble effect of random forests resembles the principles of K-fold cross- validation, contributing to an overall improvement in the final model's performance.

## IV. METHODOLOGY

Convolution Neural Network:
Within the realm of deep learning, a Convolutional Neural Network (CNN or Conv Net) emerges as a specialized class of deep neural networks, predominantly employed for the analysis of visual imagery. Recognized as shift-invariant or space- invariant artificial neural networks (SIANN), these networks adopt a shared-weights architecture, showcasing translation invariance characteristics. CNNs find extensive applications in diverse domains such as image and video recognition, recommender systems, image classification, image segmentation, medical image analysis, natural language processing, brain-computer interfaces, and financial time series analysis. Convolutional Neural Networks (CNNs) excel in efficient processing and extracting features from intricate visual data, establishing themselves as fundamental tools in diverse artificial intelligence and machine learning applications across industries. CNNs are essentially regularized versions of multilayer perceptron where the conventional fully connected networks, linking each neuron in one layer to all neurons in the next, are prone to overfitting data due to their extensive connectedness. To address this, CNNs introduce a distinctive regularization approach by capitalizing on the hierarchical patterns in data, constructing more intricate patterns through the utilization of smaller and simpler patterns. This unique strategy positions CNNs on the lower extreme concerning connectedness and complexity, diverging from the conventional fully connected networks, and contributes to their effectiveness in handling complex visual information while mitigating the riskof overfitting.
Convolutional networks draw inspiration from biological processes, mirroring the connectivity pattern observed in the visual cortex of animals. This design is influenced by the organization of the animal visual cortex, where individual cortical neurons exhibit responses solely within a limited region of the visual field termed the receptive field. Notably, the receptive fields of distinct neurons exhibit partial overlap, collectively spanning the entire visual field. This bio-inspired approach in convolutional networks reflects the intricate and interconnected nature of the animal visual cortex, enhancing the network's ability to capture complex visual patterns with a spatially hierarchical structure.
Convolutional Neural Networks (CNNs) distinguish themselves by requiring minimal pre-processing in comparison to alternative image classification algorithms. In contrast to traditional methods where filters were meticulously hand-engineered, CNNs autonomously learn these filters. This intrinsic ability of CNNs to grasp intricate features without the need for extensive pre-processing or human intervention in feature design stands as a significant advantage. The network's capacity to independently learn and adapt to relevant features not only streamlines the overall process but also highlights the efficiency and adaptability of CNNs in image classification tasks.

The proposed system aims to create a finger-reader- based text-reading system catering to the needs of visually impaired individuals, emphasizing their self-independence in accessing written content. Addressing the critical issue of self-dependency for visually impaired users, the system focuses on facilitating the collection of information with ease. The framework integrates various modules, including a finger reading device, a Text-to-Speech (TTS) module, and an Optical Character Recognition (OCR) module, to achieve the desired outcome. The text reading system comprises three primary components: the finger reading module, the OCR process module, and the TTS module. The finger reader device, equipped with a camera and vibration sensor for finger position control, plays a pivotal role in empowering visually impaired users by enabling them to independently engage with written text. This initiative aims to enhance accessibility and autonomy for visually impaired individuals, fostering a more inclusive and self- reliant user experience.

### A. Reader Module

The initial development of the reader module was primarily focused on text formats, utilizing finger- based form

factors such as small rings. In the current prototype, the camera is affixed to an adjustable Velcro ring, positioned at the center, while a vibration sensor, crucial for finger movement and control, is situated at the ring's corner. Processing is facilitated by a wrist-mounted Arduino board, complemented by an attached Bluetooth module responsible for managing haptic feedback cues. The real-time processing of the video feed captured by the camera is currently executed on a laptop computer, showcasing the integration of various components to enable effective text reading for users, particularly those with visual impairments. This innovative design emphasizes practicality and user-friendly interfaces, aiming to enhance accessibility and usability in the context of text perception for individuals with visual challenges.

B. Optical Character Recognition

The Optical Character Recognition (OCR) module serves as a mechanical or electronic tool for transforming images of typed, handwritten, or printed text into machine-encoded text, facilitating the digitization of printed content for machine processes such as text-to-speech conversion. In this system, the input is provided in text form through a finger device-mounted camera, capturing the text and forwarding it to the OCR process. Within the OCR process, the extraction of text-to-speech is executed. The captured input text undergoes segmentation on a word-by-word basis, employing boundary detection to isolate words for separate reading. Words that fit within the designated boundaries are retained, while unfit text is eliminated. The text extraction process involves template matching, where each word is matched with templates one by one, ultimately forming complete words. The identified line or word is then read aloud from the captured input text through appropriate coding. Utilizing a USB camera, the system captures input in text format, channels it to the OCR process for text conversion, and subsequently converts it into speech, providing an accessible means for individuals, especially those with visual impairments, to engage with writtencontent.

C.TTS Module

A Text-to-Speech (TTS) system plays a crucial role in converting regular text into audible speech, distinguishing itself from other systems that translate symbolic linguistic representations, such as phonetic transcriptions, into speech. Employed in this context, the TTS system serves the purpose of reading each word as a user's finger passes over it, with additional audio and/or haptic cues signaling various events, including the end or start of a line. This system consists of two integral components: the front end and the back end. The front end encompasses tasks like converting raw text, containing symbols like numbers and abbreviations, into the equivalent of written-out words—an operation often referred to as text normalization, pre-processing, or tokenization. Following this, the front end assigns phonetic transcriptions to each word, effectively dividing and marking the text into prosodic units such as phrases, clauses, and sentences. The assignment of phonetic transcriptions to words is specifically termed text-to-phoneme or grapheme-to-phoneme conversion, solidifying the front-end's role in preparing the text for subsequent speech synthesis by the back-end. This dual- component system plays a pivotal role in enhancing accessibility for users, particularly those with visualimpairments, by transforming written content into an auditory format.

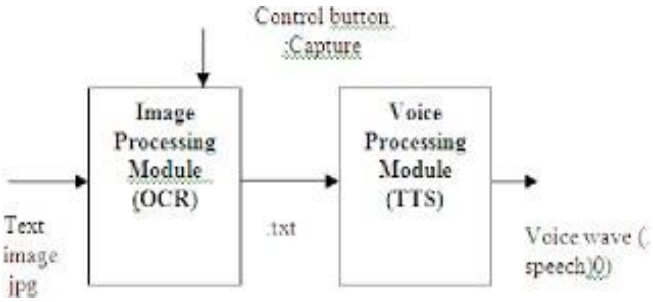


Fig 1: Block Diagram

## V. MODULE DESCRIPTION

Documents Collection:

The initial phase of the classification process involves the collection and categorization of various document types or formats. This encompasses adiverse range, including but not limited to HTML,
.pdf, .doc, web content, and more.

Pre-Processing:

Pre-processing at its inception is essential to converting text documents into a logical word format. This initial stage of preparation guarantees that the documents are presented in a comprehensible and organized manner for the next steps in the text classification process.

Tokenization:

The use of stop words, which are frequently encountered and relatively inconsequential terms like "the," "a," "and,"

and others, is crucial to improving the efficiency and significance of stop words.
Stemming word:
The stemming technique is used to transform different word forms—like "connection" to "connect" or "computing" to "compute"—into a single, universal canonical form. To streamline text processing, this step seeks to combine tokens to their base form. One of the most important preprocessing techniques for moving from full-text versions of documents to document vectors is document representation. For this, the vector space model— most notably, the SMART vector space model—is frequently used. Documents are represented in this approach as word vectors that create a document matrix with a dimension assigned to each word. This technique makes it easier to compare and evaluate documents that are part of a collection.

Feature Selection:
Following the pre-processing and indexing stages, an integral aspect of text classification involves feature selection, aimed at constructing a vector space to enhance the scalability, efficiency, and accuracy of text classifiers. Feature selection (FS) is pivotal in this process, involving the extraction of a subset of features from the original documents. This is achieved by retaining words with the highest scores based on a predetermined measure of word importance. The primary goal of FS is to streamline the feature set, thereby optimizing the performance of the text classifier by focusing on the most relevantand informative terms.

Classification:
The automatic classification of documents into predefined categories has garnered considerable attention, with three primary methods utilized: unsupervised, supervised, and semi-supervised techniques. Over the past few years, significant advancements have been made in the realm of automatic text classification, with notable progress observed in areas such as machine learning approaches including Convolutional Neural Networks (CNN). This ongoing research and development indicate a growing understanding of the complexities involved in text classification tasks, reflecting a concerted effort to enhance the accuracyand efficiency of classification algorithms.

**TOOLS USED**
OpenCV is a comprehensive repository of programming operations tailored for real-time computer vision tasks, originally developed by Intel and now supported by Willogarage, available under the permissive BSD license. It boasts over five hundred effective algorithms, making it a versatile tool widely utilized across various fields worldwide, with a vibrant user community comprising forty thousand users. Its applications span a wide spectrum, from communication resource management to precise auditing and emerging robotics applications. Developed primarily in C, OpenCV's portability extends to specific platforms such as Digital Signal Processors (DSPs). Furthermore, it is packaged for multiple programming languages including C, Python, Ruby, and Java (utilizing Java CV), ensuring accessibility and ease of integration across diverse development environments.

**A. Python**
Python is an object-oriented, dynamic programming language with amazing capabilities that finds use in many different fields of application. It includes a large number of standard libraries and provides robust support for integrating with other tools and languages. More specifically, here are severalcharacteristics that set Python apart:
- Very clear, readable syntax.
- Strong introspection capabilities.
- Full modularity.
- Exception-based error handling.
- High-level dynamic data types.
- Supports object-oriented, imperative, andfunctional programming styles.
- Embeddable.
- Scalable
- Mature

Python's great degree of flexibility makes it easier for users to think problem-centrically rather than language-centrically as in other situations. Python isthe greatest choice for scientific computing becauseof these features.

**B. Open CV**
OpenCV serves as a comprehensive library of programming functions tailored for real-time computer vision tasks, initially crafted by Intel and currently backed by Willo Garage, available for free under the open-source BSD license. Featuring over

five hundred optimized algorithms, it boasts a widespread user base of forty thousand individuals globally, utilized across a broad spectrum of applications ranging from interactive art to mine inspection and cutting-edge robotics. Predominantly developed in C, OpenCV's portability extends to specific platforms like Digital Signal Processors (DSPs), with wrappers facilitating integration into languages such as C, Python, Ruby, and Java (via JavaCV), aimed at fostering broader adoption. Recent updates have introduced interfaces for C++, focusing primarily on real-time image processing tasks. As a cross-platform library, OpenCV supports execution on Linux, macOS, and Windows systems, solidifying its status as the premier open-source computer vision solution for developers and researchers alike.

### C. Tesseract

Tesseract stands as a freely available OCR (Optical Character Recognition) engine originally developed at HP during the period from 1984 to 1994. In 2005, HP relinquished control of Tesseract to the community, marking its release as open-source software. Debuting at the 1995 UNLV Annual Test OCR Accuracy, Tesseract is currently maintained by Google and distributed under the Apache License. Capable of recognizing six languages and fully UTF8 compatible, Tesseract offers developers the flexibility to train the engine with custom fonts and character mappings to achieve optimal performance. This versatility and adaptability contribute to Tesseract's widespread adoption and continued relevance in the field of OCR technology. It works by breaking down the image into components, analyzing them, and then converting them into machine-readable text. This extracted text can then be fed into a separate text-to-speech system for conversion into spoken audio. Tesseract's core functionality is impressive, making it a valuable tool for anyone looking to unlock the textual treasures hidden within images.

## VI. SIMULATION RESULT

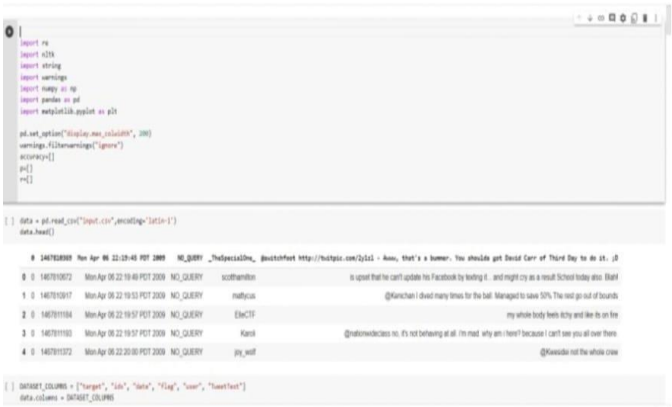

*Fig 2: Program Compiling*

## VII. CONCLUSION

Right now, we are concentrating on putting forth an OCR algorithm for our system's integration. We intend to use other algorithms to implement this system in libraries in the future and measure its effectiveness through performance assessments. In particular, we want to evaluate the accuracy with which the system can translate visuals to voice. Even if our present algorithms seem appropriate and promising, we're nonetheless willing to investigate fresh ideas and compare various OCR products on the market. Using this method, we can choose the best OCR algorithm to use in our system, guaranteeing its dependability and efficiency.

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