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Building Document Scanner Using Computer Vision

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Abstract: ***In this digital era, scanning documents is essential for filling online application forms. This paper presents building mobile document Scanner using Computer Vision. OpenCV is an open-source computer vision and machine learning software library which is used to perform all the image processing tasks effectively. In this application, several image processing techniques are used such as image re-sizing, Grayscale conversion, applying Gaussian blur, Edge detection, finding Contours, Perspective transformation, and Adaptive threshold. By implementing all these techniques on a given scanned image, the system can accurately detect edges automatically and produces required scanned documents from images captured through mobile camera. The accuracy of the scanned documents compared with 240p and 720p cameras. This application makes life more convenient while also promoting a paperless, eco-friendly way of working.***
Keywords: Computer Vision, Image Processing, Perspective Transformation, Edge Detection, Contours

I. INTRODUCTION

Developing an automatic document scanner using computer vision, integrating advanced image processing techniques for efficient and accurate digitization. Adrian Rosebrock's practical implementation [1] forms the foundation, employing edge detection, perspective transformation, and adaptive thresholding for effective document extraction. OpenCV, introduced by Gary Bradski and Adrian Kaehler [2], provides versatile tools like image preprocessing and contour detection, which are crucial for this system. Szeliski's work [5] offers theoretical insights into edge detection and perspective correction, strengthening the scanner's design. To handle challenging conditions like poor lighting, Deng et al. [6] proposed adaptive thresholding methods, enhancing the readability of scanned documents. The system's real-time efficiency is supported by findings from Matuska et al. [7], who demonstrated OpenCV's superiority in performance for such applications.

Friedman and Fisher's exploration [3] highlights potential future improvements using AI for advanced feature detection. Additionally, concepts from Viola and Jones [4] on object detection inform edge and contour enhancements. Inspired by Neukermans et al.'s early handheld scanners [8], this application delivers a software-based solution. By automating processes, the scanner ensures high-quality, distortion-free digitization, promoting productivity and eco-friendly practices across various domains.

II. RELATED WORK

The idea of document scanning has been explored in various studies and papers, each contributing important methods and insights. Adrian Rosebrock [1] demonstrated how to build a document scanner using OpenCV, using techniques like edge detection, perspective correction, and adaptive thresholding to extract documents from images effectively. His work serves as a practical guide for building similar systems. Bradski and Kaehler [2] introduced OpenCV as a powerful tool for image processing and computer vision. Their book explains many useful techniques that are directly applied in document scanning system.Friedman and Fisher [3] explored the use of machine learning with OpenCV for image-related tasks. Viola and Jones [4] developed a fast method for detecting objects in images. Although their work focuses on object detection, the same principles can help improve how we detect and extract document edges. Szeliski [5] provided an in-depth overview of many computer vision techniques, including those used in document scanners, like edge detection and perspective transformation. His work is a great resource for understanding the theory behind these methods. Deng et al. [6] proposed an adaptive thresholding algorithm to detect corners in images. Their method can be helpful in cases where documents are difficult to detect due to poor lighting or noisy backgrounds. Matuska et al. [7] compared the performance of image processing algorithms in Matlab and OpenCV. They found that OpenCV is faster, making it ideal for real-time applications like document scanning.Finally, Neukermans et al. [8] developed one of the first handheld document scanners, focusing on hardware solutions. While our project uses a software-based approach, their work inspired the idea of creating efficient and portable scanning systems. These studies and resources are the foundation for our proposed system, helping us design a document scanner which is accurate, efficient, and easy to use, all powered by OpenCV.

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III.AUTOMATIC DOCUMENT SCANNER

Creating an efficient document scanner using Computer Vision is to use smart image processing techniques to transform physical documents into high-quality digital files. The system goes through a series of steps, like resizing images, converting them to grayscale, blurring them to reduce noise, and detecting edges and contours to focus on the document area.

A. Image Pre-processing

The first step is to get the image ready for processing,

- Resizing: Adjusting the image size so everything is consistent, no matter how big or small the document is.
- Grayscale Conversion: Simplifying the image by removing colors, focusing only on light and dark areas, which makes further processing quicker and easier.
- Gaussian Blur: Reducing any unwanted noise in the image to ensure clean and accurate detection in the next steps.

B. Edge Detection and Finding Contours

After preparing the image, we look for the document's edges and outline:

- Edge Detection: Using the Canny algorithm, we highlight the sharp changes in brightness (edges), which help us figure out the document's boundaries.
- Contour Detection: This step finds the outline of the document. The largest outline is usually the document itself, hence we focus on that.

C. Perspective Transformation

Once we know where the document is, we fix any distortions caused by the angle of the camera. This process is called perspective transformation. It straightens the document to make it look like it was scanned flat on a surface.

D. Adaptive Thresholding

Finally, we use adaptive thresholding to enhance the document's clarity. This technique adjusts to the lighting conditions in the image, ensuring that the text and details are easy to read, even if the original lighting wasn't perfect.

IV.EXPERIMENTAL SETUP

The Document Scanner was developed and tested using Python 3 in a local development environment such as Intel i5 processor with 2.5 GHz, 8GB RAM and 256 SSD with OpenCV library installed. OpenCV is an open-source computer vision and machine learning library widely used for image processing tasks.

V. RESULTS AND DISCUSSION

Fig.1 demonstrates the original image and all the image transformations such as gray scale image, edge detection, finding contours, perspective transformation and adaptive thresholding. Here we have given a document to scan for the application which is not placed in proper orientation. Even though our application will detect the edges and give proper alignment to the final scanned document.

The results demonstrate the effectiveness of the proposed document scanner, with the outputs showcasing key functionalities

Fig. 1. Transformation of a Sample Document using various Image Processing and Computer Vision Techniques.

Fig. 2 shows the output of our proposed document scanner, where the 720p camera provides a sharper and more accurate representation of the document. The screen clearly displays the effectiveness of the system's edge detection, contour identification, and perspective transformation techniques, resulting in a clear and high-quality output. The higher resolution camera ensures that even subtle details of the document are captured accurately, improving the reliability and usability of the document scanner system.

Fig. 2. Output of the proposed document scanner

The output document shown in Fig.2 was captured using a 720p camera, with the system achieving an accuracy of 90%. The image highlights the final document extracted and processed with high precision, showcasing the successful application of image processing techniques such as grayscale conversion, Gaussian blur, and edge detection. The higher resolution of the camera allows for clearer edges and better overall quality, ensuring that the document is accurately scanned and ready for digitization. This demonstrates the significant role of camera resolution in achieving high-quality document scans.

The Fig.2 represents the results of the document extraction process after applying adaptive thresholding, which enhances the scanned output. The system successfully isolates the document, even in complex or cluttered backgrounds, producing a clean and usable scan. This output is ideal for applications like digitizing receipts, notes, or other printed materials. The enhanced quality of the final document scan demonstrates the system's effectiveness, particularly with higher-resolution cameras like the 720p camera, making it suitable for real-time document scanning applications.

Accuracy refers to the percentage of correct document detections and extractions by the system. It measures how closely the scanned output matches the actual document, indicating the system's effectiveness in capturing important details. Fig.3 represents the accuracy of using 240p,740p cameras with document scanner application. The system's accuracy was measured by comparing the extracted document's alignment and clarity against the original. A 720p camera was used to capture input images, ensuring high-quality document scanning. By combining all these techniques, the system creates clear, distortion-free digital versions of physical documents. It's fast, reliable, and removes the hassle of manual scanning. This automated process saves time and makes digitizing documents much easier.

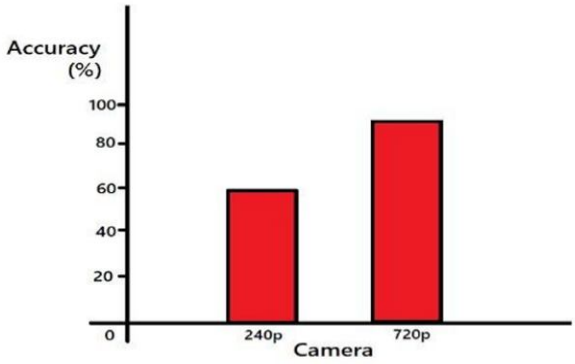

Fig. 3. Accuracy Comparison of using 240p and 720p cameras for document scanner application.

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This document scanner can be useful in various places like offices, schools, or even at home. It's a step toward making life more convenient while also promoting a paperless, eco-friendly way of working. By turning bulky physical papers into neat digital files, this system shows how technology can simplify everyday tasks.

VI. CONCLUSION AND FUTURE SCOPE

In this paper, we built an application that scans the documents using camera. We primarily used python 3 with opencv library for faster image processing tasks. By using image processing techniques such as image Resizing, Grayscale conversion, Gaussian blur, Canny edge detection, and Perspective transformation, the system accurately scans and processes documents. The result is a clear, top-down view of the document with improved readability. We compared the results with two different cameras such as 240p and 720p cameras. The enhanced quality of the final document scan demonstrates the system's effectiveness, particularly with higher-resolution cameras like the 720p camera, making it suitable for real-time document scanning applications.

The future improvements could focus on a more user-friendly interface, advanced machine learning algorithms for better document detection, multi-page scanning, and cloud integration. Developing a mobile version could also enhance accessibility, addressing the growing need for mobile document scanning.

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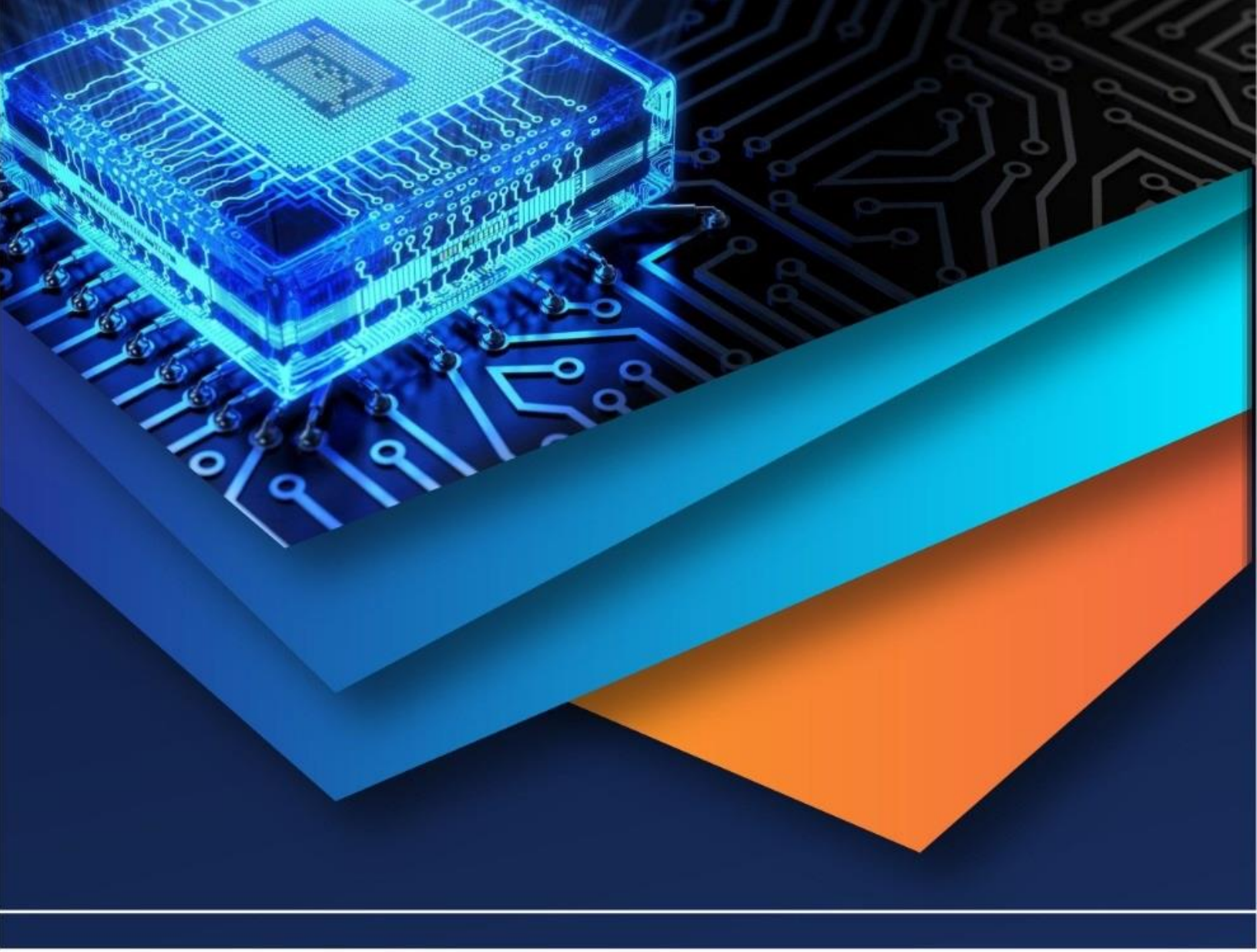

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