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Analysis of Image Improvement and Edge Identification Methods in Watermelon Image

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ABSTRACT

The initial stage in digital image processing, known as pre-processing, plays a vital role in enhancing image quality. This essential step involves employing various techniques to prepare the image for subsequent analysis and feature extraction. Among the array of pre-processing methodologies utilized, thresholding, median averaging, median filtering, rapid Fourier transform, point operations, intensity modification, and histogram equalization stand out as prominent tools. These techniques are employed to mitigate noise, enhance contrast, and optimize the overall visual quality of the image. Once the pre-processing phase is complete, the focus often shifts to specific tasks, such as identifying objects or features within the image. In the context of analyzing watermelon images, one such task is the detection of watermelon seeds. To accomplish this, the pre-processed image undergoes further refinement through the application of edge detection techniques. Gradient edge detection, isotropic, Canny, and Sobel edge detection are among the methods commonly employed for this purpose. These techniques aim to highlight the edges and contours of objects within the image, facilitating the identification of distinct features such as watermelon seeds. However, our investigation reveals that not all edge detection methods are equally effective in this context. By employing a combination of pre-processing techniques and judiciously selecting edge detection methods, researchers can enhance the accuracy and reliability of their image processing workflows, ultimately advancing our understanding of complex biological structures such as watermelon seeds.

1. INTRODUCTION

First, the first step in image processing is to improve image quality [1]. This means performing a series of techniques and algorithms to improve clarity, sharpness, and detail in digital images. By improving image quality, we can ensure that the information contained in the image can be better interpreted by the human eye [2]. This is important because there are many applications where image processing is used, from pattern recognition to medical processing and satellite image processing [3].

The goal of improving image quality is to make it easier to understand by the human eye. This means not only improving sharpness and clarity, but also considering the psychological aspects of human visual perception [4]. By doing this, we can ensure that the information conveyed by images, whether in a medical, scientific, or commercial context, is understood quickly and accurately by the end user. So, through careful image processing steps, we not only improve its visual quality, but also ensure that the message contained therein can be well received by human viewers. Thus, image processing is not just about technicalities, but also about understanding how humans process visual information.

There are several image processing techniques that can be used to take steps to improve image quality, as mentioned in the literature. One of them is intensity adjustment [5], which involves adjusting brightness and contrast levels to optimize image visualization. Histogram equalization, a method used to equalize the histogram distribution of an image, effectively improves image contrast and clarity by correcting uneven lighting. Contrast stretching [6] is another technique that extends the range of brightness and contrast in an image, giving the image a more dynamic appearance. Furthermore, the Multiscale Retinex technique aims to improve clarity and color in images by considering the effects of locally uneven lighting. Median filter, which is a type of non-linear filter, is used to reduce noise in an image by preserving the edges of the image. Edge detection is a key step in image processing, which allows identifying the edges of objects in images [7].

It is important to note that these pre-processing techniques can be modified according to the type of research object and image processing techniques to be used. For example, in the context of medical image processing, these techniques may be adapted to deal with specific noise in MRI or CT scan images. Likewise, in satellite image processing, these techniques can be adapted to handle lighting variations and different atmospheric conditions. By understanding and mastering various pre-processing techniques, researchers can select and apply the strategies that best suit their goals, whether it is to improve visualization, reduce noise, or highlight certain features in an image. This is an important step in ensuring that the information contained in the images can be analyzed accurately and efficiently according to specific research needs [8].

An image is a two-dimensional depiction of an object from the visual world that combines knowledge from various fields, such as engineering, astronomy, human vision, and art [9]. A subfield of informatics known as "digital image processing" examines how images are created, modified, and interpreted to provide data that can be read by computers or humans [10]. The first step in digital image processing that tries to improve image quality is called pre-processing. Pre-processing techniques include thresholding, median filtering, median averaging, fast four transformation, point operation, intensity correction, and histogram equalization [11]. To enhance the watermelon image, the pre-processed image then processed once again using gradient, isotropic, canny, and Sobel edge detection techniques. Based on the results of the edge detection carried out, the canny operation is least suitable for finding watermelon images. To determine the optimal way to improve image quality and correctly identify watermelon photos, this research compares various edge detection and pre-processing techniques on watermelon images.

2. RELATED WORK

The initial study conducted by [12] focused on exploring the efficacy of dilated morphology in the creation of batik motifs. The findings of this research demonstrated that employing dilated morphology techniques resulted in the production of ten batik motifs with exceptional precision, showcasing the skillful.

Other study [13] developed into Edge Detection within Digital Image Processing, aimed at identifying the most effective method for enhancing image quality. The research involved comprehensive comparisons of various edge detection techniques, including Gradient, Kompas, Prewitt, Sobel, Robert, and Canny. Moreover, the absence of a conclusive determination on the optimal method in the study leaves a notable gap in understanding the comparative efficacy of the various techniques explored. The lack of a comprehensive comparison of the final outcomes generated by each employed technique further complicates the assessment of their respective strengths and weaknesses. Without a clear indication of which method yields the most favorable results in terms of image enhancement, researchers and practitioners are left with uncertainty regarding the most effective approach to adopt in their specific contexts.

In this study [14], the researchers delve into the application of the histogram equalization method to enhance image quality, shedding light on its effectiveness in achieving clearer and more visually appealing images. By employing histogram equalization, a technique that redistributes pixel intensities to maximize the overall contrast of an image, significant improvements in clarity and detail are observed. This method works by adjusting the histogram of the image to spread out pixel values evenly across the entire range, thereby enhancing the visibility of features and details that may have been previously obscured or overshadowed by uneven lighting or poor contrast.

The highlights significance of image enhancement in image analysis [15], emphasizing its role in refining image quality for specific purposes. It acknowledges the multitude of enhancement techniques developed over time to meet diverse needs, with a focus on improving outcomes while minimizing computational and memory resources. The study focuses on Histogram Equalization (HE) as a method for image enhancement, providing a thorough review of existing research and suggesting directions for future advancements. It recognizes the unique advantages and limitations of each method, offering valuable insights for researchers aiming to innovate in this field. Ultimately, the study serves as a guiding resource for the development of advanced enhancement techniques in the future [16].

3. METHODOLOGY

The research approach in this study begins with the selection of digital images with a series of tests carried out during the subsequent pre-processing phase. After the pre-processing step, edge detection techniques are used. The whitefly image has been chosen as the main research subject, as seen in Figure 1. In the pre-processing stage, several methods are applied, such as point operation, intensity adjustment, histogram equalization, thresholding, neighbor averaging, median filtering, and Fourier transform fast. Sobel, isotropic, gradient, and Canny approaches are then used in the edge detection process to combine the results of these pre-processing steps.

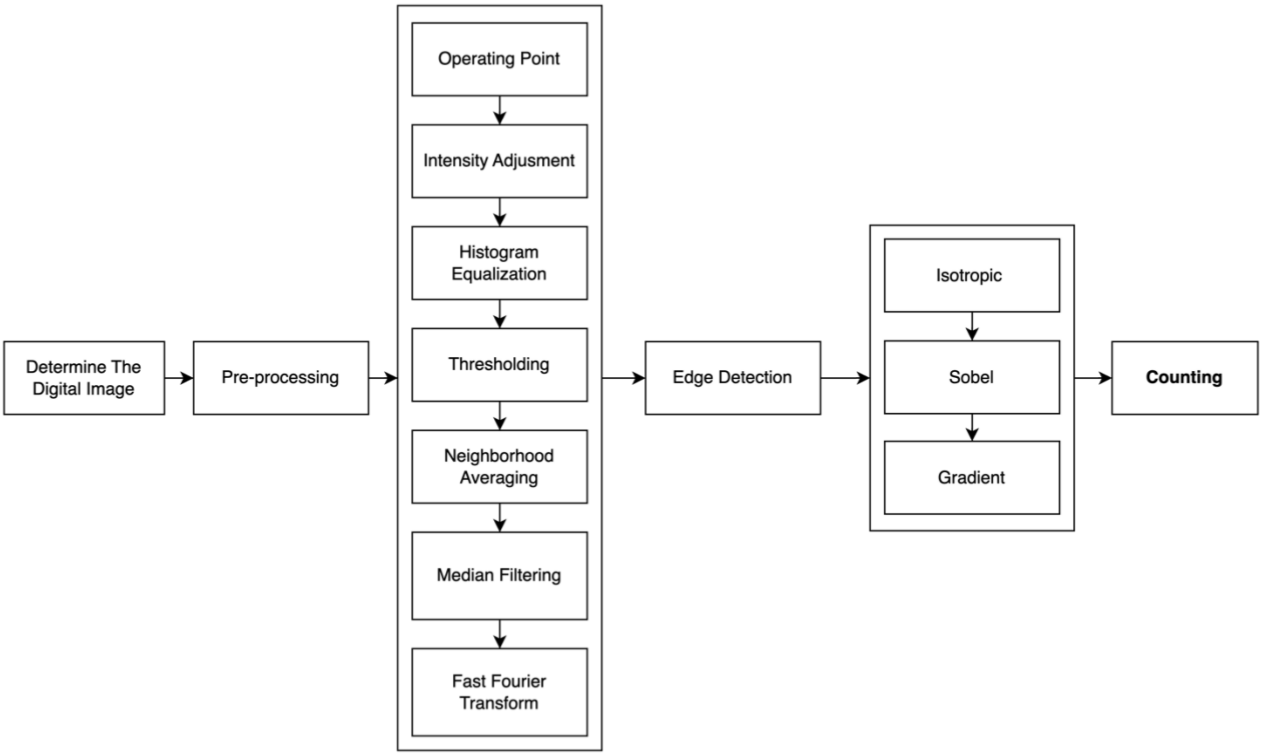


FIGURE 1. RESEARCH METHODOLOGY

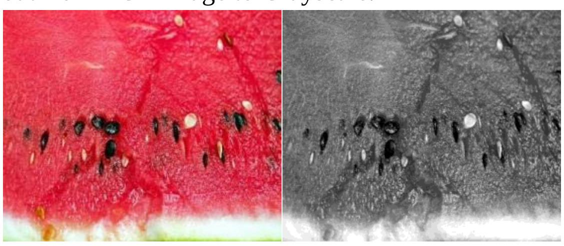
4. RESULT AND DISCUSSION

This stage focuses on techniques that can be applied to improve image quality digital of whitefly found on leaves. By applying image quality improvement techniques, the goal is to determine the most effective method for improving image quality. The experiments were carried out by applying various image enhancement methods using software. It should be noted that only grayscale images are used in this experiment.

A. Pre-processing Stages

1. Point Operations

This operation is carried out by adjusting the histogram of the initial image, the aim of which is to change the image characteristics according to the desired ones. For image b, conversion was carried out from RGB image to Grayscale.



(a) (b)

FIGURE 2. POINT OPERATION RESULTS

2. Intensity Adjustment

Figure 3 presents the watermelon image transformed into grayscale format following a series of meticulous adjustments. The journey from the original input image, denoted as image a, to the finely tailored image c, showcases the evolution of the visual narrative. Each adjustment, meticulously crafted, serves as a testament to the intricate process of refining and enhancing visual content. In image c, the culmination of these adjustments is vividly evident, encapsulating a harmonious blend of contrasts and tones that breathe new life into the composition. Through this transformative journey, the essence of the watermelon image is distilled into a captivating grayscale portrayal, inviting viewers to delve deeper.

(a) (b)

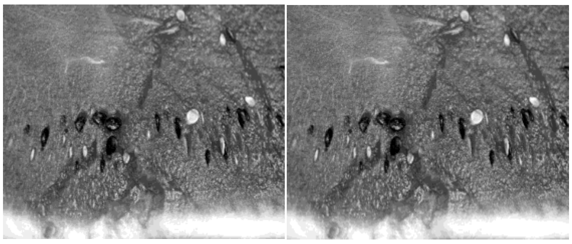


FIGURE 3. GRAYSCALE WATERMELON IMAGE RESULT OF INTENSITY ADJUSTMENT

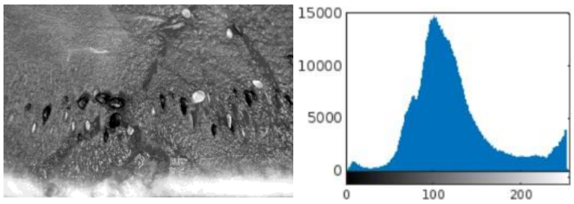
Watermelon Image Result of AdjustmentImage 4a represents the pristine original input image captured in vibrant RGB format, embodying the raw essence of the visual subject. In contrast, image 4b stands as a testament to the transformative power of meticulous adjustments within the same RGB format.

(a) (b)

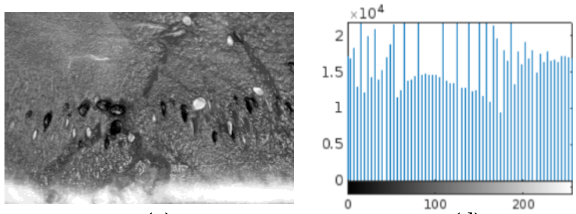
FIGURE 3. WATERMELON IMAGE RESULT OF ADJUSTMENT

3. Histogram Equalization

In image processing, histogram equalization is a frequently used approach. This technique aims to show the distribution of pixel intensity values in the form of an image histogram. The results are interpreted as a statistical probability distribution of each gray level in the digital image. To produce an output image with a more even histogram distribution, one improvement strategy is the histogram equalization technique. Figure 5b shows a histogram of watermelon, while Figure 5a shows a grayscale image of watermelon. Next, image 5c displays an image that has undergone smoothing and image 5d displays the histogram of the smoothing process.



(a) (b)

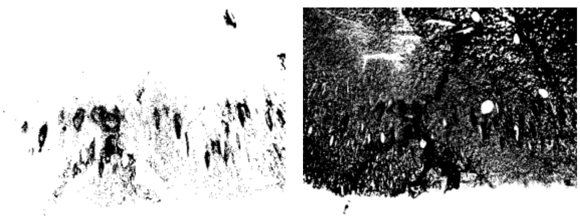


(c) (d)

FIGURE 3. WATERMELON IMAGE RESULTING FROM HISTOGRAM EQUALIZATION

4. Thresholding

Using this method, pixels are divided based on the amount of gray they contain. Pixels whose gray degree is more than the specified limit will be given a value of 1, while pixels whose gray degree is less than the specified limit value will be given a value of 0. The image generated with a threshold of 0.3 is shown in Figure 6a, and the image generated with a threshold of 0.6 is shown in Figure 6b.

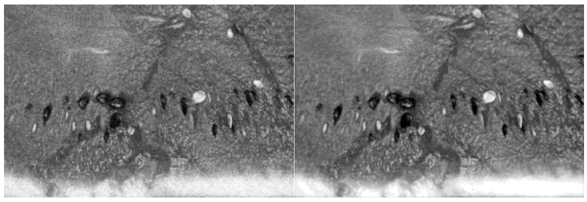


(a) (b)

FIGURE 3. WATERMELON IMAGE RESULTING FROM THRESHOLDING

5. Neighborhood Averaging

A low-pass filter known as neighborhood average is used in this process, and it works by utilizing the average value of a pixel and its neighbors to change the pixel values in the original image. Images with a low-pass filter may appear less detailed and blurry.

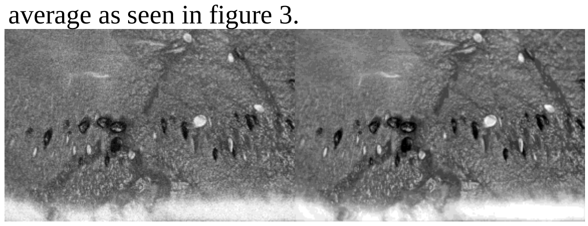


(a) (b)

FIGURE 5. WATERMELON IMAGE RESULTING FROM NEIGHBORHOOD AVERAGING

6. Media Filtering

A kind of low-pass filter, the median filter is less sensitive to intensity variations than the neighborhood average as seen in figure 3.

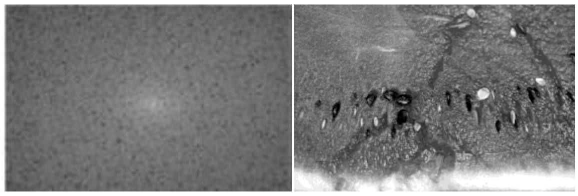


(a) (b)

FIGURE 5. WATERMELON IMAGE RESULTING WITH MEDIA FILTERING

7. Fast Fourier Transform

Quick Fourier One of the popular transformation methods is the transformation. The transformation process is used to increase the domain's ability to return an image to the spatial domain. One operation that can be applied in the frequency domain is the high pass filter operation, as seen in Figure 9a which is the input image. Meanwhile, the image that has been returned to the spatial domain is shown in Figure 9b.



(a) (b)

FIGURE 5. WATERMELON IMAGE RESULTING WITH FAST FOURIER TRANSFORM

B. Edge Detection Approach

To evaluate and compare the best operations in improving watermelon images, tests were carried out with detection approaches using the sobel, isotropic, canny, and gradient methods.

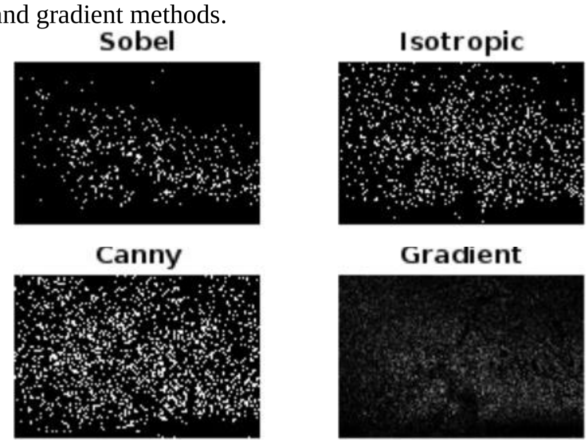


FIGURE 3. WATERMELON IMAGE WITH EDGE DETECTION

Figure 10 shows how the edge detection method is used for each action performed during the pre-processing stage. Figure 10 provides documentation of the image processing results of the edge detection method. From the image we can see that the canny operation produces an image that depicts a watermelon with poor quality.

5. Conclusions

Despite its initial promise, the Canny procedure's effectiveness in accurately identifying watermelon patterns diminished significantly following the pre-processing stage. The resultant image displayed a disconcerting ambiguity in its portrayal of watermelon features, failing to deliver the desired clarity and precision. However, when juxtaposed with more sophisticated methodologies, such as smart approaches, the limitations of the Canny procedure become starkly apparent. Edge detection techniques employing Sobel, isotropic, and gradient algorithms showcased superior performance, yielding image results that far surpassed the Canny method in terms of accuracy and detail. Through their nuanced understanding of image gradients and intensity variations, these advanced approaches excelled in delineating the intricate contours and defining characteristics of watermelon specimens. Consequently, in the pursuit of refined image analysis and precise object detection, the adoption of sophisticated edge detection algorithms emerges as an indispensable tool, empowering researchers, and practitioners to unlock new realms of insight and understanding within the domain of visual data processing.

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