JOURNAL PUNJAB ACADEMY OF SCIENCES (Peer Reviewed Open Access Journal)
JPAS, 24: 45-52 (January-December 2024)
Available online at www.jpas.in
ISSN 2229-7014 (P)

ENHANCED IMAGE PREPROCESSING FOR AUTOMATED MAIZE GRAIN VARIETY IDENTIFICATION

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ABSTRACT
Image identification is based on identifying the basics of geometry and shapes of the objects. The implementation of computer technology for identifying agricultural products based on their visual characteristics has been increasing popularity in the last few years. Methods for image processing based on product visual characteristics are used in a variety of fields for identification and analysis purposes.For the development of hybrid model for automated identification of maize grain varieties, several processes involved including image preprocessing, segmentation, feature extraction and identification. This paper is about the preprocessing of maize grain images after capturing images. Image preprocessing was necessary to resize images, augment images, gray-scale conversion and eliminate the noise from images in order to obtain more accurate feature information.

KEYWORDS: Maize Grain, Identification, Preprocessing, Filters.

INTRODUCTION
The methods of image processing are employed to detect and analyse data in a variety of fields. In the agriculture industry, income and quality of product are especially important for farmers.

Expert advice is usually laborious and susceptible to human error because it is sometimes not possible to connect with the person having expertise. Such issues are being addressed by the development of image processing methods as well as analysis and classification systems. These created solutions can replace professional guidance because they offer good results (Golcuk and Yasar, 2023). The use of computer technology to evaluate agricultural products based on their visual characteristics has gained popularity in the last few years. Image processing methods (IPTs) can be used to identify products based on their visual characteristics (Kayabasi et al., 2017).To identify the grains or objects based on images captured using digital cameras, several operations have to be performed. Raw data does not provide good accuracy when applied to identification algorithms. In order to obtain the current state of any dataset, methods for pre-processing are critical (Pal and Sudeep, 2016).

Image processing methods are used for quick grain detection. To accomplish this task, two main processes are present. First, one must distinguish the object from its surroundings; second, one must overcome the challenge of separating adjacent grains. A common strategy for the initial phase is to select just one colour plate to be the background, followed by rapidly and easily isolate an object from the background using an accurate colour separation method (Wei et al., 2020). Identification of the basic shapes and geometry of the objects around us forms the basis of image classification. Modern image identification algorithms are more accurate and faster than ever, and they are applicable to a variety of operations, such as security features, face recognition for authorization and authentication, traffic identification, and medical diagnostics, among other things. Different methods can be used to solve the problem of image identification. But among all of them, machine learning algorithms are the most effective (Jogin et al., 2018). The process of identifying images is complicated and dependent on many variables. To accurately identify the features that are present in an image is the main objective of image identification. Kaur & Singh (2012) presented an enhancement of night images. Singh & Sran (2012) discussed the noise filters to improve the quality of images. Image identification is done using both supervised and unsupervised techniques (Nath et al., 2014).

The basic outline of the paper is as follows. Section 1 introduces the importance of preprocessing images for the development of identification model, while Section 2 describes preprocessing techniques and presents comparative analysis of discussed techniques. Section 3 presents the proposed preprocessing method for maize grain identification model, while Section 4 includes the report's conclusion and references.

PREPROCESSING METHODS

Images captured using the digital camera for various investigations are cropped, resized and converted to grayscale (Maheshan and Prasanna Kumar., 2020). As many random and redundant pieces of information were available along the image data that the computer collected during the picture capturing process. Thus the quality of image generation is impacted by noise produced by surroundings or equipment during the transmission of image information data (Zhu et al., 2023). A variety of preprocessing methods of filtering are used to optimize the image for restoration and lessen noise (Maheshan and Prasanna Kumar, 2020).

Prior to acquiring the feature data, image pre-processing was carried out to ensure that the acquired region was clear and valuable. For the purpose of obtaining more precise feature information, image preprocessing was required (Zhu et al., 2023). The process of pre-processing involves preparing data for filters, noise reduction or contrast enhancement (Ghatkamble, 2016). Morphological processing, image enhancement, image segmentation and binarization were all included in the image preprocessing (Zhu et al., 2023). Image filtering was a part of image enhancement process which have gained a lot of popularity as solutions for edge enhancement, highlight contours, sharpen contrast and noise reduction (Ghatkamble, 2016). An essential stage in image processing for picture analysis is image de-noising. De-noising methods include two distinct types: non-linear and linear (Verma and Ali, 2013). The nonlinear linear filter has a threshold and the linear filter has a convolution representation in a matrix (Hemalatha and Sumathi, 2016). Even though non-linear methods retain more image detail than linear methods do. Linear filters provide the most popular, straightforward and quick type of filtering (Verma and Ali, 2013). There are numerous techniques for improving images, including Gaussian, mean and median filtering (Zhu et al., 2023). Techniques for image preprocessing and filtering:

Mean or Average Filter

The term "mean filter" refers to an average linear filter (Verma and Ali, 2013). It is an easy to understand, instinctual, and basic technique to use for improving an image (Maheshan and Prasanna Kumar, 2020). The filter computes the average value of the distorted image within an area that has been selected. The average value is then used instead of the intensity value of the center pixel. This procedure is repeated for each pixel in the image (Verma and Ali, 2013). It is frequently used to blur and smooth out images, or to reduce image noise (Maheshan and Prasanna Kumar, 2020).The mean value of every pixel in a neighborhood can be greatly impacted by a single, highly unrepresentative pixel. Edge preservation is poor for the Mean Filter (Singh and Shree, 2016).

Median filter

Median filtering is a nonlinear statistical approach used to eliminate noise from images. The median filter handles both of the issues that emerge with the mean filter (Singh and Shree, 2016). The essential data of image is preserved, and the original pixel's grey value is replaced with the neighborhood's median of grey values. This filter reduces noise in a picture without causing edge blur. To find the median, first sort the neighborhood window's entire pixel values numerically, then replace each pixel that is taken into consideration with the middle (median) pixel value (Maheshan and Prasanna Kumar, 2020).

Adaptive median filter

The Adaptive Median Filter (AMF) reduces noise using different window sizes. AMF works effectively at medium and low noise densities. When the noise density is high, the image becomes obscured. Increased window size can obscure the picture (Seethalakshmi and Hemachitra, 2020).

Gabor filter

To enhance edges, a linear filter known as a gabor filter is applied. Using the local spatial frequency distribution as a band pass filter, it provides the highest resolution in both the frequency and spatial domains. The gabor filter is similar to the human visual system in terms of frequency and direction (Hemalatha and Sumathi, 2016).

Wiener-filter
The Wiener filter method uses statistics to remove noise from each pixel in an image. A superior transaction is implemented between noise smoothing and inverse filtering.
In the noise smoothing process, it is the most effective filter for lowering the total mean square error. Through the application of an MSE constraint between the estimated and original image, the approach aims to create an image. Wiener filters sometimes fall short in restoring frequency components that have been warped by noise when frequencies are being analysed (Maheshan and Prasanna Kumar, 2020).

Gaussian filter
Both MRI and digital pictures can usually show speckle noise, a frequent kind of noise that can be induced by internal or external sources. A Gaussian filter is used to eliminate speckle noise from brain pictures obtained by MRI or ultrasonography. With this technique, the average value of the adjacent or surrounding pixels is used to replace the noisy pixel in the image, which is based on a Gaussian distribution (Kumar and Nachamai, 2017).

Inverse filter
This is beneficial in getting rid of blurring. Inverse filtering is the deconvolution restoration technique. In other words, when an image is blurred using a recognised low pass filter, it can be recovered using inverse filtering or generalised inverse filtering. Still, additive noise greatly affects inverse filtering. By following the approach of lowering one deterioration at a time, it is possible to develop a restoration algorithm for each type of degradation and then simply merge them. Wiener filtering is the best way to balance the trade-off between inverse filtering and noise smoothing. At the same time, the blurring is reversed and the additive noise is removed (Singh and Shree, 2016).

Image normalization
The data set includes images of different sizes. To obtain better results, image sizes should be normalized (Gebeyehu and Shibeshi, 2024).

Binarization
Binarization was applied in the preprocessing of images, because the colour camera-generated images comprised colour, brightness, saturation, and other information that was not required to acquire the precise region (Zhu et al., 2023). It converts grayscale to binary. The output image assigns the value 1 (white) to pixels with a luminance greater than level, and 0 (black) to all other pixels (Ghatkamble, 2016).

Morphological operations
Morphological techniques analyze images using a small “structuring element” template. The elements are evenly distributed throughout the image and compared to pixel neighborhoods. The two processes of morphology are "dilation and erosion." Erosion reduces the size of the ROI and removes minor features from pictures. Dilation expands shapes in the input image (Jeyavathana et al., 2016).

Histogram equalization
This is a enhancement of Contrast technique. A histogram is a type of graphic that shows how data distribution is visualized. The Image Histogram serves as a graphical depiction of the distribution of colors or lightness in digital images. The histogram depicts the relative frequency with which different grey levels appear in the image. There are four different types of histograms: equalized image, low contrast, bright, and dark. The benefit of the histogram is its spatial domain processing methods; its multiplication is applied to improve images, it offers effective image statistics, and it excels in image compression and segmentation (Hemalatha and Sumathi, 2016).

Table 1. Comparative Analysis of Preprocessing Techniques

Author name	Technique used	Advantages	Disadvantages
Singh and Shree(2016)	Mean Filter/ Average Filter	Simple technique and easy-to-use filter to eliminate noise from photos. It is also an intuitive technique.	The mean value of every pixel in a neighborhood can be greatly impacted by a single, highly unrepresentative pixel. Edge preservation is poor for the Mean Filter.
Hemalatha and Sumathi (2016), Jeyavathana et al.(2016)	Gabor Filter	A linear filter called a gabor filter is employed to improve edges. By acting as a band pass filter for the local spatial frequency distribution, it achieves the highest spatial and frequency resolution possible.	The frequency domain and time domain descriptions of a signal are inversely related. Also indicating a boundary condition issue.
Kanagalakshm and Chandra(2011), Singh and Shree(2016)	Median Filter	Preserve the input image's fine details, sharpness and thin line edges. In terms of eliminating noise from an image, such as salt and pepper noise, it works better. It takes less time to calculate.	The edges are slightly blurred.
Jeyavathana et al. (2016)	Image Normalization	Endorsements sizes and normalized locations coordinate with those in the dataset.	Time-consuming method. Poor normalization reduces the quality of the images.
Hemalatha and Sumathi (2016), Jeyavathana et al.(2016)	Histogram equalization	In image preprocessing, histogram equalisation is used to enhance contrast levels.	This method fails when gray values are physically separated in an image.
Kanagalakshm and Chandra(2011)	Adaptive Wiener Filter	Comparing it with other linear filtering methods, the results are better. It can keep edges and other high-frequency image components intact.	Compared to other methods, takes more time to calculate.
Jeyavathana et al. (2016)	Weighted Median Filter	Effectively eliminates noise.	Mapping the texture area and rounded the edges to produce an identical shade.

METHODOLOGY

To capture the images in uniform lighting condition and controlled environment, a special image box is prepared using thermocol. The environment is set to enhance data collection, with a simple plain background. Two LED lights of 6 watt are used within box to provide proper light. To prevent distractions and make sure the attention is focused on the maize grains, we choose a simple, non-reflective, gray background that is neutral in color. The image acquisition system consisted of a color digital camera (Canon EOS 80D) mounted on an adjustable stand was used for image capturing.

The proposed system preprocesses the maize grain images from dataset using various preprocessing techniques mentioned in the figure below. Figure 1 depicts the steps and flow of the preprocessing phase.

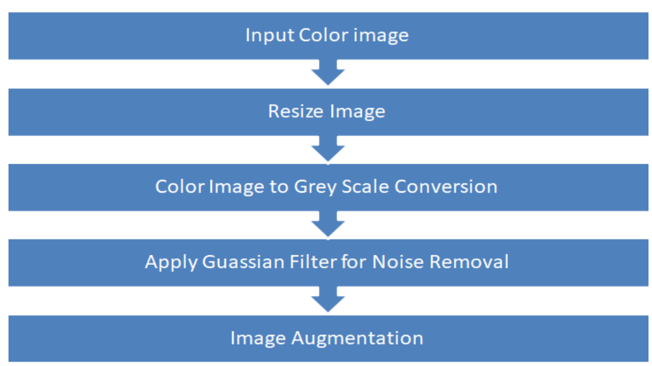
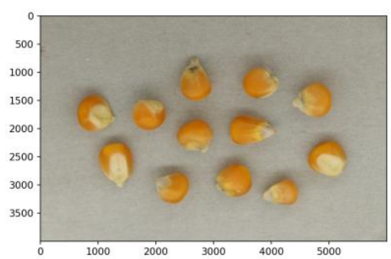
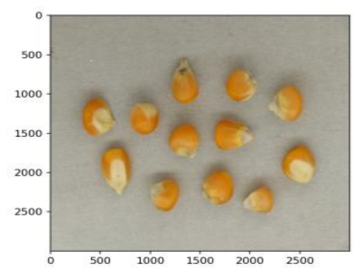
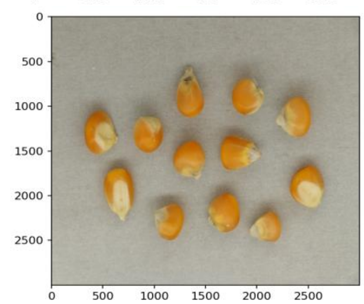
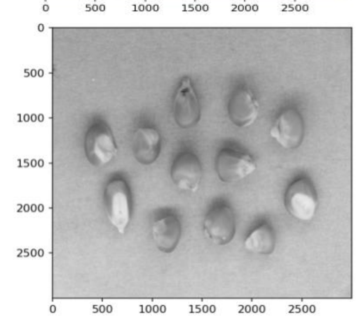
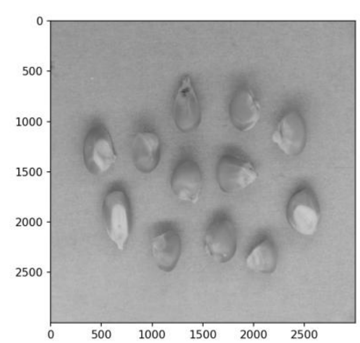
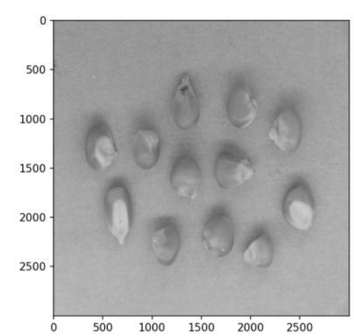
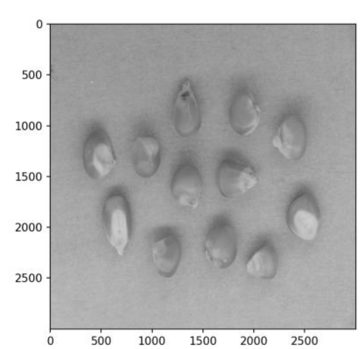
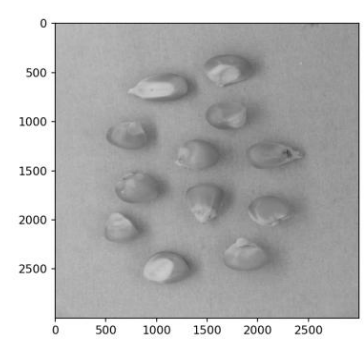
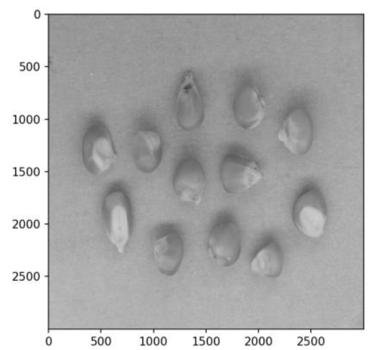
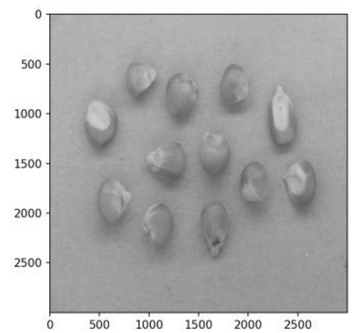
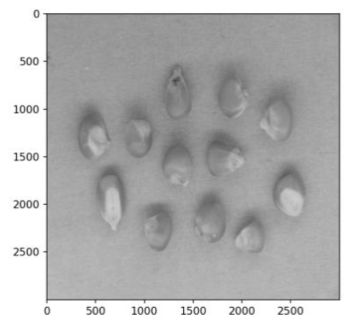
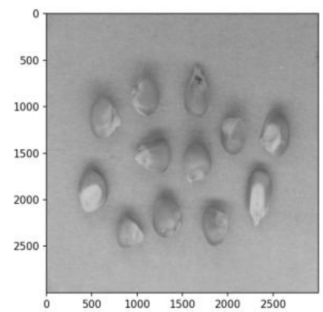
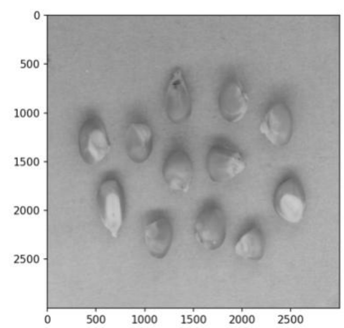
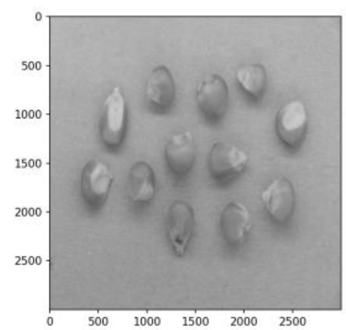
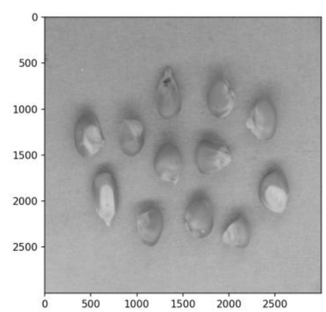
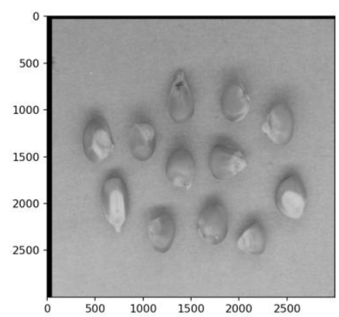


Figure 1. Image Preprocessing Steps

As shown below in Table 2, randomly 12 numbers of seeds are placed on the grey background with the kernels not touching each other to capture images. Original size of captured image is 6000*4000. First operation of proposed preprocessing technique is resizing images into a 3000*3000 consistent size rather than variable size of captured images, so that further operations applied on same size images. Second preprocessing operation is converting color image into grayscale image having shades of intensity that helps to reduce the processing time and calculating several features. Third preprocessing operation is denoising grayscale image that is one of the major challenges in image processing. Denoising eliminates image noise so that the original image can be assessed. For this investigation, the greyscale input images are denoised using a Gaussian filter. Further operations are applied for the purpose of data augmentation including 90 degree and 180 degree rotation, horizontal and vertical flipping and translation because small datasets may not always be sufficient for the deep model to train effectively. This issue can be resolved with the help of the data augmentation technique.   .

Table 2. Results of the operations applied on images

Operations	**Original Image**	**Resultant Image**
Resize image		
Grayscale image		
Denoised image		
90 degree rotated image		

180 degree rotated image		
Horizontally flipped image		
Vertically flipped image		
Translated image		

INVESTIGATION AND ANALYSIS

By using sophisticated preprocessing techniques the study "Enhanced Image Preprocessing for Automated Maize Grain Variety Identification" aims to increase the precision of maize grain classification. High-resolution images are captured under controlled conditions is the initial stage in the investigation. Next, improved preprocessing techniques including resizing images, gray scale conversion, noise reduction and data augmentation are applied. The purpose of these techniques is to segregate and emphasize key features of maize grains, such as their size, texture, shape, and color distribution.

The study shows that these improvements result in a substantial gain in classification accuracy by greatly improving the clarity of differentiating traits compared to conventional techniques. Quantitative measures like accuracy and F1-score confirm the enhanced performance, while qualitative evaluations show increased feature representation and decreased misclassification for visually equivalent types. The findings demonstrate potential uses in business and agriculture, such as automated grain sorting and quality monitoring, even when computing costs marginally increase. It is suggested that future research investigate real-time processing capabilities for broader adoption and integrate blockchain for traceability.

CONCLUSIONS

For image processing, preprocessing of an image is crucial. Preprocessing is used to enhance image quality before to any type of processing. Several methods for image enhancement can be used. This paper analyses various preprocessing approaches. All approaches are effective for different purposes. The table highlights the advantages and disadvantages of each approach. Our paper proposes a preprocessing method to improve image identification and recognition in automatic object detection systems. This method includes converting images into consistent size, gray-scale conversion of resized images and using Gaussian filter, removing noise from gray-scale images. In addition to it, images are augmented using various techniques like translation, flipping and rotation. The preprocessing method enhances the quality of images for further processing for the development of automated maize grain variety identification system.

ACKNOWLEDGEMENT

I sincerely thank supervisors for their invaluable guidance and support throughout this research. Their expertise and encouragement have greatly contributed to the success of this study. Special thanks to my colleagues and friends in the Department of Computer Science and Engineering at Punjabi University, Patiala for their assistance, discussions, and moral support. Their collaboration has been immensely beneficial and has fostered a stimulating research environment.

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