Reduction of Mango Fruit Noisiness through the Use of a Mean Convolution Mass Filter

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Abstract*: Communication is increasingly reliant on the transfer of visual information through digital pictures. The noise is the consequence of picture capture flaws that don't accurately represent the intensity of the real scene. Using this picture as a decision-making tool is a possibility. Use the appropriate algorithm to remove the noise to obtain a high-quality picture. Salt and pepper, Gaussian, and Poisson noise all degrade images, thus it is important to know what kind of noise is present in the picture before attempting to remove it. The "Mean Convolution Mass Filter (MCMF)" method was proposed in the publication. Digital images may be de-noised more effectively with this method compared to other current techniques.

Keywords: MCMF, Noise Removal

I. INTRODUCTION

A country's economy relies heavily on the production of fruits. Fruit yields may be increased if disease incidence can be predicted earlier. Digital images are widely used in a variety of industries, including traffic monitoring, improving geographic information systems, and recognising handwritten data. In the categorization of illnesses and their characteristics in fruits, digital photographs may also be employed. This software's precision, however, is largely dependent on the image's quality. During the collection of a picture, there may be a variety of sorts of noise. Image contrast will be reduced and undesired consequences such as damage to edge features, superfluous lines, and a lack of intuitive understanding may result.

The picture's quality may be improved by reducing the amount of noise in the image. Noise may degrade the picture quality in a variety of ways, including impulse noise, fractal noise, speckle noise, and gaussian noise, amongst others. Researchers have a difficult challenge when it comes to removing the noise from a picture without damaging the rest of the data. It is possible to decrease or eliminate noise using a variety of techniques, but the goal of a de-noising algorithm is to retain the image's edges and quality. As a result, the goal of this research is to reduce noise while keeping edge information by using PSNR values that are substantially larger.

TYPES OF FILTERS

A. Mean Filter

The principle behind mean filtering is to replace every pixel value in a picture with the mean (average) value of everything around it, including the image itself. Mean filtering removes pixel values that are not indicative of their surroundings. It is also known as a convolutional filter or a mean filter. In order to calculate the average, it is based on a kernel, which describes the size and shape of the area to be sampled.

B. Median Filter

Image pixels are dependent on their immediate neighbours, who use the median filter to determine whether or not this pixel is indicative of its surrounds. Instead of using the average of the neighbouring pixels' values to replace the pixel value, this algorithm prefers to use the median value.

C. Gaussian Filter

Usually, pictures are 'blurred' using the convolution operator while noise and detail are removed using the Gaussian smoothing operator. The mean filter's workings are identical here, but the kernel represents a Gaussian hump in the form of a bell. The nomenclature for the Gaussian distribution is as follows:

$$G(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{x^2}{2\sigma^2}}$$

D. Adaptive Filter

This filter works exclusively on images that have been distorted by noise. In this case, it is dependent on the size of the mxn window. The mean and variance are the two statistical measurements used. Edges and high-frequency areas of the picture benefit from this filter, making it superior than other filters.

II. EXISTING METHODS

Cao, Wang, Han, G., Yao, J., and Cichocki, A. (2018) [1] The proposed PCA method for restoring hyper spectral images. They included anisotropic spatial-spectral to strengthen the robustness of this method. Afterwards, they merged the Expectation-Maximization method with a different direction to get an optimum output.

An enhanced median trimmed filter was developed by Lalit Kumar, Jyoti, and Mithlesh (2018) [4]. Ninety percent of the noise was eliminated, and the PSNR value was higher than with any other filter. It was possible to eliminate the salt and pepper sounds by using the right filter. The same and distinct photographs of the same and other formats have been analysed with various levels of noise, ranging from 30% to 70%. Final calculations are made to estimate the efficiency with which salt and pepper noise from the original data has been eliminated. These metrics include the PSNR, MSE, and IEF.. In general, the higher the PSNR number, the better the picture is deemed to be, since PSNR and MSE are inversely related.

In an effort to reduce the disturbance in apples, Chithra, P. L. and Henila (2017) [3] used the middle channel to do so. It distinguishes between pixels with high force esteem and pixels with lower force esteem. The estimate of the focus pixel is made by selecting from a set of characteristics inside m x n neighbouring reference pixels and then comparing the results. This method reestablishes the initial pixel value with the middle value after sorting all properties inside a window. In the presence of Gaussian and motion blur, Sharma, S., Sharma, S., and Mehra, R(2013)[2] proposed the "Modified Lucy Richardson method." Only Gaussian noise was eliminated, and the PSNR value was higher than with previous approaches, and the picture quality was improved.

III. PROPOSED METHODOLOGY

Image Capture, Size Conversion, Color Translation, Noise Removal, and Image Enhancement are all part of the suggested technique. It's all laid out in full in the accompanying diagram (Figure 1)

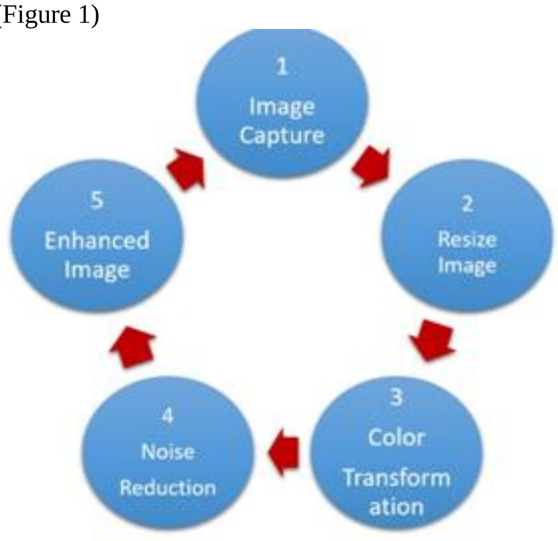

Figure 1 Proposed Method

An RGB-shading camera with 10 mega pixels and 3120 x 4160 pixels captures the mango fruit images as the input information. Images are scaled so that they may fit within an area of 256 pixels by 256 pixels. Now that the image has been enlarged, it must be converted to the HSV shading space.

Luma (Y) is the black portion of the image, and the suggested framework separates it from the rest. The bustle of salt and pepper has been included into the dimmer image. The Mean Convolution Mass Filter is used to remove the noise from this picture (MCMF). The suggested method's calculation is shown in figure 2.

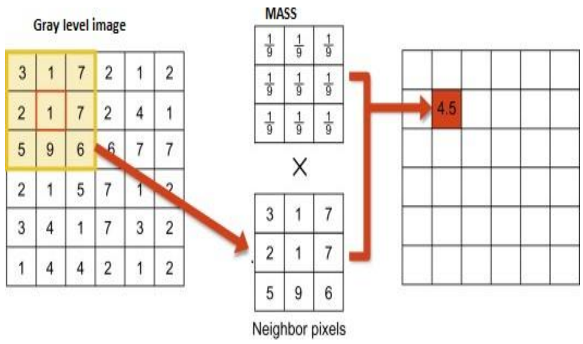

Figure 2 Computation of Proposed filter

This filter computes the mass of neighbouring pixels using a predetermined weight mask that is applied to all pixels in the picture, regardless of their location in the image. The following formula is used to calculate the value of a pixel in image I at coordinates (a, b):

$$I_{new}(a,b) = \sum s = X\ X \sum t = -\ Y\ Y\ K(s\ ,t)\ \ I(a+s, b+t) \quad [1]$$

where I_{new} filtering results in a new picture. According to this generalisation, the mask K is symmetrical along both axes of a two-dimensional picture, and M and N are odd numbers, then $X = (M - 1) / 2$, and $Y = (N - 1) / 2$. Using a 3 ×3 mask as a test, the suggested filter is computed in Figure 2. Due to the separate computation utilising predetermined mass and the only usage of nearby pixels for the calculation, this filter is very quick and effective at the expense of increased access to spatial memory.

IV. RESULTS AND DISCUSSIONS

Five photos are used to demonstrate the effectiveness of the suggested filter. Removes noise and improves picture quality by using the Mean Convolution Mass Filter (MCMF). Removes almost all of the noise in the picture. It retains the image's edge information and reduces processing time. PSNR (Peak Signal to Noise Ratio) and MSE (Mean Signal to Noise Ratio) are two metrics used to quantify picture quality (Mean Square Error). The metrics of our proposed MCMF are compared to those of the current filters in the table below. Figure 3 depicts the original picture used as an input.

Figure 3 Original Input Image

Figure 4 depicts the input image's colour conversion using the HSV model. Y-Luma is a grayscale picture in this model. Unlike the S and V parts, this is distinct. After then, this grey picture is put to use for further in-depth investigation.

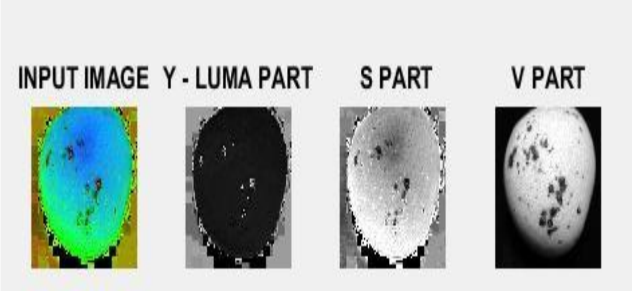

Figure 4. Color conversion using HSV

Figure 5 depicts the final outcome of using MCMF to denoise the input picture. The suggested filter outperforms all other filters tested thus far.

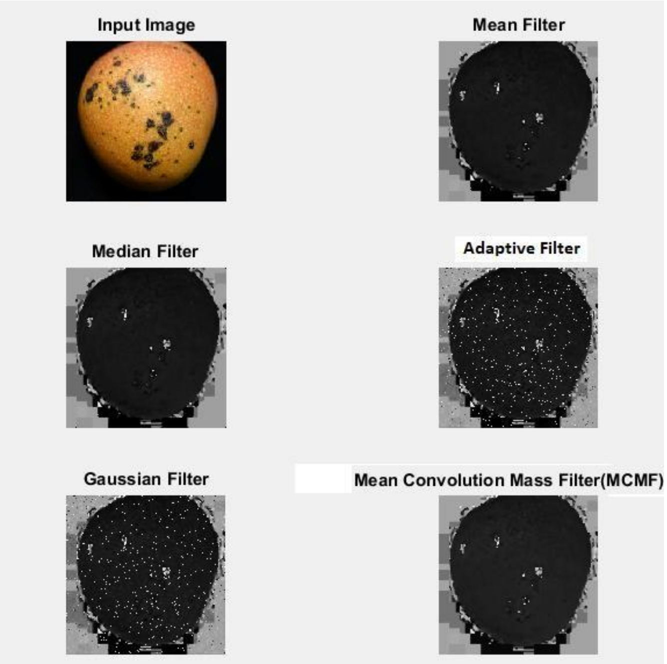

Figure 5. Image De-noising using various filters

The PSNR Value is calculated by using the equation (2).

$$PSNR = 20\log_{10}\frac{255}{RMSE} \qquad [2]$$

RMSE (Root Mean Square Error) is found with the square root of MSE.

$$MSE = \frac{1}{M * N}\sum_{j,k}(f(j,k) - g(j,k))^2$$

$$RMSE = \sqrt{MSE} \qquad [3]$$

Table-1: Comparison of PSNR Values

Image	Mean Filter	Median Filter	Gaussian Filter	Adaptive Filter	MCMF Filter
Mango1.jpg	85.637	74.123	55.715	60.523	**89.276**
Mango2.jpg	84.072	73.724	57.781	61.433	**87.124**
Mango3.jpg	85.228	73.524	58.423	61.453	**90.278**
Mango4.jpg	85.431	73.282	57.378	61.342	**93.682**
Mango5.jpg	84.128	74.421	54.043	61.532	**85.104**

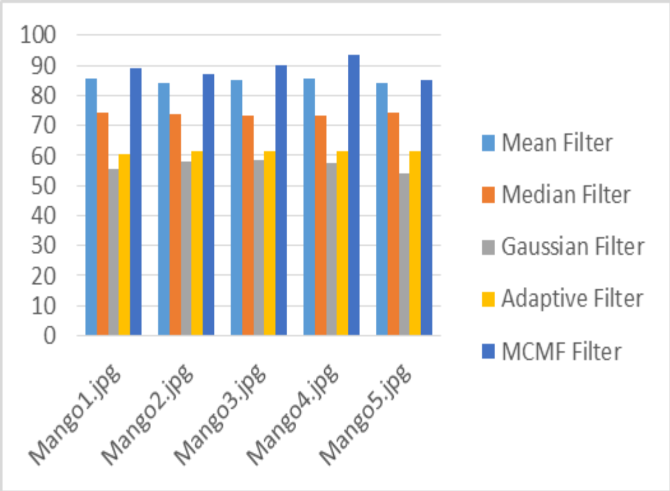

Figure 6. Comparison of PSNR Values

According to Table 1 and Figure 6, the suggested method's PSNR values are compared to those of the following filters: the Mean, Median, Gaussian, and Adaptive (MCMF). Mango1.jpg has a PSNR value of 89.276 and Mango4.jpg has a PSNR value of 93.682, which is the highest among the other fruits studied.

A comparison of Mean, Median, Gaussian and Adaptive filter MSE values is shown in Table 2 and Figure 7. The proposed filter was found to have a lower error rate than any other approach currently in use.

Table-2: Comparison of MSE Values

Image	Mean Filter	Median Filter	Gaussian Filter	Adaptive Filter	MCMF Filter
Mango1.jpg	0.022	0.022	0.210	0.312	**0.0001**
Mango2.jpg	0.021	0.022	0.119	0.231	**0.0001**
Mango3.jpg	0.023	0.022	0.294	0.123	**0.0001**
Mango4.jpg	0.023	0.032	0.219	0.213	**0.0000**
Mango5.jpg	0.023	0.023	0.259	0.321	**0.0002**

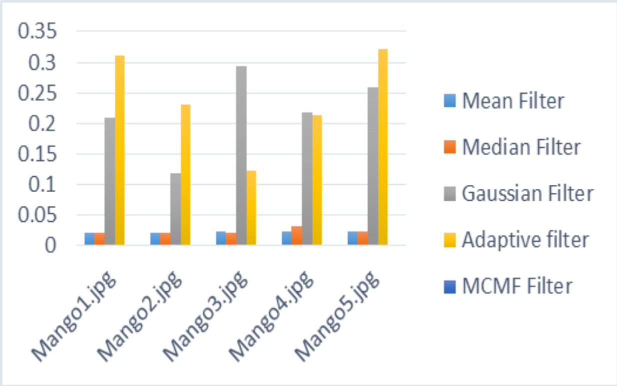

Figure 7. Comparison of MSE Values

VI. CONCLUSION

A novel filter called the "Mean Convolution Mass Filter" (MCMF) was suggested in this study and compared to an existing filter. Different filter types utilised in various studies are described and reviewed in this study. The suggested filter does not distort the picture and keeps the edge information. Results of this experiment reveal a high PSNR of 93% Mean, Gaussian, Median, and Adaptive Filters were shown to be less effective in improving mango photos than the suggested filter. When compared to the other filters, it has the lowest MSE value (0.0001) available. It demonstrates the superiority of image enrichment over other approaches already in use.

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