Greedy Edge Conserve Filtering Algorithm for Digital Image Pre-Processing in Tea leaves Fermentation.

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Abstract
In the world, black Tea is an important beverage. But its manufacturing process includes the number of steps such as Withering, drying, fermentation, rolling and firing. Fermentation is important process to predict the quality. But monitoring color changes in fermentation process by manual is challenging task and also not accurate. Image processing play vital role to predict optimum point of the fermentation. Greedy Edge Conserve filter algorithm has been implemented to remove noise from badly corrupted images and preserve edges. Mean, median, Wiener and adaptive filters are used for noise detection. It shows the basics of image processing, image degradation, and recovery process. The image is distorted and reconstructed with different noise densities. The algorithm is designed to calculate PSNR and MSE.

Keywords: Image Processing, Mean, Median, Fermentation**.**

I.INTRODUCTION

Tea is one of the cheapest and most common aromatic beverages. It is treated from the soft shoots of a tea plant consisting of two or three leaves and open non-apical shoots. Tea is sold all over the world[1]. Tea is located near water and is the second most consumed beverage in the world, with two-thirds of the world's population drinking tea. Tea is located near water and is the second most consumed beverage in the world, with two-thirds of the world's population drinking tea. Tea is located near water and is the second most consumed beverage in the world, with two-thirds of the world's population drinking tea[1]. India is the second largest producer of tea after China. It occupies an important place and plays a very important role in India's national economy[1]. Tea is probably the only industry in which India took the lead 150 years ago. Based on fermentation, tea can be classified as black tea, green tea, white tea, or oolong tea, and black tea is fully fermented or oxidized tea. , Green tea and white tea are neither oxidized nor boiled, and oolong tea is a type of lightly fermented tea[2][3]. The process of making oolong tea is similar to that of black tea, except that the fermentation time is short.

II.TEA MANUFACTURING PROCESS

Black tea is the only tea that is completely oxidized. The process of making black tea varies from country to country and even from region to region[4]. There are four basic
stages in tea production: withering, rolling, fermentation and shooting. The taste and aroma of tea is achieved over time in the fermentation step[5]. Oxidation of polyphenol compounds in tea leaves to theaflavin and its effect on color change and flavor improvement of the arubigin. In the fermentation process, particles are dispersed in a small layer under cold, moist air in the tea leaf process and oxidized for 50-80 minutes[6]. The industry keeps the internal humidity at a constant rate of,and temperature differences are also taken into account when determining the duration of fermentation[7].

The "fermentation process" plays an important role in ensuring the quality and flavor of black tea[8]. The method used by most tea factories to time the end of fermentation is to use the naked eye of a skilled worker[9]. The characteristic of , which is the end point, is the copper-brown color of the tea leaves. However, the color recognition of varies from person to person. As a result, tea leaves may be preserved below beyond fermentation. Another option is to touch and smell the tea leaves, which may not be hygienic[10].

Figure 1. Tea Manufacturing Process

III.TYPES OF FILTERS

Mean Filter:

The mean filter replaces adjacent pixels in the image with the mean of the image pixels. This average contains the pixels to replace. Here, a pixel that does not belong to the similarity of other pixels in the image. The averaging filter is also known as the convolution filter[11].

Median Filter:

The median filter calculates the median of the entire image pixel and replaces the pixel with the median. The median filter examines adjacent pixels to determine if the surrounding pixels belong to a similar image pixel type. In contrast to the average filter, the pixels are replaced with the median. The median of an image is calculated by arranging the entire pixels of the image in numerical order[12].

Wiener Filter:

The Wiener filter is the MSE-optimal stationary linear filter for images degraded by additive noise and blurring. Calculation of the Wiener filter requires the assumption that the signal and noise processes are second-order stationary(in the random process sense)[13].

Adaptive Filter:

Adaptive filters are digital filters whose coefficients change for the purpose of converging the filter to the optimum state. The optimization criterion is the cost function, which is most commonly the mean square of the error signal between the adaptive filter output and the signal of interest[14].

IV DATA COLLECTION

The images collected during the tea fermentation process were the first inputs to start the process. Images are collected using the Canon-650D model with an 18 megapixel camera. The camera's manual mode was used, the ISO was set to 400, the shutter speed was set to 1/250 second and the focal length was set to 36mm. The white balance was set manually. Light boxes are used to capture images to maintain a controlled environment. Figure 2 shows the sample tea leaf images. Since there was no existing standard dataset on tea fermentation images existing in the community, Images are collected from tea manufacturing process at tea factory. Nearly 500 images were collected during the fermentation process.

Figure 2 Sample Images

V.PROPOSED METHODOLOGY

The proposed work explores the possibility of using digital images of tea particles as a tool for monitoring fermentation in the processing of black teas. Copper patina is the predicted color used to measure the degree of fermentation. Therefore, determining the degree of fermentation by visually observing the green color of copper is error-prone and affects the overall product results. After the rolling step, the tea particles in a particular batch are divided into three different groups as Dhool 1-3 based on the particle size. Therefore, the duration of fermentation depends on the number of dolls in a particular batch due to the different sizes of tea particles. The method used in this project is divided into three main phases: image pre-processing, doll number identification, and fermentation degree prediction.

The captured tea image sample contained irrelevant areas. For further analysis of the image, the area required for analysis was extracted from the original image sample. Next, it was reduced to a pixel size of 256 x 256 to reduce processing time. In this

research, MATLAB software was used for image processing. The captured image may contain shaded areas. To remove the shadows in the image, the threshold value is set to 0.11 (white 1, black 0) based on trial and error. This procedure has greatly improved the image quality. The highlighted image consists of three separate matrices: red, green, and blue. These matrices were used in subsequent calculations.

After the noise removal the Brightness, Darkness and Contrast of the image is improved by histogram equalization. Generally, histogram is used to represent the range of intensity for the image. Image has darkness noise when elements are in low intensity scale. When the elements of histogram biased with high scale then image has brightness noise. High contrast noise also spoil the image information. These three noise also deals by histogram equalization.

Greedy Edge Conserve Filter (GEC)

Input: Input Noisy Tealeaf Image

Output: Enhanced De-noised Tealeaf Image

Step 1: *Read the noisy image*

Step 2: *Image resize:Original Image of size 3456 x 2304 is resized to 256 x 256 pixels*

Step3: *Colour Conversion: resized image transformed to HSV colour image and separate the Y luma part from the image*

Step 4: *A two dimensional window (denoted by 3×3 W) of size 3x3 is selected and centered around the processed pixel p(x, y) in the corrupted image.*

Step 5: *Sort the pixels in the selected window according to the ascending order and find the median pixel value denoted by Pmed), maximum pixel value (Pmax) and minimum pixel value (Pmin) of the sorted vector V0. Now the first and last elements of the vector V0 is the Pmin and Pmax respectively and the middle element of the vector is the Pmed.*

Step 6: *If the processed pixel is within the range Pmin < P(x, y) < Pmax , Pmin > 0 and Pmax < 255,it is classified as uncorrupted pixel and it is left unchanged. Otherwise p(x, y)is classified as corrupted pixel.*

Step 7: If p(x, y) is corrupted pixel, then we have the following two cases:

Case 1: If Pmin < Pmed < Pmax and 0 < Pmed < 255, replace the corrupted pixel p(x, y) with Pmed

Case 2: If the condition in case 1 is not satisfied then Pmed is a noisy pixel. In this case compute the difference between each pair of adjacent pixel across the sorted vector V0 and obtain the difference vector VD .Then find the maximum difference in the VD and mark its corresponding pixel in the V0 to the processed pixel.

Step 5: *Step 1 to step 4 are repeated until the processing is completed for the entire image.*

Step 6: *predict the magnitude of the edge and direction of the gradient by Eqn 1,2 and 3*

Magnitude – both direction horizontal ($G_{x)\,and}$ vertical directions ($G_{y)}$

$M = G_x + G_y \rightarrow (1)$

$$G = \sqrt{Gx^2 + Gy^2} \quad \rightarrow (2)$$

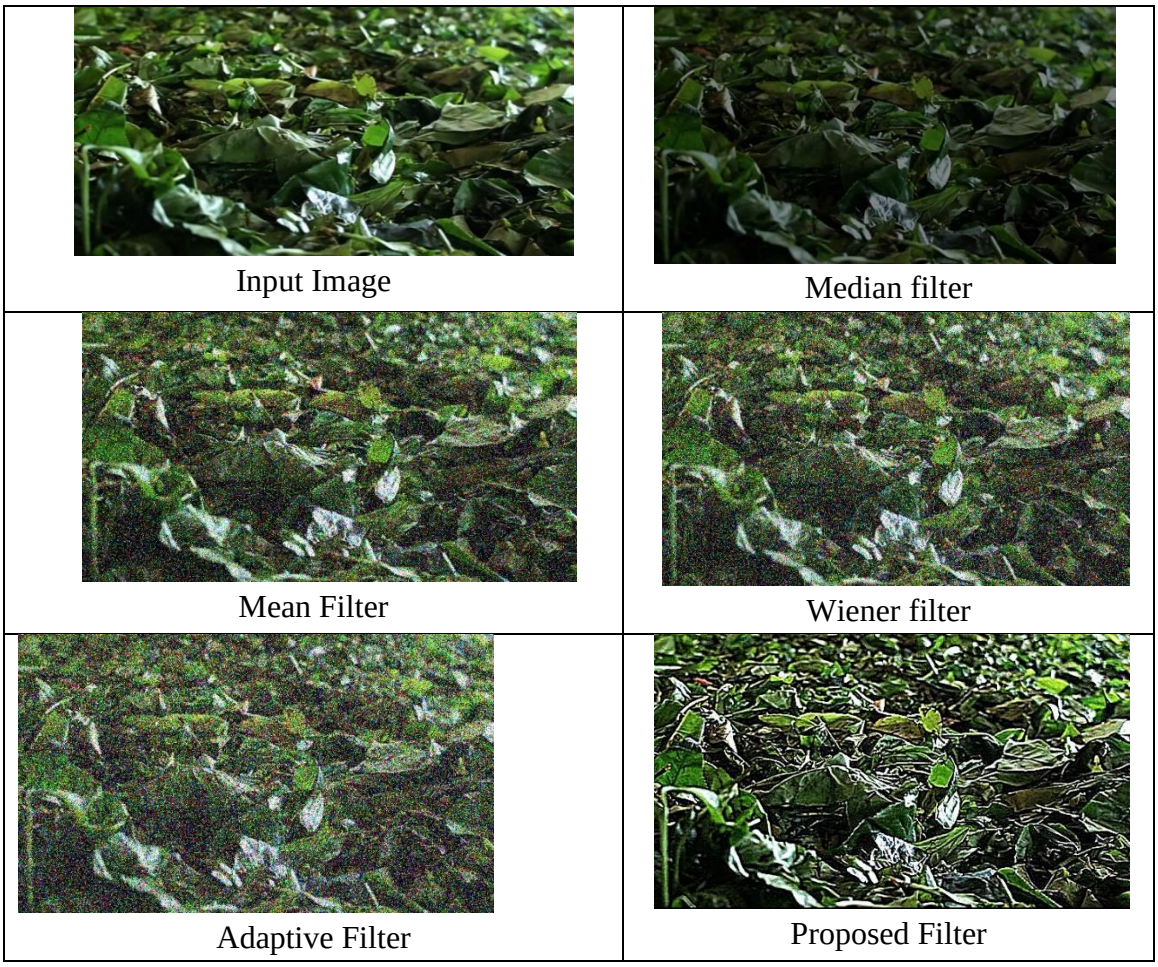
$$direction\ of\ the\ gradient\ \alpha = \tan^{-1}\frac{Gx}{Gy} \rightarrow (3)$$

Step 7: *Hysteresis Thresholding*
if G < th_{low} : discard the edge
if G > th_{hign} : discard the edge

VI RESULT AND DISCUSSION

The performance of the proposed filter was examined by passing tea leaf images as input. The proposed filter removes the noise by retaining the edges of the images. The proposed filter preserves the edges without any loss during the entire process of filter. The performance of the filter is measured using two metrics such as Mean Square Error (MSE) and Peak Signal to Noise (PSNR). The proposed filter is faster in its computational speed. Figure 3 shows the result and comparison of proposed filters.

Figure 3 Result and comparison of proposed filter



The following Table 1 shows the comparison chart of the various filters with their PSNR value for the input tea leaf image. The proposed GEC filter is compared with mean, median wiener filter and adaptive filters. The highest PSNR value for the tea leaf image is given by GEC filter with 98.368 for the TeaLeaf_3.jpg. PSNR value of the image is calculated by the following formula.

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

$$PSNR = 20\log_{10}\frac{255}{RMSE} \longrightarrow (2)$$

RMSE (Root Mean Square Error) is calculated through the square root of MSE.

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

$$RMSE = \sqrt{MSE} \qquad \rightarrow (3)$$

TABLE-1: Comparison of PSNR values

Images	Mean Filter	Median Filter	Wiener filter	Adaptive Filter	Proposed Filter
TeaLeaf_1.jgp	79.356	83.364	88.362	83.578	97.786
TeaLeaf_2.jgp	78.547	83.828	81.992	87.962	97.257
TeaLeaf_3.jgp	79.235	82.763	84.772	82.687	98.368
TeaLeaf_4.jgp	79.667	82.127	85.145	85.547	97.127

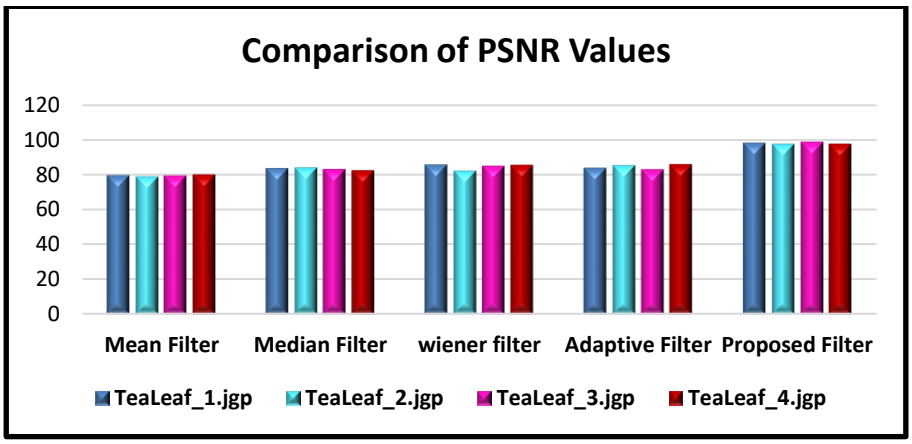


Figure 4 Comparison of PSNR Values

The following Table 2 shows the comparison chart of the various filters with their MSE value for the input tea leaf image. The proposed GEC filter is compared with mean, median, wiener and adaptive filters. The minimum MSE value for the tea leaf image is given by GEC filter with 0.0121 for the TeaLeaf_4.jpg. MSE value of the image is calculated by the following formula. Figure 4 and 5 shows the comparison result of metrices PSNR and MSE values.

TABLE-2: Comparison of MSE values

Images	Mean Filter	Median Filter	Wiener filter	Adaptive Filter	Proposed Filter
TeaLeaf_1.jgp	1.021	1.034	1.051	1.051	0.324
TeaLeaf_2.jgp	1.541	1.058	1.028	1.028	0.389
TeaLeaf_3.jgp	1.067	1.096	1.013	1.034	0.789
TeaLeaf_4.jgp	1.047	1.007	1.023	1.068	0.312

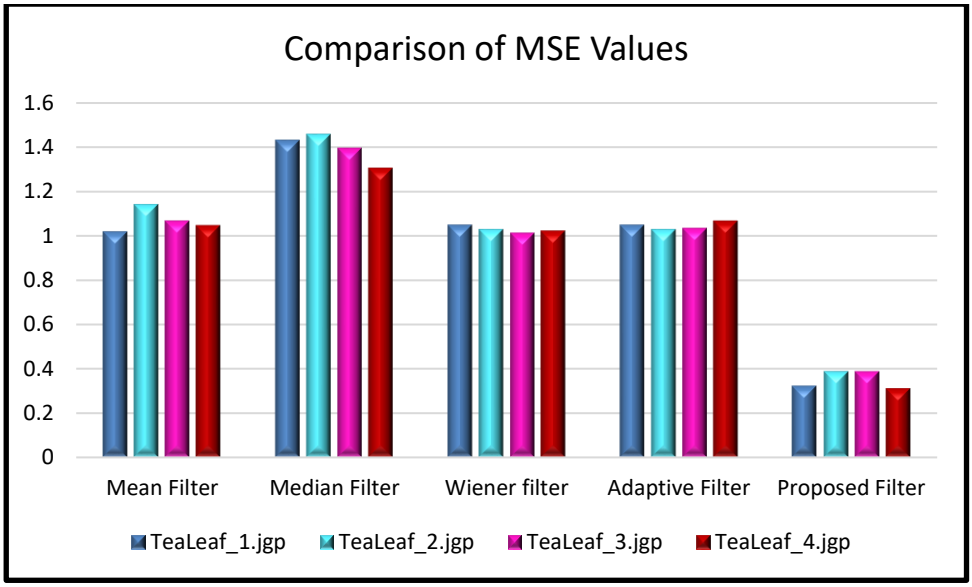


Figure 5 Comparison of MSE Values

Conclusion:

This research focused on **developing** computational **methods which use** image processing techniques to predict the **degree** of **fermentation. The proposed technique** can be used as a quality control tool. Phase-I pre-processing results are discussed in the current paper, the results show the higher accuracy with 98.368 percent and low error rate of 0.312.

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