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Defects Identification in Chocolates Using Neural Fuzzy Interface Segmentation

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ABSTRACT: *This work demonstrates an approach for identification of defects in chocolate. In the production of chocolate manufacturing raw materials is very important, improper mixing of raw materials May causes health hazard. Food grading by humans are inefficient, labor intensive and prone to errors. The Various steps involved in this work are Image Acquisition, Preprocessing and Enhancement ,Segmentation, and classification .In this work filter such as DBA interface with Neural Network, Advanced PSMF are implemented ,and for the Segmentation Neural Fuzzy interface techniques are used ,MSE and PSNR values are calculated from filtering technique and parameter such as sensitivity, specificity are determined by Neural Fuzzy interface technique. The main contribution of this work is to design and develop an efficient algorithm for detecting and sorting the food product at more than 90% accuracy in grading compared to human expert sorting.*

KEYWORDS: *DBA 1; PSMF 2; MSE 3; PSNR 4; ComputerAided Inspection Technique 5;*
Abbreviations—Decision Based Algorithm1 (DBA1); Progressive Switched Median Filter2(PSMF2)Neural Fuzzy 3 (NF3); True positive 4(TP 4); True Negative 5 (TN 5); False positive 5 (FP 5); False Negative 6 (FN 6);

I. INTRODUCTION

The term Digital image processing refers to the processing of digital image by means of digital computer. A Digital image is an array of real or complex numbers represented by a finite number of bits.Digital image iscomposed of a finite number of elements, each of which has a particular location and values. An image given in the form of a transparency, slide, photograph or an X – ray is first digitized and stored as a matrix of binary digits in computer memory. The digitized image can then be processed and or displayed on a high resolution television monitor. For display the image is stored in a rapid access buffer memory, which refreshes the monitor at a rate of 25 frames per second to produce a visually continuous display.The possible contamination of the final product may occur from one Raw material, so it is essential to check the Raw materials to avoid defects in the product. As the Raw material is checked and approved by Quality Authority department on or before issuing the productmay avoids the possibility of defects in the manufacturing stage.At high doses, of Raw material the contaminants can cause which may to the product and causes external cracks and damages. Casting and molding process for the manufacture of chocolate would some time results the product sticking in imperfection of mould leading to poor gloss and bloom. If they are too cold, poor gloss and sticking in the mould can result with an increase in air bubbles and number of markings or scratching, which may affect the marketing value of chocolate .Computer Aided vision techniques are used for evaluating the defects in chocolate during manufacturing process.

II. QUALITY MEASURES AND DEFECTS

Quality is defined as the expectation of the customer to have a best and good productivity of materialsFat bloom is the chief defects of chocolate and chocolate products. This physical imperfection makes the chocolate appear for consumers who expect a product to have a smooth surface and desired colour. Instead, bloomed chocolate appears old and not good to eat and is identified by a brown coating on the surface of the chocolate. Fat bloom is a result ofimproperly formed fat crystals larger than 5 μ m located at the surface of the Chocolate. With very small crystals (<5μm) at the surface, chocolate appears polish [9]. Larger crystals can diffuse the reflection of light from the surface giving Chocolates dull appearances.

1.1. Formation of Defects

a) Whitish coating that can appear on the surface of Chocolate; this effect is one of the main defect concerns in the Production of chocolate

b) Blooms Fig [1] arising from change in fat in Chocolate content.Sugar bloomsare formed by moisture of sugar Ingredients, this bloom content may cause the product to have an irregular shape is considered as an defect

c) External Cracks and damages can be also considered as a defect Fig [2]

Fig 1: Formation of Blooms in chocolate

The fat blooms in chocolate is due to the following reason

- Poor tempering of the chocolate
- Incorrect cooling methods
- Due to Warm Storage conditions
- Addition to chocolate of fats incompatible with cocoa butter
- Abrasion of Finger marking

Fig2: Sample defective images of Chocolate

DEFECT DETECTION

The Various Basic steps involved in Image processing techniques are followed

- Image Acquisition
- Preprocessing
- Segmentation
- Feature Extraction/ Selection

3.1 Image Acquisition

Image acquisition in image processing can be broadly defined as the action of retrieving an image from some source, usually a hardware-based source, so it can be passed through whatever processes need to occur afterward. [9]Performing image acquisition in image processing is always the first step in the workflow sequence because, without an image, no processing is possible

3.2 Preprocessing

The aim of pre-processing is an improvement of the image data that suppresses unwanted distortions or enhances some image features important for further processing. Four categories of image pre-processing methods according to the size of the pixel neighborhood are used for the calculation of new pixel brightness. Pixel brightness transformations, geometric transformations, pre-processing methods that use a local neighborhood of the processed pixel, and image restoration that requires knowledge about the entire image. Other classifications of image pre-processing methods exist. [9]Image preprocessing methods use the

considerable redundancy in images. Neighboring pixels corresponding to one object in real imageshas essentially the same or similar brightness value. Thus, distorted pixel can often be restored as an average value of neighboring pixels

3.3 Segmentation

Image segmentation is a technique for extracting information from an image. This is generally the first step in image analysis. [9]Segmentation subdivides an image in to its constituent parts or object.The level to which this subdivision is carried depends on the problem being solved. Segmentation is stopped when the objects of interest in application have been isolated. In general, autonomous segmentation is one of the most difficult tasks in image process

3.4 Feature Extraction/Selection

Feature extraction is a key step in most pattern analysis tasks. There are several general guidelines to describe about feature extraction. Firstly is discrimination: Features of pattern in different classes should have significantly different values. Secondly is reliability: Features should have similar values for pattern of same class. Thirdly is independence: Features-should not be strongly co-related to each other. [9] Finally is Optimality: Some redundant features should be detected.

FILTERS AND ALGORITHM USED

Computer Aided vision technique which provides the inspection of identification of defects in chocolate chip using image Acquisition, preprocessing and segmentation method. Here the image of the chocolate is being acquired through a Digital camera ,further the noisy component in theimage can be eliminated throughout the filtering technique ,the various filters such as ,AdvancedPSMF,DBA interface with Neural networks are being used. Mean Square error value, peak signal to noise ratio are computed for individual filters and finally the better result of filtering are selected for Segmentation .Segmentation comes under the major aspect in identifying the defect, The flow chart representation for the Basic Operations are shown in figure[3]. A new segmentation technique called Adaptive Neural Fuzzy interface technique are used are being used. Salt and pepper noise is a form of noise typically seen on images. It represents itself as randomly occurring white and black pixels.The Main Filter used for the defective sampled image of chocolate is Modified PSMF and for the comparison with proposed filter DBA interface with Neural Network are used. Adaptive Neural Fuzzy interface technique of image Segmentation is used, which is considered as the Better process for the Identification of defects in chocolate

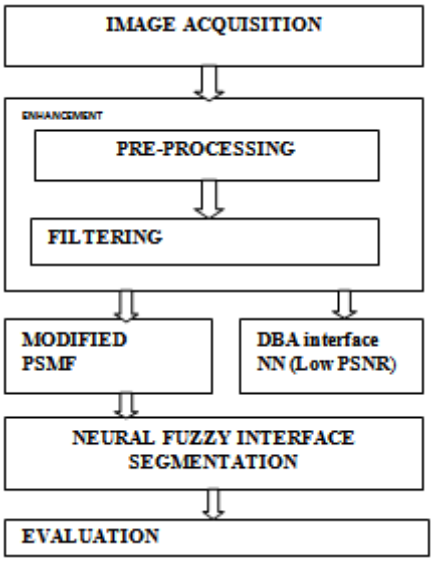

Fig3: Flow chart of the process

Fig [3] represents the flow chart, which explains the entire procedure to complete the stages of segmentation

4.1 Filtering Technique

4.1.1.DBA interface with Neural Network

A feed forward neural network is a flexible system trained by heuristic learning techniques derived from neural networks can be viewed as a layer of neuralnetwork withweights and activation functions. Fig.[4]shows the structure of the proposed impulse noise removal filter. [4]The proposed filter is obtained by

appropriately combining output image from decision based algorithm (DBA) with neural network. Learning and understanding aptitude of neural network congregate information from the two filters to compute output of the system which is equal to the restored value of noisy input pixel. The input of the image is given to the (DBA) filter, and the output of the DBA along with the noisy component is trained towards the neural network to obtain a region of defect in the image of chocolate.

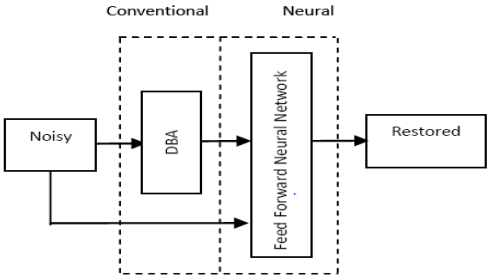

Fig4: Block diagram of the proposed filter

Using DBA interface with Neural Network the noisy component can be removed from the images of chocolate and the Mean square Error Value and peak signal to noise ratio can be calculated as

$$\text{PSNR} = 10\log_{10}\left(\frac{225^2}{\text{MSE}}\right) \qquad (1)$$

$$\text{MSE} = \frac{1}{N}\sum(u - v)^2 \qquad (2)$$

Here, uand vrepresents the number of rows and column of the image and represents the original and the restored versions of a corrupted test image, respectively. Since all experiments are related with impulse noise. The experimental procedure to evaluate the performance of a proposed filter is as follows: For each noise density step, the test images are corrupted by impulse noise with and uniform noise with zero mean .This generates different experimental images, each having the same noise density.
Levenberq-Marquardt algorithm (LM) the weights and biases are updated according to

$$D_{n+1} = D_n - [JJ^T + \mu I]^{-1} J^T e \qquad (3)$$

The Various Procedure for DBA interface with Neural Network is shown below
Step 1: Select 2-D window of size 3*3. Assume that the pixel being processed is P (i,j).
Step 2: If centre pixel 0<P (i,j)<255 then P(i,j) value is left unchanged.
Step 3: If P(i,j)=0 or P(i,j)=255then check for next condition
Step 4: If processing pixel is 0 or 255 & also surrounding all elements has same value then processing element is an information instead of noise as there is high co-relation between neighboring pixels so pixel value should keep as it was. Otherwise check for next condition.
Step 5: P(i,j) is a corrupted pixel then Using neural network find the average for the window and replace it. Else go to step 7
Step 6: repeat the above step from 1 to 5.
Step 7: end the process

a) Training of the Feed Forward Neural Network

Feed forward neural network is trained using back propagation algorithm [4]. There are two types of training or learning modes in back propagation algorithm namely sequential mode and batch mode respectively. In sequential learning, a given input pattern is propagated forward and error is determined and back propagated, and the weights are updated. Whereas, in Batch mode learning; weights are updated only after the entire set of training network has been presented to the network. Thus the weight update is only performed after every epoch. It is advantageous to accumulate the weight correction terms for several patterns

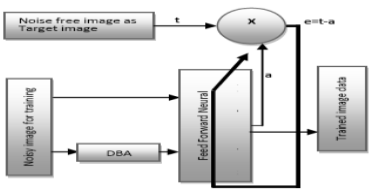

Fig 5: Training of Feed forward Neural Network

The chosen network has been extensively tested for several images with different level of impulse noise. Fig.5 shows the exact procedure for taking corrupted data for testing the received image signals for the proposed filter. In order to reduce the computation time in real time implementation; in the first stage, a special class of filter is applied on unknown images and then pixels (data) from the outputs of noisy image and decision based algorithm are obtained. Noisy image data and filtered image output data are applied as inputs for optimized neural network structure for testing

4.1.2 Modified PSMF

New median-based filter, Modified progressive switching median filter, is proposed to restore images corrupted by salt–pepper impulse noise. [8]The algorithm is developed by the following two switching scheme, an impulse detection algorithm is used before filtering, thus only aproportion of all the pixels will be filtered and .progressive method such as impulse detection and the noise filtering procedures are progressively applied through several iterations. Simulation results demonstrate that the proposed algorithm is better than traditional median-based filters and is particularly effective for the cases where the images are very highly corrupted. In this technique, a new median-based switching filter, called progressive switching median (PSM) filter, where both the impulse detector and the noise filter are applied progressively in iterative manners. The noise pixels processed in the current iteration are used to help the process of the other pixels in the subsequent iterations. A main advantage of such a method is that some impulse pixels located in the middle of large noise blotches can also be properly detected and filtered. Therefore, better restoration results are expected, especially for the cases where the images are highly corrupted

a) Impulse Detection

Similar to other impulse detection algorithms, our impulse detector is developed by prior information on natural images free image should be locally smoothly varying, and is separated by edges. The noise considered by our algorithm is only salt–pepper impulsive noise which means only a proportion of all the image pixels are corrupted while other pixels are noise-free A noise pixel takes either a very large value as a positive impulse or a very small value as a negative impulse. In this, using noise ratio to represent how much an image is corrupted. For example, if an image is corrupted by R = 30% impulse noise, then 15% of the pixels in the image are corrupted by positive impulseand15% of the pixels by negative impulses, four parameters must be predetermined. [8] They are the filtering window size WF, the impulse detection window size WD, the impulse detection iteration number ND and the impulse detection threshold TD. In addition, these two parameters are not sensitive to noise rate and image type. Therefore, it simply set both WF and ND to be 3. The other two parameters, WD and TD, are sensitive to how much the image is corrupted., here it is observed that, for image "Bridge," WD= 3 is more suitable for low noise ratio and WD= 5 is better for high noise ratio, with a cross point at about R= 30%.The following table shows the comparison among PSNR values of various filtering techniques.

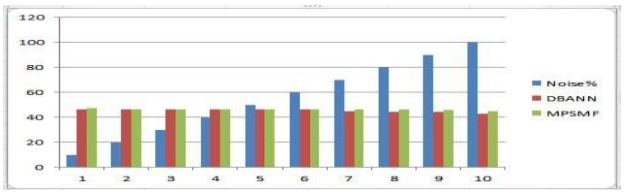

Fig 6: Representation of filters in addition of Noise

percentage of noise	PSNR value for DBA interface NN	PSNR value of Modified PSMF
10%	46.40 (LOW)	47.20 (HIGH)
20%	46.38 (LOW)	46.41 (HIGH)
30%	46.36 (LOW)	46.41 (HIGH)
40%	46.34 (LOW)	46.39 (HIGH)
50%	46.29 (LOW)	46.50 (HIGH)
60%	46.25 (LOW)	46.30 (HIGH)
70%	44.61 (LOW)	46.30 (HIGH)
80%	44.19 (LOW)	46.41 (HIGH)
90%	44.12 (LOW)	45.61 (HIGH)
100%	42.61 (LOW)	44.60 (HIGH)

Table 1: Comparison of PSNR by adding

Additional noise in Percentage

Throughout the comparisons table [1], it is analyzed that PSNR value of Modified PSMF Value is high which is chosen for Image Segmentation. The Graphical representation of Noise verses PSNR value is shown in Fig[6]

4.2. NEURAL FUZZY INTERFACE METHOD FOR IMAGE SEGMENTATION.

The Neural Fuzzy interface is a powerful classifier/recognizer with labeled exemplar data being used to set up the fuzzy set membership functions. Like all supervised learning systems, the main objective is to integrate the best features of Fuzzy Systems and Neural Networks[3].i)**From FS**: Representation of prior knowledge into a set of constraints (network topology) to reduce the optimization search space, ii) **From NN**: Adaptation of back propagation to structured network to automate FC parametric tuning ANFIS application to synthesize. The Defect in chocolate is identified by filtering through two main filters such as DBA interface with neural network and, Advanced PSMF ,PSNR and MSE values are calculated through these filters , Better PSNR value obtained is segmented through by means of fuzzy interface with neural network and various parameters such as sensitivity, Specificity, Accuracy are determined. Throughout the segmented image it is important to calculate TP, TN, FP, FN values for defining the parameters such a sensitivity, specificity and Accuracy

$$\text{Sensitivity} = \left(\frac{TP}{TP + TN}\right) \quad (4)$$

$$\text{Specificity} = \left(\frac{TN}{TP + TN}\right) \quad (5)$$

$$\text{Accuracy} = \left(\frac{TP + TN}{TP + FN + TN + FP}\right) \quad (6)$$

True positives (TP): number of defected pixels correctly detected. False positives (FP): number of healthy pixels Incorrectly detected as defect. True negatives (TN): numberof healthy pixels correctly detected. False negatives (FN): number of defected pixels incorrectly detected as health Accuracy of the proposed algorithm on the Acquired images was 92% for healthy pixels and defected ones, respectively. In this work the developed system has been successfully applied to rectangular chocolates, including identification of defective samples

The Sensitivity, Specificity, Accuracy [1] parameter are determined as shown below

- Sensitivity= 92.307
- Specificity= 92.8571
- Accuracy= 92.5926

III. RESULTS AND DISCUSSION

The Algorithm and filtering techniques used consists of various stages. The image is passed to DBA interface with Neural network and Modified PSMF .Better filtering for the identification of Defect in chocolate is obtained from Modified PSMF which is Segmented through Fuzzy interface with Neural Network. Accuracy of the proposed algorithm on the Acquired images was 92% for healthy pixels and defected ones, respectively. In this work the developed system has been successfully applied to rectangular chocolates, including identification of defective samples. Since the entire performance of the resulting system is autonomous, the results may be applied to automatic quality control applications in the industry The sampled images of chocolate contains external cracks and some whitish blooms spring led on their surface is chooses for filtering and segmentation

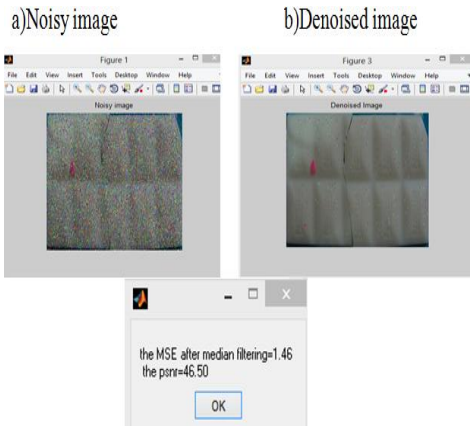

Fig7: DBA interface with neural network a) Noisy image b) De Noised image, c) PSNR/MSE Value

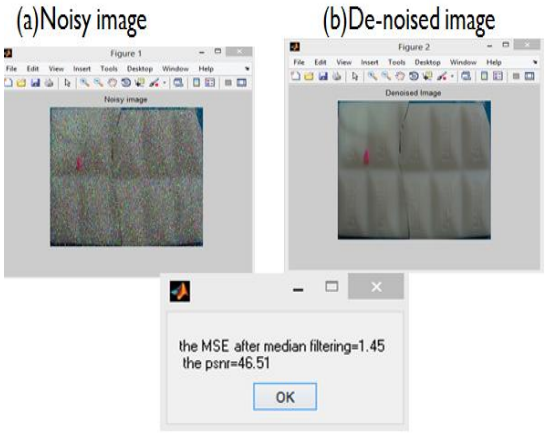

Fig 8: Modified PSMFa) Noisy image,

b) De Noised image, c) PSNR/MSE value

Figure [7],[8] shows the noisy and denoised images of chocolate using DBA interface with neural network and Modified PSMF Based Filtering Technique ,whose PSNR and MSE value calculations are defined.

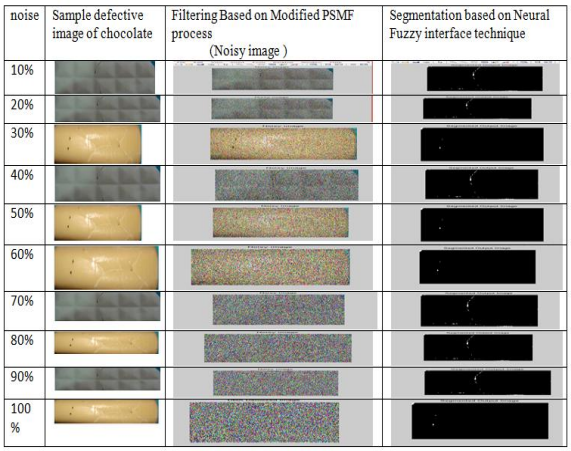

Fig 9 Segmented images of Modified PSMF

Figure[9] showsthe varioussample defective images of chocolate which is filtered using Modified PSMF by adding Noise percentage and it is segmented by using neural fuzzy interface method of image segmentation

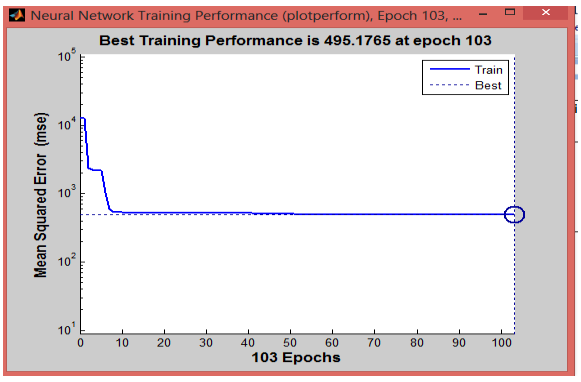

Fig 10:Epoch Plot performance for the sample image of chocolate in addition of 10% noisein DBA interface with Neural Network

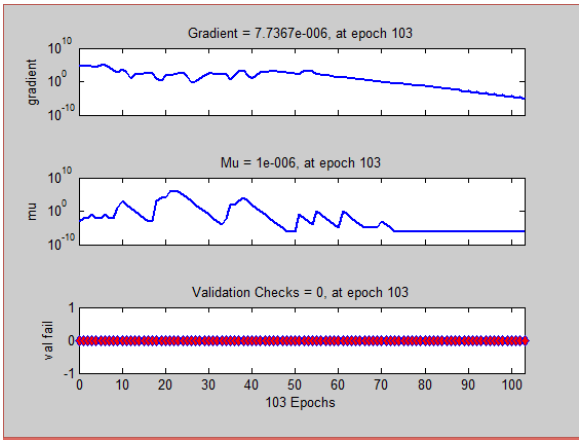

Fig11:Performance of gradient for feed Forward neural network with back propagation algorithm

Fig [10],Fig[11] explains the various performance curvethat are included in Neural Fuzzy interface Technique

IV. CONCLUSION

In this work, an important application of image processing in defect identification in chocolate is implemented and a Neural-Fuzzy Algorithm presents in order to determine the defects. The Algorithm and filtering technique used consists of various stages. The image is passed to DBA interface with Neural network and Modified PSMF .Better filtering for the identification of Defect in chocolate is obtained from Modified PSMF which is Segmented through Fuzzy interface with Neural Network. Accuracy of the proposed algorithm on the Acquired images was 92% for healthy pixels anddefected ones, respectively. In this work the developed system has been successfully applied to rectangular chocolates, including Identification of defective samples. Since the entire performance of the resulting system is autonomous, the results may be applied to automatic quality control applications in the industries.

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