Advanced Median Filters Based Noise Robust Descriptor for Texture Classification

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Abstract- The major challenges of texture classification are how to extract the texture features that are insensitive to noise, rotation-invariant, illumination etc. In the field of texture analysis, removing noise is a critical issue. Image noise is random variation of brightness or colour and image texture gives us information about the spatial arrangement of colour or intensities in an image. When noise is added to the image, it destroys the details of it. So, in order to preserve the details of an image, noise should be removed. The denoising process by using some efficient techniques is of main concern. This paper presents a new approach to remove noise using different Median filters and the texture features are extracted using GLCM (Gray Level Co-occurrence Matrix) approach. The recommended approach is assessed on STex database. The images of STex database are subjected to Gaussian noise and Salt-Pepper noise and the texture features are extracted for both noisy and noise free images. K- Nearest Neighbor (k-NN) classifier is utilized in the classification task. The results are compared with the original Co-occurrence approach. The results indicate that the suggested approach outperforms the original approach.

Keywords- *upgraded median filters; GLCM; texture feature; classification;*

I. INTRODUCTION

Texture analysis is important in many applications of computer image analysis for classification or segmentation of images based on local spatial variations of intensity or color. A successful classification requires an efficient description of image texture. Important applications include industrial and biomedical surface inspection. Texture descriptors are used to extract the texture features of an image. In recent years, many methods have been developed for texture analysis such as GLCM (Gray Level Co-Occurrence Matrix), GRLM, GLDM, DWT, Law mask, and LBP. [1-6].

in the literature various improvements have been suggested for the noise reduction in texture images by using various filters. the previously known techniques have been used for denoising of images and are simulated by using matlab for analysing the performance of the filters [7]. developments are made in median filter in order to increase its efficiency of denoising. noise adaptive median filter is designed by using fuzzy reasoning in order to handle the uncertainty in extracting the local information [8].the complexity of the median filter is reduced by correlating the image to process the features of filtering mask over the image. the mask can be adaptively resized according to the noise of the mask thereby reducing the complexity to o(n) [9]. median filter is widely used in medical image processing. often though, at the same time as reducing the noise in the signal, it is important to preserve edges. the removal of impulse noise brings about blurring in images. edges are of critical importance to the visual appearance of images. noise detection basing on simple thresholding of pixels is proposed to preserve the edges and fine details of the image [10]. verma et al. have suggested an enhanced adaptive filter by preserving the edges [11] in 2015. a new improvement is made by specifying the location of the noise and determining the size of the median filtering window that improves the accuracy of noise detection and fidelity of image filtering [12]. the weighted median filter is extended to use multi-dimensional signals for efficient removal of salt and pepper noise [13-14]. a filter using intelligent recursive algorithm that can efficiently remove salt and pepper noise is designed based on lifting scheme [15].

local binary pattern is based on the local information and they use exact values as the quantitative thresholds, making it sensitive to small changes in noise, so a noise robust adaptive hybrid pattern is developed and for noise texture analysis [16]. the performance of lbp is improved and compared to gabor filter and classic lbp to analyse its improvement [17].

hence after a thorough research and study, this paper proposes a new approach for noise robust texture image classification combining adaptive median filter and glcm texture descriptor

the rest of this paper is arranged as follows.1. brief introduction to median filters and co-occurrence method. 2. section 3 describes the proposed method. experiments and results are discussed in section 4. section 5 gives some concluding remarks.EASE OF USE

II. Brief Introduction To Median Filters And Co-Occurrence Method

A. adaptive median filter

Adaptive median filter is an advanced median filter used for removing impulse noise. This filter performs spatial processing to preserve the details of the image without eroding away edges and smoothens impulsive noise. In this filter, the size of the window surrounding each pixel can be varied depending on the median of the pixels in the present window. If the median value is impulse, the size of the window can be expanded. This is done by evaluating the

centre pixel of the window. In case of impulse noise, the new value of that pixel in the filtered image will be the median value of the pixels in that window. Otherwise, the value of the centre pixel is retained in the filtered image and further processing is done on the image without any further specifications.
In this way, the Adaptive Median Filter handles the filtering operation, reducing the distortion in the image without destroying the fine details of the image [18].

B. Efficient median filter

Median filter has good noise reducing effects, but its time complexity is undesirable. An improved median filter is a combination of both averaging filter and a median filter. Efficient median filter is more advantageous than the traditional median filter as the complexity is reduced and the impulse noise is reduced without destroying the details. The filtering mask is generally a n × n square or cross mask where n is commonly odd. The smaller the mask is, the better the image details are preserved, the stronger the noise reduction performance. As average filter has better performance for filtering random noises, median filter is combined with average filter to certain the size of the filtering mask [19].

C. . Hybrid median filter

When noise is added to an image, image pixels get damaged. There is a necessity to remove this noise in maximum amount by preserving the main image details. One such filter which can remove noise efficiently without destroying the fine details of the image is Hybrid Filter, which is an improved version of median filter. The median filter removes most of the noise, but this advanced filter preserves the corner of the image along with the removal of noise. The computational complexity of this filter is less when compared to traditional median filter. This is a three step process where a window of size 5×5 is selected and two sub-neighbourhoods are formed. The medians of both the neighbourhoods are calculated and the centre pixel value is compared with both the obtained median value. Now the median of all the three values is computed and the centre pixel is replaced by that value [20].

D. Co-occurrence method

Gray Level Co-Occurrence Matrix is a matrix where the number of rows and columns is equal to the number of gray levels in the image. It is a statistical method of extracting texture features. These features are calculated from the statistical distribution of observed combinations of intensities at specified positions that are relative to each other in the image. It calculates how often a pixel with gray level value, 'i' occurs either horizontally or vertically or diagonally to adjacent pixels with value, 'j'. The textural features that can be extracted using GLCM are Contrast, Maximum Probability, Uniformity, Homogeneity, Variance and Correlation. These features are extracted using MATLAB .

III. PROPOSED NOISE ROBUST CO-OCCURRENCE METHOD

The focus of this work to improve the classification accuracy by proposing efficient noise removal methods for noisy images. Different types of upgraded median filters are used to remove noise from the database. Co-occurrence approach is used for the extraction of texture features. To validate the efficiency of the proposed method, experiments are conducted on the STex database. The various steps of the recommended method are represented in Fig. I.

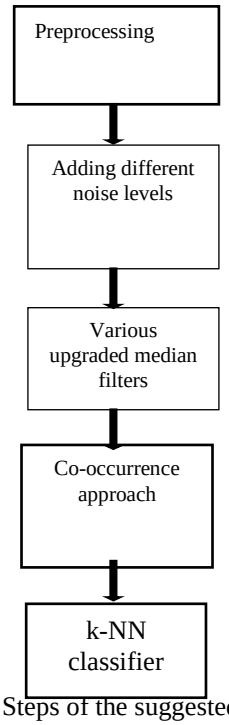

Fig.1: Steps of the suggested approach.

Step1: It starts with generating the database by converting the colour images into gray images and then splitting into subimages.

Step 2: This step contains generating of noisy images by adding two different noises such as salt & pepper noise and Gaussian noise of different levels. The Salt and Pepper noise is also known as impulse noise, often caused by sharp and sudden disturbances in the image signal. This noise is seen as sparsely occurring white and black pixels. Median Filter is the ideal filter for removing this noise.

Step 3: The generated noisy images are applied on the various upgraded median filters for the noise removal.

Step 4: By using the co-occurrence approach texture features are extracted. The texture features extracted are given as follows.

$$Energy = \sum_x \sum_y P_d^2(x,y) \quad (1)$$

$$Entropy = -\sum_x \sum_y P_d(x,y) log_2 P_d(x,y) \quad (2)$$

$$Contrast = \sum_x \sum_y (x-y)^2 P_d(x,y) \quad (3)$$

$$Homogeneity = \sum_x \sum_y \frac{P_d(x,y)}{1+|x-y|} \quad (4)$$

$$Correlation = \frac{\sum_x \sum_y (x-\mu_x)(y-\mu_y) P_d(x,y)}{\sigma_x \sigma_y} \quad (5)$$

Step 5: K-NN classifier is employed for the classification.

IV. EXPERIMENTAL RESULTS AND DISCUSSIONS

The STex database is considered for the assessment of the recommended approaches. 25 color images of size 512 × 512 are randomly selected from STex database, which are represented in Fig. II. Each image is sub-divided into non-overlapping 128 × 128 size images, thus generating 400 sub-images from which, 200 images are used as training database images and 200 images are used as testing database images.

Fig.2: Examples of texture images of STex dataset.

Initially the experiment is carried out on the noise free STex database by using the original co-occurrence approach. Texture features are extracted through co-occurrence method. The classification success rate achieved is 33%. The result is shown in Table I.

TABLE I. PERFORMANCE RESULTS BY ORIGINAL GLCM ON STEX

Feature extraction method	Classification Accuracy (%)
GLCM	33.00

Secondly, the experiments are carried out for generating the salt & pepper noisy database. Salt & Pepper noises for different values of .01, .02, .03 are added to the database to create the noisy database. Texture features are extracted through co-occurrence method. The classification rates achieved for the three different levels are 29%, 28%, and 22.50%. The results are shown in Table II.

TABLE II. PERFORMANCE RESULTS BY GLCM ON SALT & PEPPER NOISY IMAGES

GLCM Feature extraction method	Classification Accuracy (%)
Level 1 (.01)	29.00
Level 2 (.02)	28.00
Level 3 (.03)	22.50

Similarly, the experiments are carried out for generating the Gaussian noisy database. Gaussian noises for different values of 0.01, 0.02, 0.03 are added to the database to create the noisy database. Texture features are extracted through co-occurrence method. The classification rates achieved for the three different levels are 26%, 25%, and 24.50%. The results are shown in Table III.

From Tables II & III it is observed that by adding various values of noise levels for both types of noises the classification accuracies are reduced.

TABLE III. PERFORMANCE RESULTS BY GLCM ON GAUSSIAN NOISY IMAGES

GLCM Feature extraction method	Classification Accuracy (%)
Level 1 (.01)	26.00
Level 2 (.02)	25.00
Level 3 (.03)	24.50

In the next step, individually the upgraded median filters applied to the noisy images of different levels for the noise removal. For feature extraction, co-occurrence method is utilized. Firstly, the adaptive median filter is applied to the noisy databases. The classification rates achieved for the salt & pepper noise removal images at three different levels are of 32%, 31.50%, and 29% respectively. Similarly, the classification rates achieved for the Gaussian noise removal images at three different levels are of 33%, 32%, and 27.50% respectively. Secondly, the hybrid median filter is applied to the noisy databases. The classification rates achieved for the salt & pepper noise removal images at three different levels are of 30%, 29.50%, and 26.50% respectively. Similarly, the classification rates achieved for the Gaussian noise removal images at three different levels are of 28.50%, 27%, and 25.50% respectively. Thirdly, the improved median filter is applied to the noisy databases. The classification rates achieved for the salt & pepper noise removal images at three different levels are of 30.50%, 29.50%, and 29.50% respectively. Similarly, the classification rates achieved for the Gaussian noise removal images at three different levels are of 29.50%, 27.50%, and 25.00% respectively. The results are shown in Table IV, V and VI correspondingly.

TABLE IV. PERFORMANCE RESULTS BY ADAPTIVE MEDIAN FILTER BASED GLCM ON BOTH TYPES OF NOISY IMAGES

Adaptive Median Filter+ GLCM Feature extraction method	Classification Accuracy for Salt and Pepper noisy data (%)	Classification Accuracy for Gaussian noisy data (%)
Level 1 (.01)	32.00	33.00
Level 2 (.02)	31.50	32.00
Level 3 (.03)	29.00	27.50

TABLE V. PERFORMANCE RESULTS BY HYBRID MEDIAN FILTER BASED GLCM ON BOTH TYPES OF NOISY IMAGES

Hybrid Median Filter+ GLCM Feature extraction method	Classification Accuracy for Salt and Pepper noisy data (%)	Classification Accuracy for Gaussian noisy data (%)
Level 1 (.01)	30.00	28.50
Level 2 (.02)	29.50	27.00
Level 3 (.03)	26.50	25.50

TABLE VI. PERFORMANCE RESULTS BY IMPROVED MEDIAN FILTER BASED GLCM ON BOTH TYPES OF NOISY IMAGES

Improved Median Filter+ GLCM Feature extraction method	Classification Accuracy for Salt and Pepper noisy data (%)	Classification Accuracy for Gaussian noisy data (%)
Level 1 (.01)	30.50	29.50
Level 2 (.02)	29.50	27.50
Level 3 (.03)	29.50	25.00

From the results, it is clearly observed that among all the recommended methods the adaptive mean filter integrated with co-occurrence delivers the best result for the salt & pepper noise. For level 1 of Salt-Pepper noise, the classification accuracy has improved from 29% to 32%, for level 2 it has improved from 28% to 31.5% and for level 3, it has improved from 22.5% to 29%. For level 1 of Gaussian noise, the success rate has improved from 26% to 33%, for level 2 it has improved from 25% to 32% and for level 3 it has improved from 24.5% to 27.5%.

Figure III represents the bar presentation of the classification rates of the noisy images.

Figures IV, V, and VI are representing the classification rates of adaptive median filter based Co-occurrence, hybrid median filter based Co-occurrence, and improved median filter based Co-occurrence approaches respectively.

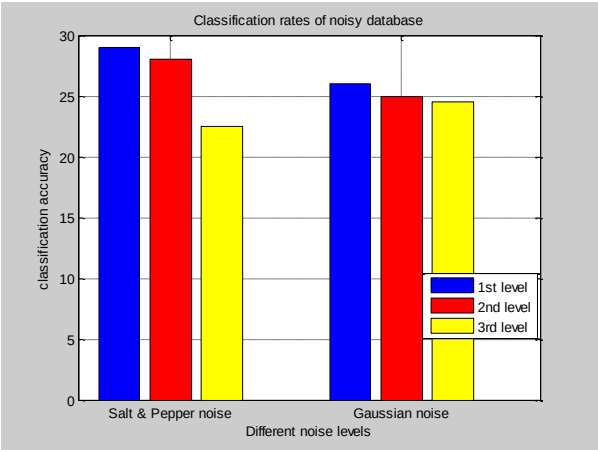

Fig.3: Classification results using GLCM on both the noisy image datasets.

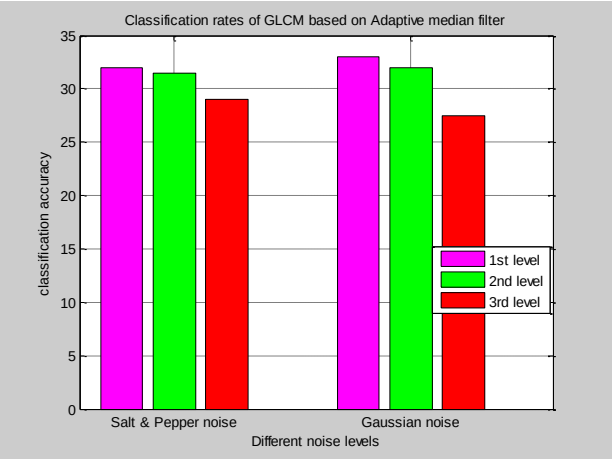

Fig.4: Classification results using Adaptive median filter based GLCM.

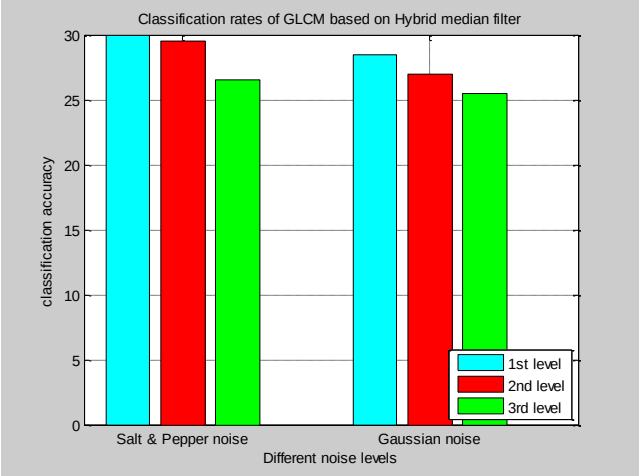

Fig.5: Classification results using Hybrid median filter based GLCM.

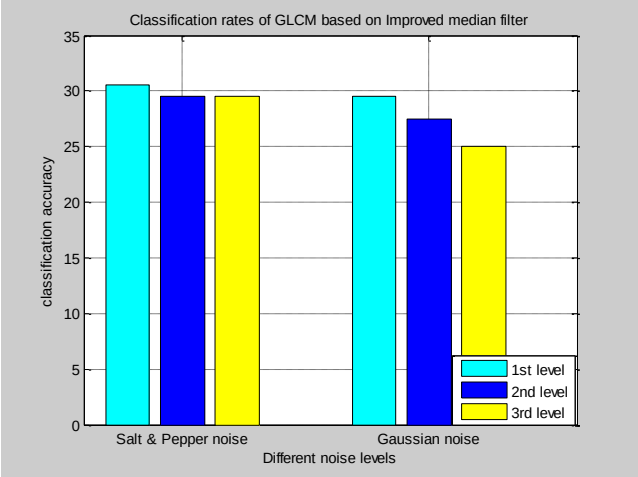

Fig.6: Classification results using Improved median filter based GLCM.

V. CONCLUSIONS

In this paper, robust noise texture descriptor is suggested by combining the upgraded median filters with co-occurrence approach. The experimental results prove that the suggested approaches are outperforms the traditional approaches.
In future the recommended approaches can be verified on other types of noises such as speckle noise, Rayleigh noise.

VI. REFERENCES

[1]. R. M. Haralick, K. Shanmugam, I. Dinstein, "Texture features for image classification", IEEE Transactions on Systems Man and Cybernetics, Vol. 3(6), pp.610-621, 1973.
[2]. M.M.Galloway,"Texture Classification using Gray Level Run Length", Computer Graphics and Image Processing, vol no. 4, pp 172-179, 1975.
[3]. Achmad Rizal, RisanuriHidayat and HanungAdiNugroho,"Multiresolution Modified Gray Level Difference for Respiratory Sound Classification", Advanced Science Letters, Vol no. 23(5), pp 3869-3873, 2017.
[4]. G. P Nason and B.W Silverman, "The Discrete Wavelet Transform in S ",Journal of Computational and Graphical Statistics, Vol no.3(2), pp 163-191, 1994
[5]. M. Rachidi, A. Marchadier, C. Gadios, "Laws' masks Descriptors applied to Bone Texture Analysis: an Innovative and Discriminant tool in Otereoporosis", Skeletal Radiology, Springer Publications, Vol no. 37, pp 541, 2008.
[6]. T. Ojala, M. Peitikainen, T. Maenpaa, "MultiresolutionGray Scale and Rotation Invariant Texture Classification with Local Binary Patterns", IEEE transactions on Pattern Analysis and Machine Intelligence, Vol no. 27(7), pp 971-987, 2002.
[7]. SumanShrestha, "Image denoising using new Adaptive based Median Filter", Signal and Image Processing, Vol no.5, issue no.4, 2014
[8]. Kenny KalVinToh and Nor Ashidi Mat Isa, "Noise Adaptive Fuzzy Switching Median Filter for Salt and Pepper Noise Reduction", IEEE Transactions on Signal Processing Letters, Vol no.17, pp.281-284,2010
[9]. Youlian Zhu and Cheng Huang, "An Improved Median Filtering for Image Noise", Physics Procedia, Vol no.25, pp.609-616, 2012.
[10]. S. Deivalakshmi, S Sarath and Palanyswami, "Detection and Removal of Salt and Pepper noise in images by Improved Median Filter", IEEE Transactions on Recent Advances in Intelligent Computational Systems, 2011.
[11]. KesariVarma, Bikesh Kumar Singh and A.S. Thoke, "An Enhancement in Adaptive Median Filter for Edge Preservation", Intelligent Computing, Communication and Convergence, Vol no.48, pp.29-36, 2015
[12]. Jiafu Jiang and Jing Chen, "An Effective Adaptive Median Filter Algorithm for Removing Salt and Pepper Noise in images", IEEE Transactions on Symposium on Photonics and Optoelectronics, 2010.
[13]. Y. Li, Bacca Rodriguez, G. R. Arce, "Weighted Median Filters for Multichannel Signals", IEEE Transactions on Signal Processing, pp. 157-160, 2006.
[14]. Qin Xu, Oiang Zhang, Duo Hu and Jinpei Liu, "Removal of Salt and Pepper Noise in Corrupted Image based on Multilevel Weighted Graphs and IGOWA operator", Mathematical Problems in Engineering, pp.1-11, 2018.
[15]. Rajesh Siddavatam, AnshulSood, SyamalaJayasree and S. P. Ghrera, "An Intelligent Recursive Algorithm for 95% noise removal in Gray Scale and Binary Images using Lifting Scheme", World Congress on Engineering and Computer Science Vol No. 1, pp 19-21, 2011 .
[16]. Ziqi Zhu , Xinge You, C.L PhillipChen, DachengTao, WeihuaOu, XiubaoJiang, JixinZou, "An Adaptive Hybrid Pattern for Noise Robust Texture Analysis", Pattern Recognition, Vol no. 48, pp. 2592-2608, 2015.
[17]. GustafKylberg and Ida-Maria Sintorn, "Evolution of Noise Robustness for Local Binary Pattern Descriptors in Texture Classification", Image and Video Processing, Vol no. 17, 2013.
[18]. Prateek Kumar Garg, PuspneelVerma, AnkurBharadwaz, "A Survey Paper on Various Median Filtering Techniques for Noise Removal from Digital Images ", American International Journal of Research in Formal, Applied and Natural Sciences, Vol no. 7, Issue no. 1, pp. 43-46 ,2014.
[19]. Youlian Zhu, Cheng Huang, "An Improved Median Filtering Algorithm for Impulse Noise Reduction", International Conference Conference on Solid State Devices and Material Sciences, Vol no. 25, pp. 609-616, 2012.
[20]. Zeinab Mustafa, Banazier A. Abrahim, Yasser M. Kadah, "Modified Hybrid Filter for Image Denoising", 29th National Radio Conference, IEEE transactions, pp 705-712, 2012.

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