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Image Enhancement Using Adaptive Gaussian Notch Filter

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ABSTRACT : Periodic noise adds repeating patterns to digital pictures throughout the capture and transmission stages, causing them to be corrupted. This paper offers a novel adaptive Gaussian notch filter (AGNF) for successfully recovering pictures polluted with periodic, quasi-periodic, and Moiré pattern disturbances in the Fourier transform domain. Periodic noises are sinusoidal functions that are introduced to uncorrupted pictures, and the Fourier transform of images concentrates these noisy functions as readily recognisable conjugate peaks in the frequency domain.

Using an adaptively variable window technique, the proposed AGNF algorithm adaptively calculates the peak regions associated with noisy frequencies of the damaged frequency domain picture. The suggested filter's filtering windows are adaptively extended in size from lower sizes until they encompass noisy peak areas of the Fourier transformed picture. The suggested algorithm employs two adaptive windows, W1 and W2, with W1 serving as the inner window and W2 serving as the outside window.

When compared to other approaches, AGNF performs better in recovering pictures polluted with periodic disturbances, as measured by mean absolute error, peak signal-to-noise ratio, mean structural similarity index measure, and computation time.

KEYWORDS: Noise, Image Processing, Filtering, Adaptive Gaussian Notch Filter, Fourier and Inverse Fourier Transform.

I.INTRODUCTION

Noise degradations are induced by flaws in sensors, scanners, virtual cameras, and garagedevices, and result in random changes in the within the depthof an uncorrupted photo. Restoring an image try to get better or recreate the original photo from its corrupted state versions with a lot of noise. Periodic noises are unaffected by the presence of a signal, yet sounds that are spatially dependent and distort digital images byadding repetitive patterns that are distributed periodically or quasi-periodically when there are external interferences during the collection of an image/transmission[1-5]. When sinusoidal/quasi-sinusoidal noisy functions are used, natural images are damaged with periodic/quasiperiodic noises external electrical/mechanical interferences are amplified during picture acquisition/transmission, with pure image contents levels. Each noisy sinusoidal/semi sinusoidal capacity was combined with Individual periodic patterns in natural images are created by the satisfied of natural photos.

Separate periodic styles in snap shots are created thru combining herbal images. As a give up result, a single mixture of sinusoidal features with unique frequencies produces numerous periodic styles in images, every with a unique periodicity, and the amplitude of these sinusoidal competencies affects the power of those styles. When electric interferences rise up in the course of photo seize, periodic noises harm digital snap shots with the aid of using manner of which includes regularly or quasi periodic exceptional pal allotted repetitive styles to the photograph. Line quitter, striping, and banding consequences in corrupted photograph are as a consequence of electric powered interferences, which impact reprographic techniques which includes 1/2-tone printing and cathode ray strategies. Because of the vibration of imaging holders, imaging tool installation in non-stabilized of the image holders, consisting of choppers / aircrafts, produce periodic of noises.

Regular voice blends its additives with different uncorrupted pixel esteems and disperses in course of the spatial area image, making noisy additives tougher to expect in spatial phrases area. Furthermore any direct noise detection based on a spatial domain the procedure is challenging since it is difficult to forecast the spatial distribution. The image is corrupted by a pattern/sinusoidal/quasi-sinusoidal function by way of addition. As a result, early kernel based filtering was ineffective. Attempts to provide better restoration have been unsuccessful. Since Linear combinations of periodic/quasi periodic noises are called periodic/quasi-periodic of noises. The noises are concentrated in

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sinusoidal/quasi-sinusoidal functions spectral coefficients of great magnitude in the frequency domain and as a result, impulsive star/spike shaped noise peaks are produced. These noise height areas have the very best ghostly price within the middle point, which corresponds to the noisy sinusoidal characteristic's essential frequency. The noise bandwidth refers to the diminishing noisy portions inside the peak's famous person form. The recurrence of sinusoidal/semi sinusoidal capacity that then corrupts the photograph in spatial area determines the placements of these noisy spikes within the frequency spectrum. Low-frequency sinusoidal/quasi-sinusoidal capabilities pay attention on the direct modern (DC) coefficient, while extraordinarily excessive-frequency sinusoidal/quasi-sinusoidal functions pay attention at the Fourier spectrum's edges, generating superstar/spike-formed peaks. Restoration strategies can without difficulty come across ruined frequencies from other uncorrupted frequencies due to the fact ghostly coefficients similar to periodic sounds generate noise height areas with the spike appears inside the of Fourier transform image[6-10].

To construct the noise of map from the accelerated frequency of spectrum, the frequency domain-primarily based totally switching median clear out makes use of a traditional region developing technique. The after that, the located noisy spectral coefficients are substituted with the decided through the median of the uncorrupted frequency spectrum median recursive clear Varghese's proposed clear out. Adaptively shifts from the DC co efficient inside the middle of graph photograph to the photo's end line to find out and fasten the corrupted

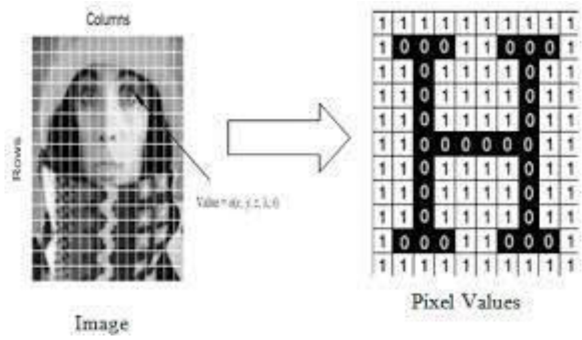

Fig .1 Image as Pixel values

frequencies. These algorithms, on the opposite hand, cope with a number of the targets of noise filtering on an ordinary basis, however it became not able to completely remedy different troubles goals for photo healing Computational efficiency, for example, is this type of targets. Adaptation to numerous noise and photograph kinds, in addition to precision in efficacy in spotting noisy peaks and their accompanying places protecting thin/slim edges and rejecting distorted frequencies outputs have been restorred

The main focus of the project is to remove the noises from corrupted image and get a noise free image as output. This removal of noises should be done by using the adaptive Gaussian notch filtering Fourier remodel location for successfully restoring images defiled with the periodic, quasi-periodic and Moiré pattern noises. To do Experimental analysis and check situations on various photos proved that the fee grounded absolutely function- developing standards of the proposed set of rules provides higher delicacy in detecting and quantifying noisy top areas in frequency sphere snapshots

II. LITERATURE REVIEW

The first method proposed for noise removal was band reject filter. Spectral Band reject filter method involves the rejection of circular band frequency around center of frequency domain image. Then the statistics based algorithm was implemented where the noisy areas are replaced with suitable statistics value but here noise attenuation is limited which does not de noise neighboring noisy frequencies which is then overcome by the Gaussian notch based filter. SBA , GNF has difficulty in determining noisy areas. FDMF1, FDMF2 ,GNRF ,IF ,WGNF are non- adaptive and window size is fixed here. GSF uses threshold based region identification technique In AONF the drawback is noisy peaks with large variations Chakraborty el al filter ,Zhonef al filer and frequency domain based switching median the drawbacks are computational efficiency and it cant adapt to various noises.

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III.PROPOSED METHOD

In this section we review about different types of noises like as periodic noise, salt, pepper noise and Gaussian noise. But here we are considering the salt and pepper noise and filtering is done by using adaptive Gaussian notch filter. Here the noise is identified using the ratio of outer and inner frequencies which is then compared to the threshold value. After which the filter is used and the determination of the distorted image is done by applying the inverse fourier transform. The first step in this is to add noise to the uncorrupted image then de noise the image using agnf.

IV. IMPLEMENTATION

The project here is carried out the use of a Gaussian notch clear out to dispose of the salt and pepper noises and provide a de noise photograph because the output. So the principle intention is to discover the noisy vicinity the use of an adaptively variable window technique. These noise capabilities with strength, a [0.1 0.9] are described under as N1 and N2.The noise this is going to be introduced with inside the authentic uncorrupted photograph is achieved through the use of the given formulae:

$$N_{1(i,j)=a*255}\begin{pmatrix}(\mathrm{Sin}(1.8i)+\mathrm{Sin}(1.8j)+\mathrm{Sin}(+j)\\ +\mathrm{Sin}(2.2i+2.2j)+\mathrm{Sin}(1.8i-1.8j)+\mathrm{Sin}(i-j)+\mathrm{Sin}(2.2i-2.2j))\end{pmatrix}\text{-(1)}$$

$$N_{2(i,j)=a*255}\begin{pmatrix}(\mathrm{Sin}(1.1i+1.1j)+\mathrm{Sin}(1.5i)\\ +\mathrm{Sin}(1.5j+2.2j)+\mathrm{Sin}(1.1i-1.1j))\end{pmatrix}\text{------(2)}$$

$$\tilde{\Omega}^{W}_{u,v}=\begin{matrix}J_1, J_2 : u-d \le J_1 \le u+d,\\ v-d \le J_2 \le v+d\end{matrix}\text{------(3)}$$

These windows are used to discover relative common frequency deviations of frequencies from internal and another neighborhood for every frequency value. Because the frequency values of the internal frequencies are extraordinarily better than the ones of the outer window, the set of rules considers the frequency positions described through the internal window to be noisy if the ratio averages of outer and internal neighborhood frequencies is much rather than a predefined threshold[15-20].

Let $\tilde{\Omega}^{W}_{u,v}$ stand for a generalized set of images. These of rules starts off evolved through assuming that each one of F's frequency positions are uncorrupted, after which involves F=F.

Here F(u, v) will denote the Fourier position u, v. Fourier spectrum of P of F make the noise frequency detect process very easy in the real domain and is expressed as

$$F u,v=\frac{1}{M x N}\sum_{i=0}^{M-1}.\sum_{J=0}^{N-1}(-1)^{i+j}\,Y i,j e^{-\sqrt{1}2\pi(\frac{uxi}{M}+\frac{vxj}{N})}\text{--(4)}$$

$$Pu,v=\sqrt{(Ru,v)2+(Iu,v)2}\text{----------(5)}$$

Here $R_{u,v}$ and $I_{u,v}$ indicates the real and complex parts of $F_{u,v}$. Because the proposed AGNF excludes the DC frequency from the filter process, the performed algorithm perform the below steps to identify the corrupted frequencies for every frequency spectrum around the DC coefficient. Then in this scenario, the notch filter operation applied to Fu,v to generate the recovered frequency image Fu,v for every (i1, i2)(u, v) W2.

The operation of notch filtering is defined by

$$\tilde{F}u+i1,\ v+i2=\mathrm{Min}(\tilde{F}u+i1,v+i2,\ \boldsymbol{F}u+i1,v+i2\ x\ \boldsymbol{G}\ i1,i2)\text{------------}\mathbf{(6)}$$

Where

$$\boldsymbol{G}i1,i2 = 1-Ae-B(i12+i22)\text{----------------(7)}$$

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Where A is the filter's magnitude and its value is in the range [0, 1]. Along the rows and columns of G [7], B is a positive scaling constant. When the Gaussian notch filters corresponding to separate noisy peaks overlap, the operation ensures that the algorithm accomplishes. After the algorithm have done all of the frequencies inthe frequency range domain image, the inverses of shifting and theFourier transform are used to recreate the final in de-noised image, Z.

$$\mathbf{Z}_{x,y} = \sum_{i=0}^{M-1} . \sum_{j=0}^{N-1} (-1)^{i+j}\, \breve{\boldsymbol{F}}_{i,j}\, e^{\sqrt{-1}\,2\pi\left(\frac{i*x}{M}+\frac{j*y}{N}\right)} \text{-------(8)}$$

ADAPTIVE GUASSIAN NOTCH FILTER METHODOLOGY

STEP 1: The algorithms start from initializing the inner size window, W1= 3, max window size, Wmax= 21 and the binary variable, f = 0 indicates an uncorrupted of frequency of position.

STEP 2: The outer size window W2 is set to W2= W1+ 2. Then also that uses adaptive varying inner and the outer of position that sets and $\tilde{\Omega}^{Out}$u,v centered at u, v for effective quantifying of noisy frequency of areas.

STEP 3: The frequency values that corresponding to $\tilde{\Omega}^{In}$u,v and $\tilde{\Omega}^{Out}$u,v are used for determining the ratio between averages of outer and also inner of frequencies and neighborhood sets are, respectively, defined by

$\tilde{\Omega}^{In}_{u,v}$= $\tilde{\Omega}^{W1}$u,v and $\tilde{\Omega}^{Out}$u,v = $\tilde{\Omega}^{W2}$u,v /$\tilde{\Omega}^{W1}$u,v -------(9)

$\tilde{\Omega}$u,vthe algorithm then identifies the position frequency Fu, v as then corrupted that when ratio of the averages of the pixels from the $\tilde{\Omega}^{Out}$u,vand $\tilde{\Omega}^{In}$u,vis less than the threshold, T , it is clearer that Fu,v is the noisy peak.

STEP 4: Set W1=W1+2,f=1 and continue from step 2

STEP 5: If µ Out/µIn> T and f =1, then algorithm performed the de-noising for process of noisy effected peak areas Apply notch filtering to replace pixelsby W2 , if f=0 then it is non corrupted frequency which moves to step 1

STEP 6: Determine restored image by IFT.

V.RESULTS AND DISCUSSION

The image corrupted using the noise signals are in the below figure2 as well as the denoised image are acquired using the Gaussian notch filter function in figure 3 which is done using MATLAB. The observations made are the noisy image is having the more dots and unclear view of image indicating that noise is present in the acquired image. Here we tune the tuning parameter with various values and note the best reading. Adapts to different noise and imagedtypes. It has correct accuracy to identify noisy peaks and their associated areas. And has highComputational Efficiency. Efficacy to reject the corrupted of frequencies and to preserve thin/narrow of edges in outputs restored. The observable results are shown below.

The figure 2, 3 shows the input given to Adaptive Gaussian notch filter and output image extracted from it. The difference can be clearly observed in the image where the dots that is noises are being observed and the removal of that noise is seen clearly in the output image. And here we differ t values from [0.2 to 0.55] and a between [0.1 to 1].

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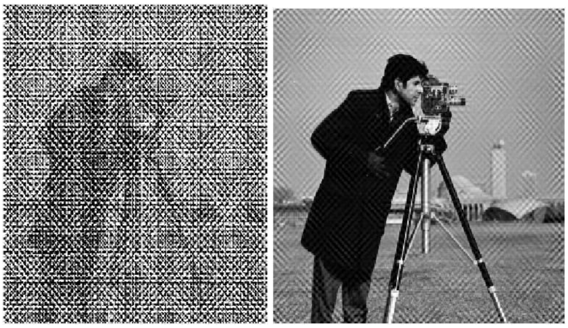
Fig 2. Noised Image

Fig 3. Denoised Image

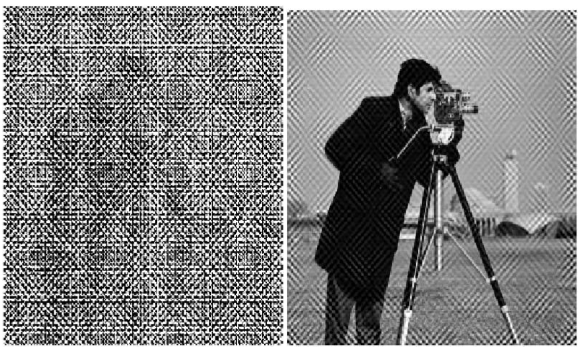
NOISY IMAGE OUTPUT

Fig . 4 FOR A=0.1



NOISY IMAGE OUTPUT

Fig 5 FOR A=0.5



NOISY IMAGE OUTPUT

Fig 6 FOR A=0.9

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A	T=0.2	=0.25	=0.3	0.35	0.4	0.45
0.1	19.93	40.41	**40.67**	40.16	40.10	39.29
0.5	6.01	31.13	31.91	**32.03**	31.79	31.95
0.9	0.91	27.26	27.40	27.49	**27.52**	27.12

Table 1 PSNR values with differing T

Based on the above readings we consider t=0.35 as the best value to consider in this algorithm

VI.CONCLUSIONS

We have successfully added noise to an image and applied the algorithm to denoise the image. And while doing this we have noted various factors which will yield better results (psnr, mae, mssim, ct). Based on those observations selected a better tuning parameter. The frequency domain based proposed algorithm has the capability of adaptively detecting and quantifying noisy peak areas for diffusing these noisy peaks by Gaussian notch filter of adaptively varying sizes.Experimental analysis conducted under different test conditions on various images proved that the ratio based region-growing criteria of the proposed algorithm provides better accuracy in detecting and quantifying noisy peak regions in frequency domain image.

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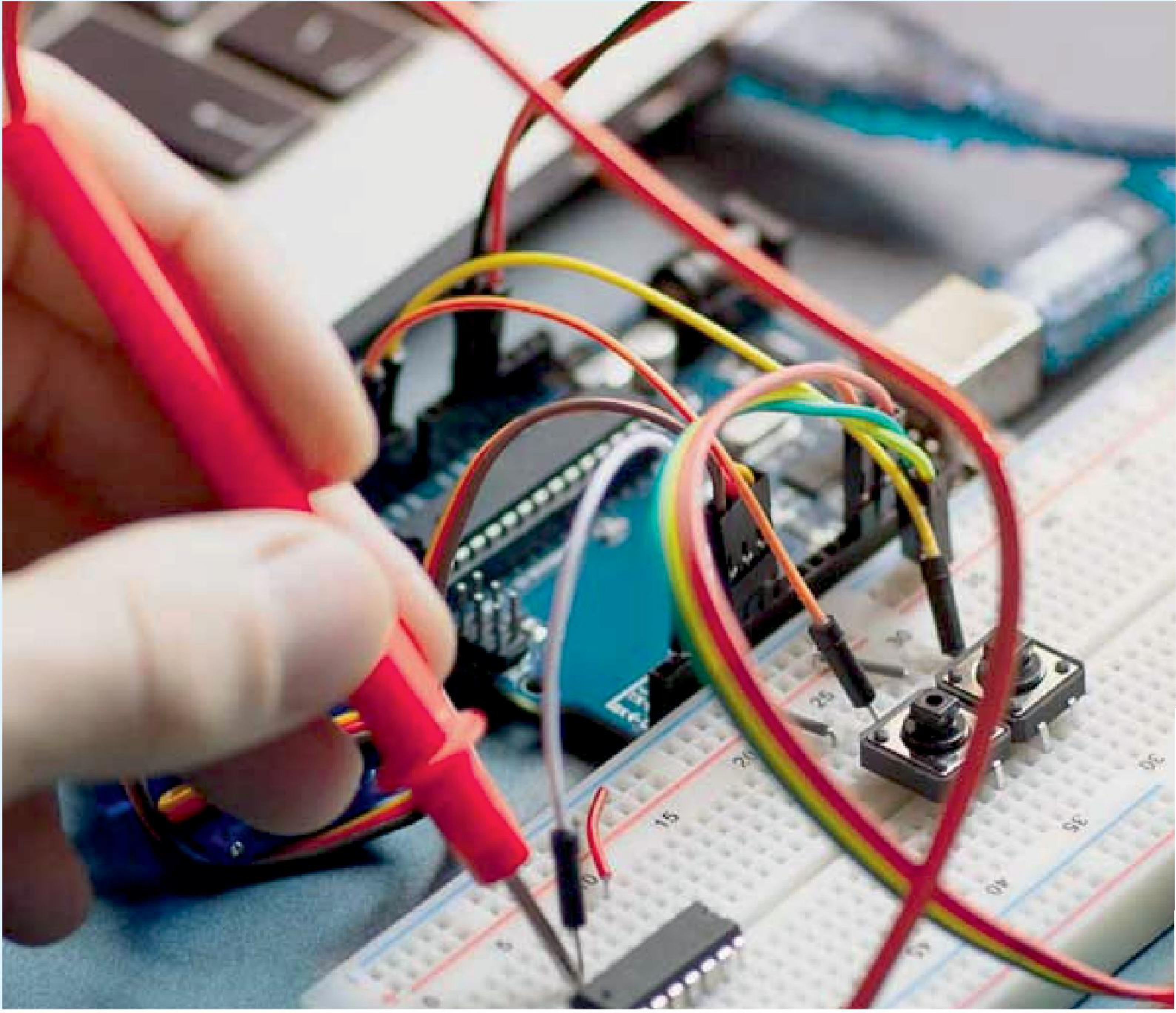

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