# Enhance Mobile Phone Digital Camera Images Using Band Reject Filter and Discrete Fourier Transform

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**Abstract—**These days, We know that mobile phones with camera are very common to used by most of the people because of their ease of use and carry. So I figured I need for mobile phone images processing. These images are often subjected to a variety of types of distortion, such as noise, poor illumination, and blur due to transmission, image acquisition and mobile movement during capturing scene. This Degradation leads to produce distorted images are not suitable for viewing or application. To overcome this degradation, this paper presents image improvement in mobile phone by distortion removal using Band Reject Filter and DFT to obtain on the best clear image. Periodic noise is sinusoidal of several of certain frequencies and periodic in nature. It looks identical to the bars that the image is covered. The proposed method is subjected to eliminate this noise from a set of images using Band Reject Filter using discrete Fourier transform that attenuate and replace a number of degradation bands. Then, computes the peak signal to noise ratio metric for each band. After that, select the largest value of each band for the purpose the making one clear image. Finally, the bands that carry value large are merged to produce a one image. The final image is converted to the spatial domain using an inverse Fourier transform. The experimental outcomes indicate that the proposed method improves the degraded image by a greater percentage without using the better value for metric and makes image more clear and informative compare with the input image.

**Keyword—**Band Reject Filter (BRF), periodic noise, image enhancement, DFT, mobile phone images

## 1 Introduction

Distortion is unwanted information about the image or an error in the pixel value of an image by a peripheral external operation (Russell, 2019). Usually periodic noise is caused by electrical or electromechanic overlaps. It is analogous to the set of bars as in Figure 1. It is one of the structural noise has general effects of degradation. This type of noise occurs because equipments of image or network and external effects of nature. This noise effect can be decreased using two dimensional discrete Fourier transform (Varghese et.al, 2020). When the frequency is low of periodic noise, the

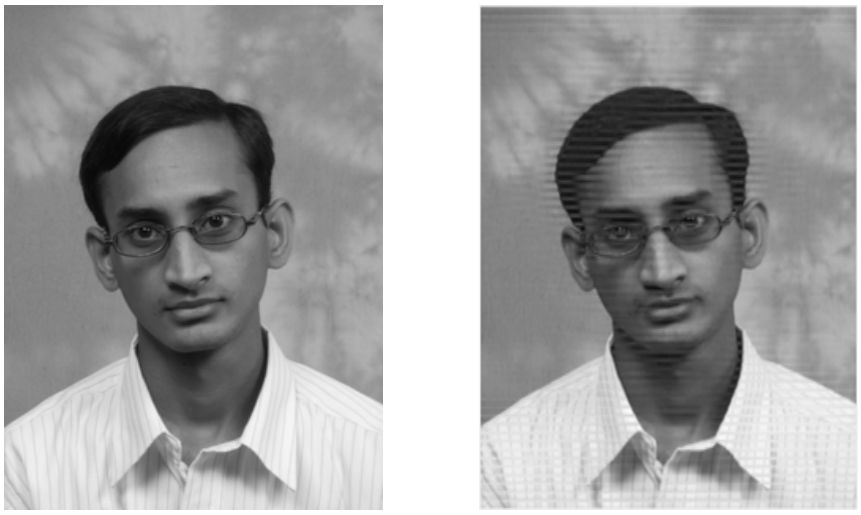
points may be close to the center of the image as well as vice vers. Band Stop Filter is also called as Notch Filter, frequency blocking and reject them that located in two cutoff frequency arguments (Hamd, 2014). Low-pass RC filter is mereg with high-pass RC filter to configure simple band pass filter which passes a frequencies of ranges. These filters are combined to create Band Reject Filter that block range of frequencies. If Band Reject Filter very narrow then it is referred notch filter it is more universally (Grossi et.al, 2016; Alibabaie & Latif, 2019).

Original image

Original image with periodic noise ripples

**Fig. 1.** Original image and noise image (Ionita et.al , 2017)

The band rejection filter function passes all frequencies starting with zero to the first and lowest frequency and passes these frequencies over it which is the second upper frequency. It blocks all these frequencies in between. Whenever noise location is known, Band Reject Filter is useful. It blocks frequencies in the certain range while frequencies outside of the range is let to pass through (Hassan et.al, 2022). Band Reje ct Filter removes periodic noise from the image as in Figure 2. There are two types of it (Wide band reject) filter and (Narrow band reject) filter (Notch Filter). These noises are commonly in several applications such as medical applications, remote sensing and television applications (Ketenci & Gangal, 2017; Hamd, 2014).



Original image Filtered image

**Fig. 2.** Original image and filtered image (Chakraborty et.al, 2016)

Image enhancement denotes the process of emphasizing definite information of an image as well as eliminating unnecessary or redundant information such as eliminating noise, removing blurred, and etc. Image enhancement is applied to improve the image vision for human visual. Images is degraded by different noise types such as salt & pepper ,Gaussian, speckle noises and blur (Rusul, 2021).

Image combination is a process for collecting all essential information from several images and producing single image is more accurate and informative than source images. The purpose of it is creating image that is more unstandable for human and machine (Ali and Rusul, 2016). It is performed on spatial domain and transform domain. For example, Averaging, principal component analysis and Brovey method are spatial domain methods while discrete wavelet and discrete Fourier transforms are frequency domain (Zahraa et.al, 2021; Flusser et.al, 2007). This paper presents a method to enhance an image by BRF and DFT.

## 2 Mobile phone image noise

Key camera factors influence final image quality is the size of the image sensor. Larger megapixel sensors have smaller individual pixel sizes, which in practice increases the spatial images resolution and density of the sample that get it by a a lens with limited focal length, also noise levels up, which makes the sensitivity of the real Light is decreased. Because of the presence of these limitations, a trade-off occurs between light sensitivity and spatial resolution. At more lower megapixels can be achieve the optimal performance. the digital camera processor amplifies the electrical signal, resulting in a higher equal level of noise.

Regrettably, noise with high sensitivity cannot be separated while one always accompanies the other. As the temperature of the sensor rises, so does noise.

## 3 The method

A useful method is presented throughout this paper for image optimization using Reject Band filter & DFT for mobile phone images. In the beginning, set of various frequencies of noisy in the images. Then, 2D Discrete Fourier transform of images are calculated according to Equation (1) as in Figure 3. Reject Band filter applied on images that contains noise to delete it from images. After that, peak signal to noise ratio is computed for each band. The largest value of the metric is taken from all image then merged it to become signal image that more informative from original images. The inverse DFT is performed on a result image in order to transform it to spatial domain after she was in frequency domain to construct an enhanced image as in Equation (2). Figure 4 shows proposed method that clarifies the method.

$$F(k,l) = \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} f(i,j)\, e^{-\iota 2\pi \left(\frac{ki}{N} + \frac{lj}{N}\right)} \tag{1}$$

$$f(a,b) = \frac{1}{N^2} \sum_{k=0}^{N-1} \sum_{l=0}^{N-1} F(k,l)\, e^{\iota 2\pi \left(\frac{ka}{N} + \frac{lb}{N}\right)} \tag{2}$$

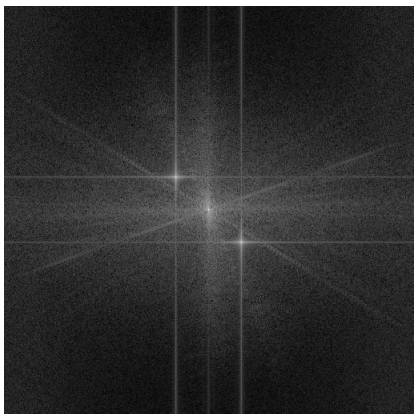


**Fig. 3.** 2D Discrete Fourier transform of the input image that contains periodic noise

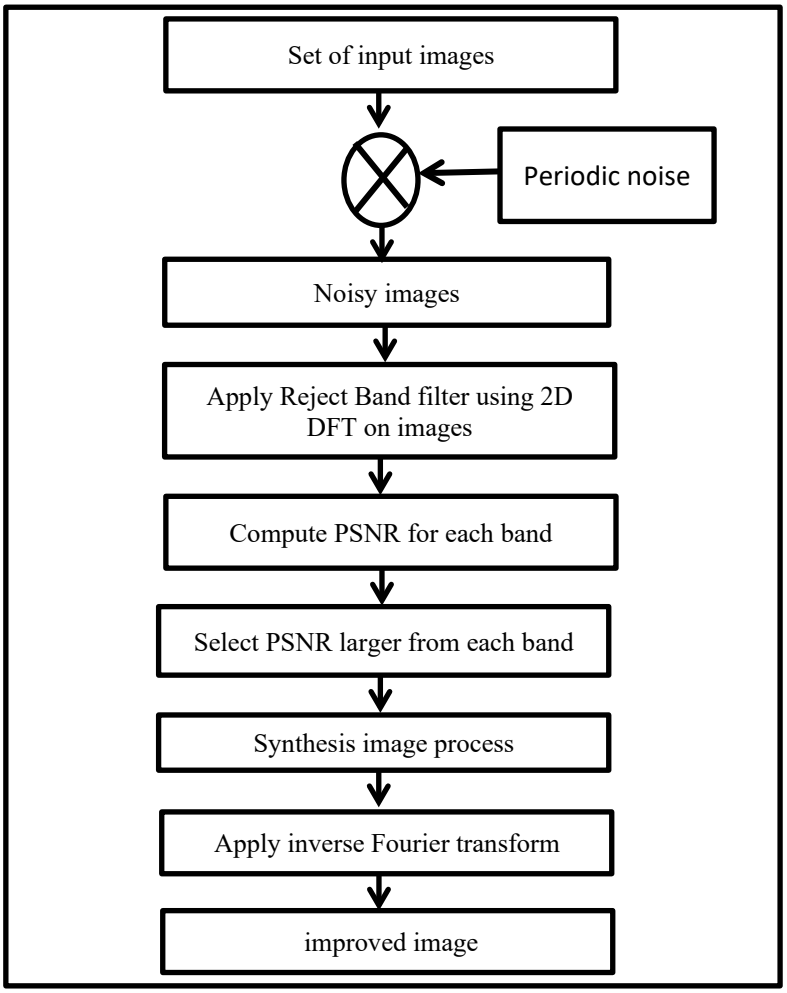



**Fig. 4.** Proposed Method Diagram

## 4 Results

The experimental results are performed in Visual Basic 2012 software. Three images are tested by different frequencies of periodic noise. These images are the same size and same scene. The goal comparison between various algorithms is executed with (Peak Signal to Noise Ratio PSNR), (Mean Absolute Error MAE) and (Computation Time (CT)) at second measures. First, Discrete Fourier transform is applied to these images to transform images from a spatial domain to frequency domain. Second, Band Reject Filter is performed to eliminate noise from images. Figure 5 illuminates input noisy bird images. It presents periodic noise removal from images using BRF and improved image is formed from taking value larger of PSNR

measure. The larger value of PSNR of each image is taken to form improved image. The enhanced image is transformed from frequency domain to spatial domain to build final image. The efficiency of this proposed method has been compared with Windowed Gaussian Notch Filter (WGNF) (Aizenberg & Butakoff 2008) and Adaptive threshold based filter (ATBF) (Varghese 2016). A good method gives high value of PSNR and low values of MAE and CT.

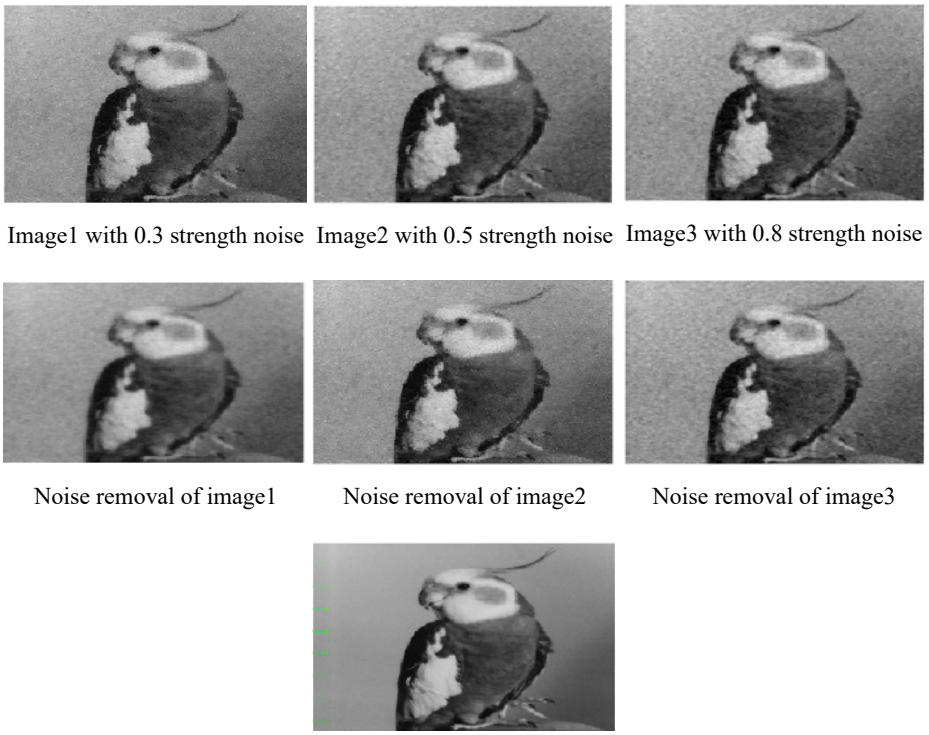


Image1 with 0.3 strength noise Image2 with 0.5 strength noise Image3 with 0.8 strength noise

Noise removal of image1 Noise removal of image2 Noise removal of image3

Improved image

**Fig. 5.** Noisy images, Denoised images and improved image

PSNR and MAE are calculated according to equations (3,4), Where Z original image and O improved image.

$$MAE = \frac{\sum_{x=0}^{M-1} \sum_{y=0}^{N-1} |Z(x,y) - O(x,y)|}{M \times N} \tag{3}$$

$$PSNR = 10\, log_{10}\left(\frac{M \times N \times (255)^2}{\sum_{x=0}^{M-1} \sum_{y=0}^{N-1} |Z(x,y) - O(x,y)|^2}\right) \tag{4}$$

Table 1 offers comparisons between different algorithms for several measures are PSNR, MAE and CT. These images are degraded with different amounts of noise and are eliminated by Band Reject Filter.

**Table 1.** Comparative PSNR, MAE and CT Produced by different Algorithm of birds images corrupted with various noise strength

| Denoising method | Noise strength 0.3 | | | Noise strength 0.5 | | | Noise strength 0.8 | | |
|---|---|---|---|---|---|---|---|---|---|
| | ***PSNR*** | ***CT*** | ***MAE*** | ***PSNR*** | ***CT*** | ***MAE*** | ***PSNR*** | ***CT*** | ***MAE*** |
| WGNF | 25.18 | 12.22 | 4.18 | 17.88 | 12.32 | 15.35 | 13.45 | 12.42 | 29.34 |
| ATBF | 32.23 | 4.2 | 2.34 | 22.8 | 4.1 | 9.23 | 17.43 | 4.3 | 17.56 |
| Proposed method | **37.43** | **1.71** | **1.23** | **34.23** | **2.68** | **5.20** | **26.5** | **1.78** | **7.46** |

Figure 6 shows original noisy Barbara images. Band Reject Filter are applied on the images to attenuate noise from them and then merged image is formed through the taking larger value of PSNR measure. This Figure presents periodic noise elimination from images using Band Reject Filter. The larger value of PSNR of each image is joined to construct an improved image. The final image is transformed to spatial domain using inverse discrete Fourier transform (IDFT) to construct an enhanced image.

Image1 with 0.3 strength noise  Image2 with 0.5 strength noise  Image3 with 0.8 strength noise

Noise removal of image1  Noise removal of image2  Noise removal of image3

Improved image

**Fig. 6.** Noisy images, Denoised images and Improved image

Table 2 presents comparisons between different equality measures for several algorithms are WGNF, BRF with the proposed method. The images in Table 2 are corrupted with different strengths of noise and are removed using BRF.

**Table 2.** Compartive PSNR, MAE and CT produced by different Algorithms of Barbara Images corrupted with various noise strength

| **Denoising method** | **Noise strength 0.3** | | | **Noise strength 0.5** | | | **Noise strength 0.8** | | |
|---|---|---|---|---|---|---|---|---|---|
| | ***PSNR*** | ***CT*** | ***MAE*** | ***PSNR*** | ***CT*** | ***MAE*** | ***PSNR*** | ***CT*** | ***MAE*** |
| WGNF | 23.16 | 11.22 | 3.17 | 15.82 | 12.26 | 13.33 | 11.35 | 11.24 | 27.24 |
| ATBF | 30.21 | 4.1 | 2.36 | 22.8 | 4.1 | 7.25 | 17.43 | 4.3 | 16.36 |
| Proposed method | **38.33** | **1.74** | **1.21** | **33.21** | **1.66** | **4.23** | **24.7** | **1.72** | **7.43** |

## 5 Conclusions

In this proposed, Band Reject Filter was proposed to remove periodic noise from mobile phone images at domain of the frequancy. The techniques of spatial domain are good to remove random noise while the methods of frequency domain are suitable to eliminate periodic noise. The blending process with Band Reject Filter are given more clear image and quality better from original images. The improved image is built depend on the Peak signal noise ratio. The larger value for the measure is taken to form a merged image and then it is transformed to spatial domain to construct an improved image.

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