# QUALITY HYPOTHESIZING OF DENTAL SHADOWGRAPHS USING MULTIPLE FILTERS

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**Abstract**
Unavoidable noise appears within all the data. Noise and unwanted information mask the true quality of the data. The most crucial element of every shadowgraph which is also known as a dental radiograph, that is crucial for evaluation is quality. Denoising of photos is required to be done for that. Gaussian, median, and mode filters are only a few examples of filters. Quality assessment is necessary in order to verify the uniqueness of dental shadowgraphs. To determine the image quality, an estimate of the ground validity is required. Particularly in dentistry, image denoising is the first step prior to segmentation and classification. To assess the quality of the image, different performance metrics are used namely Peak Signal-to-Noise Ratio, Signal-to-Noise Ratio and Mean Squared Error. For different noises, different filters yield good results in the experimentation. In this work, during noise removal, the Mode, Median and Gaussian filters give better accuracy for Poisson, Salt and pepper & Gaussian, and Speckle noise, respectively.

**Keywords:** Denoise, Image hypothesizing, PSNR, SNR, MSE, Filters

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**DOI: -** 10.48047/ecb/2023.12.si5a.0231

**Introduction**

Dental photos are crucial for recognizing the many dental problems that are concentrated in and around the mouth. Unwanted data or addon pixels are present in the images by default. While concentrating on the images, heterogeneous image modalities are present in dentistry subsumes X-rays, Intraoral X-rays, Bitewing, Periapical, Dental cone beam computed tomography, Magnetic resonance images, Panoramic radiograph, and cephalograms. Bitewing concentrated on the Molar and premolar teeth. Periapical images compile the front teeth view and panoramic images acquire the knowledge of the entire tooth view including both jaws. Preferably, image enhancement is done after pre-processing the dental images.

Various noises are present in the image during various processes including Image Acquisition, data collection and processing. This noise can be additive, multiplicative or impulsive noise. The additive and multiplicative noise is nothing but the add-on of unnecessary pixels to the image. The impulsive noise holds pixel values that are completely different by varying the originality of the image. The additive noise comprises Gaussian and Poisson noise. Multiplicative noise includes Speckle noise. Salt and pepper are the type that belongs to Impulsive noise. Filtering techniques are available to remove the noise from the images such as Mean, Mode, and Gaussian that includes operations such as smoothening, sharpening, and edge detection of the images which helps in the detection of images to classify them accurately.

Images hold the noise in such a way
$c = a + b$

where c = denoised image; a = original image; b = noise

Rajni et al., insist that noise reduction must be applied before images are processed, which is a key technology in image analysis. Therefore, picture-denoising algorithms are required to stop this kind of digital image distortion [1].

Lingli Huang et.al [2] augmented the weighted non-local means algorithm for picture denoising has been proposed by the author. Using the non-local means denoising technique, each pixel is substituted by the weighted average of pixels from the nearby neighborhoods. The proposed approach assesses photos with varying levels of noise. As per experimental findings, the algorithm enhances denoising performance.

Chandrika et.al [3] proposed there are several sorts of noise models, including additive and multiplicative ones. They consist of Brownian noise, Gaussian noise, salt-and-pepper noise, and speckle noise. Applications determine which denoising algorithm to use. When the image is distorted by salt and pepper noise, the filtering method has been shown to be the most effective. Images tainted with Gaussian noise can be denoised using a wavelet-based method.

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A. Jaiswal et.al. [5] experimented with Gaussian and salt-pepper noise denoising. The work is divided into the following four steps: (1) Filtering is used to denoise the image, (2) Wavelet-based approaches are used to denoise the image using thresholding, (3) Hard thresholding and filtering are applied simultaneously towards the noisy image, and (4) Results of PSNR and MSE are identified by comparing all cases.

**Materials and Methodology**

This section discusses information regarding the dataset and the methodology used. This also holds the description of various noises, filters to remove the noises, and quality evaluation metrics. This work is done using the panoramic images obtained from the public dataset. The Tufus Dental databasehttp://tdd.ece.tufts.edu/Tufts_Dental_Database/?C=D;O=A to perform various noise removal and image enhancement techniques.

**Image noises and types**

The images can be broadly divided into three types such as additive, multiplicative and impulsive noise.

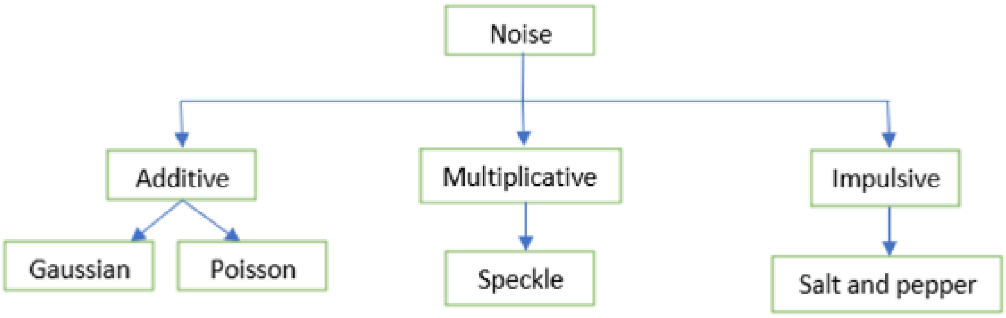



**Fig. 1** Noise and its types

**A. Gaussian noise**

Gaussian noise is present in medical images due to the electrical signals or statistical fluctuation that pass during the image acquisition. Each pixel and signal intensity are independent of the Gaussian distribution. Gaussian noise can distort an image, diminish contrast, and degrade the reliability of measurements made from it. In order to increase the quality and diagnostic significance of medical images, it is crucial to minimize or eradicate Gaussian noise. Gaussian noise in medical radiographs can be diminished in various ways, such as filtering algorithms that eliminate noise while conserving visual quality. Wavelet, median, and Gaussian filtering are a few examples of filtering techniques. The right filter should always be chosen on the basis of the image's features and the precise imaging modality being deployed.

Deep neural networks and other machine learning-based image-denoising algorithms have also demonstrated promising outcomes in the eradication of Gaussian noise in medical pictures. Weiner filter is appropriate for the gaussian noise[9].

**B. Poisson Noise**

Poisson noise, otherwise photon noise is present in medical images due to the intensity of light. It is considered to be a default noise that is caused by the photons accumulating on a detector. Photon noise is highly associated with the measurement of light. This noise is present in the MRI images. This noise is particularly present in the MRI images. As X-rays encounter a compound Poisson noise process, the energy deposited at an image pixel does not accurately represent the proportion of monochromatic photons absorbed. Due to the wide spectrum of the energy, the converted counts of X-rays have a compound Poisson noise distribution, whilst the volume of X-rays follows a Poisson noise distribution. Because of this noise, the disease prediction may become highly complicated due to its presence and maybe wrongly predicted. Electromagnetic noise, radiant temperature, and environmental noise are some other sources of noise. For photon noise gaussian, Weiner, and median filters can be applied to denoise [9].

**C. Salt and Pepper**

Salt and pepper are considered to be the default noise present in radiographic images. It seems to be black and white dots spotted on the images of various noise ranges. These pixels may show up as solitary clusters or dispersed across the entire image. The rapid development of digital images may have salt and pepper noise for a number of reasons, such as faults in image capture or transmission, fatal flaws in digital imaging techniques, or external influences like electro magnetic interference. The median filter suits better for the salt and pepper noise in medical radiology. But still, Gaussian and Weiner are also been used for denoising the images [9].

**D. Speckle noise**

Speckle is the multiplicative noise found predominantly on geographical images. It is produced in unified imaging methods like synthetic aperture radar (SAR) imaging, ultrasonic imaging, and others. Speckle noise, which is mostly created by coherent processing of backscattered signals from widely distant targets, makes it challenging to understand SAR images. Speckle noise can obscure tiny details and distort visual features, making interpreting and analyzing images challenging. Several techniques for image processing such as filtering or statistical analysis can be used to reduce the consequences of speckle noise. These techniques reduce the noise while retaining as much of the original image data as possible. Gaussian filter is preferred for the speckle noise on images [10].

**Noise removal filters**

Applying filters to noise present in the images is the predominant phase in standardizing the images. These filters help in retaining the originality of the image after denoising. Various filters such as Gaussian, Median, and Mode are used in getting back the originality of the image by removing unwanted signals or waves.

***A. Median Filter***

Spatial domain filter seems to be the median filter. It can also be defined as a filter for order statistics. The most widespread and often applied nonlinear filter is the median filter. The MR images are smoothed to eliminate noise. Furthermore, this filter reduces the intensity difference between individual pixels in a medical image. The median filter procedure calculates the median value for each pixel in the medical picture. Along with signal processing and time series processing, median filters are frequently utilized as smoothers for medical image processing.

***B. Gaussian Filter***

An example of a linear filter used in signal processing and image processing is the Gaussian filter. It is frequently used for smoothing and noise reduction of images and data and is based on the Gaussian distribution. Due to its ability to maintain edges while lowering noise, a Gaussian filter is a common option for image smoothing. This is due to the filter's ability to reduce high-frequency components while mostly preserving low-frequency components.

***C. Mode Filter***

A non-linear filter known as a mode filter is used in signal and image processing to reduce noise and eliminate erroneous or outlier pixels. Salt-and-pepper noise, also known as impulsive noise, can be removed with this technique. Each pixel value in an image is replaced by the mode value of the nearby pixels within a specified neighborhood as part of the mode filter's operation.
Performance metrics

Performance metrics are used to evaluate the quality of the noisy image after denoising using different metrics such as Peak Signal to Noise Ratio, Signal to Noise Ratio, and Mean Squared Error. These metrics evaluate how far these images have been improvised in order to determine the accuracy to perform classification and segmentation of the images.

**A. Peak Signal–to–Noise Ratio (PSNR)**

The term "PSNR" refers to the association between a signal's absolute maximum value and the amount of noise that distorts it and degrades the signal's representation quality. [7]. PSNR is typically stated as a decibel-scaled logarithmic value. It is a widely used statistic to gauge how consistently lossy compression approaches perform. PSNR does have some restrictions, though. It excludes other aspects of an image's quality, such as contrast, sharpness, and color accuracy, and is based on the idea that the human visual system is more sensitive to variations in brightness. In order to assess the quality of images and videos, PSNR should be used in collaboration with other metrics and qualitative testing as it does not always correlate well with human perceptual quality.

**B. Signal-to-noise ratio (SNR)**

The ratio of the average signal value to the standard deviation of the signal value is referred to as the signal-to-noise ratio (SNR). [8]. In many applications, such as wireless communication or digital audio and video, where signals are sent through a noisy channel, SNR is a key term. By modifying variables including the transmit power, bandwidth, and modulation scheme, is used to assess the signal's quality and to maximize the signal's transmission and reception.

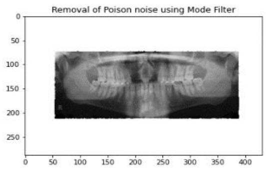
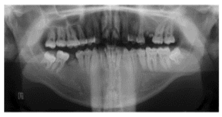
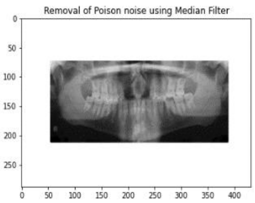
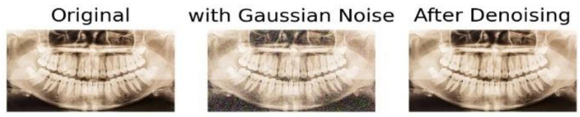
**C. Mean Squared Error (MSE)**

The Mean Squared Error (MSE) is the image quality measurement metrics as the absolute error. Mean Squared Error (MSE) between two images such as g(n,m) and g῀(n,m) is defined as [6]

**Results and discussions**

Below table 1 elaborates on the MSE, SNR and PSNR values of the original and denoised images of different filters and tabulated the highest of the obtained values. In this experiment Mode filter gives better accuracy for Poisson noise, the Median filter suits better with the Salt and Pepper and Gaussian noise which is predominant in the shadowgraph images and Gaussian filters work better with Speckle noise.

**Table 1:** Results from radiography and quality assessment using MSE, SNR, PSNR

| Noise | Filter | Original Image | Denoised Image | MSE | SNR | PSNR |
|---|---|---|---|---|---|---|
| Poisson | Mode |  |  | 96.83 | 2.72 | 29.52 |
| Poisson | Median |  |  | 45.02 | 2.85 | 31.99 |
| Salt and pepper | Median |  | | 25.40 | 2.52 | 37.65 |
| Gaussian | Median |  | | 17.84 | 3.03 | 39.11 |
| Speckle | Gaussian |  | | 16.55 | 7.25 | 34.49 |

## Conclusion

The denoising of images along with the filters associated are tabulated and it does not work well for the speckle since they are far applicable to geographical images. In future work, Structural Similarity Index (SSIM), and Feature Similarity Index (FSIM) are to be found. Edge detection using Canny and Laplacian edge detection is to be used.

## Acknowledgment

The MHRD RUSA 2.0 (2021-2023) provided funding for this research project on Biomaterials – Research Innovation and Quality Improvement-Nano informatics on the role of Nano-HAp in dental: Schema and System Design under Functional Synthetic Material for Biomedical Applications Theme-2 from the University of Madras.

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