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Intelligent Filtering Techniques for Reducing Various Noise in Image of Mango Leaves.

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Abstract: One of the greatest challenges in image processing is to remove noise from the image. Since ages, it is seen that reducing the noise level in the image as a greater challenge. The intelligent image processing has been equipped with the smart algorithms in this arena that can remove the noise and retrieve the image with its crucial results. That the distortion of the signals and the noise can be easily removed using the image processing algorithms. The application includes in the field of medical science, radar and satellite imaging as well. In this research article tries to find out which algorithm and the technique have better efficacy in removing the noise for a mango leaf image. To verify the functionality, the noise like poison, salt and pepper, Gaussian and speckle noise are considered. The image is verified with median average and adaptive weiner filters. The entropy and the time taken to execute are the performance parameters that are likely to be measured in research article. After removing the noises present in the mango leaf image, it can be further processed to identify disease present, if any.

Keywords: *Adaptive Weiner Filter, denoising, Gaussian noise, Image processing, impulse Noise, Median Filters, Poisson Noise, Speckle noise, noise.*

1. Introduction

Noise effects most of the images, In the process of analyzing the image, noise is an unwanted signal that causes most of the difficulties. To remove these noises from the image, a technique called image denoising is used. In this image, denoising the disturbance or the unwanted noise can be removed And the image can be processed for further data extractions. The unwanted noise is filtered out using image denoising This helps in accentation of the features and improves the quality of image. The filtering is a process that helps in the improvement to the visual enhancement, and also for the interpretation of laying down foundation for image segmentation.

The process of interpolation and the resampling is further accomplished for different data extraction from the images. Based on the behavior of data and the form of image, the type of the filter that is used to remove the noise can be decided. the linear and the non-linear filter are the two main categories of filter. The superposition property and the shift invariance are the two main principles of working of linear filtering. Based on the priorities like smoothening or preserving the edges, the type of filters is decided [1]. The main agenda of nonlinear filter is to have a median or rank order filter. The linear filter will have more advantage when the image contains large amount of noise with a lesser magnitude of data.

The nonlinear filter can be used whenever there is lesser noise and higher magnitude of data. The noise may be of random variations in the image making the visual and pictorial interpretation laborious. In this research article, Various kinds of filtering techniques such as Median, Average and Adaptive Weiner filters are applied to a mango leaf image having Gaussian, Poisson, Salt & Pepper and Speckle noise[2][3]. To evaluate the results measuring of parameters like time for execution and entropy has been used. Further execution time is also critically evaluated for comparison of each filter with the help of graphical analysis[4].

2. Categories of Noises in Mango Leaf Images

If there is some variation in the image intensity and affected by the grains in any part of the image, it is termed as noise. The reason for noise in the image may be arised due to different physical properties of a photon or it might be due to the thermal energy within the image sensors. During the image transmission or during the stage of capturing the image, the noise would have been added. Technically, noise in an image can be defined as an different intensity value of the pixel displayed instead of

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the true value that is obtained from the image. In image processing, there are different algorithms that helps in reducing or in removing the noise from the images. The algorithms that help introduction of noise, it removes the visible noise by smoothening the entire image and taking the Image values very near to the contrast boundaries. In this research article, a normally found mango leaf is considered where the simple noises that are merged in the mango leaves are Gaussian noise, poison noise and salt and pepper noise. There are other noises as well, like speckle noise and multiplicative noise and impulse noise. As it is aware, the noise have their own characteristic and are distinguishable from each other [6].

A. Gaussian noise (Amplifier Noise)

The simple mode of Gaussian noise is also called as additive noise. It depends on the pixel and also signal intensity in the image. This kind of noise is also called as Johnson Nyquist noise. This noise comes with a reset noise of capacitor. It is also the idealized form of white noise, which is a result of reset noise in the capacitor. If there are any amplifications done with respect to blue colour, then the noise in the Blue Channel is predominantly more when compared with the Red Channel and the Green Channel. In the image sensor, the amplifier noise plays a major role in contaminating the images. They affect the darker area of images in a high intensity levels. When an image is affected with the Gaussian noise, the original value of the image will be changed by a very small amount in Gaussian noise. In the histogram, the noise distribution will be normal whenever the image is affected by Gaussian noise. The frequency of the pixel against which the distortion occur is plotted in the histogram. Normally, the Gaussian distribution is considered as a very good model because of certain limits of the theorem that makes the sum of different noises to approach the Gaussian distribution. It is seen that the Gaussian distribution is 10 to represent the Gaussian noise in probability density function. This is also called as Gaussian distribution the equation one represents the probability density function of the Gaussian Random variables [7].

$$P_z = \frac{1}{\alpha\sqrt{2\pi}} e \frac{-(z-\mu)^2}{2\sigma^2} \quad ------(1)$$

In the above expression, the grey level is represented α. The standard deviation and the mean value are σ and μ Respectively. The figure 1 represents the addition of Gaussian noise to the mango leaf.

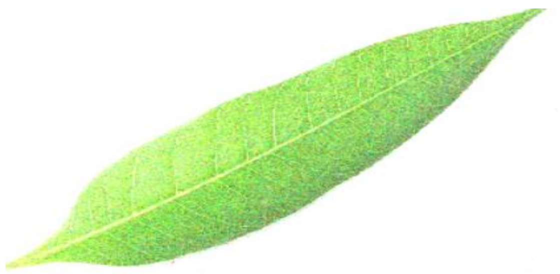

Fig. 1: Mango leaf Image with Gaussian Noise

B. Poisson Noise

Photo noise is the alternative name for the poison noise, It is also a signal dependent noise. This kind of noise is obtained whenever a large number of particles help in carrying the energy falls to give you the boosted statistical fluctuation. Latest theoretically proven that the poisons distribution is always higher than the Gaussian distribution. The image in figure 2 represents Poison noise added for a mango leaf image [8]7[9].

Fig. 2: Mango leaf Image with Poisson Noise

C. Speckle or Multiplicative Noise

This is a granular noise and exists inherently to decrease the quality of images in the applications like nature photography, oceanography, SAR – Synthetic Aperture Radar. Speckle noise occurs due to the random variations in the return-signals from the objects that are not larger than the single unit pixel. It also occurs from coherent-processing of the signals that are back-scattered from the multiple targets, which are distributed randomly. Speckle noise rises the mean grey-levels of the pixels in the local areas and causes the significant challenges in the interpretation of the images. Speckle noise can be computed as difference of the pixel's measured intensity value and the actual mean intensity value. The image that are affected by speckle noise are represented by the Equation (2),

$$g(n, m)=f(n, m) *u(n, m) + \varepsilon(n, m) \text{ ------(2)}$$

where g(n, m) is an observed image, speckle noise's multiplicative-component is represented by u(n, m) and speckle noise's additive-component is represented by ε(n, m). Lateral indices and axial indices are denoted by m and n respectively. The name multiplicative noise is due to the fact that speckle noise is modeled from the values that are obtained by the multiplication of random values with the values of pixels. Fig.4 is shows the added speckle noise to mango leaf image[10].

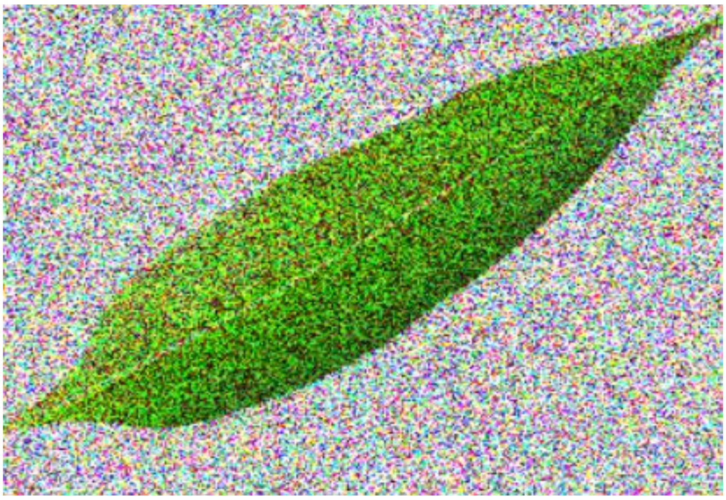

Fig. 4: Mango Leaf with the Speckle Noise

3. Filtering Techniques

Filters are necessary to remove noise in the images before they are processed. Several types of filters are available in the literature to eliminate noises in the images. Here we considered three different filters for analyzing the performance in removing the different noises in mango leaf images. In the filtering methods, three significant components of an image, i.e., R, G and B are separated by using appropriate filters which are built-in the Matlab tool. Next, amplification is done to increase the gain for compensating for attenuation caused by filtering. Then, appropriate filter (Median Filter, Average Filter and Adaptive Weiner Filer) is applied to eliminate noises present in an image. The filtered primary components are next merged to obtain colored image. The block diagram of this complete process is shown in the Fig.5 [11].

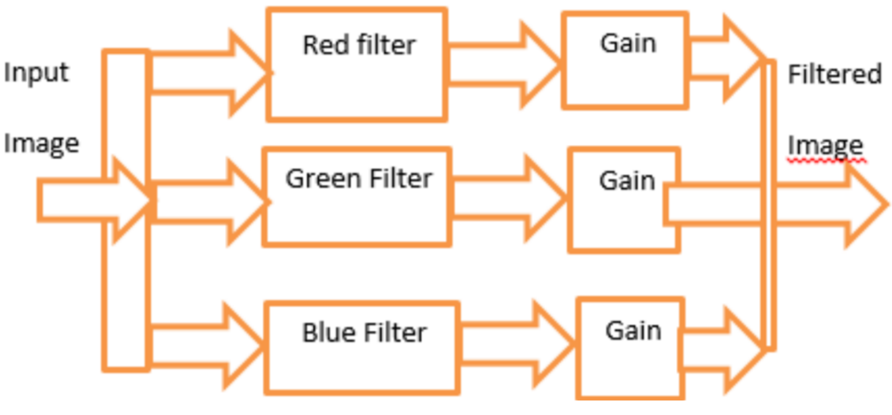

Fig. 5: Block diagram of the proposed filtering technique for analysis

A. Median Filter

It is also known as edge preserving filter and is nonlinear technique in the process of denoising. It proceeds in a way that every pixel is reacquired with median value from neighboring pixels. It proves to preserve the edges and lines of the image in best possible way and removes the outliers. The mathematical expression of median filter is given in the equation (3).

Y[m,n] = median{x[i, j], (i, j)∈w} ------(3)

where w is neighborhood absorbed on location [m, n] in an image.

Median filter Algorithm:

Example of the median filter is shown in the Fig.6. and median filter algorithm is given below:

Step-1: Select a two-dimensional window, W with the size 3x3. Let pixel to be processed is Cx, y.

Step-2: Calculate W_{med}, which is the median value of pixels in W.

Step-3: Replace the value of pixel Cx, y with W_{med} value.

Step-4: Repeat the Steps-1 to Step-3 until all pixels of the image will be processed.

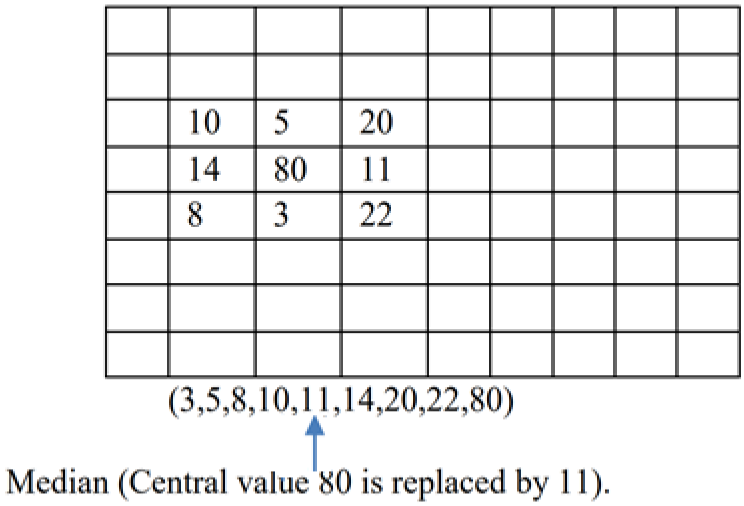

Fig.6: Example of the Median filter

B. Average Filter

Mean filtering is a process of image smoothing by compressing the extent of intensity variations among the neighboring pixels. This filter proceeds in a way that every pixel is replaced with mean value of neighboring pixel including itself. There exists certain issues while implementing the mean or the average filter and they are: (i) A single pixel with peculiar value can influences pixels average value in the neighborhood. (ii) Edges might get blurred while interpolating the new values[12].

C. Adaptive Weiner Filter

Removal of blur due to linear motion in the image can be efficiently achieved by Wiener filter. This proceeds with the method such that optimum solution is acquired between converse filtering and polished noise. It is a continuous assessment of the actual image which can be stated in Fourier domain as given by equation (4),

$$W(f_1, f_2) = \frac{H*(f_1,f_2)S_{xx}(f_1,f_2)}{(|H(f_1,f_2)|)^2\, S_{xx}(f_1,f_2)+S_{nn}(f_1,f_2)} \quad (4)$$

The major drawback of this method is that it is singular in nature and hence focusing on the use of generalized inverse filtering [13].

4. Results and Discussion

The Mango leaf images with four different noises i.e., Gaussian, Poisson, Salt & Pepper and Speckle noises are considered. To effectively remove these noises from the mango leaf images, three different filtering techniques i.e., median, average and adaptive wiener are applied. All the three filters behave differently for each type of noise. Filtering techniques results for the Gaussian noise are shown in the Fig.7. Similarly, results of the Posisson noise are shown in the Fig.8, the outcomes of removing Salt & Pepper noise is indicated in Fig.9. Also Fig.10 indicates results of the Speckle noise removal. The comparative efficacy of these filtering techniques is done by determining the parameters, time of execution and Entropy are summarized in Table-1 and Table-2.

Fig.7(a): Mango leaf image with Gaussian Noise

Fig.7(b): Noise Removal with Median Filter

Fig.7(c): Noise Removal with Average Filter

Fig.7(d): Noise Removal with Gaussian Filter.

Fig.8(a): Mango leaf image with Poisson Noise

Fig.8(b): Noise Removal with Median Filter

Fig.8(c): Noise Removal with Average Filter.

Fig.8(d): Noise Removal with Gaussian Filter.

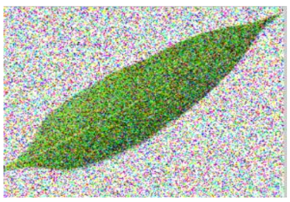

Fig.9(a): Mango leaf image with Salt & Pepper Noise.

Fig.9(b): Noise Removal with Median Filter

Fig.9(c): Noise Removal with Average Filter

Fig.9(d): Noise Removal with Gaussian Filter

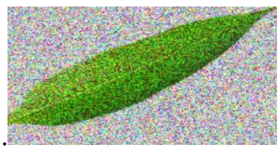

Fig.10(a): Mango leaf image with Speckle Noise.

Fig.10(b): Noise Removal with Median Filter

Fig.10(c): Noise Removal with Average Filter

Fig.10(d): Noise Removal with Gaussian Filter

Table-1: Execution time (in seconds) of different filters for Mango leaf image with different noises

Type of Noises	Type of Filters		
	Median	Average	Wiener
Gaussian	0.1388	0.13631	0.92193
Poisson	0.14914	0.16771	0.14113
Salt & Pepper	0.11961	**0.12426**	0.91137
Speckle	**0.09535**	0.14118	**0.08193**

From Table-1, it is observed that the median, average and wiener filter behave differently for Gaussian, Poisson, Salt & Pepper and Speckle noise. This fact is evaluated by performance measuring parameter i.e., execution time. For Gaussian noise, Median, Average and Wiener filter, the execution time is 0.13886 sec, 0.13631sec and 0.92193 sec respectively. For Poisson noise, Median, Average and Wiener filter gives the execution time 0.14914 sec, 0.16771 sec and 0.14113 sec respectively. For Salt & Pepper noise, Median, Average and the Wiener filter execution time 0.11961 see, 0.12426 sec and 0.91137 sec respectively. Similarly for Speckle noise, Median, Average and the Wiener filter gives the execution time 0.09535 sec, 0.14118 sec and 0.08193 sec respectively.

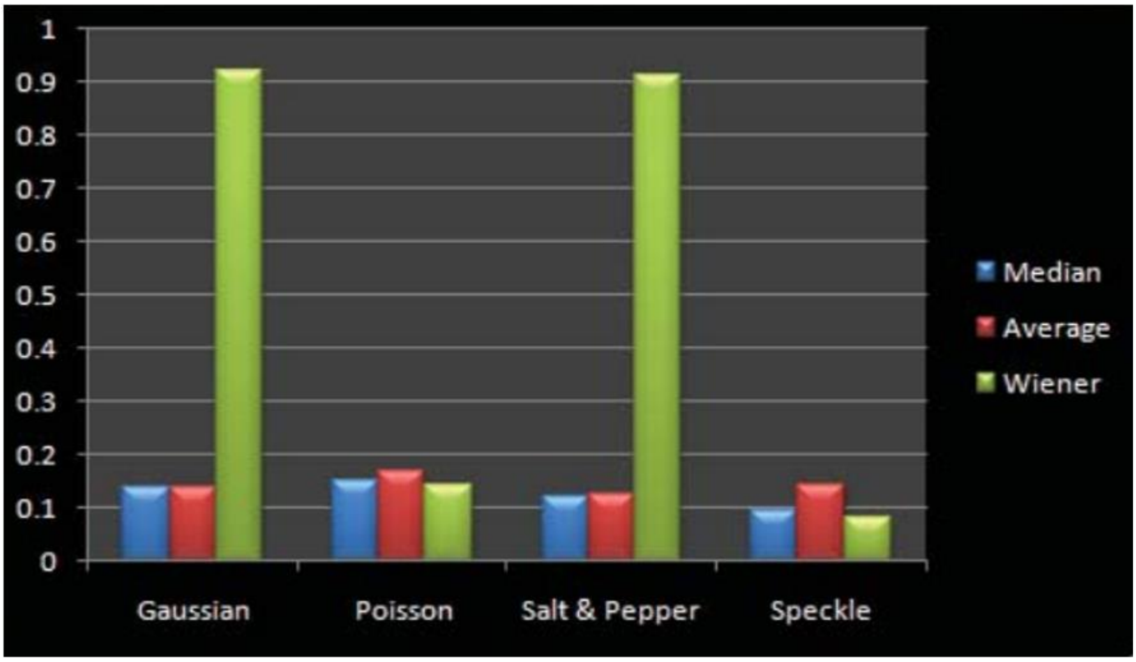

Fig.11: Graphical analysis of execution time

Table-2: Entropy of different filtered Mango leaf images with different noises

Type of Noises	Type of Filters		
	Median	Average	Wiener
Gaussian	0.14397	7.01561	6.88412
Poisson	0.21365	7.02671	4.23211
Salt & Pepper	0.1689	6.5946	7.1983
Speckle	**0.32168**	**7.8623**	**7.2341**

From Table-2, it has been observed that the median, average and wiener filter behave differently for Gaussian, Poisson, Salt & Pepper and Speckle noise. This fact has been evaluated by performance measuring parameter i.e., entropy. For Gaussian noise, Median, Average and Wiener filter, the entropy is 0.14397, 7.01561 and 6.88412 respectively. For Poisson noise, Median, Average and Wiener filter gives the entropy 0.21365, 7.02671 and 4.23211 respectively. For Salt & Pepper noise, Median, Average and Wiener filter has entropy 0.1689, 6.5946 and 7.1983 respectively. Similarly for Speckle noise, Median, Average and Wiener filter gives the entropy 0.32168, 7.8623 and 7.2341 respectively.

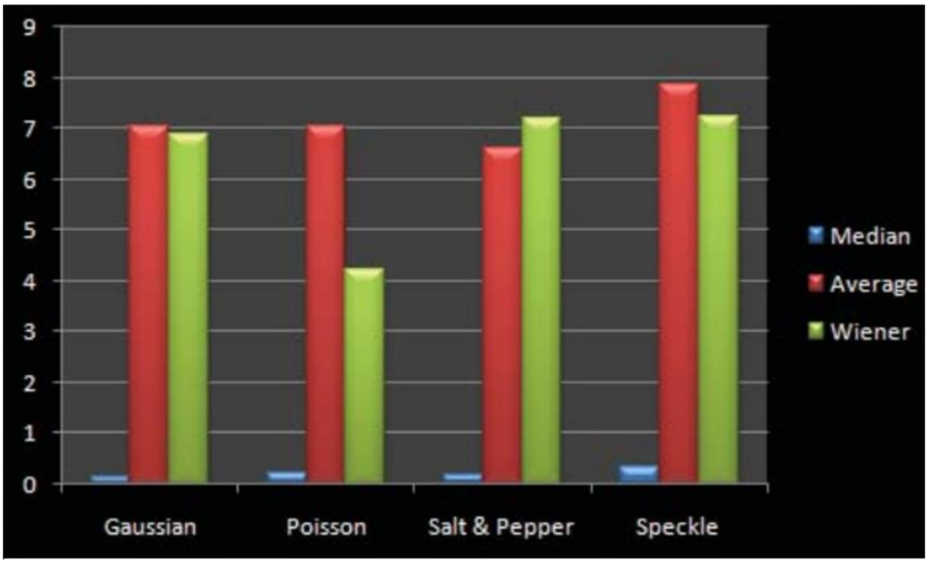

Fig.12: Graphical analysis of entropy

5. Conclusion

Intelligent Noise removal serves as one of the crucial step for improving the quality of an image for visual interpretation. Effective de noising can be achieved by filtering out the unwanted signals. From the analysis, it clearly depicted that among all the noises (Gaussian, Poisson, Salt & pepper and Speckle) speckle noise give the best entropy for median, average and wiener filter. For median and wiener filter least execution time is taken in comparison of other filters. Salt and pepper noise gives the best results on average filter. As an future scope of the present research article the same algorithm can be propsoed to apply for the other family of leaf and similar kind of image data base of consideration

References

[1] Murat Alparson, Gungor and Irfan Karagoz, "The Effects of the Median Filter with Different Window Sizes for Ultrasound Images", Proc IEEE International Conference on Computer and Communications, pp 549-552,2016.

[2] Chikako Abe and Tetsuya Shimamura, "Iterative Edge Preserving Adaptive Wiener Filter for Image De noising", International Journal of Computer and Electrical Engineering, Vol 4, No.4, pp 503-506, 2012.

[3] Prajoy Podder and Md Mehedi Hasan," A Meta Study of Reduction of Speckle Noise Adopting Different Filtering Techniques, Proc IEEE International Conference of Electrical Engineering and Information Communication Technology, pp1-6, 2016.

[4] G A Eninicke," iterative Filtering and Smoothing of Measurements Possessing Poisson Noise", IEEE Transactions on Aerospace and Electronic Systems, Vol 51, No. 3, pp 2205-2211, 2015.

[5] Priyanka Punhani and Dr Naresh Kumar Garg," Noise removal in MR Images using Non-Linear Filters", Proc IEEE International Conference on Computing, Communication and Networking Technologies, pp1-6, 2015.

[6] Jingdong Chen, Jacob Benesty, Yiteng Huang and Simon Doclo, "New insights into the Noise Reduction Wiener Filter". IEEE Transactions on Audio Speech and Language Processing. Vol 14, No 4, pp 1218-1234, 2006.

[7] Teng Li, Bingbing Ni, Mengdi Xu, Meng Wang, Qingwei Gao and Shuicheg Yang, Data Driven Affective Filtering for Images and Videos", IEEE Transactions on Cybernetics, Vol 45, Issue 10, pp 2336-2349, 2015.

[8] Yi Wang, Jiangyun Wang, Xiao Song and Liang Han, "An Efficient Adaptive Fuzzy Switching Weighted Mean Filter for Salt and Pepper Noise Removal", IEEE Signal Processing Letters, pp 1582-1586, 2016.

[9] Sashikala Gurusamy and K Sidappa Naidu, " An Efficient De noising Method for Salt and Pepper Noise with Removal of Blur in an Original Image", Proc IEEE International Conference of Inventive Computation Technologies, Vol 3, pp 1-5, 2016.

[10] Qiao Jihong, Chen Lei and Chen Yan, "A Method for Wide Density Salt and Pepper Noise Removal", Proc IEEE Control and Decision Conference, pp 2940-2943, 2014.

[11] Isabel Rodrigues, Joa Sanches and Jose Bioucas Dias, "De noising of Medical Images Corrupted by

Poisson Noise, Proc IEEE International Conference on Image Processing, pp 1756-1759, 2008.

[12] Suhailo Sari, Hazlu Roslan and Tetsuya Shimamura, "Noise Estimation by Utilizing Mean Deviation of Smooth Region in Noisy Image", Proc IEEE International. Conference on Computational Intelligence, Modeling and Simulatiion, pp 232-236, 2012.

[13] Fitri Utaminingrum, KeiichiaUchimura and Gou Koutaki, "High Density Impulse Noise Removal Based on Linear Median Filters". Proc IEEE Korean Japan Joint Workshop on Frontiers of Computer Vision, pp 11-17, 2013.

[14] Kumar, D. ., & Sonia, S. (2023). Resources Efficient Dynamic Clustering Algorithm for Flying Ad-Hoc Network. International Journal on Recent and Innovation Trends in Computing and Communication, 11(2s), 106–117. https://doi.org/10.17762/ijritcc.v11i2s.6034

[15] Prof. Prachiti Deshpande. (2016). Performance Analysis of RPL Routing Protocol for WBANs. International Journal of New Practices in Management and Engineering, 5(01), 14 - 21. Retrieved from http://ijnpme.org/index.php/IJNPME/article/view/43

[16] Pande, S.D., Gudipalli, A., Joshi, R., Chaudhari, S., Dhabliya, D., Ahammad, S.K.H., Kale, S. D. A Fuzzy-Based Slip Resistive Controller for Front Wheel Drive Autonomous Electric Vehicle (2023) Electric Power Components and Systems, .