Title Page**:**

Efficient Noise Detection and Removal in X Ray Images using Novel Kalman Filters Compared with Median Filter for Better Accuracy

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**Keywords**: Real-time Images, Novel Kalman Filters, Median Filter, Accuracy, Detection Accuracy, Noise elimination, *Environment*

**ABSTRACT**

**Aim :**The principal goal of this work is to enhance the noise detection and noise environment removal in X-Ray images using the Novel Kalman Filters for efficient medical findings and it is compared with the popular Median Filter. **Materials and Methods**: The models are designed to remove environment noise from X-Ray images using Novel Kalman Filters and Median filters with sample size of 110 the g-power value of 0.8. The X-Ray image dataset is used for investigational work in this research Novel Kalman Filter is executed using the MATLAB image processing tool. **Results and Discussion**: Based on the simulation result of the novel kalman Filter accuracy value is compared with the existing median filter. The proposed novel kalman Filter accuracy value is outperforms the existing Median filter with considerable improvement (93.87% Vs 92.67%).The p value of 0.005 (p < 0.05) indicates that there is statistically significant difference between the two groups.**Conclusion:** This proposed research work of Novel Kalman Filters outcome suggest that it is superior than the existing Median filter in the field of X-ray images evaluations and findings.

**Keywords**: Real-time Images, Novel Kalman Filters, Median Filter, Detection Accuracy, Noise Removal, *Environment*

**INTRODUCTION**

Earlier psychological investigational studies have described that people obtain the highest amount of data via vision. But, recently people's vision ability has been extended; the number of computer-based images has increased in various fields and human life. Due to this enormous growth of image filtering or noise removal is more significant in all domains. The accuracy rate of the classification models is affected because of noises [(Garg, Gupta, and Prasad 2022)](https://paperpile.com/c/EKX5ip/PhbP). In most industrial domains images are collected from sensors. Environment Noise removal is one of the serious issues in image-based applications, which are obtained by different types of filters . This algorithm is used in medical equipment.

Reducing noise is the major step in the image-extracting process [(A. E. Hassanien and Oliva 2017)](https://paperpile.com/c/EKX5ip/tZT5). Currently, huge numbers of images are extracted from various sensors. Decreasing noises from the images makes an original image from the damaged images[(Vaseghi 2013)](https://paperpile.com/c/EKX5ip/iyek). Noise reduction is very difficult unless anyone can create the original arrangement of the images[(Raza 2020)](https://paperpile.com/c/EKX5ip/O7Ca). Noise removal filters are designed with different rules based on the image types and the aim of the restoration process .[(McCollough, Rajendran),](https://paperpile.com/c/EKX5ip/Kb54)

A complex image is a mixture of pictures, graphs, and text. Reduction of noises in a complex image is important to manage image quality. Noise is automatically integrated with the images environment during image collection or image capturing. [(van der Aalst et al. 2017)](https://paperpile.com/c/EKX5ip/i2W9) After collecting, preprocessing is important to adjust and precise the images for next-level processes like segmentation and classification[(Bertalmío 2018;](https://paperpile.com/c/EKX5ip/OTQe+i2W9)  From the earlier studies, various filtering approaches are offered for noise reduction from complex pictures..Real-time Images Over the past 5 years, more than 300 research articles were available in GS (Google Scholar) and nearly 150 papers were existing in science direct journals with different filtering methods. Compared to the outcome of the other filtering techniques, The novel kalman Filter removes the noises from the images with better accuracy. The main objective of this research work is to remove the noises from real-time images using filtering approaches with a better accuracy rate[(Roman-Rangel et al. 2021)](https://paperpile.com/c/EKX5ip/2vxR).

**MATERIALS AND METHODS**

This cutting-edge lookup work was once created and developed at the Environment Image Processing Laboratory, Saveetha School of Engineering, SIMATS (Saveetha Institute of Medical and Technical Sciences). The encouraged noise elimination gadget consists of two kinds of businesses: Group 1 is taken as the novel Kalman Filter and group 2 as Median Filter 10 sample size. The novel Kalman Filter and Median filter were assessed many times by sample sizes. After the collection of the image database, repetitive and unnecessary portions of the images were removed by filtering and data cleaning tasks. Then, it is connected to the relevant data sets, and the accuracy rate Real-time Images of the novel Kalman Filter and Median filter is measured and compared.

The real-time images are collected and applied in this present work for the experimental process. It uses a MATLAB tool for designing the Filtering system. Among the various tools, MATLAB is one of the most commonly used tools for designing and evaluating the performance of the filters. Real-time Images It contains a huge number of library functions and various tools that are used for entire processes related to the filtering system.

**Novel Kalman Filters**

The novel kalman Filters (NKF) is one of the ultimate filters that comprise a team of mathematical formulation that assumes the situation of a discrete-time linear kind venture from ancillary, erroneous, and undefined observations. This filter is termed foremost as, when the photos are affected by way of white Gaussian-type noise, the novel kalman Filter decreases the MSE(Mean Square Error) of the assessed attributes. The circumstance of the discrete kind time system is developed the use of a linear-based equation with z∈Rn measure :

From the above equations, denotes the matrix that friends the circumstance of the past time stage to the modern-day stage in the non-existence of noise, and represents the matrix that buddies the nation manipulates enter value. represents the matrix that relays the dimension kingdom and denotes the noise measurement, and the method respectively..

**Pseudo code**

Input: coaching and checking out data.

1.Load the dataset, first.

2: Randomly selected data from dataset into training and testing data

3: Define the target variable.

4.Create the Classifier using the training set as a basis in step4.

5: Use real-time picture domain analysis to train the classifier while removing noise.

6. Use the training dataset to predict the testing set.

7.Review the classifier in

Results: Accuracy in %

**MEDIAN FILTER (MF)**

MF is a special type of filtering technique and it is also called rank filtering. It is a familiar filter because of its better performance for special types of noises like salt and pepper, and Gaussian noises. In MF, the middle pixel neighborhood value is exchanged by the concerned window average value [(Qian, Sun, and Clark 2002)](https://paperpile.com/c/EKX5ip/zG0k). Pixels containing noise values are different from actual image pixel values. With the help of this concept, MF extracts the noises from the corrupted images,[(Kyriacou and Allen 2021)](https://paperpile.com/c/EKX5ip/cKAD)

MF is a kind of non-linear type filtering approach and it is familiar to reduce the impulsive based noise during reserving the sharp ends. MF substitutes the average pixel data but this type of filter does not save the details of the images. Some noises are deleted with the help of MF. But in this research task replace the pixel values with the median values. The median value is measured based on nearest neighbor values and exchanged the values with center pixel data .

The advantages of the Kalman-median filter are: (i) it increases accuracy rate ; (ii) it reserves image edge and time-series low-frequency actual signal (iii) it is suitable for real-time images.

**Pseudo code**

Inputs - Training and Testing data.

Outputs - Accuracy.

1:Read and import the dataset.

2. Randomly choose some features from the dataset.

3.Create a parameter for the median filter classifier in step

4.Train the samples for the median filter regression models.

5. Determine the discrepancy between the expected and actual output.

6.Voting was conducted for each expected outcome.

7.The outcome was chosen based on the predictions that received the most votes

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# **STATISTICAL ANALYSIS**

Statistical software tool IBM SPSS with the common version 26.0 to discover the value of SD (Standard Deviation), mean deviation information, significance point data and also drawing the graphical demonstration, etc. The SPSS tool was inclined in the present research process for investigating given data. Group statistics practice and self-determining sample tests were directed at the experimental outcomes and the graph was created for two different graphs with two different kinds of features under the specific investigational phase. Datasets [(Roman-Rangel et al. 2021)](https://paperpile.com/c/EKX5ip/2vxR) for training and testing are selected for the database. The training dataset is established by reclaiming the test dataset from the real dataset. The T-Test for autonomous examples is run.median filtering, wavelet denoising, the size of the window used in a median filter,

**RESULT**

MATLAB tool is used to analyze the data and the accuracy value is assessed among Kalman and Median filters. For real-time datasets, the proposed novel kalman Filters offers a better accuracy rate than the Median filter. The accuracy rate of the novel kalman Filters is 93.87 % and the Median filter 92.67 %.illustrates group statistics based on the real-time dataset of this current research work.

Table 1. Comparison of prediction of accuracy between novel kalman Filters and median filter. The novel kalman Filters achieved an accuracy of 93.87% compared to median filter having 92.67%. It shows that the novel kalman Filters performed significantly better than median filter For Noise Detection and Removal in X Ray Images. The precision and execution of novel kalman filters were found to be significantly higher than those of median filter.This indicates that novel kalman filter is a better choice than median filter for this particular dataset and task.

Table 2 Group information displaying the mean, popular deviation, and fashionable error imply values for the two algorithms, novel kalman filter and median filter algorithm - with 10 sample sizes. The Performance of novel kalman filter and median filter on theNoise Detection and Removal in X Ray Images is implemented for the given dataset. The results show that the novel kalman filter has a standard deviation of 3.092 and a standard error mean of 0.9780. For median filter, with a standard deviation of 3.097 and a standard error mean of 0.9790.

Table 3 It shows the results of the 2-tailed significance test, which indicates that the difference in accuracy between the two algorithms is statistically insignificant. The 2-tailed significance value of less than 0.019 (p< 0.05) supports the hypothesis that the novel kalman filter is a better choice than median filter for this dataset and task.

**DISCUSSION**

The median filter is used in the preceding research work, accuracy rate is 92.67%. The proposed Novel Kalman Filter is developed, which has a mean accuracy rate of 93.87% Within various filtering concepts, the novel kalman Filter is one of the best filters[(Roman-Rangel et al. 2021)](https://paperpile.com/c/EKX5ip/2vxR). It uses the based statistical type theory estimation . Novel Kalman Filters generates a recursive method, which creates real-time usage to systems more suitable. Commonly it is used to identify locations through navigation, target placing, image handling, voice data processing, prediction of an earthquake, fault identification, etc. Normally, the novel kalman Filtering concept is applied for corrupted by noisy grayscale pictures .

The conducted a comparative study among three various filters [(Garg, Gupta, and Prasad 2022)](https://paperpile.com/c/EKX5ip/PhbP) . Here filters are applied to decrease the noise level originating from the RFID UWB concept connected with an 18 cm error[(Roman-Rangel et al. 2021;](https://paperpile.com/c/EKX5ip/2vxR+9y5j) . To reach this objective, a group of investigations is implemented using two various shapes oval and linear[(Kyriacou and Allen 2021)](https://paperpile.com/c/EKX5ip/cKAD). The reached outcome showed that KF( novel kalman Filters ) produces superior results than existing filters [(A.-E. Hassanien et al. 2020)](https://paperpile.com/c/EKX5ip/pXfT).

In most of the applications, a Median filter is applied for extracting salt and pepper-type noises from different types of complex pictures[(Chui and Chen 2013](https://paperpile.com/c/EKX5ip/9y5j+IdJH)). Various experiments are directed to assess the median filter performance on noisy data. A novel concept, spatial median filtering, is expressed by the investigator and the outcomes are related to the existing smoothing approaches [(A. E. Hassanien et al. 2021)](https://paperpile.com/c/EKX5ip/vVWL).

**CONCLUSION**

In the image noise detection and removal, the proposed Novel Kalman Filters outperforms the existing Median Filter in terms of accuracy (93.87% Vs 92.67%). From the simulation results and statistical analysis, the Novel Kalman Filters is recommended to use in the field of image processing for sensitive information.

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# **DECLARATIONS**

**Conflicts of Interest**

The author declares no conflicts of interest.

# **Author’s contribution**

Author KD was involved in data collection, data analysis, and manuscript writing. Author GK was involved in conceptualization, data validation, and critical review of the manuscript.

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**TABLES AND FIGURES**

**Table 1**. Comparison of prediction of accuracy between novel kalman filter and median filter. Novel kalman filter achieved an accuracy of 93.87% compared to the median filter having 92.67%.

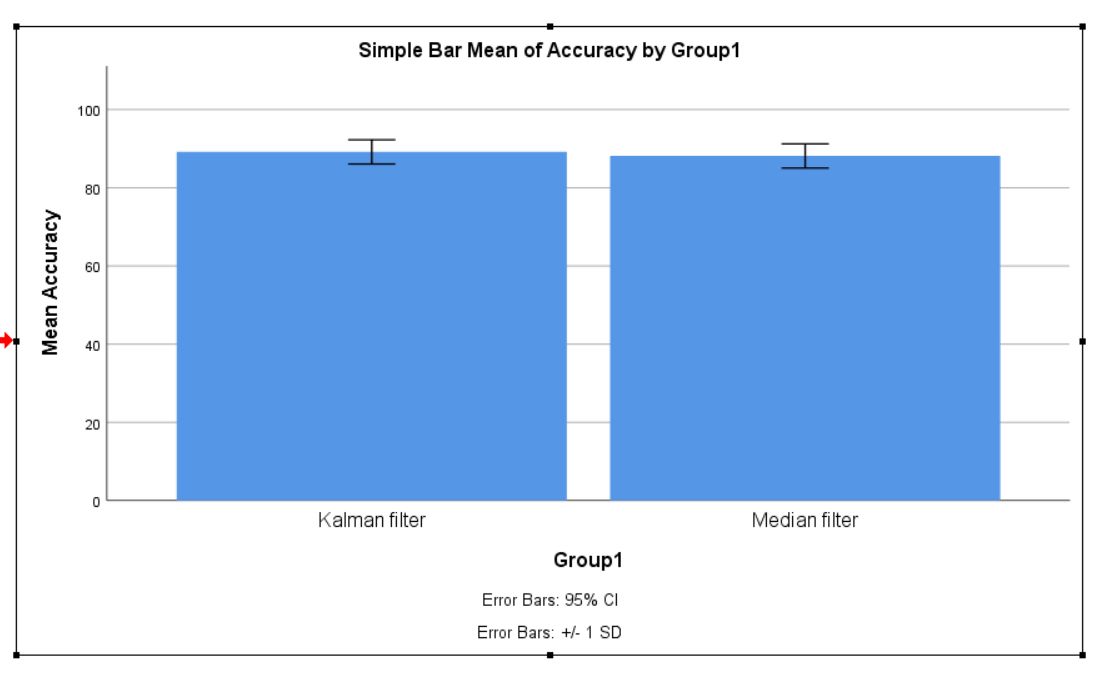
| **Sl.no** | **Novel kalman filter** | **Median filter** |
| --- | --- | --- |
| 1 | 93.87 | 92.67 |
| 2 | 92.48 | 91.96 |
| 3 | 91.89 | 90.98 |
| 4 | 90.56 | 89.94 |
| 5 | 89.98 | 88.88 |
| 6 | 88.59 | 87.75 |
| 7 | 87.98 | 86.69 |
| 8 | 86.94 | 85.87 |
| 9 | 85.99 | 84.96 |
| 10 | 84.56 | 83.58 |

**Table 2.** Mean, standard deviation, and standard error mean, novel kalman Filters and median filter- are given below.

| **Algorithm** | | **N** | **Mean** | **Standard Deviation** | **Standard Error Mean** |
| --- | --- | --- | --- | --- | --- |
| Accuracy | Novel Kalman Filters | 10 | 93.87 | 3.092 | 0.9780 |
| Median filter | 10 | 92.67 | 3.097 | 0.9790 |

**Table 3.** An independent sample T-test is performed for the two groups for significance and standard error determination. The significance value p=0.05 (p<0.05) shows that two groups are statistically significant

|  | | **Levene’s test for equality of variables** | | **T-test for Equality of means** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **F** | **Sig** | **t** | **df** | **Sig (2-tailed)** | **Mean Difference** | **Std. Error Difference** | **95% confidence interval of the Difference** | |
| **Lower** | **Upper** |
| **Accuracy** | Equal variances assumed | .005 | .945 | .746 | 18 | 0.005 | 1.033 | 1.384 | -1.874 | 3.940 |
| Equal variances not assumed |  |  | .746 | 18 | 0.005 | 1.033 | 1.384 | -1.874 | 3.940 |

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**Fig. 1.** Comparison of novel kalman Filters and median filter in terms of mean accuracy . The mean accuracy of the median filter is better than the novel kalman Filters and the standard deviation of the decision tree algorithm is slightly better than the support vector machine. X Axis: median filter Vs novel kalman Filters . Y Axis: Means Accuracy and of Detection ±1 SD.