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BLUR REDUCTION AT HIGH DENSITY IMPULSE NOISE

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***Abstract*--This improved method is a simple, and efficient way to remove impulse noise from highly corrupted digital images. This method has two stages. The first stage is to detect the impulse noise in the image. In this stage, the pixels are divided into two classes (noise free pixels/ noise free pixels) based on only the intensity values .Then, the second stage is to eliminate the impulse noise from the image. In this stage, only the "noise-pixels" are processed. But the "noise-free pixels" are not modified and are copied directly to the output image. The method used gradient based adptive median filter,so that this method adaptively changes the size of the median filter based on the number of the "noise-free pixels" in the neighborhood. For the filtering, the gradian value of every pixel location at (x,y) is calculated. Then the median value can be find out under the consideration of only "noise-free pixels" .In this algorithm for effective noise detection is proposed. The Proposed algorithm produces better edge and fine details preservations and reduces blurring at the high density impulse noise. Because of its simplicity, this proposed method is suitable to be implemented in consumer electronics products such as digital television, or digital camera.**

***Index Terms* — Noise reduction, salt-and-pepper noise,impulse noise, median filter, adaptive filter.**

I.INTRODUCTION

Impulse noise removal in digital images is an important pre-processing step as images are often corrupted by impulse noise. Impulse noise is caused by malfunctioning pixels in camera sensors, faulty memory locations in hardware, or transmission in a noisy channel. Two common types of impulse noise are the salt-and-pepper noise and the random valued noise. For images corrupted by salt- and-pepper noise (respectively random-valued noise), the noisy pixels can take only the maximum and the minimum values (respectively any random value) in the dynamic range. Two types of filters used for remove the impulse noise is linear filter and non-linear filter.

A large number of linear and non linear filtering algorithms have been proposed to remove impulse noise from corrupted image to enhance image quality. Most of the linear filters mechanism generally used to remove impulse noise and tend to destroy all high frequency details like edges, lines and other fine image details. This led to the development of nonlinear median-type filters. Some of them are fixed and some others are adaptive. Median filter is one of the order-statistic filters, which falls in the group of nonlinear filter.

In this project, I present a new median filter based technique, which is a hybrid of adaptive median filter and switching median filter. This proposed method is fast, simple, and adaptable to the local noise level. The method can remove the impulse noise effectively from the image, and at the same time can preserve the details inside the image, even when the input image is very highly corrupted by the noise. The method is also does not require any parameter to be tuned, thus suitable for an automated system. The method does not need previous training.

I use switching median filter framework in order to speed up the process, because only the noise pixels are filtered. In addition to this, switching median filter also allows local details in the image to be preserved. We divide this method into two stages, which are the noise detection, and the noise cancellation. In order to implement this method, we need three 2D arrays of the same size to hold the pixel values of the input image f, the output image g, and the mask to mark the noise pixels α. The dimensions of these arrays are equal to the dimensions of f (i.e. M×N). The two stages of my proposed method is noise detection ,noise cancellation .

First part of my project is to detect the pixels from highly corrupted image, and classify that particular image pixels into two categories , such as "noise free pixels'' and "noise pixels". then calculate the total number of noise pixels, from that result estimate the local impulse noise level. And also I compare various non-linear filter performance over on impulse noise with my proposed filter.

A novel class of nonlinear filter for image processing known as order statistics (OS) filter. Median based filters are the popular methods to be employed for reducing the impulse noise level from corrupted images. This is because of their simplicity and capability to preserve edges . This median filter method, processes all pixels in the image equally, including the noise free pixels. This will result the elimination of fine details such as thin lines and corner, blurring, or distortion in the images.

Another type of the median based methods is the switching method, which is constructed from two stages. The first stage in these methods is normally to detect the noise pixel. The second stage is to remove the noise. In this stage, only noise pixels are filtered. Other pixels, which are considered as noise-free pixels, are kept unchanged.

Luo has proposed a simple switching median filter based on fuzzy impulse detection technique. First, the method finds the two peaks from the histogram to approximate two intensity values that present the impulse noise. Pixels with these intensity values become the candidates for the impulse noise. For each candidate, the minimum absolute intensity difference between a pixel with its eight-neighbors in a 3×3 window is determined. This minimum value is assigned to the value of *r*, a parameter that indicate how likely the pixel to be an impulse noise. The minimum value is selected in order to preserve the fine details in the image. Then, based on the value of *r* and two predefined threshold values, *T1* and *T2* (i.e. *T1* < *T2*), the pixels are grouped into three groups, which are; "noise-free pixels", "noise-pixels", and "possibly noise pixels". The filtering is only carried out to the "noise-pixels" and "possibly noise-pixels". For the "noise-pixels", filtering in (1) is carried out. For the "possible noise-pixels", the median value based on (1) is first determined, and then this value is recombined with the intensity of the image, using weighting value that is calculated based on a fuzzy membership function.

Another filter known as signal adaptive median filter, that performs better than other nonlinear adaptive filters for different kinds of noise. Adaptive filters adapt themselves to the noise type and noise power level and, thus, they perform better than the fixed filters. Two types of adaptive images filters are proposed in this thesis. One is based on Order statistics adaptation scheme. It performs much better than the linear filter. It may not need an on-line training always. An off-line training is good enough. The size of the median filter applied to the individual pixel is determined based on the approximation of the local noise level. Bigger filter is applied to the areas with high level of noise, and smaller filter is applied to the areas with low level of noise. That is approximate the noise pixels based on the minimum, maximum and median intensity values contained inside a local window. Christo Ananth et al. [1] proposed a method in which the minimization is per-formed in a sequential manner by the fusion move algorithm that uses the QPBO min-cut algorithm. Multi-shape GCs are proven to be more beneficial than single-shape GCs. Hence, the segmentation methods are validated by calculating statistical measures. The false positive (FP) is reduced and sensitivity and specificity improved by multiple MTANN. Christo Ananth et al. [2] proposed a system, this system has concentrated on finding a fast and interactive segmentation method for liver and tumor segmentation. In the pre-processing stage, Mean shift filter is applied to CT image process and statistical thresholding method is applied for reducing processing area with improving detections rate. In the Second stage, the liver region has been segmented using the algorithm of the proposed method. Next, the tumor region has been segmented using Geodesic Graph cut method. Results show that the proposed method is less prone to shortcutting than typical graph cut methods while being less sensitive to seed placement and better at edge localization than geodesic methods.

This leads to increased segmentation accuracy and reduced effort on the part of the user. Finally Segmented Liver and Tumor Regions were shown from the abdominal Computed Tomographic image. Christo Ananth et al. [3] proposed a system, in which a predicate is defined for measuring the evidence for a boundary between two regions using Geodesic Graph-based representation of the image. The algorithm is applied to image segmentation using two different kinds of local neighborhoods in constructing the graph. Liver and hepatic tumor segmentation can be automatically processed by the Geodesic graph-cut based method. This system has concentrated on finding a fast and interactive segmentation method for liver and tumor segmentation. In the preprocessing stage, the CT image process is carried over with mean shift filter and statistical thresholding method for reducing processing area with improving detections rate. Second stage is liver segmentation; the liver region has been segmented using the algorithm of the proposed method. The next stage tumor segmentation also followed the same steps.

Finally the liver and tumor regions are separately segmented from the computer tomography image. Christo Ananth et al. [4] proposed a system in which the cross-diamond search algorithm employs two diamond search patterns (a large and small) and a halfway-stop technique. It finds small motion vectors with fewer search points than the DS algorithm while maintaining similar or even better search quality. The efficient Three Step Search (E3SS) algorithm requires less computation and performs better in terms of PSNR. Modified objected block-base vector search algorithm (MOBS) fully utilizes the correlations existing in motion vectors to reduce the computations. Fast Objected - Base Efficient (FOBE) Three Step Search algorithm combines E3SS and MOBS. By combining these two existing algorithms CDS and MOBS, a new algorithm is proposed with reduced computational complexity without degradation in quality. Christo Ananth et al. [5] proposed a system in which this study presented the implementation of two fully automatic liver and tumors segmentation techniques and their comparative assessment. The described adaptive initialization method enabled fully automatic liver surface segmentation with both GVF active contour and graph-cut techniques, demonstrating the feasibility of two different approaches. The comparative assessment showed that the graph-cut method provided superior results in terms of accuracy and did not present the described main limitations related to the GVF method. The proposed image processing method will improve computerized CT-based 3-D visualizations enabling noninvasive diagnosis of hepatic tumors. The described imaging approach might be valuable also for monitoring of postoperative outcomes through CT-volumetric assessments.

Processing time is an important feature for any computer-aided diagnosis system, especially in the intra-operative phase. Christo Ananth et al. [6] proposed a system in which an automatic anatomy segmentation method is proposed which effectively combines the Active Appearance Model, Live Wire and Graph Cut (ALG) ideas to exploit their complementary strengths. It consists of three main parts: model building, initialization, and delineation. For the initialization (recognition) part, a pseudo strategy is employed and the organs are segmented slice by slice via the OAAM (Oriented Active Appearance method). The purpose of initialization is to provide rough object localization and shape constraints for a latter GC method, which will produce refined delineation. It is better to have a fast and robust method than a slow and more accurate technique for initialization. Christo Ananth et al. [7] proposed a system which uses intermediate features of maximum overlap wavelet transform (IMOWT) as a pre-processing step. The coefficients derived from IMOWT are subjected to 2D histogram Grouping. This method is simple, fast and unsupervised. 2D histograms are used to obtain Grouping of color image. This Grouping output gives three segmentation maps which are fused together to get the final segmented output. This method produces good segmentation results when compared to the direct application of 2D Histogram Grouping.

IMOWT is the efficient transform in which a set of wavelet features of the same size of various levels of resolutions and different local window sizes for different levels are used. IMOWT is efficient because of its time effectiveness, flexibility and translation invariance which are useful for good segmentation results. Christo Ananth et al. [8] proposed a system in which OWT extracts wavelet features which give a good separation of different patterns. Moreover the proposed algorithm uses morphological operators for effective segmentation. From the qualitative and quantitative results, it is concluded that our proposed method has improved segmentation quality and it is reliable, fast and can be used with reduced computational complexity than direct applications of Histogram Clustering. The main advantage of this method is the use of single parameter and also very faster. While comparing with five color spaces, segmentation scheme produces results noticeably better in RGB color space compared to all other color spaces. Christo Ananth et al. [9] presented an automatic segmentation method which effectively combines Active Contour Model, Live Wire method and Graph Cut approach (CLG). The aim of Live wire method is to provide control to the user on segmentation process during execution. Active Contour Model provides a statistical model of object shape and appearance to a new image which are built during a training phase. In the graph cut technique, each pixel is represented as a node and the distance between those nodes is represented as edges. In graph theory, a cut is a partition of the nodes that divides the graph into two disjoint subsets. For initialization, a pseudo strategy is employed and the organs are segmented slice by slice through the OACAM (Oriented Active Contour Appearance Model). Initialization provides rough object localization and shape constraints which produce refined delineation.

This method is tested with different set of images including CT and MR images especially 3D images and produced perfect segmentation results. Christo Ananth et al. [10] proposed a work, in this work, a framework of feature distribution scheme is proposed for object matching. In this approach, information is distributed in such a way that each individual node maintains only a small amount of information about the objects seen by the network. Nevertheless, this amount is sufficient to efficiently route queries through the network without any degradation of the matching performance. Digital image processing approaches have been investigated to reconstruct a high resolution image from aliased low resolution images. The accurate registrations between low resolution images are very important to the reconstruction of a high resolution image. The proposed feature distribution scheme results in far lower network traffic load.

To achieve the maximum performance as with the full distribution of feature vectors, a set of requirements regarding abstraction, storage space, similarity metric and convergence has been proposed to implement this work in C++ and QT. Christo Ananth et al. [11] discussed about an important work which presents a metal detecting robot using RF communication with wireless audio and video transmission and it is designed and implemented with Atmel 89C51 MCU in embedded system domain. The robot is moved in particular direction using switches and the images are captured along with the audio and images are watched on the television .Experimental work has been carried out carefully. The result shows that higher efficiency is indeed achieved using the embedded system. The proposed method is verified to be highly beneficial for the security purpose and industrial purpose. The mine sensor worked at a constant speed without any problem despite its extension, meeting the specification required for the mine detection sensor. It contributed to the improvement of detection rate, while enhancing the operability as evidenced by completion of all the detection work as scheduled. The tests demonstrated that the robot would not pose any performance problem for installation of the mine detection sensor. On the other hand, however, the tests also clearly indicated areas where improvement, modification, specification change and additional features to the robot are required to serve better for the intended purpose. Valuable data and hints were obtained in connection with such issues as control method with the mine detection robot tilted, merits and drawbacks of mounting the sensor, cost, handling the cable between the robot and support vehicle, maintainability, serviceability and easiness of adjustments.

These issues became identified as a result of our engineers conducting both the domestic tests and the overseas tests by themselves, and in this respect the findings were all the more practical. Christo Ananth et al. [12] discussed about Vision based Path Planning and Tracking control using Mobile Robot. This paper proposes a novel methodology for autonomous mobile robot navigation utilizing the concept of tracking control. Vision-based path planning and subsequent tracking are performed by utilizing proposed stable adaptive state feedback fuzzy tracking controllers designed using the Lyapunov theory and particle-swarm-optimization (PSO)-based hybrid approaches. The objective is to design two self-adaptive fuzzy controllers, for x-direction and y-direction movements, optimizing both its structures and free parameters, such that the designed controllers can guarantee desired stability and, simultaneously, can provide satisfactory tracking performance for the vision-based navigation of mobile robot.

The design methodology for the controllers simultaneously utilizes the global search capability of PSO and Lyapunovtheory-based local search method, thus providing a high degree of automation. Two different variants of hybrid approaches have been employed in this work. The proposed schemes have been implemented in both simulation and experimentations with a real robot, and the results demonstrate the usefulness of the proposed concept. Christo Ananth et al. [13] discussed about a model, a new model is designed for boundary detection and applied it to object segmentation problem in medical images. Our edge following technique incorporates a vector image model and the edge map information. The proposed technique was applied to detect the object boundaries in several types of noisy images where the ill-defined edges were encountered. The proposed techniques performances on object segmentation and computation time were evaluated by comparing with the popular methods, i.e., the ACM, GVF snake models. Several synthetic noisy images were created and tested.

The method is successfully tested in different types of medical images including aortas in cardiovascular MR images, and heart in CT images. Christo Ananth et al. [14] discussed about the issue of intuitive frontal area/foundation division in still pictures is of awesome down to earth significance in picture altering. They maintain a strategic distance from the limit length predisposition of chart cut strategies and results in expanded affectability to seed situation. Another proposed technique for completely programmed handling structures is given taking into account Graph-cut and Geodesic Graph cut calculations. This paper addresses the issue of dividing liver and tumor locales from the stomach CT pictures. The absence of edge displaying in geodesic or comparable methodologies confines their capacity to exactly restrict object limits, something at which chart cut strategies by and large exceed expectations. A predicate is characterized for measuring the confirmation for a limit between two locales utilizing Geodesic Graph-based representation of the picture. The calculation is connected to picture division utilizing two various types of nearby neighborhoods in building the chart. Liver and hepatic tumor division can be naturally prepared by the Geodesic chart cut based strategy. This framework has focused on finding a quick and intuitive division strategy for liver and tumor division.

In the pre-handling stage, Mean movement channel is connected to CT picture process and factual thresholding technique is connected for diminishing preparing zone with enhancing discoveries rate. In the Second stage, the liver area has been divided utilizing the calculation of the proposed strategy. Next, the tumor district has been portioned utilizing Geodesic Graph cut strategy. Results demonstrate that the proposed strategy is less inclined to shortcutting than run of the mill diagram cut techniques while being less delicate to seed position and preferable at edge restriction over geodesic strategies. This prompts expanded division exactness and decreased exertion with respect to the client. At long last Segmented Liver and Tumor Regions were appeared from the stomach Computed Tomographic picture. Christo Ananth et al. [15] discussed about efficient content-based medical image retrieval, dignified according to the Patterns for Next generation Database systems (PANDA) framework for pattern representation and management. The proposed scheme use 2-D Wavelet Transform that involves block-based low-level feature extraction from images. An expectation–maximization algorithm is used to cluster the feature space to form higher level, semantically meaningful patterns. Then, the 2-component property of PANDA is exploited: the similarity between two clusters is estimated as a function of the similarity of both their structures and the measure components. Experiments were performed on a large set of reference radiographic images, using different kinds of features to encode the low-level image content. Through this experimentation, it is shown that the proposed scheme can be efficiently and effectively applied for medical image retrieval from large databases, providing unsupervised semantic interpretation of the results, which can be further extended by knowledge representation methodologies.

II. BACKGROUND

Median filter is a low-pass filter that attempts to remove noisy pixels while keeping the edges intact. The value of the pixels in the window are sorted and the median (the middle value in the sorted list) is chosen. The MED filter is a smoothing device for discrete signals. In particular, he noted this filtering process to be quite effective in suppressing impulse noise as well as preserving the locally monotonic signal structures often containing significant information. The MED filter has been extensively used in image processing, particularly for suppressing impulse noise in an image. Many variants of the MED filter have also been proposed. One modified version of it is the center weighted median (CWM) filter. The ranked-ordered mean (ROM) is another variant.

For example, if a 3×3 window is used for spatial sampling, then 9 pixel data are available at a time. First of all, the 2-D data is converted to a 1-D data, i.e. a vector. Let this vector of 9 data be sorted. Then, if the mid value (5^{th} position pixel value in the sorted vector of length 9) is taken, it becomes median filtering with the filter weight vector [0 0 0 0 1 0 0 0 0]. If all the order statistics are given equal weightage, then it becomes a mean or moving average (MAV) filter. Strictly speaking, the MAV filter is a simple linear filter.

An input image $f(x, y)$ the filtered image $g(x, y)$ is defined by

$$g = \underset{(s,t)\epsilon s_{x,y}}{\text{median}}\{f(s,t) \quad \} \qquad ....(1)$$

where R takes any positive integer value.

III.PROPOSED METHOD

The filters used in my proposed method are given below.

A. *Adaptive median filter*

The size of the median filter applied to the individual pixels is determine based on the approximation of the local noise level. Big filter is applied to the areas with high level of noise, and the smaller filter is applied to the areas with low noise level. That is approximate the noise level based on the noise pixels contained inside the local window. Here they start with smaller window size first, and increase its size until conditions are met.

The Adaptive Median Filter is designed to eliminate the problems faced with the standard median filter. The basic difference between the two filters is that, in the Adaptive Median Filter, the size of the window surrounding each pixel is variable. This variation depends on the median of the pixels in the present window. If the median value is an impulse, then the size of the window is expanded. Otherwise, further processing is done on the part of the image within the current window specifications. 'Processing' the image basically entails the following: The center pixel of the window is evaluated to verify whether it is an impulse or not. If it is an impulse, then the new value of that pixel in the filtered image will be the median value of the pixels in that window.

This method have a filter known as gradient based adaptive median filter, the purpose of that filter is if a chance a noise free pixel value in an image has the same value of noise pixels that time that paticular pixels is not filtered, intead it replaced by its gradient value. Thus, the Adaptive Median Filter solves the dual purpose of removing the impulse noise from the image and reducing distortion in the image.

1) *Notations*

The adaptive filter works on a rectangular regionS_{xy}. The adaptive median filter changes the size of S_{xy} during the filtering operation depending on certain criteria as listed below. The output of the filter is a single value which the replaces the current pixel value at (x, y), the point on which S_{xy} is centered at the time. The following notation is adapted from the book and is reintroduced here: $Z_{min=}$ minimum gray-level value inS_{xy}, Z_{max} =maximum gray-level value inS_{xy}, Z_{med} =median gray-level value in S_{xy}, Z_{xy} =gray-level at (x,y), $S_{max=}$ maximum allowed size of S_{xy}

2) *Algorithm*

1. The adaptive median filter algorithm works in two levels: *A* and *B*
2. Level A: A1= $Z_{med} - Z_{min}$
   A2= $Z_{med-Z_{max}}$
3. If A1>0 and A2<0 go to level B else increase the window size
4. If window size ≤ S_{xy} repeat level A else output Z_{xy}
5. Level B: B1=$Z_{xy-Z_{min}}$
   B2=$Z_{xy-Z_{max}}$
6. If B1>0 and B2<0, output Z_{xy} else output Z_{med}

The algorithm has three main purposes,

1. To remove 'Salt and Pepper' noise
2. To smoothen any non impulsive noise
3. To reduce excessive distortions such as too much thinning or thickening of object boundaries.

B. *Switched median Filter*

Switching median filter speed up the process, because only the noise pixels are filtered. In addition to this, switching median filter also allows local details in the image to be preserved.

C. *Noise detection*

There are two main purposes of this stage. The first one is to identify the "noise pixel", and the second one is to roughly approximate the noise level of the image.

The histogram of the input image to find two intensity values that presents the impulse noises. The identification is based on the peak values contained in the histogram. He assumes that the bright and dark intensity values of the impulse noise produce two peaks in the histogram. However, in our method, we do not use this assumption because this statement is not always true, especially when the input is only corrupted by low level of noise.

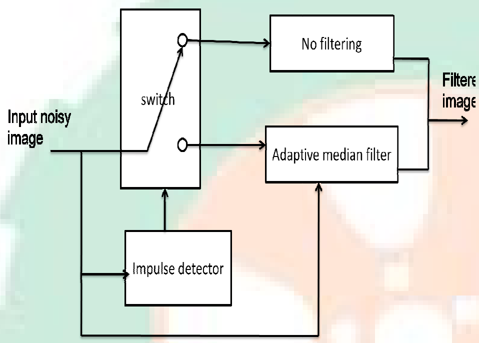


Fig.1. schematic diagram of proposed method

The steps needed for the noise detection is,

1) Identifying the pixels (i.e. noise free pixels and noise pixels).
2) Calculate the total number of noise pixels K.
3) Roughly estimate the impulse noise level η.

1) Identifying The Pixels

we assume that the two intensities that present the impulse noise are the maximum and the minimum values of the image's dynamic range (i.e. 0 and L-1). Thus, in this stage, at each pixel location (x,y), we find out the gradient value G by using the following equation,

$$G(x,y) = \big[\big((x,y) - (x-1,y-1)\big) + \big((x,y) - (x-1,y)\big) + \cdots + \big((x,y) - (x+1,y+1)\big)\big] \quad \ldots\ldots\ldots(2)$$

Then mark the mask α by using the following equation,

$$\alpha(x,y) = \begin{cases} 1 : f(x,y) = L-1 \\ 1 : f(x,y) = 0 \\ 0 : otherwise \end{cases} \quad \ldots\ldots..(3)$$

where the value 1 presents the "noise pixel" and the value 0 presents the "noise-free pixel". Christo Ananth et al. [18] gave a brief outline on Electronic devices and circuits which is the basis for formation of patterns.

TABLE I
comparison of RMSE values of various filters over noise

Noise percentage	RMSE for mean filter	RMSE for median filter	RMSE for switched median filter	RMSE for adaptive median filter
5	17.3634	8.2822	7.0523	6.0345
10	21.9882	9.3530	7.7588	6.4382
20	31.5857	14.6379	10.579	7.7832
30	40.0170	23.4652	13.702	10.503
40	48.772	36.3367	17.661	14.5321
50	51.1471	52.8069	22.057	18.9238
60	65.3283	72.0954	33.28	24.02
70	74.3637	95.0303	47.911	36.2563
80	82.4669	115.7300	65.167	52.1647
90	90.384	135.9533	88.009	87.923
95	94.1260	146.0532	99.561	92.9523
99	98.0525	154.5263	107.34	101.265

2) Calculate The Total Number Of Noise Pixels K

We calculate the total number of the "noise pixel", K. This is given by,

$$K = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} \alpha(x,y) \quad \ldots\ldots\ldots\ldots(4)$$

Here we use adaptive median filter, that means the filter mask size adaptively changes local noise level. So finding the value of K is need for the further operation.

3) Estimate The Impulse Noise Level η

Using the value of K, we can roughly estimate the impulse noise level η that corrupts the image. The value of η is the ratio of the "noise pixels" to the total number of pixels contained in the image, as defined in the following equation,

$$\eta = \frac{K}{MN} \quad \ldots\ldots\ldots\ldots (5)$$

The value of η is in between 0 and 1 (i.e. $0 \le \eta \le 1$). This value and the noise mask α will be used in the following stage, which is for the noise removal.

D. Noise cancellation

In this stage, we filter the input image *f*, and produce the filtered image *g*. Similar to many switching median filter methods, the output is defined as:

$$g(x, y) = [1-\alpha(x, y)]\, f(x, y) + \alpha(x, y) m(x, y) \quad \ldots\ldots\ldots(6)$$

where α is the noise mask, defined by (2) in Stage 1, where *m* is the median value obtained from our adaptive method. The determination of *m* will be explained later.

As $\alpha(x,y)$ only can take value of either 0 or 1, as defined by (5) the output value $g(x,y)$ is either equal to $f(x,y)$ or $m(x,y)$. Thus, the calculation of $m(x,y)$ is only done when $f(x,y)$ is a "*noise pixel*" (i.e. $\alpha(x,y) = 1$). For the "*noise-free pixel*" (i.e. $\alpha(x,y) = 0$), the value of $f(x,y)$ is copied directly as the value of $g(x,y)$. This significantly speeds up the process, because not all pixels need to be filtered. Thus, alternatively, $g(x,y)$ can be re-written as:

$$g(x,y) = \begin{cases} f(x,y): \alpha(x,y) = 0 \\ m(x,y) : otherwise \end{cases} \quad \ldots\ldots(7)$$

We use the adaptive methodology to determine $m(x,y)$. This means that the size of the filter used at every pixel location is changing accordingly to the local information. In this work, we only consider the square filters with odd dimensions for the filtering process, as given by,

$$W = WM = WN = 2R + 1 \ldots\ldots\ldots\ldots(8)$$

where *R* takes any positive integer value.

Our method, uses only "*noise-free pixels*" that are contained in the contextual region, defined by the area of $W \times W$ (i.e. the filter size), as the samples for the calculation of $m(x,y)$. This procedure ensures that the value of $g(x,y)$ will not be affected by the noise, but be more biased towards the real data values. To determine the value of $m(x,y)$, in our proposed method, we set a rule that the minimum number of samples of "*noise-free pixels*" needed for this calculation must be greater or equal to eight pixels. Christo Ananth et al. [16] discussed about E-plane and H-plane waveguides (Microwave Engineering) applicable to image processing. Christo Ananth et al. [17] discussed about principles of electronic devices to explain this feature. Our novel adaptive method for finding m(x,y) is described by the following algorithm. For each pixel location (x,y) with α(x,y)=1 (i.e. "noise pixel"), do the following

1. Initialize the size of the filter W = $2R_{min}$+1, where R_{min} is a small integer value.
2. Compute the number of "noise-free pixels" contained in the contextual region defined by this W×W filter.
3. If the number of "noise-free pixels" is less than eight pixels, increase the size of the filter by two (i.e. W = W+2) and return to step 2.
4. Calculate the value of m(x,y) based on the "noise-free pixels" contained in W×W window.
5. Update the value of g(x,y) using the equation(6 or 7)

IV.EXPERIMENTAL RESULTS

In order to demonstrate the performance of our method, we also implemented three other median filtering methods. As our method is a hybrid of an adaptive median filter and a switching median filter, we implement the mean filter, median filter, switched median filter and adaptive median filter.

In this work, we use 100 images of size 1600×1200 as our test images. These images present a wide variety of images, and with different characteristics. Example of these images are shown in Fig. 2(a), and . These images are free from impulse noise, and we denote them as *e*. Then, we contaminate these images with impulse noise to get the corrupted images, *f*. If image *e* is corrupted by *Q*% of noise, 0.5Q% will be the positive impulses and another 0.5Q% will be the negative impulses. We then process *f* using the four mentioned methods in this section. The results are presented in terms of the visual appearance, root mean square error (RMSE) and processing time.

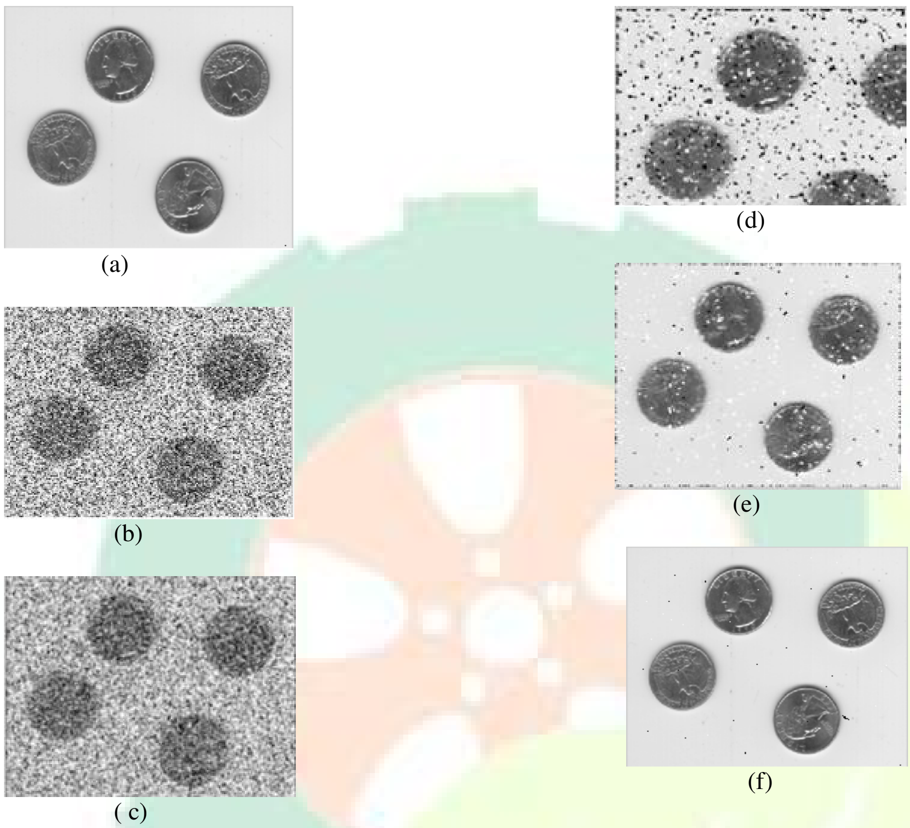
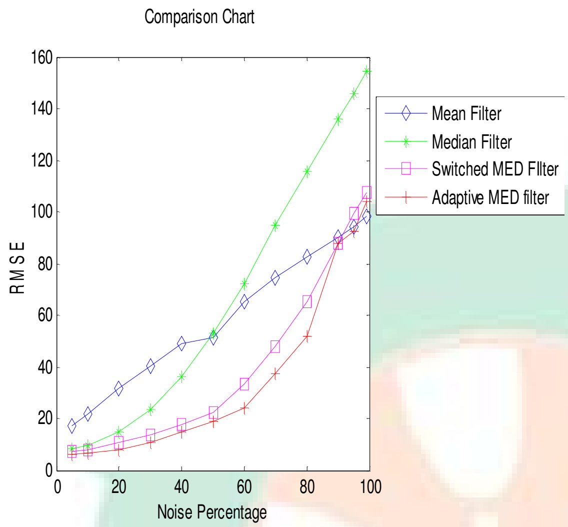


Fig. 2. "*Coin*" (a) The original image. (b) Image corrupted by 50% of impulse noise. (c) Result obtained by using mean filter (RMSE = 51.1471) (d) Result obtained by using median filter (RMSE = 52.8069) (e) Result obtained by using switching median filter (RMSE = 22.057) (f) Result obtained by using adaptive median filter (RMSE = 18.9238)



V.CONCLUSION

One very important merit of this adaptive MED filter is its edge-preserving characteristic. If an image is contaminated with low or medium density SPN, then a adaptive MED filter can do justice by rejecting the outliers very easily. But at some locations, the density of impulses could be very high. At those points, the simple adaptive MED filter fails. Even if the impulse noise density in an image is very low, the adaptive MED can never guarantee the true pixel replacement. The adaptive MED operation changes the pixel value to the median of the neighborhood unnecessarily even if the center pixel is noise-free. Thus, there is some unwanted error in the output.

REFERENCES

[1] Christo Ananth, G.Gayathri, M.Majitha Barvin, N.Juki Parsana, M.Parvin Banu, "Image Segmentation by Multi-shape GC-OAAM", American Journal of Sustainable Cities and Society (AJSCS), Vol. 1, Issue 3, January 2014, pp 274-280

[2] Christo Ananth, D.L.Roshni Bai , K.Renuka, C.Savithra, A.Vidhya, "Interactive Automatic Hepatic Tumor CT Image Segmentation", International Journal of Emerging Research in Management &Technology (IJERMT), Volume-3, Issue-1, January 2014,pp 16-20

[3]Christo Ananth, D.L.Roshni Bai, K.Renuka, A.Vidhya, C.Savithra, "Liver and Hepatic Tumor Segmentation in 3D CT Images", International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), Volume 3,Issue-2, February 2014,pp 496-503

[4] Christo Ananth, A.Sujitha Nandhini, A.Subha Shree, S.V.Ramyaa, J.Princess, "Fobe Algorithm for Video Processing", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (IJAREEIE), Vol. 3, Issue 3,March 2014 , pp 7569-7574

[5] Christo Ananth, Karthika.S, Shivangi Singh, Jennifer Christa.J, Gracelyn Ida.I, "Graph Cutting Tumor Images", International Journal of Advanced Research in Computer Science and Software Engineering (IJARCSSE), Volume 4, Issue 3, March 2014,pp 309-314

[6] Christo Ananth, G.Gayathri, I.Uma Sankari, A.Vidhya, P.Karthiga, "Automatic Image Segmentation method based on ALG", International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE), Vol. 2, Issue 4, April 2014,pp- 3716-3721

[7] Christo Ananth, A.S.Senthilkani, S.Kamala Gomathy, J.Arockia Renilda, G.Blesslin Jebitha, Sankari @Saranya.S., "Color Image Segmentation using IMOWT with 2D Histogram Grouping", International Journal of Computer Science and Mobile Computing (IJCSMC), Vol. 3, Issue. 5, May 2014, pp-1 – 7

[8] Christo Ananth, A.S.Senthilkani, Praghash.K, Chakka Raja.M., Jerrin John, I.Annadurai, "Overlap Wavelet Transform for Image Segmentation", International Journal of Electronics Communication and Computer Technology (IJECCT), Volume 4, Issue 3 (May 2014), pp-656-658

[9] Christo Ananth, S.Santhana Priya, S.Manisha, T.Ezhil Jothi, M.S.Ramasubhaeswari, "CLG for Automatic Image Segmentation", International Journal of Electrical and Electronics Research (IJEER), Vol. 2, Issue 3, Month: July - September 2014, pp: 51-57

[10] Christo Ananth, R.Nikitha, C.K.Sankavi, H.Mehnaz, N.Rajalakshmi, "High Resolution Image Reconstruction with Smart Camera Network", International Journal of Advanced Research in Biology, Ecology, Science and Technology (IJARBEST), Volume 1,Issue 4,July 2015, pp:1-5

[11] Christo Ananth, B.Prem Kumar, M.Sai Suman, D.Paul Samuel, V.Pillai Vishal Vadivel, Praghash.K., "Autonomous Mobile Robot Navigation System", International Journal of Advanced Research in Biology, Ecology, Science and Technology (IJARBEST), Volume 1,Issue 4,July 2015,pp:15-19

[12] Christo Ananth , Mersi Jesintha.R., Jeba Roslin.R., Sahaya Nithya.S., Niveda V.C.Mani, Praghash.K., "Vision based Path Planning and Tracking control using Mobile Robot", International Journal of Advanced Research in Biology, Ecology, Science and Technology (IJARBEST), Volume 1,Issue 4,July 2015, pp:20-25

[13] Christo Ananth, S.Suryakala, I.V.Sushmitha Dani, I.Shibiya Sherlin, S.Sheba Monic, A.Sushma Thavakumari, "Vector Image Model to Object Boundary Detection in Noisy Images", International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE), Volume 1,Issue 2,September 2015, pp:13-15

[14] Christo Ananth," Geo-cutting Liver Tumor", International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE), Volume 2,Issue 3, March 2016,pp:122-128

[15] Christo Ananth, S.Shafiqa Shalaysha, M.Vaishnavi, J.Sasi Rabiyathul Sabena, A.P.L.Sangeetha, M.Santhi, "Realtime Monitoring Of Cardiac Patients At Distance Using Tarang Communication", International Journal of Innovative Research in Engineering & Science (IJIRES), Volume 9, Issue 3,September 2014,pp-15-20

[16] Christo Ananth, S.Esakki Rajavel, S.Allwin Devaraj, M.Suresh Chinnathampy. "RF and Microwave Engineering (Microwave Engineering)." (2014): 300,ACES Publishers

[17] Christo Ananth, S.Esakki Rajavel, S.Allwin Devaraj, P.Kannan. "Electronic Devices." (2014): 300, ACES Publishers.

[18] Christo Ananth,W.Stalin Jacob,P.Jenifer Darling Rosita. "A Brief Outline On ELECTRONIC DEVICES & CIRCUITS." (2016): 300.

[19] Zhou Wang, and David Zhang, "Restoration of impulse noise corrupted images using long-range correlation", *IEEE Signal Processing Letters,* vol. 5, no. 1, pp. 4-7, 1998.