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Research Article

Efficiency of Edge Detection Properties of Images Contaminated with Gaussian Noise of Different Noise Levels

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ABSTRACT: In digital image processing, edge detection plays a crucial role. As edges within a digital image contribute to acquire critical insight of the object which are implicit in the image. As a view of fact, edges constitute boundaries between objects exists in the image. The extraction of these attributes can be utilized to greater extent in real time purpose. However it is arduous to extract out all the edges systematically without any consequences that may cause damage to the constitution of an image. This paper narrates the domination of various intensity of noise in the edge detection of images and comprehensive statistical metric to get insight of the capability of the proposed strategy. This strategy is utilized a modified canny method using s-membership function. In this technique, two images were considered and Gaussian noise is introduced to these images at various levels of intensity. In the next stage a Gaussian filter is exploited to denoise the image and edges are examined with the help of modified canny method using S-membership function. Various statistical parameters are evaluated to identify the performance of proposed strategy.

Keywords – edge detection, S-membership, denoise, Gaussian noise and Gaussian filter.

I. INTRODUCTION:

In this era of digitization, digital image processing is becoming immensely dominant to retrieve the productive information from the image. Image processing is a set of strategies which are utilized to implement operations on images like filter, enhancement, edge detection etc. Edge indicates the instantaneous changes in the intensity of the pixels, which cause variation in the brightness (or) contrast of digital image. Normally edges are utilized for the separation of various regions within the image. To identify these edges, edge detection seems to be one of the fundamental image processing techniques. It works on the principle of identifying various instantaneous changes in the contrast of the image. It is utilized for edge detection in the domain of image processing.

Image noise is arbitrary variation of contrast information in images and it is normally a characteristic feature of electronic noise. An edge in an image represents an instantaneous variation of intensity of contrast and noise also represent the same objective within the image. In presence of noise , edge detection becomes arduous. Edge detection of the noisy image can be acquired by harmonization of denoising and edge preserving capabilities. In case of edge detection various strategies were exploited.

The canny edge detector is an edge detection operator that is exploited a multi level algorithm to identify a huge range of edges within an image. It was introduced by John F.Canny in the year 1986. Canny also produced a computational theory of edge detection and gives detailed information.

Among the existing edge detection strategies that are developed so for, canny edge detection algorithms is one of the finest and strictly defined strategies which is reliable and precised for edge detection. Owing to it's optimality, it is very simple to implement even for sophisticated images. It was utilized in most circumstances for edge detection in image processing. [1].

The traditional Canny edge detection algorithm is more widely accepted in practical engineering applications. However, improvements are still needed for the traditional Canny algorithm. The classical canny operator has two most obvious problems when it comes to image edge detection. Firstly, Traditional Canny algorithm is unable to determine the threshold levels automatically and exhibits weak robustness. It also lack in adaptability in the processing of edge detection with in an image [2]. To resolve this issue many researchers and scholars made modifications in the Canny method to improve the performance of the algorithm. Secondly, if there exists an abundant amount of noise in the image, faulty edges will be detected. Some edges may lost in several region where change of intensity of contrast not obvious which is difficult to identify.

II. IMAGE DENOISING

Filtering is a fundamental step in every aspect of image processing. In general noise is preserved in the acquisition of the image due to environmental issues which causes extra edges identification during the edge detection process. To eliminate the noise appropriate filter need to be utilized depending on the behavior of noise. Noise causes abrupt changes in the intensities in the image. The choice of applying the mask on the image varies as 3*3, 5*5 or 7*7 etc, as the choice of mask selection is always depending on domain of the problem. Preservation of edges is very crucial in edge detection. In this work, Gaussian noise is considered in various levels to identify the impact of Gaussian filter in edge preservation and edge detection. The Gaussian filter is always constructed with the help of distribution function with a bell curve. The detailed description of Gaussian filter and noise described as follows.

2.1 Gaussian Noise

it is also known as amplifier noise, the effect of this noise is not only in the part of image but also it affects the whole image because it's a correlated noise by its nature[3]. It is an additive noise that is characterized by its variance (σ).Additive Gaussian noise is represented mathematically as shown in equ. 1.

η NAWGN(t)= ηG(t)σ fAWGN =f(x,y)+ ηG(x,y) (1)

Edge detection efficiency always depends on intensity level of noise embedded in the image. In case of edge detection, edge and noise looks same for effective detection of edges. This work proposes Gaussian filter to eliminate the noise and noise levels are varied from 0 to80% and analysis has been done.

In the proposed method various percentage levels of additive noise is applied to an image. The experimental results are extracted to visualize the details of the edges with respect to canny edge detection as well as modified canny edge detection with S-membership function. Both the methods are compared with original ground truth image and their impact is noticed with the help of various parameters like True Positive, True Negative, False Positive, False Negative, False alarm etc, at various proportionate levels. The corrupted image of 30% of noise and the result of image after applying Gaussian filter is as shown in Fig 1. The flow of proposed methodology is represented in Fig 2.

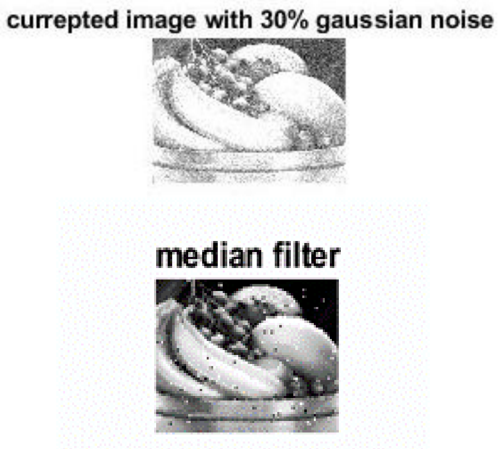


Fig 1: Applying filter to noisy image

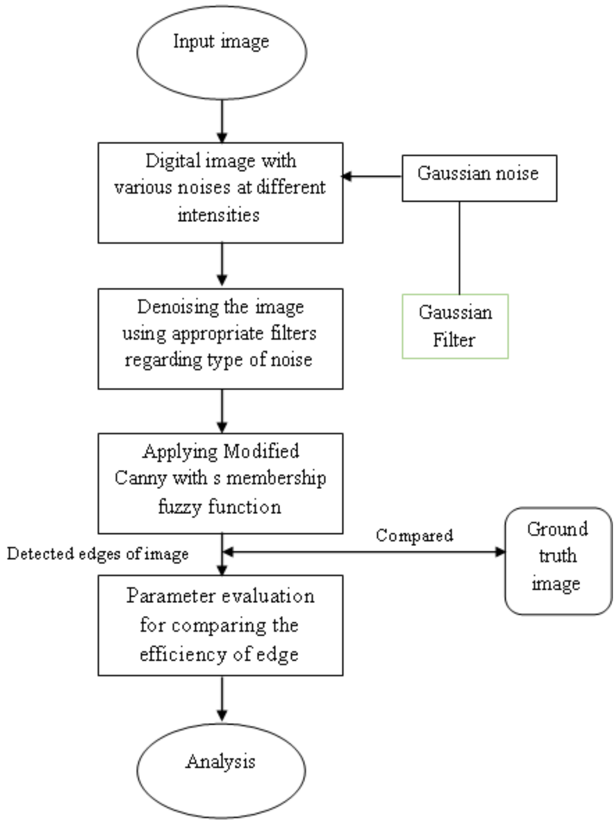


Fig 2: Flow chart for Detecting edges and analysis

III. MODIFIED CANNY USING S-MEMBERSHIP FUNCTION

In the proposed algorithm image is resized with help of scaling. Scaling is a significant process which trade-offs between softness, sharpness and effectiveness. Scaling process has been divided into two categories such as standard and automatic. In the case of standard, threshold is decided manually but in case of automatic it is decided based on factors influence by the image. Canny utilizes automatic threshold which is an effective parameter with a scale down process using canny edge detector.

Steps included in the proposed algorithm:

1. Read the source image; if it is RGB convert it into grey-scale.
2. Scale down the image with multiple of 16, initiated with 32 to 128.
3. Applying Gaussian filter and on the noisy images and evaluating with various parameters
4. Find the edges of image with scale down process using canny edge detector.
5. Implement S membership function to decide hypothesis of canny.
6. Applying noise at various level upto 80% on resultant image after performing S membership function.

3.1 Fuzzy S-membership function

Few works were reported on image segmentation using membership functions[4-6]. A fuzzy logic system was introduced for image segmentation with minimum number of rules and least error rate[6]. As the fuzzy system had a smaller number of rules and less computational load the proposed method shows highest computational speed.There are so many membership functions are existed in neural networks and fuzzy logic among them S-membership function is one of the functions which is used to determine hypothesis of canny to find out more edges in the given input image [7].

The shape of S function is commonly used to represent brightness of given input image pixels. Originally S function is introduced by Zadeh [8] for flexibility the definition of S function is given in eq. 2.

$$S(x;a,b,c)=\begin{cases} 0, & x\leq a \\ \frac{(x-a)^2}{(b-a)(c-a)}, & a<x\leq b \\ 1-\frac{(x-c)^2}{(c-b)(c-a)} & b<x\leq c \\ 1 & x\geq c \end{cases} \tag{2}$$

Where a,b and c are parameters determining the shape as shown in Fig 3. The definition of b can be median, a and c are two random values generated as mean-variance and mean + variance.

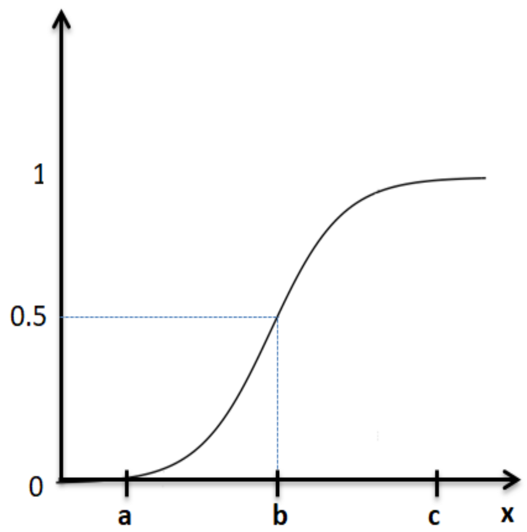
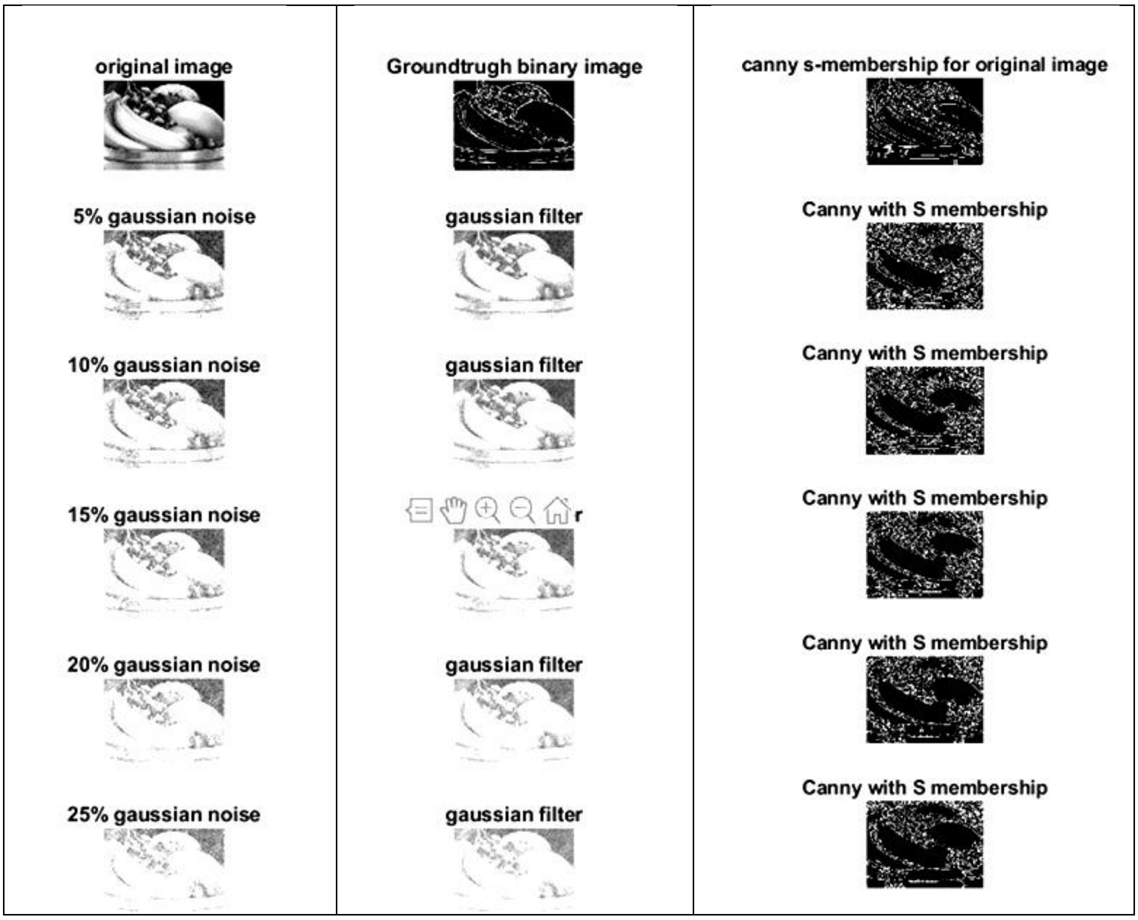


Fig. 3 S-membership curve showing the variables a, b and c

In the S function with the help of random parameters mean, variance and standard deviation are calculated.

IV. RESULTS AND DISCUSSION

In the proposed work, Gaussian noise is considered which varies its intensity levels from 0% to 75% with the 5% intervals for better understanding of the behavior of edge detection and its efficiency. Figure 5 shows the fruit image and its edge detection efficiency for different noise levels under the influence of Gaussian filter. The statistical parameters of the fruit images are tabulated in the table 1. Butterfly image is considered as another example to understand the edge detection efficiency under the influence of different noise levels of Gaussian noise. Edge details of the Butterfly image for different noise level intensities and its statistical parameters are mentioned in Fig. 7 and Table 2 respectively. The statistical parameters are compared with Canny as reference for different noise levels for both fruit and butterfly image. Figure 8 describes the efficiency of the edge detection technique taking canny as reference. Surprisingly the modified canny edge detection technique shows superior performance in detecting the edges of the image even in the presence of noise for the noise levels upto 75%.



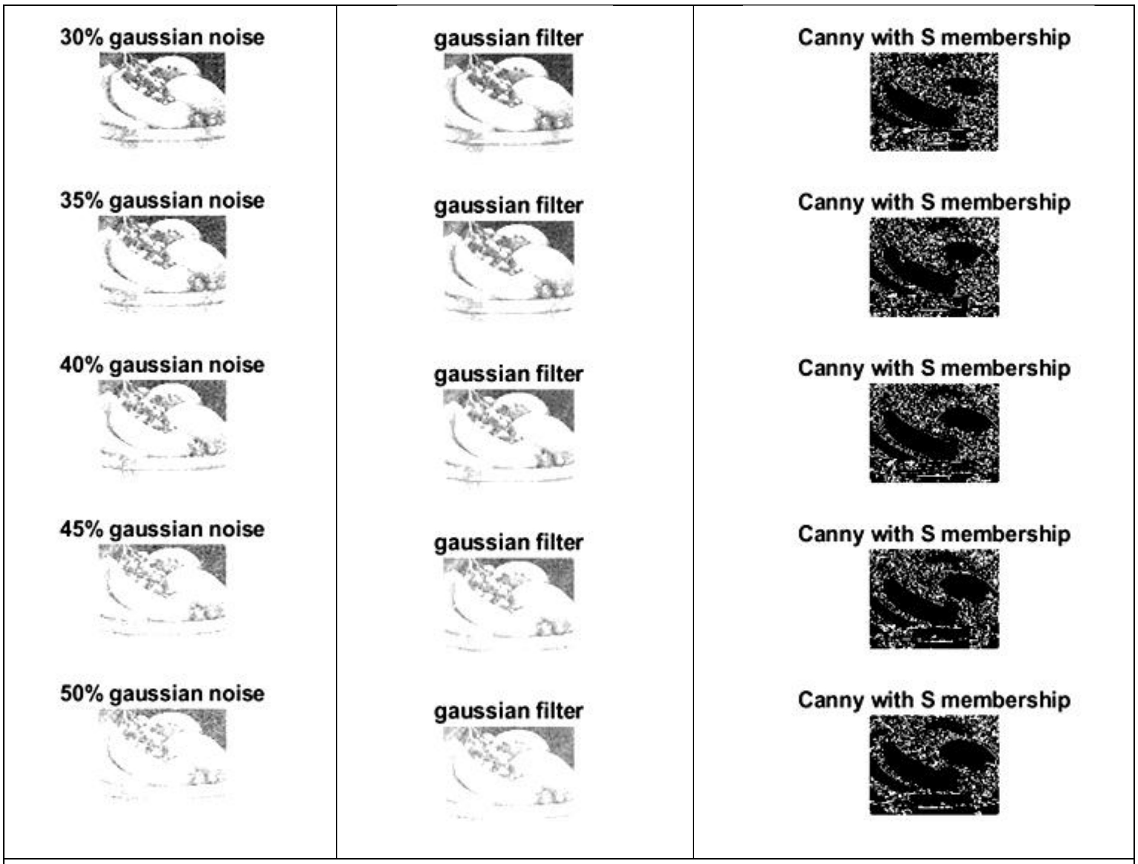


Fig 5: Output images of edge detection at 0% to 50% intensities of Gaussian noise

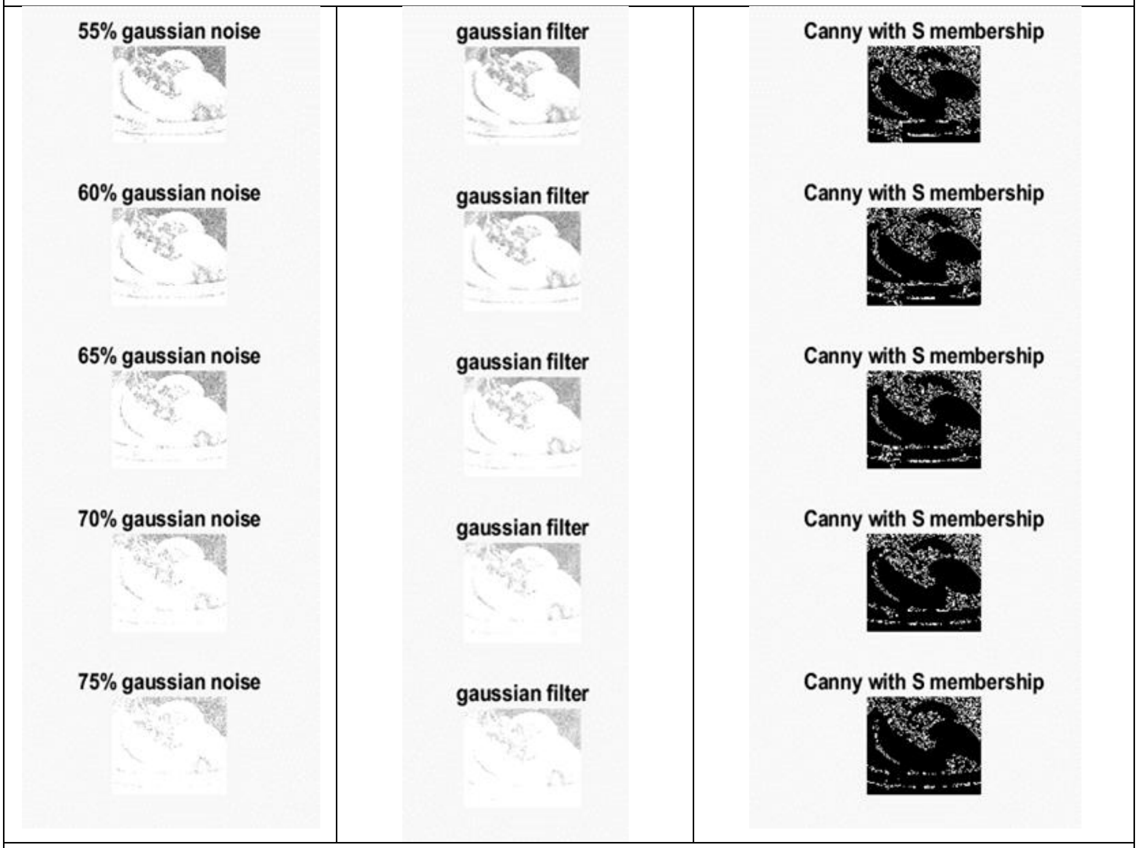
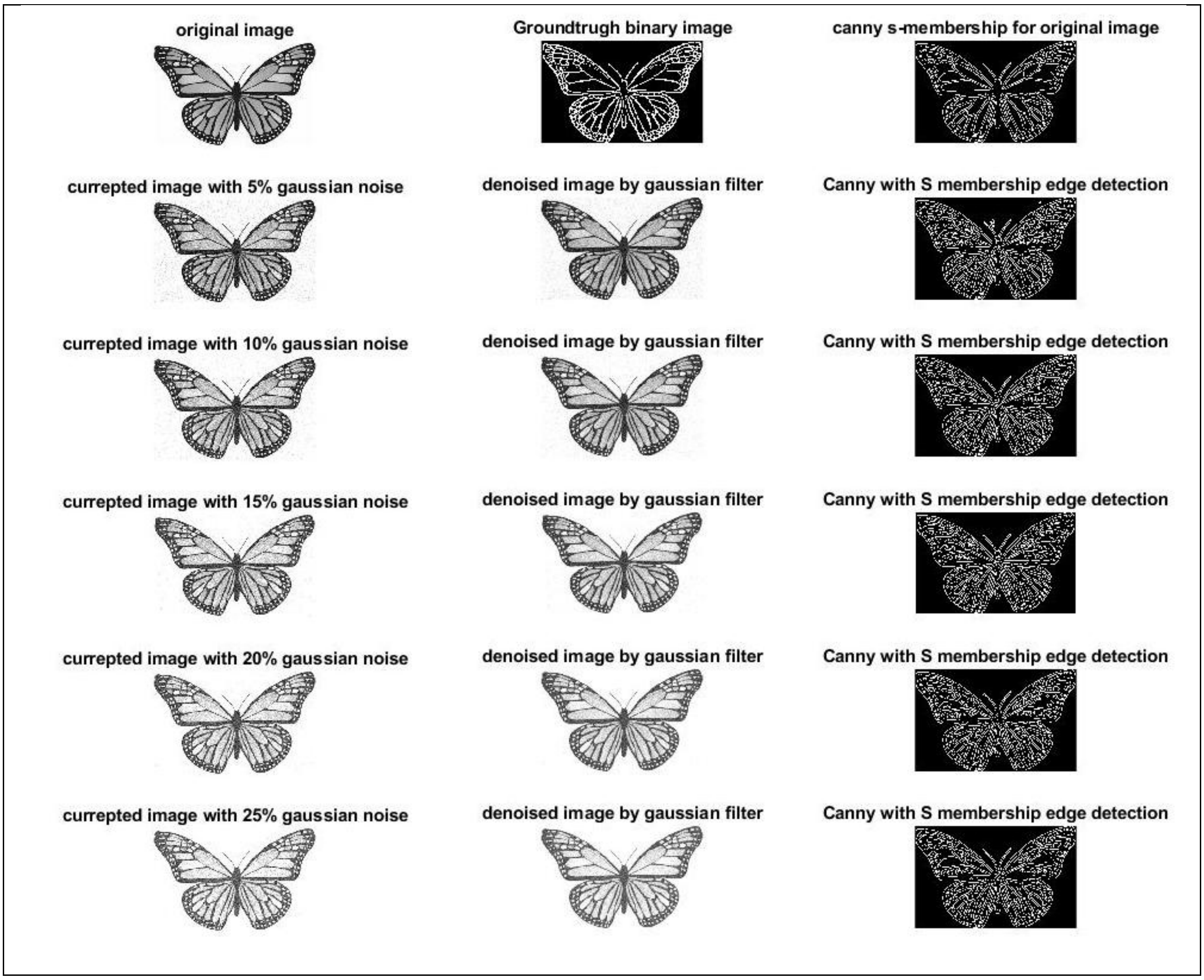


Fig 6: Output images of edge detection at 55% to 75% intensities of Gaussian noise

Table 1. Parameter values for fruit Gaussian Noise

	TPV	FPV	TNV	FNV	PCO	PND	PFA
Ideal value (0%)	0.00	0.00	37562	0.00	0.00	0.00	0.3856
S-Canny	2061	4891	32671	10623	0.1624	0.8375	0.779
5%	3194	11262	26300	9491	0.22904	0.6564	0.7718
10%	3254	11007	26555	9430	0.2281	0.6612	0.7701
15%	3194	10701	26861	9490	0.2341	0.6829	0.7583
20%	3103	9740	27822	9581	0.2416	0.746	0.6984
25%	3063	8859	28703	9621	0.2414	0.7585	0.6595
30%	3054	8366	29196	9630	0.2407	0.7592	0.6168
35%	2870	7824	29278	9814	0.2262	0.7737	0.5614
40%	2779	7121	30441	9905	0.2262	0.7809	0.5227
45%	2704	6630	30932	9980	0.2131	0.7868	0.4916
50%	2754	6236	31326	9930	0.2171	0.7828	0.4503
55%	2638	5712	31854	10046	0.2079	0.792	0.4146
60%	2630	5260	32302	10054	0.2073	0.7726	0.3792
65%	2484	4811	32751	10200	0.2073	0.8041	0.33442
70%	2376	4368	33194	10308	0.1873	0.8126	0.3069
75%	2214	3893	33669	10470	0.174	0.8254	0.3856


original image
Groundtrugh binary image
canny s-membership for original image
currepted image with 5% gaussian noise
denoised image by gaussian filter
Canny with S membership edge detection
currepted image with 10% gaussian noise
denoised image by gaussian filter
Canny with S membership edge detection
currepted image with 15% gaussian noise
denoised image by gaussian filter
Canny with S membership edge detection
currepted image with 20% gaussian noise
denoised image by gaussian filter
Canny with S membership edge detection
currepted image with 25% gaussian noise
denoised image by gaussian filter
Canny with S membership edge detection

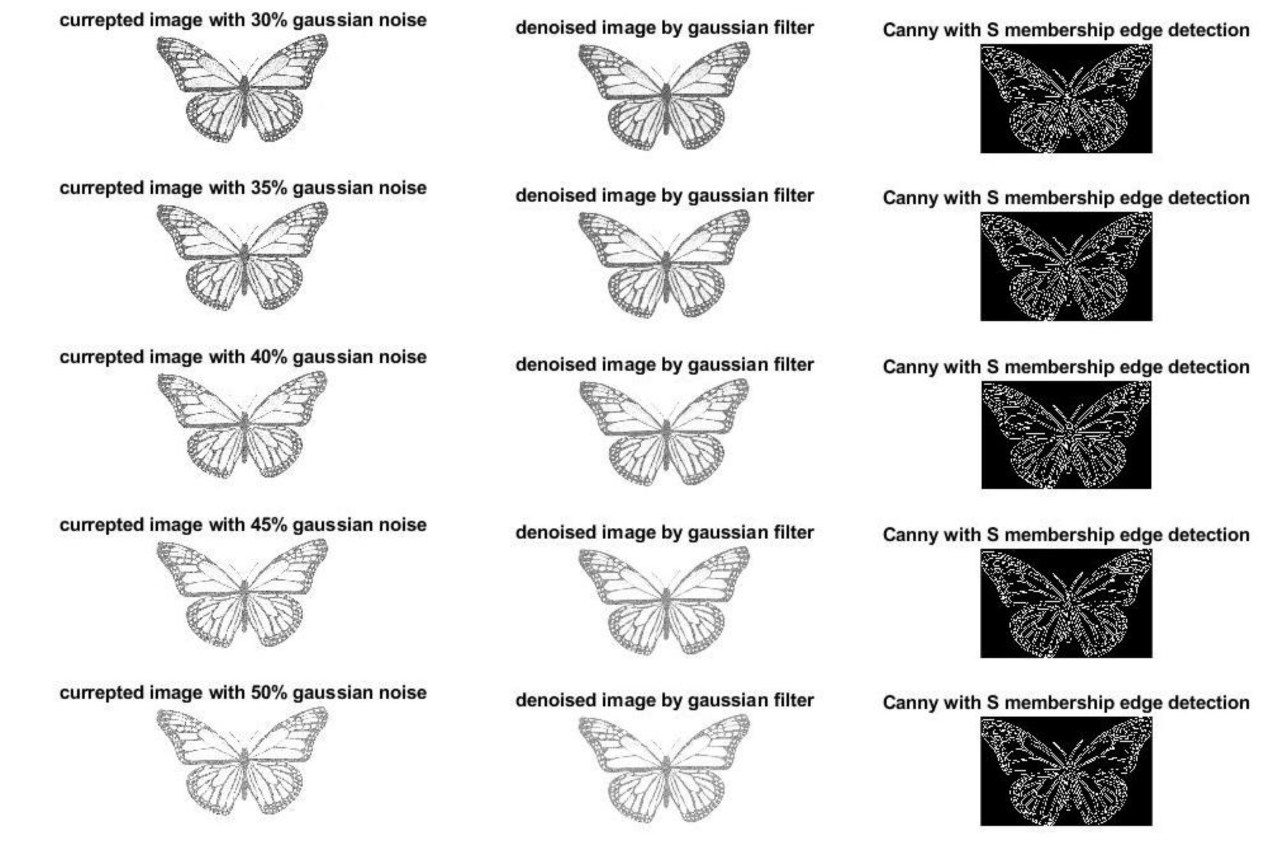


Fig 7: Output images of edge detection at 0% to 50% intensities of Gaussian noise

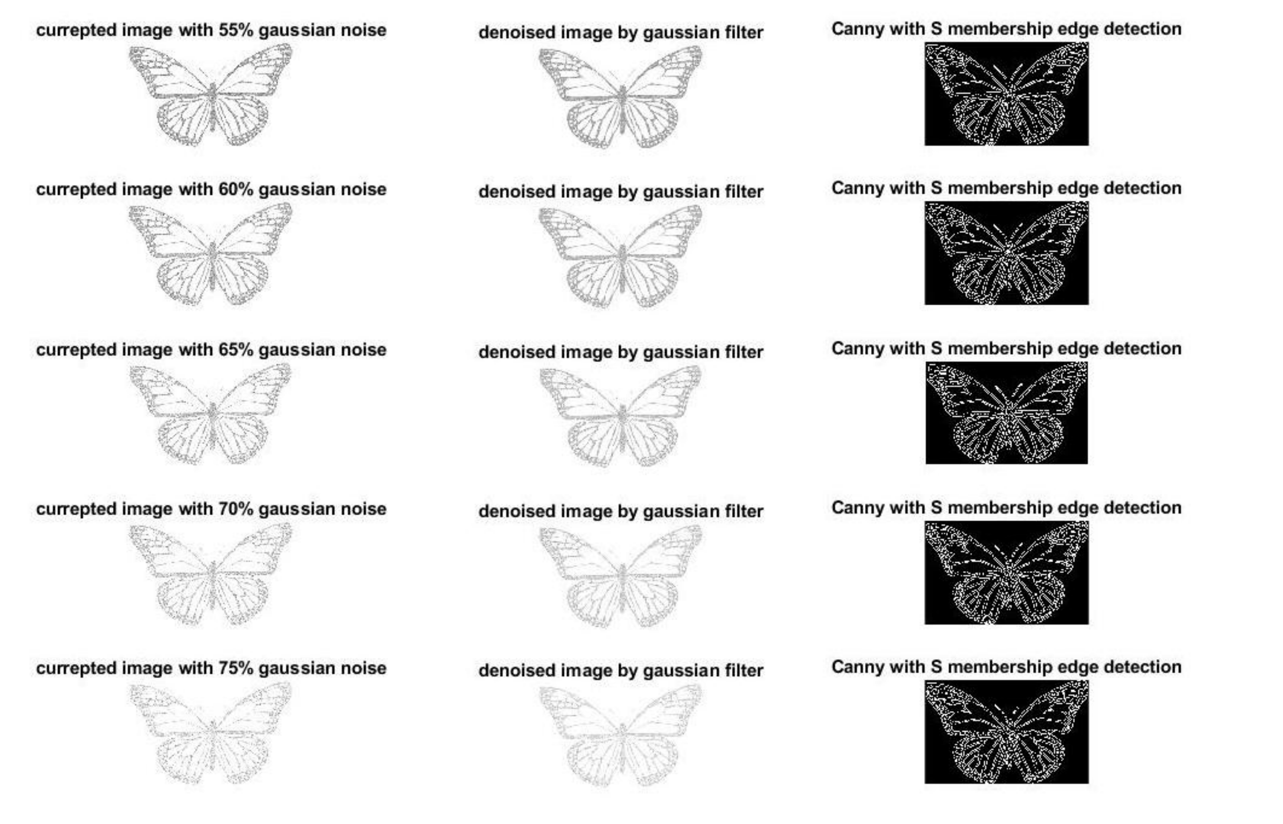
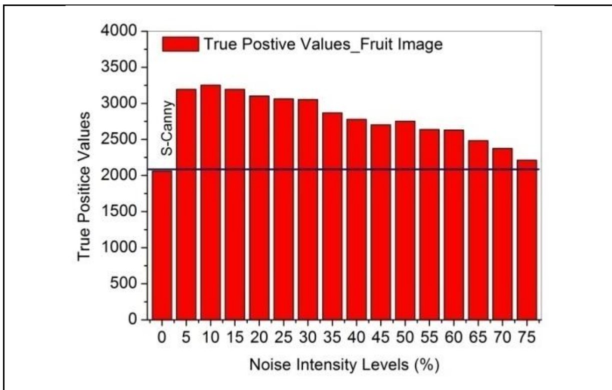
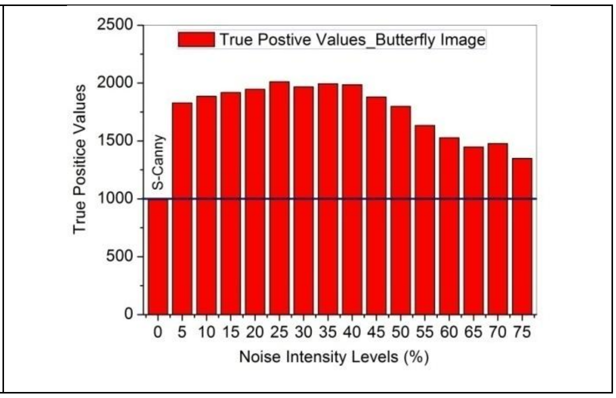


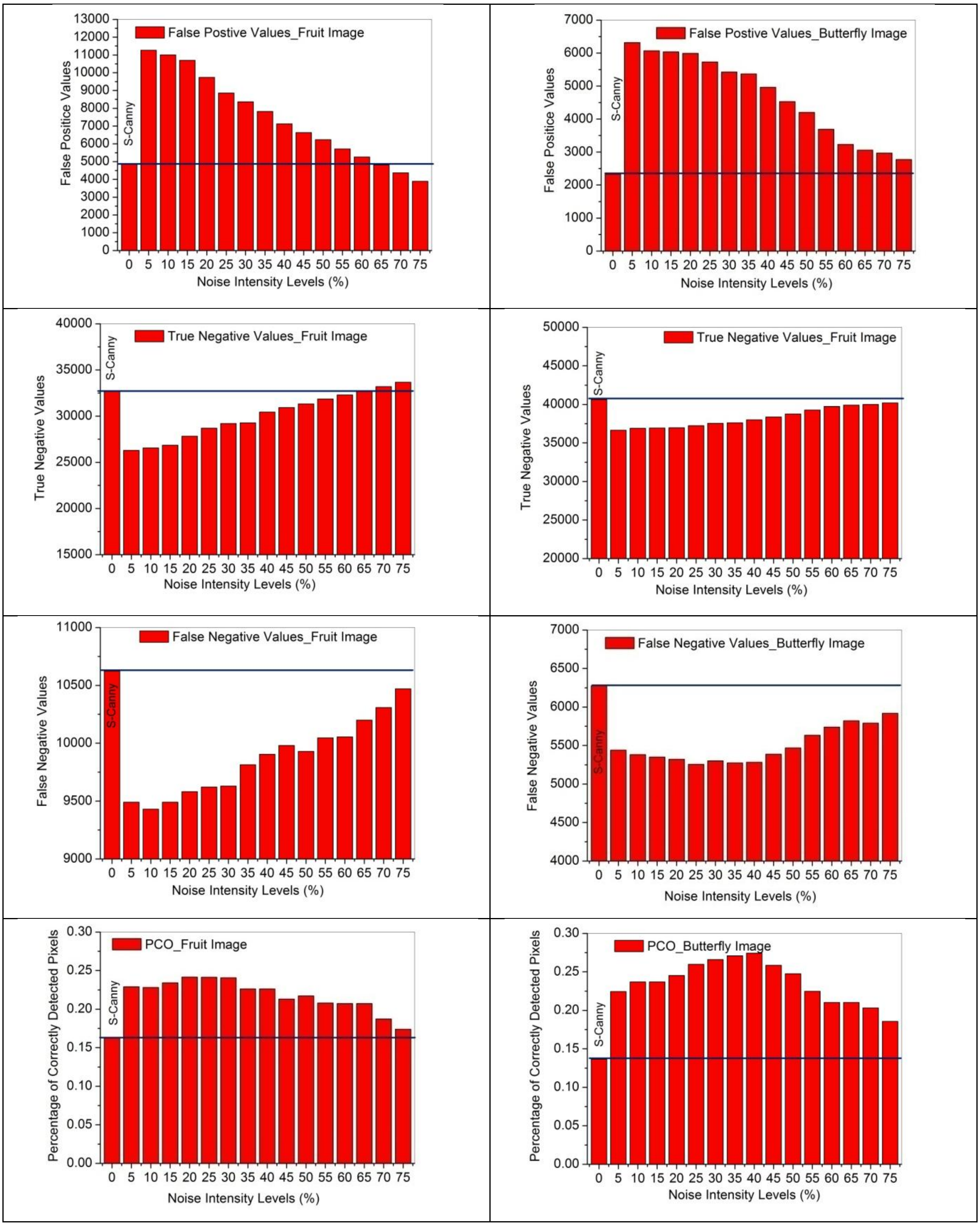
Fig 7: Output images of edge detection at 55% to 75% intensities of Gaussian noise

Table 2. Parameter values for Butterly Gaussian Noise

	TPV	FPV	TNV	FNV	PCO	PND	PFA
Ideal value (0%)	0.00	0.00	37562.00	0.00	0.00	0.00	0.00
S-Canny	993	2332	40635	6275	0.1366	0.8633	0.3208
5%	1828	6317	36650	5440	0.2244	0.6678	0.7755
10%	1886	6071	36896	5382	0.237	0.6763	0.7629
15%	1918	6037	36930	5350	0.237	0.6725	0.7588
20%	1947	5990	36977	5321	0.2453	0.6704	0.7546
25%	2011	5731	37236	5257	0.2597	0.679	0.7402
30%	1967	5427	37540	5301	0.266	0.7169	0.7339
35%	1994	5366	37601	5274	0.2709	0.7165	0.729
40%	1986	4965	38002	5282	0.2743	0.7264	0.6831
45%	1880	4529	38375	5388	0.2586	0.7413	0.6318
50%	1799	4202	38765	5469	0.2475	0.7524	0.5781
55%	1634	3692	39275	5634	0.2248	0.7751	0.5079
60%	1528	3234	39733	5740	0.2102	0.7897	0.4449
65%	1448	3059	39908	5820	0.2103	0.8007	0.4208
70%	1477	2967	40000	5791	0.2032	0.7967	0.4082
75%	1349	2774	40193	5919	0.1856	0.8143	0.3816






False Postive Values_Fruit Image
False Positice Values
Noise Intensity Levels (%)
S-Canny
False Postive Values_Butterfly Image
False Positice Values
Noise Intensity Levels (%)
S-Canny
True Negative Values_Fruit Image
True Negative Values
Noise Intensity Levels (%)
S-Canny
True Negative Values_Fruit Image
True Negative Values
Noise Intensity Levels (%)
S-Canny
False Negative Values_Fruit Image
False Negative Values
Noise Intensity Levels (%)
S-Canny
False Negative Values_Butterfly Image
False Negative Values
Noise Intensity Levels (%)
S-Canny
PCO_Fruit Image
Percentage of Correctly Detected Pixels
Noise Intensity Levels (%)
S-Canny
PCO_Butterfly Image
Percentage of Correctly Detected Pixels
Noise Intensity Levels (%)
S-Canny

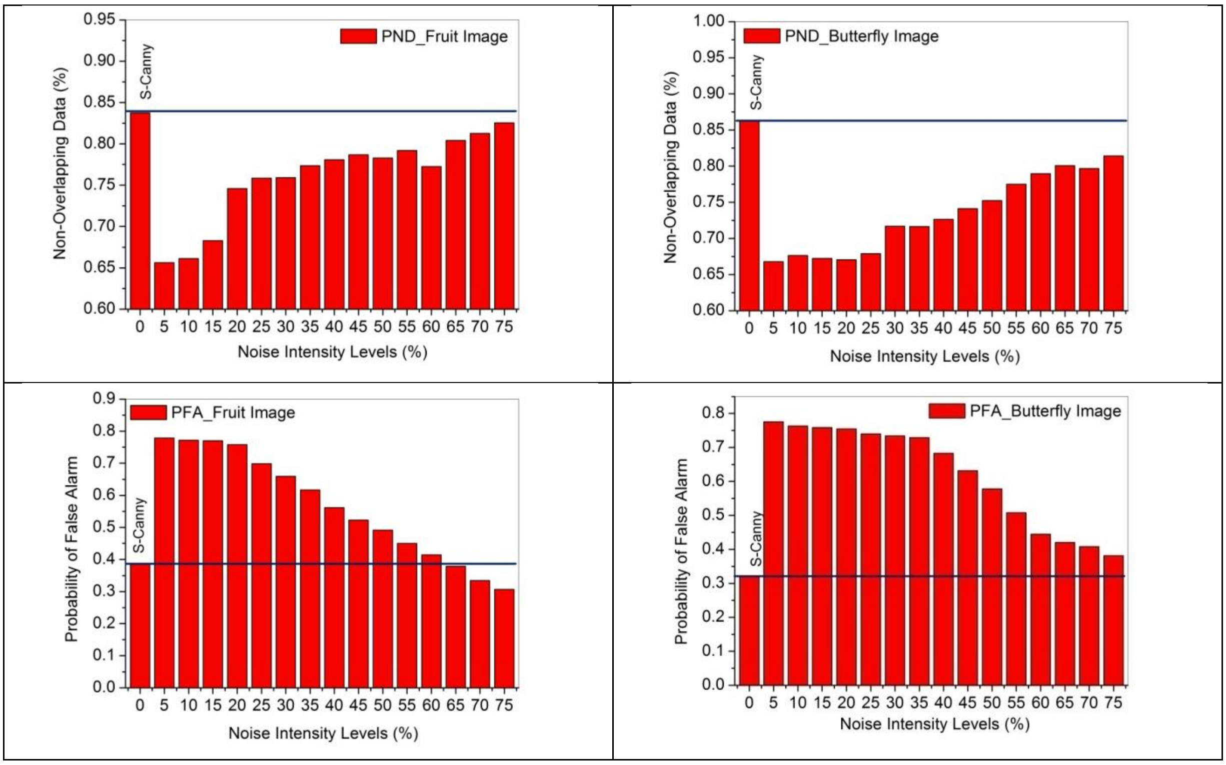


Fig. 8 Graphs drawn for various parameters

V. CONCLUSION

In general, images are sensitive to noise it is essential to take care in delivering the images from source to destination without noise distortion. Edge detection places a key role identification of internal boundaries of objects with the great deal of noise in corrected edges are identified to avoid incorrect edges Gaussian filter is applied. The important characteristic of Gaussian filter is, it is independent to noise characteristic and it is dependent to variance of Gaussian kernel with properties. The proposed method is tested edge detection with modified canny edge detection using s-membership function along with various intensive levels of noises. The effects of Gaussian filter along with various proportionate noises identifies possible number of true edges by distortion of noise statistical analysis is carried out with respect to existing canny and proposed work with the various noise intensity. Finally, It conclude that edge identification with the presence of noise is good in future work could be focuses on adaptive edge detection mechanism using deep learning techniques.

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