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# Edge Detection Enhancement Based on Filtering and Threshold Estimation

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***Abstract: An edge detection is a critical tool under image processing and computer vision. It is used for security and reliability purposes to provide enhanced information about an object and recognize the contents of the image for the applications of object recognition in computer vision. The most prominent application may be pedestrian detection, face detection, and video surveillance. Traditional edge detection method has many issues that are discussed in this paper. In this study, we enhanced the edge detection technique by applying filtering and detecting the threshold values to differentiate between different contrasts in the image. Differential operations are used to detect two adaptive thresholds on the histograms of the images. We have examined this technique on three databases Pascal, Corel, and Berkeley. The results obtained were then examined with qualitative and quantitative assessments test. Entropy, Mean Squares Error, and Peak Signal to Noise Ratio values were examined and it gave better results.***

***Keywords: Edge detection, Canny, Sobel, Prewitt, Computer vision, Image processing.***

## I. INTRODUCTION

Edge detection is one of the important image processing and computer vision algorithms with the responsibility of detecting the most important features and properties of the objects present in a digital image. These properties of the object could be irregularities in the photometrical, geometrical shape, and other bodily appearance of the object. These characteristics lead to the dissimilarities at the gray level of the image. Among the other variations, the most common is the discontinuity, local extremum, and at the point of meeting two edges like 2D features, e.g., corners [1]. Basically, edge detection is the process of detecting and tracing the edge of the objects inside the image [2]. Image edge detection is an active research topic and an image processing tool that provides critical information in the image. This tool is used widely like in image segmentation, the characterization of the image, registration of images, image visualization, and pattern recognition. All these discussed applications may vary in their outcomes but have a common requirement and need, that is, to precisely detect the edge information for further fulfilling their needs successfully. An edge detector can be defined as a mathematical operator that responds to the spatial change and discontinuities in a gray-level (luminance) of a pixel set in an image [3].

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Tracing the edges in the image is the most vital step in the process of understanding the features of the image. The main goal in edge detection is to mine the most striking pixels of objects in the image that can be the boundaries of a certain object, which may lead to an abrupt change in the appearance of the image. The traditional edge detection method applies a linear function in the following form (Eq.1), which may represent the needed edge information:

$$E(n) = \sum_{j=1}^{p} I_j(n) X W_j(n) \quad (1)$$

Where $W$ is the image edge filter, $p$ is the filter size, and $I$ and $E$ represent the original and edge map images, correspondingly. The different features of $W$ will denote the numerous edge filter features. Thus, having known problems in the image, edge detection comes into picture with the purpose of localizing these kinds of variations and further identifying the reasons that lead to such dissimilarities in the images. But, the most important task is to develop an edge detection technique that is efficient and most reliable in any dissimilarity since the whole process of complete image and further image processing tasks depend on such detection. To overcome such discontinuities and dissimilarities in edge detection techniques can help in providing the needed information on the image. The core element in edge detection is the implementation and computation of image derivatives. But, it is revealed that image differentiation is an ill-posed problem because these derivatives are sensitive to noises like electronic semantics and the effects of discretization. However, image-smoothing procedure provides the solution by regularizing the differentiation, but it is ineffective since it leads to the loss of some crucial information in the detection of noticeable structures in the image plane. Differentiation operators which are used commonly have different properties and produce different edges. So it is demanding to develop an effective and efficient generic edge detection technique. Because of these regulations, researchers have been developing different edge detectors in digital image processing with variation in their purpose, mathematical, and algorithmic properties. Another conventional method used in edge detection is through detecting the maximum value of the first derivatives or zero crossing of the second derivatives since these two derivatives have lot of advantages. The following techniques come under the first-order differential operations like Roberts, Prewitt, Sobel, and other operators. The second order differential operator consists of Laplace and LOG operators. The advantages these operators have are computational effectiveness, easy implementation, and speed is quickly, but besides these advantages they are sensitive to noise and lead to defects in detection.

The best edge detection was discovered by Canny in 1986 and it followed few criteria to decide the performance of edge detection. There were three criteria upon which the proposed techniques could be judged and there were SNR, localization precision, and single edge response criteria. The best Canny edge detection operator was introduced based on these criteria and it proved to be more effective in performance compared to traditional edge detection techniques [4].

As discussed initially, the quality of the image is disturbed due to some reasons like noise and during the image acquisition if the image is exposed to illumination. Because of these reasons the contrast in the image is different when compared to the original, which needs to be fixed. But, these parameters are fixed and cannot adapt to the change in the conditions in the Canny edge detection algorithm. In this study, we focus on these issues and address them to produce a robust edge detection technique devoid of these shortcomings.

The motivation to modify the edge detection algorithm came when one of the authors applied one of the edge detectors in locating discontinuities in image intensity for image segmentation and identification of objects in a sight. This led to tracing joint borders that symbolize a 3D point in the scene which corresponds to an object point. Edge detect filters have been evaluated based on detecting image intersection points and then showed the ones that corresponded to polygonal object planes [5]. Various edge detect filters are based on the gradient calculation methods. Fig.1a represents color intensity variations, where the left is a slow color gradient, which is not a border, while the right is a quick variation, which is an edge. To detect the color variation speed within an image, we need to calculate the gradient of this edge. This can be obtained using one of the various edge detect filters, i.e., the first derivative. We decide that a border is detected when gradient is more than a threshold value (Fig. 1b).

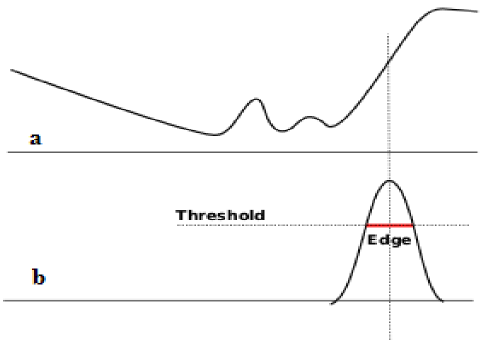


**Fig. 1. Gradient calculation**

Therefore, this paper improves the image gradient design operator that is caring to reserve more valuable detail edges and extra robust to noise. Two adaptive threshold mixture approaches were discussed for two types of typical images, correspondingly, and it can contribute to fitting different conditions automatically.

Recently, few researchers have modified and enhanced the Canny version of edge detention algorithms and applied those algorithms in practical engineering. The following are few of the improved versions of Canny edge detection.

Er-Sen Li enhanced the image gradient magnitude design operator and automaticity of edge detection by Otsu's threshold assortment method, and it displayed decent edge detection outcomes to some extent [6]. Agaian S. presented an enhanced Canny operator for Asphalt Concrete uses [7]. Xiangdan Hou planned an enhanced Canny algorithm built on the Histogram-based fuzzy C-means clustering procedure. It was applied in discovering road surface suffering image and it had good effect [8].

The paper comprises of the following section, Literature review related to edge detection technique is discussed in section 2, Problem constraint is discussed in section 3, different datasets used in this study is discussed in section 4, Methodology applied is discussed in section 5, Simulation results and performance analysis is discussed in section6, followed by conclusion in section 7 and then section 8 as reference list.

## II. LITERATURE REVIEW

Previously, many techniques were introduced for edge detection and were grouped as search-based and zero crossing based. In the search-based method, the edges are detected by measuring the strength of the edge with the help of first-order derivatives like the gradient magnitude computation, followed by searching the maxima of gradient magnitude using a computed estimate of the local orientation of the edge, usually the gradient direction. Based on the Gaussian derivatives, Canny [9] successfully devised an optimal edge detector. Similarly, Deriche [10] introduced a fast recursive implementation of Canny's edge detector. The second order difference or zero crossing edge detection was introduced by the strong influence of biological vision. Recent works on unified frameworks for neighborhood operators can be found in Koen-derink and van Doom [11] and Danielson et al. [12]. Numerous techniques are available which help in improving the edge detection. A fuzzy rule-based edge detection was introduced by Choi et al. [13] with the intention of providing more reliable results for edge detection, this method consists of empirically defined fuzzy rules and a membership function. These parameters act as decision makers that help in deciding whether it is an edge or non-edge area. During the edge detection process, there is an edge missing problem which was handled by Zhang et al. [14] using automatic Anisotropic Gaussian Kernels, it was developed with the help of revising the edge extraction technique. This method aimed to remove the noise and increase the smoothness in the input image and its ultimate goal was to attain a closed edge contour. Another method introduced for edge detection used the enhanced Moore-Neighbor algorithm to locate an edge accurately, this method was proposed by Biswas and Hazra [15]. This method aimed to extract the features for tracing the boundaries in the image, further modifications were performed on the Moore-Neighbor algorithm by incorporating the filter range to detect the edges in the objects. Avots et al. [16] presented a methodology for edge detection, in this method,


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a kernel was developed with the help of singular value ratios. The singular values of the images were used for the construction of kernels. These kernels help in making the image edge and finally the last image edge was produced with the help of OR operations and the ultimate image edge is produced using all these operations.

The detection of edges in the image without postprocessing was performed by Hu et al. [17], in this work, the authors introduced convolutional neural network for detection edges in the images. The proposed method could efficiently fuse multilevel information for collecting feature maps and then ultimately produce hybrid convolution features, these hybrid features are core in detecting the edges in the image.

Bioinspired algorithms play critical roles in solving big scientific and engineering problems and they influence image processing field especially during the last two decades (Yang et al. 2013). Digital image processing tasks are solved by these algorithms to an extent and necessitated numerous discoveries of methodologies, especially for the segmentation issues, classification, and pattern recognition [18]. Considerably, some of these algorithms are related to evolutionary computation like genetic algorithm (GA) followed by the bat algorithm (BA), these types of algorithms are basically applied in detecting the edges in image [23, 24]. Lee et al. [20] implanted genetic algorithm for detecting edges in images, the dataset used is a simple image and it was used as a training for GA and applied edge filters to detect the edges.

In another study, Jin-Yu et al. [21] overcame and resolved the shortcomings of Sobel edge detection techniques with the help of GA algorithm by optimizing the performance of detecting the edges in image. Differently, Tian et al. [19] tackled the image detection by introducing the ACO technique and particularly artificial ants were moved throughout the image that were driven with the help of local variations with the intensity of the image values, consequently, the pheromone matrix was developed. This matrix helped in representing the information needed to design the edge in the image with the pixel information. Another bioinspired algorithm used for detecting edges is that of Alipoor et al. [22], they proposed a technique with the help of PSO and the ultimate outcome was to find the optimal coefficient values of the edge filters. Chen et al. [23] focused on the noisy images to detect the edges, they used PSO for the noisy images to improve the performance of the technique in detecting the edges and also discovering the curves in the images which may best fit the edge.

Edge detection based on the ABC algorithm was introduced by Yigitbasi and Baykan to identify the edges of objects in images without using any mask operator [24].

The BA was used by Dwivedi et al. [25] to solve the edge detection problem optimally. The local variations of image intensity discovered by the movement of bats in search of food were used to reveal the edge pixels. Studies are open for the development of new edge detection algorithms because not all edges are detected when using the available edge detectors.

From the literature review, it is observed that studies on edge detection have run parallel and are intermittent for the last 40 years. Incremental progress has been reported in successive studies for years. Additionally, studies are reported from various universities across the continents. From the literature review, it has been identified that the existing methods are inaccurate in detecting edges, fail in edge connectivity and require optimal qualitative and quantitative analyses. Therefore, in this study, an effective edge detection algorithm is proposed and it satisfies better edge connectivity, improved edge width uniformity, acceptable entropy value, and maximum similarity with minimum error to the respective ground truth as per result.

## III. PROBLEM CONSTRAINT

Basically, edge detection is classified into spatial and frequency domains. The operation performed by the spatial domain is directly on the pixels of image and is called operator-based method. Further, this method is classified into the first-order and second order methods. The two orders have unique operational methods, the first-order has first derivative of the image gradient, while the second has second derivative of the image gradients, and both work on the image gradient, but with different orders. The edge detection techniques that come under the first-order methods are Sobel, Prewitt, and Roberts, while those of the second are Laplacian and Canny edge detection techniques. Limitations of Spatial Domain Methods are discussed in Table I.

While an image could be converted into the frequency domain by applying the Fourier Transform method, it is not so in the spatial domain. After converting it into the frequency domain, more operations could be applied. Initially, adequate number of details is extracted through a low frequency operation and equivalent image contours were attained from high frequencies. Frequency domain has big limitations for the search space. The most important objective is a quick and accurate detection of edges of objects in the image. In this context, a researcher Gonzalez and Woods [26] made an initial attempt for detecting effective edges in the image. Let us now discuss about the first and second order techniques. Prewitt operator is considered as the discrete differential operator used to calculate the gradient and for calculating the intensity function of an image. This operator is very easy as per implementation, but the results are extremely sensitive to the noise present in the image. This first-order differential method for edge detection was further modified with a name Sobel operator for detecting edges. The major enhancement was on the gradient with the functional variation because of this operation the image is reflected as a continuous function of the gray image. Because of this operation, a large variation has occurred in the gray image caused by the gradient functionality. Robert operator has shortcomings too, it is affected due to the presence of noise in the image and is very sensitive to noise.

**Table-I: Limitations of spatial domain methods**

| Operator | Technique | Pros | | Cons | |
|---|---|---|---|---|---|
| Sobel | Spatial First Order | Detection of edges | Simplicity in operation | Very sensitive to noise | Accuracy is not good |
| Robert | Spatial Second Order | All the directions are fixed | Detection of edges | Only few edges are responded | Very sensitive to noise |
| Canny | Gaussian | Find the error rate | Localization and Response | Very complex | Computation is an issue |

The Sobel operators are omnidirectional differential operators, the derivatives are divided into ***m*** and ***n*** partially. The detection of edges using Sobel is through weights. A weighting algorithm is used at the adjacent points of the pixels in the four directions left, right, up, and down. Detecting edges is through finding the extreme values at the edge points. This approach works well regardless of noise, but the size of the edges harshly worsens, which leads to detect false edges and the localization of the pixels is very low because of these issues. As per these issues, Sobel is not considered as the best edge detection technique as its accuracy is strikingly affected. Considering the limitations of Sobel operator, a new operator was discovered by Canny [23] in 1986 called Canny operator. This operator is based on Gaussian filter for smoothing the image and removing the noise for effective edge detection. The technical details of the Canny are as follows: it uses non-maxima suppression method that helps in enhancing the signal for the noise ratio, this approach allows a one-pixel wide range as the final results to be produced. Although it is a superb approach, but still this technique faces issues like 1) time-intensiveness, 2) it has excessive parameters needing modifications and these parameters in Canny edge operator algorithm is hard to manage as it leads to difficulty in getting better results, 3) the connectivity among the resulting edges is still a task for the extraction of full edges which are very clear to the human perspective, 4) the Gaussian smoothing causes difficulty in extracting the localization of the detected edges, and 5) the pixels at the corner lead to open-ended edges, and thus omitting the junctions. Because of these shortcomings, researchers like Rong et al. [24] introduced new techniques to overcome these issues and were called improved Canny edge detection techniques.

For a reliable edge detection technique, various edge detectors have been examined using different images from a number of data sets, visual inspection of the results showed that the Canny method was the most reliable as per number of extracted edges and connectivity. Despite that, noise tends to cause false edges. Consequently, the Canny algorithm was selected to be modified in this study. The performance of the Canny edge detector was investigated over threshold parameters and a range of Gaussain smoothing function. The best results were obtained with higher and lower thresholds of 40 and 20, respectively, and with σ = 1 (Fig. 2).

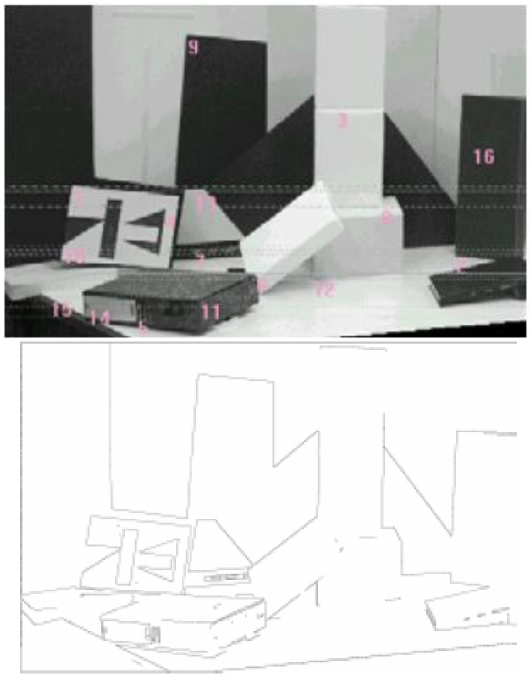

**Fig. 2. Applying Canny edge detection with higher and lower threshold of 40 and 20, respectively, and with σ = 1 in the Gaussian filtering kernel.**

In this study, the author proposed an improved edge detection algorithm. The technical detail was initially a gravitational field intensity perception introduced with the intention of replacing the image gradient as it was implemented in the traditional Canny edge detection algorithm. Further study focused on the selection of threshold and two adaptive methods for threshold selection was introduced for the detection of image edge with rich information. In the ICA, the templates of the image gradient with a 2 × 2 neighboring area operator were improved with a replacement of 3 × 3 neighboring area operator. Considering the drawbacks of image edge detection operations and to overcome them, a new and efficient edge detection algorithm is proposed.

## IV. DATA

We have worked on the three well known datasets Pascal, Corel, and Berkeley. These are freely available and will be useful for research purposes.

### A. Pascal

We have used VOC2012 [27] data for our experimentation. It is freely available and comprises 17,125 images. The dataset is categorized into people, vehicles, animals, plants, indoor, outdoor scenes and others (Fig. 3).

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Twenty categories of images are included in this dataset. This dataset is used to verify the proposed technique. The annotation details of the images in this dataset are classified into 20 classes. For classification and detection challenges, this dataset is annotated with bounding boxes for each object with attributes like “orientation”, “occluded”, “truncated”, and “difficult” specified.

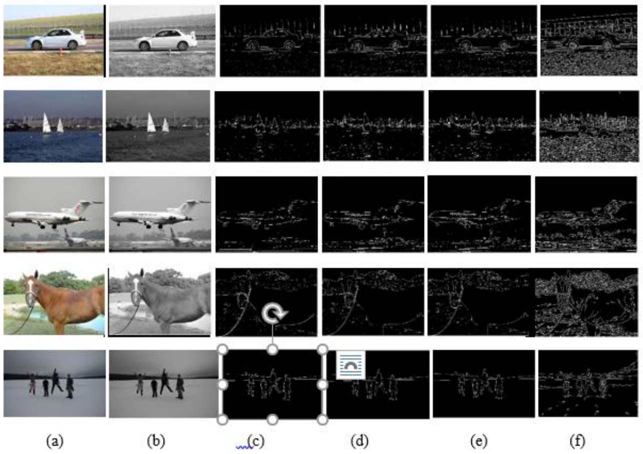


**Fig. 3. (a) is the original image, (b) Grayscale image, (c) Prewitt image, (d) Sobel image, (e) Canny image, and (f) proposed image**

**Table-II: Parametric evaluation of selected images through entropy difference**

| Images | Prewitt | Robert | Sobel | Canny | Proposed |
|---|---|---|---|---|---|
| **Img- 1** | 0.1759 | 0.1563 | 0.1459 | 0.4912 | 0.3761 |
| **Img-2** | 0.1378 | 0.1298 | 0.1457 | 0.5316 | 0.2879 |
| **Img-3** | 0.1036 | 0.1076 | 0.1098 | 0.3865 | 0.1754 |
| **Img-4** | 0.1651 | 0.1497 | 0.1613 | 0.2861 | 0.2761 |
| **Img-5** | 0.0731 | 0.0862 | 0.0832 | 0.2276 | 0.0841 |

## B. COREL

Corel dataset consists of about 17,800 Corel real life images—a subsection of the Corel Photo Gallery [30, 32]. Some of the images we have taken for experimentation are as shown in Fig. 4. Each folder in Corel dataset consists of about 100 images and in total there are 17,800 images. These images are categorized into 100 categories, and there are 10,000 images from diverse contents such as sunset, beach, flower, building, car, horses, mountains, fish, food, door, and others. Each category contains 100 images of size 192 × 128 or 128 × 192 in JPEG format.

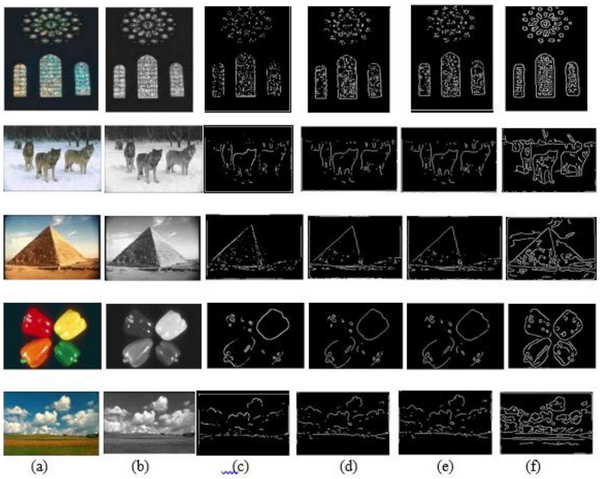


**Fig. 4. (a) is the original image, (b) Grayscale image, (c) Prewitt image, (d) Sobel image, (e) Canny image, and (f) proposed image**

**Table-III: Parametric evaluation of selected images through MSE**

| Images | Prewitt | Robert | Sobel | Canny | Proposed |
|---|---|---|---|---|---|
| **Img- 1** | 0.1559 | 0.15232 | 0.15591 | 0.19121 | 0.13761 |
| **Img-2** | 0.14878 | 0.14291 | 0.12757 | 0.15316 | 0.02872 |
| **Img-3** | 0.15361 | 0.15076 | 0.16098 | 0.13365 | 0.01754 |
| **Img-4** | 0.16251 | 0.13497 | 0.14613 | 0.28361 | 0.12761 |
| **Img-5** | 0.10711 | 0.15862 | 0.14832 | 0.02276 | 0.08471 |

## C. Berkeley

We have taken MSRC [29] and Berkeley segmentation datasets in our experiments. The first one consisted of about 591 images which were divided into 23 categories. Some samples are shown in Fig. 5. Here, we use the cleaned up ground truth object instance labeling [30] that is cleaner and more precise than the original data. The Berkeley segmentation dataset comprises 500 natural images covering various natural scene categories such as portraits, animals, landscapes, beaches, and so on. It also provides ground truth segmentation results of all images obtained from various human subjects. On average, five segmentation maps are available per image. Berkeley dataset comprises 300 natural images. This dataset was chosen because it comprises ground truth segmentation and could be used to compare the segmentation outcome of UGC with the Normalized Cuts method.

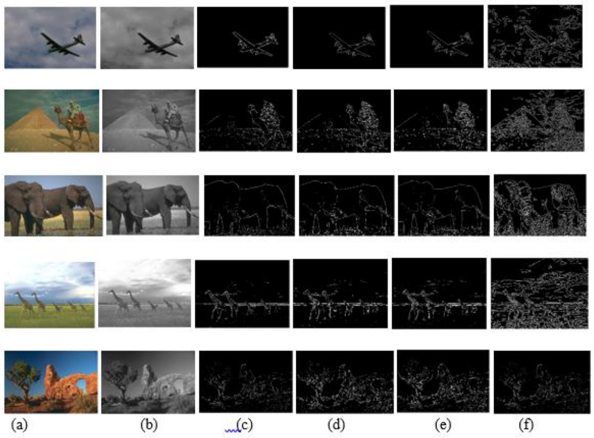


**Fig. 5. (a) is the original image, (b) Grayscale image, (c) Prewitt image, (d) Sobel image, (e) Canny image, and (f) proposed image**

**Table IV: Parametric evaluation of selected images through PSNR**

| Images | Prewitt | Robert | Sobel | Canny | Proposed |
|---|---|---|---|---|---|
| **Img-1** | 59.1559 | 57.15146 | 57.12691 | 55.89121 | 56.13237 |
| **Img-2** | 58.11378 | 58.11781 | 58.136157 | 56.15222 | 56.02312 |
| **Img-3** | 57.15671 | 57.15370 | 58.11608 | 57.14505 | 58.02144 |
| **Img-4** | 57.16341 | 59.13721 | 57.14182 | 57.21231 | 61.12109 |
| **Img-5** | 59.10011 | 58.13692 | 59.11502 | 59.01096 | 60.08239 |

## V. METHODOLOGY

This section comprises two subsections: enhanced Canny operator and Canny edge detector.

### a) Algorithm for calculating the median of the filter

In this study, we have replaced the Gaussian Filtering method with a median filter algorithm. The pixel value calculation of median filter algorithm is: it takes the median value from its neighbor pixels corresponding to a particular point in the image and substitutes that median value to this pixel point in the image. The advantage of this technique is that it reduces the noise effects and remove the isolation point [31].

For example, in the input image, if the gray value of each point is assumed as $f(x,y)$ , then the filter window would be M= $(M_{mn})$, two dimensional of the median filter function is G$(x,y)$ :

$$G(x,y) = Med\{f(x+m,y+n)|M_{mn}=1,\ (x,y)\epsilon N\} \quad (2)$$

### b) Algorithm for threshold calculation

An image with its amplitude histogram is taken and differential operation is applied to it. The application of differential operator leads to the implementation of adaptive real-time dual threshold algorithm. First, a non-maximum value suppression method is applied to the central pixel to detect the maximum value and the direction is maintained as the same as the gradient direction, this maximum value is then processed by the double threshold method, if the detected value is not maximum the amplitude of the pixel is set to zero, if so then the gradient amplitude histogram is generated and named as $G_1$. But, the most serious issue is how to develop an adaptive threshold. There are different steps to follow to make an adaptive threshold like different operation on adjacent gradient amplitude.

$$G_i(i+1) - G_1(i) \quad (3)$$

Now, we can make the high and low threshold. The high is selected as the first zero of the amplitude and the low is estimated as 0.3 times of high threshold. Based on these rules, the adaptive threshold could be set as defined below:

$$Th_H = Arg(G_1(i+1) - G(i) = 0) \quad (4)$$

$$Th_L = 0.3\, Th_H \quad (5)$$

Now, following the segmentation for double threshold, the image is directly sent to double threshold segmentation. As shown above, the high threshold is named as $Th_H$ and the low threshold is named as $Th_L$ . Now, after segmentation, the center pixel of the image is termed as $G_i(i,j)$

### c) Generation of chains

Now, we have extracted the high and low threshold, it is time to compare these and develop a strong and week edge points (Fig 6). Finding the edge starting point is very crucial, in this study, it is assumed to be the maximum point, and then it is linked to the weak edge points. Using this procedure, all the edge points are detected and edge chains are made. Technically, these chains are named as generalized chains that may contain and vary in lengths. The maximum and minimum length chains are, respectively, $d_{max}$ and $d_{min}$. After extracting these values, the average $d_{average}$ is also calculated using (Eq. 6).

$$\frac{d_{max} + d_{min}}{2} < d_{average} \quad (6)$$

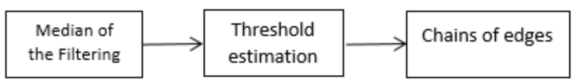


**Fig. 6. Proposed framework**

### d) Enhanced Canny Algorithm

This algorithm is programmed in Matlab (Fig. 7), steps are as follows:

**Step 1:** Reading imaged from the database.

**Step 2:** Computation of Grayscale and threshold.

**Step 3:** The images are preprocessed; Preprocessing is performed using the median-filtering method discussed above. It is represented as $G$.

**Step 4:** Amplitude gradient calculation: Each pixel of the image is calculated for its amplitude gradient value. The pixel is convolved around its neighboring pixels with horizontal and vertical templates.

**Step 5:** Double threshold calculation: We apply non-maximum suppression to calculate the maximum value. Initial edge points are calculated with the help of double threshold and comparison with the maximum value of the edge point.

**Step 6:** Formation of edge chains: Strong edge points are selected considered as the initial point and then connected to the weak points for the formation of chains of edges.

**Step 7:** Detection of edges: Finally, linear fitting methods are used to detect the edges.

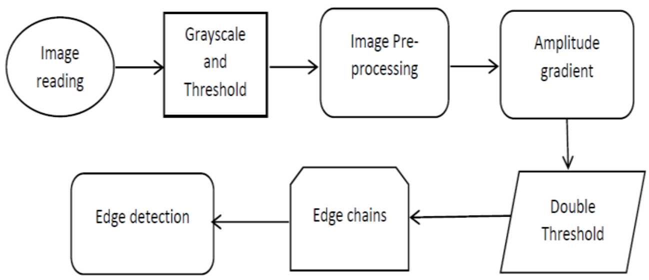


**Fig. 7. Flowchart of the edge detection method.**

## VI. SIMULATION RESULTS WITH PERFORMANCE ANALYSIS

We are going to do two analyses first is the Qualitative and the other is the quantitative analysis

### A. Qualitative assessment

The results obtained are analyzed based on qualitative methodology. The results are compared to the four benchmark technologies for detecting the edges [32][26][9][33] the images are shown in the (Fig. 3-5). As we can see in the (Fig. 3-4) the initial (a) represents the original image then followed by (b), (c), (d), (e) and (f) as described in the caption of the images for Prewitt [26], Sobel [32], and Canny [9]. The results of the proposed technique is displayed at (f). As we can see from the images there is much similarity between Prewitt and Sobel because of the ground truth and also due to the fewer continuity in detecting the edges but in the proposed technique images more edges are detected.

### B. Quantitative analysis

Followed by qualitative analysis we also intend to do quantitative analysis also. In this regard we have chosen the following criteria to judge the feasibility and reliability of the proposed technique to evaluate the results. The first is the Entropy [34], we then applied the results to Mean Squares Error (MSE) to measure the robustness of the proposed technique, then followed by Peak Signal to Noise Ratio (PSNR) [35], and lastly the Structural Similarity Index (SSIM) [36] all these results are listed in the Table II, Table III and Table IV.

### C. Entropy

Entropy is a measuring function applied to the images to get the information of the image contents, it was presented in [34]. Entropy is defined by (Eq. 7).

$$H(I) = -\sum_{i=0}^{L} p_i \log p_i \qquad (7)$$

From the above equation, I represents image, $p_i$ is the rate at which the pixel has recurred with intensity *i*. This entropy states that a lower value of $H(I)$ designates low content information and if it is too high, then noise or double edges are suspected. Hence, it is preferred to have $H(I)$ values in the middle for the best results.

In the proposed approach, the discovery of successful and meaningful edges is detected (Table III). Observably, the obtained entropy difference value is less than Canny's and slightly higher than Prewitt and Sobel techniques, but nearly to Canny in some images. It shows that the entropy difference lies between the two extreme limits.

### D. Mean Square Error And PSNR

The MSE of the respective outcome is computed from (Eq. 8).

$$MSE = \frac{1}{mn}\sum_{0}^{m-1}\sum_{0}^{n-1} ||O(s,t) - P(s,t)||^2 \qquad (8)$$

The following are the details of the above equation. Here, `*O*' represents the matrix data of the original image, `*P*' represents as the matrix data for the image obtained after operation, `*m*' and `*n*', represents the complete rows and columns counts of the image pixels and `*s*' represents as the index value for rows and `*t*' represents the index value of columns. As stated in [26] the satisfactory results for MSE is when then values are low and the results are not satisfactory when the values of MSE are high. For our work the MSE values obtained are shown in the Table III. As it can be seen that the values of MSE values for Prewitt and Sobel are comparatively higher for many images as the images are over segmented. Also MSE values for the proposed technique is less which satisfies the MSE principle. Also in both PSNR and SSIM the proposed technique values are satisfying according to the principles of PSNR and SSIM.

## VII. CONCLUSION

Based on the issues and loopholes of traditional Canny edge detection technique, we proposed a technique that differentiates between contrast colors and detects edges based on the threshold value. Initially, we used median filters, then calculated the high and low threshold values to make a chain of edge between start and week edge.

The technique was examined on three well known databases Pascal, Corel, and Berkeley. Finally, the results were evaluated with qualitative and quantitative assessment tests. The results were within the range of entropy. The proposed technique does not work well on blur images, which could be taken as future task and the authors want to apply this technique to a deep learning approach. The authors would also like to urge applying this technique on real-time images. This technique could be used in many real-time applications such as robots, 3D reconstruction, automation, medical care, and others.

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