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A Survey on Various Approaches for Edge Detection

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ABSTRACT

Edge detection is a fundamental image processing technique used to spot sudden shifts in color or intensity in image. It is utilized to detect and highlight boundaries between various items or regions in image, as well as to detect features such as corners, circles and lines. Edge detection approaches typically work by applying a filter to an image to detect areas where the image undergoes an immediate shift in magnitude. Applications for edge detection techniques include recognizing objects, healthcare images, and background segmentation. Many techniques have been presented based on the classical approaches (such as Sobel, Prewitt, and Roberts, Canny, Laplacian of Gaussian (LOG), etc.) and soft computing approaches (SCA), which are the two main approaches for detection of edge. This paper provides an overview of studies carried out on edge detection using various approaches. That will assist brand-new researchers in learning about these techniques and selecting one from among them to evolve or improve according to their field of study.

Keywords : Edge detection, Sobel, Prewitt, Roberts, Canny, LOG, DoG, Soft computing, ANN, FL, GA.

I. INTRODUCTION

Digital computers are used to manipulate images during digital image processing. A matrix, of square pixels arranged in rows and columns makes up the image. The process of converting tangible image into a digital format and running different operations on it to improve the image and extract useful information from it is known as image processing. It requires a number of stages, including image analysis (noise reduction, image enhancement), segmentation, edge extraction, and compression, among others [1].

An image's basic characteristic is its edge. the change from one region to another's visual characteristics, such as color, brightness, or texture, are indicative of changes in scene content and are referred to as edges. the edges provide rich information that is highly important. Edge detection is a method for finding and identifying abruptions in visual data. Machine vision and image processing need the use of edge detection.

Numerous tasks, such as object recognition, scene segmentation, motion detection, medical imaging, road detection, and image compression, depend on accurate edge detection [2].

Its use has skyrocketed during the last few decades. Everyone is apprehensive and anticipates the development of a system that does computations more efficiently, correctly, affordably, and completely [1]. the main aim of this paper is to survey a variety of approaches in edge detection.

The structure of this essay is as follows. Under Section 2 (**Types of Edge**), I'll show different types of edges. In Section 3 (**Main Steps in Edge Detection**), I'll explain the fundamental steps in edge detection. in Section 4 (**Edge Detection Approaches**), I'll give a review of different approaches in Edge Detection. Section 5 (**Conclusion**) illustrated the conclusion from the audit work.

II. TYPES OF EDGE

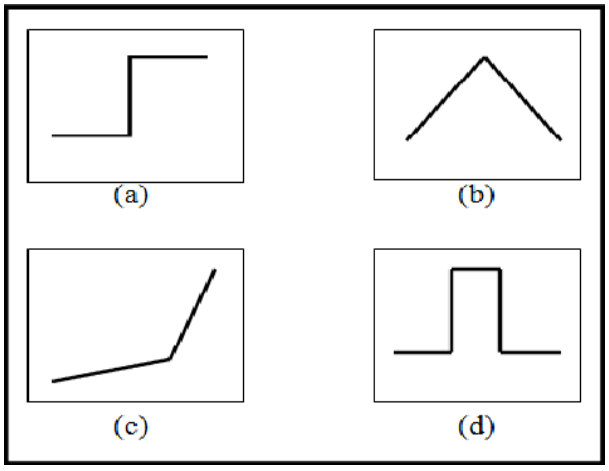

Figure 1: Types of edges (a) Step edge (b) Roof edge (c) Ramp edge (d) Line edge [3]

III. MAIN STEPS IN EDGE DETECTION

1- Filtering

Edge detectors can't work fine enough in noise. In order to lower noise and improve the efficiency of the edge detector, the image is filtered.

2- Enhancement

Enhancement techniques aim to raise the digital images overall quality. The fundamental objective of image enhancement techniques is to produce an image that is better than the original and more suitable for a certain use. There are many image enhancement techniques that have been suggested over the history such as linear and Nonlinear filters to solve the image sharpening issue.

3- Detection

Determine whether a point is an edge point or not.

4- Localization

locate the precise location of an edge [3] [4].

IV. Edge Detection Approaches

The current edge detection techniques are introduced and outlined in this section. According to our research, the edge detection techniques now in use may be classified into two groups: Traditional and Soft computing approaches.

A. Traditional Approaches

Traditional approaches divided into many types, but we can talk specifically about four types:

1) Classical edge detection
2) Difference-of-Gaussian (DoG)
3) Multi-scale feature\ (Multi-Resolution)
4) Structured learning

1) Classical edge detection

The many types of classical edge detection operators include: -

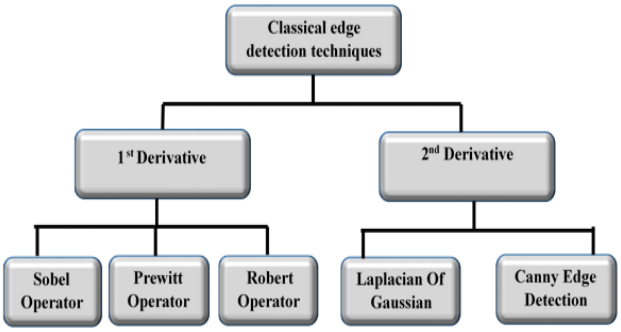

Figure 2: Classical approaches for Edge detection [5]

a) 1st Derivative (Gradient Change-Based)

The earliest well-known works in this category are the algorithms created by Roberts, Sobel, Prewitt, Kirsch, and Robinson, Frei-Chen [6].

1- Roberts Cross Operator

Roberts operator proposed by Lawrence Roberts in 1963, Figure (3) illustrates how it uses 2x2 convolution masks. One kernel is just another kernel turned 90 degrees. the Roberts operator are extremely similar to Sobel and Prewitt Operator in achieving quick calculation and simplicity. However, it is prone to noise interference, making it unsuitable for producing edges from images with high levels of noise.

+1	0
0	-1

Gx

0	+1
-1	0

Gy

Figure 3: The masks of Robert operator [7]

2- Prewitt Operator

Prewitt filter was proposed in 1970, which is a quick edge detection technique. As seen in Figure (4), it is similar to the Sobel but uses different mask coefficient axes. The spectral response is where the Sobel filter and this filter vary. Only images with strong contrast and zero noise are appropriate. This operator outperforms Robert's operator.

-1	0	+1
-1	0	+1
-1	0	+1

Gx

+1	+1	+1
0	0	0
-1	-1	-1

Gy

Figure 4: The masks of Prewitt operator [7]

3- Sobel Operator

The Sobel filter proposed in 1983. as seen in Figure (5), it uses 3 x 3 convolution mask to detect gradients in both of the axes X and Y. One kernel is just other kernel turned 90°. The horizontal and vertical edges are searched for by the Sobel edge detection masks, which then integrate this data into a single metric.

-1	0	+1
-2	0	+2
-1	0	+1

Gx

+1	+2	+1
0	0	0
-1	-2	-1

Gy

Figure 5: The masks of Sobel operator [5]

b) 2nd Derivative (Zero Cross/ Laplacian-Based)

1- Laplacian of Gaussian (LOG)

Since LOG is noise-sensitive, therefore it applied to the image after it has been smoothed by using Gaussian filter. The degree of image smoothing depends on the Gaussian filter's standard deviation. LOG use the 2nd derivative of zero for edges detection. Some of frequently employed discrete Laplacian filter approximations is shown in Figure (6).

-1	+2	-1
+2	-4	+2
-1	+2	-1

Gx

+1	+1	+1
+1	-8	+1
+1	+1	+1

Gy

Figure 6: The masks of Laplacian of Gaussian(LOG) [7]

2- Canny Operator

canny edge detector is one of the most often used tools for image processing. It has very robust edge detection. The canny operation is less sensitive to noise than Roberts Cross and Sobel, so it firstly smooths the image using a Gaussian filter. Therefore this method can work in a variety of circumstance and can identify the strong and weak edges of the image [5] [7].

2) Difference-of-Gaussian(DoG)

DoG is used to improve blurry images by removing all other frequency information except for the frequencies that are preserved in the original image.

DoG based on q-Gaussian and extended-based (XDoG) methods are based on the concept of Gaussian difference with some enhancement.

3) Multi-scale feature-based

The scale variance of the object presents edge detection with its most difficult issue. objects are constantly varied sizes and forms, and there may even be some highly oddly shaped, small, or enormous objects. This makes it very challenging to identify and locate object edges accurately.

Wavelet method are based on the concept of multi-scale feature.

4) Structured learning-based

The real problem of edge detection methods is the representation ability, which assumed that input and output were always in the shape of a vector. The high-dimensional data may be more effectively represented using structured learning approaches, which can also capture comprehensive information.

Sketch Tokens, SE methods are based on the concept of structured learning [8].

A survey of different methodologies based on traditional approaches for edge detection are shown in Table 1 and 2.

B. Soft Computing Approaches

In previous years of image processing, soft computing has showed a stronger ability to handle ambiguity and uncertainty than traditional methods. When soft computing is utilized for edge detection, the results are better than using the traditional method. The traditional methods, such as Roberts, Prewitt, Sobel and Canny edge detector, have drawbacks when utilizing thresholds or parameters with fixed values. Few edges remain by being recognized since the nature of edges is not constant [9]. Soft Computing includes different techniques are explained below: -

1) Fuzzy Logic (FL)

The concept of fuzzy logic has been widely applied to describe the behaviour of nonlinear systems. The nonlinear behaviour of the system was effectively captured and expressed by a set of fuzzy rules [10].

Fuzzy logic enabling the values to exist without any limitations, so it gives us the flexibility. Fuzzy logic provides straightforward implementation and IF-THEN principles. The outcome may be modified simply by adding or removing a few additional fuzzy rules, and other strategies are knowledge-based and call for training. A logical system called fuzzy logic is an extension of multi-valued logic. There are several truth values in this propositional calculus. It is also possible to identify edges with varying thickness using fuzzy approaches.

Fuzzy logic is flexible, easy to conceptualize, and accepting of imperfect facts. Fuzzy logic maps an input space to an output space by evaluating a number of if-then expressions known as rules concurrently. Because they employ variables and adverbs that explain those variables, these Rules are helpful [9].

type-1 FL system (T1FLS), an interval type-2 FL system (IT2FLS) and generalized type-2 FL system (GT2FLS) methods are all types of FL [11].

2) Genetic algorithm (GA)

A search technique called a GA is used to locate the precise or approximative answers to optimization issues depending on the biological principles of evolution.

Basically, it consists of three primary processes: selection, cross-over, and mutation are involved. The most suitable pixels are chosen during selection. Cross over combines them to create a much superior pixel. Finally, a little modification is included in mutation in order to preserve the population. These population clusters are believed to be able to identify the Edge and are utilized mostly with huge search areas and minimal prior knowledge [10] [12].

3) Artificial Neural Network (ANN)

ANN and Deep learning and can learn to detect edges in images and providing valuable information, in another meaning" processing information while analyzing images ". ANN works is Similar to how the human nervous system in process of handling information. Neural networks are Low-level computational components with excellent performance. It is Flexible soft computing frameworks that are used to model a variety of nonlinear issues. The processing components of the neural network model are referred to as "neurons". The network model is mostly determined by the characteristics of the data. One of the conventional models is the single hidden layer feed forward network (FFNN), which consists of three layers of fundamental processing units coupled by non-cyclic connections.

Neural networks utilization in a system depends critically on training the networks. A training pattern with a specified set of inputs and predicted outputs is used to train the neural networks. Depending on the input values, the user is then provided the outputs in the prediction cycle. In order for the network to learn or absorb knowledge, the weights—also known as connectivity between the layers—are changed. When the network has learned the material completely or has undergone training, it can determine the proper solution or output for the given set of input data [10] [13].

Tables 3 through 5 provide a survey of several soft computing-based edge detection approaches.

TABLE 1. A survey of different methodologies based on classical edge detection methods

Ref	year	TECHNIQUE\ Methodology	P (Parameters)\ PL (Programing language)\ MT (Performance Measurement tools)	Domain\ Data set	Recognition rate/ Result	Cons	Future work
[14]	2011	Roberts, Sobel, Prewitt, Kirsch, Robinson, Marr-Hildreth, LoG, Canny	**P** - **PL** MATLAB R2009a **MT**-	Bharathiar University image	Canny result is significantly better than the other results.	Difficult of detection in noisy image	-
[15]	2013	Canny and Sobel	**P** - **PL** - **MT**confusion matrix	Facial images	Canny works better than Sobel. Canny provide high accuracy	Canny has less rapid execution	-
[16]	2014	Canny, Sobel, LoG, Robert's and Prewitt	**P** - **PL** Matlab 8.1 and Java used as **MT** **MT** PSNR, MSE	(Lena, Pirate Cameraman, Living room) images in TIFF	In terms accuracy, canny was discovered to be the best.	Canny consuming more processing time	-

				format and size of 512 x 512			
[17]	2015	Sobel	**P** - **PL** Matlab 7.8.0(R2009a) **MT**	Facial image	It is simple to construct and only requires one stage to identify edges.	-	-
[3]	2016	Roberts, Sobel, Prewitt, Canny, Laplacian, LOG	**P** - **PL** - **MT**SSIM +Execution time	Document images (Handwritten and Printed)	Laplacian has higher accuracy. and shorter execution times than other methods for printed text image. While Roberts perform better for handwritten image.	-	-
[18]	2017	Prewitt, Sobel, Canny, Roberts and LOG	**P** - **PL** Matlab R2015a **MT** PSNR, MSE	Sunflower and Face image (with and without Salt and Pepper, Gaussian noise)	Canny and LOG provide good results than others methods. But canny superior than LOG in presence of noise	Robert, Prewitt, Log are not reliable in the presence of noise. Canny is Complex, time consuming, and misleading zero crossing	Create a new filter that overcomes the restriction to obtain greater image quality, allowing noise to be reduced and the image to be improved.
[19]	2018	Sobel, Prewitt And Canny	**P** - **PL** C# **MT** MSE, PSNR, Time (in sec)	5 different image	Canny produces better results in PSNR and MSE than Prewitt and Sobel. Also canny works with noisy image. Prewitt consuming less time than other methods. Sobel has higher sensitivity to the diagonal edge	-	-
[20]	2018	Sobel, Homogeneity and Prewitt algorithms	**P** - **PL** C# **MT** subjective evaluation no.(1-5) and objective using equation $P(I.l.\mu)$	Real images in Jordan and 2D gray-scale synthesis	Prewitt and Homogeneity have better performance than Sobel.	-	-
[21]	2019	improved gradient operator of canny based on distance	**P**noise variance is 0.01 **PL** Visual C++ **MT** -	Image for Yangtze River field with the ship and Lena image	The suggested method operate or performs better than other operators under any noise level.	The suggested operator falls short of satisfying the gradient amplitude's	Trying to fix the cons

						rotation invariance in its entirety.	
[22]	2020	dilating the standard filters (Sobel, Prewitt and Scharr Canny) from 3 × 3 to 5×5, 7×7	**P** - **PL** Python **MT** formulas for (Precision (P), Recall (R) and F-measure) runtime	Dataset of 500 natural images (BSDS500)	Better results can be obtained using dilated filters.	Images with plenty of details, dilated filters might not be very effective that result in features being lost.	Applying dilated filters to operators with second order derivatives or other sophisticated filters
[23]	2020	Robert, Sobel, Prewitt, LOG, Canny	**P** - **PL** Matlab and python **MT** MSE, PSNR	Different images	2nd derivative yields superior results than 1st derivative. Canny approach appears to be more suited than the LOG in that it can identify both strong and weak edges.	In comparison to the canny, all other methods have some blur and noisy labels. Canny is time consuming, and misleading zero crossing	-
[24]	2023	Improved Canny Algorithm on an FPGA	**P** - **PL** MATLAB **MT** Used Slice and Memory, Max Freq, Time, Norm.	real-time applications\ 512 × 512 Gray scale image	Adaptive threshold technology outperforms traditional Canny in various lighting situations. The System detects edges in 1.231 ms, consumes few logical resources, suitable for hardware platforms	-	Candidates the system for applications requiring real-time edge detection.

TABLE 2. A survey of different methodologies based on (DoG, Multi-scale feature, Structured learning) methods

Ref	**year**	**TECHNIQUE\ Methodology**	**P (Parameters)\ PL (Programing language)\ MT (Performance Measurement tools)**	**Domain\ Data set**	**Recognition rate\ Result**	**Cons\ Future work**
[25]	2013	DoG based on q-Gaussian	**P1** standard deviations $\boldsymbol{\sigma_1}$, $\boldsymbol{\sigma_2}$ **where** $\boldsymbol{\sigma_2 = 0.1 < \sigma_1 = 0.2}$ **P2** variable entropic index $\boldsymbol{q}$ **PL** - **MT** -	Lena image	The suggested technique can extract edges with more precise information.	-
[26]	2014	Structured learning decision trees	**P** discrete labels: $k = 2$. radius $= 2$. m $= 256$. T $= 4$. 32 × 32 image patches, 16 × 16 label patches **PL** - **MT** ODS, OIS, AP, R50	BSDS500 Segmentation dataset and NYU Depth dataset.	It is faster than the majority techniques. And it also provide high-quality edge detection and efficiency (accurate)	-

[27]	2016	Multi-scale based on Two-B-spline wavelet transform.	**P** - **PL** - **MT**-	Texture image and heartbeat (Gatlin image)	The impact of proposed edge detection on the quality of image is good.	-
[28]	2016	Multi-scale adaptive wavelet transform and cubic B-spline curve.	**P**$k = 4.$ adjacent 25 pixel points. $m.n = 4$ **PL** - **MT** std, MSE	Road image	The new technique achieves high positioning accuracy, noise resistance, and outperforms other well-known methods. It has a std of 0.0043 mm and an MSE of less than 0.02 pixels.	-
[29]	2018	Improved multi-scale Harris corner detection algorithm and improved Canny	**P** Mean − shift filter : $h_s = 4. h_r = 8.$ multi − scale: $s < 1. D = 1.2.2 - \mathrm{N}$ $CRF: \varepsilon = 10^{-6}.$ radius of 3.4.5 $thresuld$: ρ $between$ 0.02 and 0.06 **PL** - **MT**-	Ship and aircraft carrier images	The proposed algorithm can extract the corner point in Accurate and fast manner. morphology filter smooths image, eliminates noise, while automatic threshold value obtain by adaptive Otsu method .	**Cons** The algorithm increases false detection rate with increased sea light and clouds. **Future work** Additional development and improvement
[30]	2019	Extended Difference of Gaussian (XDOG)	**P** **PL** MATLAB R2017a **MT** PSNR, MSE, NAE, Time.	Different sizes for 160 image	XDOG most effective approach than (Roberts, zerocross, canny, log, sobel, prewitt), and provide good results in term of PSNR, MSE, NAE	**Cobs** The time values for XDOG are approximately large.
[31]	2019	Crack Token detector	**P** Gaussian blur $\sigma =$ 0.1.5 and 5 pixels , patch size of $35 * 35$, channel features 21350, δ is $[0.4 - 0.8]$ **PL**- **MT** ODS, OIS, PR-Curve	Real world application\BSDS 500 Dataset of 118 (noisy + noise free) real world crack images	Crack Token achieves the most accurate results than other methods	**Future work** creation of alternative appropriate degeneration methods and an area generation strategy.
[32]	2022	Multi-scale based on hybrid wavelet transform. (by using B-spline, Gaussian filter, adaptive threshold) operations	**P** scales 2^j j=1,2,3 **PL** - **MT**-	Underwater image (mine)	The suggested approach is straightforward and doable, and it performs better than (Robert, sobel, CNN, mult-scale with B-spline or Gaussian wavelet) methods. Also it has best noise resistance and edge continuity.	-

TABLE 3. A survey of different methodologies based on Fuzzy Logic

Ref	year	TECHNIQUE\ Methodology	P (Parameters)\ PL (Programing language)\ MT (Performance Measurement tools)	Domain\ Data set	Recognition rate\ Result	Cons\ Future work
[33]	2014	Sobel + IT2FLS Optimization using Cuckoo behaviour (CU) and GA	**P**inputs: DH and DV membership functions (mf):(LOW, MIDDLE, HIGH) output: (BACKGROUND and EDGES) and a lot of parameters using in CU and GA **PL** - **MT** Pratt's figure of merit (FOM)	Synthetic images	Detection results show that suggested method is an effective than (T1FLS (with and without optimization) and T2FLS, and Sobel methodology).	**Future work** Using real images and using this approach in real time application
[11]	2014	Sobel operator based GT2FLS	**P** - **PL** - **MT** FOM	Synthetic and reference images	The Sobel + GT2FLS method obtains better performance than Sobel + IT2FLS; while, Sobel + IT2FLS can improve the performance better than Sobel+ T1FLS.	-
[9]	2015	Fuzzy logic (FL)	**P** Shape of membership functions characterize using constants a, b and c **PL** - **MT** -	Medical MR images with 5% noisy density	The suggested method is more effective than (Sobel, Canny, and morphological) approaches for denoising and edge identification in medical images.	-
[34]	2016	Fuzzy Logic using (Sliding Window and Prepossessing Kernels) methods for feeding	**P** sliding window of 2x2 or 3x3 Pre-processing kernel of 3x3 types. **PL** Matlab **MT\-**	640x480 image	Sliding Window Fuzzy System and Prepossessing Kernels Fuzzy System improve image edge detection, but Sliding Window reducing hardware performance.	-
[35]	2017	Fuzzy rule-based method with using of (Sobel mask and four-directional mask)	**P** - **PL** Matlab **MT\-**	Nine 720 × 540 LC images	Results show that the suggested fuzzy rule-based approach outperforms traditional approaches (Canny, HPF, Sobel). And edges found were clearly visible and many edge pixels were found.	-
[36]	2018	Fuzzy logic	**P** 3x3 convolution mask, 16 fuzzy templates template characterize of pixels edge:- $a = 0.3$, $b = 0.8$ and 0 Hesitation constant c = 1 or c=0.2 Thresholding (T)=45 **PL** MATLAB **MT** Observation	Medical images (cell) Rice, Umaralm ukthar images	suggested method has a good visual look and makes it simpler to identify the image's edge. It has the ability to adaptive by changing (c) or (T)	**Cons** If there are more than 16 templates, the edge findings do not much improve, and if there are less templates, many edges will be missed.
[37]	2019	Type-1 Fuzzy Logic (T1FLS) + guided smoothening(sharpening + Gaussian filtering)	**P** input = M1, sharpening = M2, sharpening+ Gaussian filter= M3. Sharpening parameter= $r.\varepsilon.\gamma$ $r = 16.32.64.128$ $\varepsilon = 0.01$ or 0.001	Lena, tulip, animal alphabet images, Berkley	Compared to approach M1, the suggested methods M2 and M3 perform better. And the detected edges can be significantly improved by	-

			(γ) = 5.10.20.30. 50.75.100 **PL** MATLAB **MT** FOM, SSIM, HoD, E_D , BDM, D_K, $\boldsymbol{\rho}$	Segmentation Database (BSD), USC-SIPI Database	carefully choosing the smoothening values.	

TABLE 4. A survey of different methodologies based on Genetic Algorithm

Ref	year	TECHNIQUE\ Methodology	P (Parameters)\ PL (Programing language)\ MT (Performance Measurement tools)	Domain\ Data set	Recognition rate\ Result	Future work
[38]	2015	Genetic Algorithm (GA)	**P** 3 x 3 mask, population size is 20, Binary coding, 8 chromosomes, Population size: 20 bit, Selection: Stochastic uniform, Crossover: Scattered, Mutation: Gaussian **PL** MATLAB, Genetic Programming toolbox **MT** std	One image	convergence in edge detection when chromosomes and generations are >= 8. GAs offer intelligent edge detection, utilizing local texture features and maximizing edge regions.	-
[39]	2017	Fractional edge detection enhancement using GA	**P** v=0.2, noise density=0.02 **PL** MATLAB **MT**PSNR, BER,	MRI brain images	GA-based fractional edge detection outperforms classical approaches, GA Fractional Mask1 showing the highest PSNR and less BER .	Using hybrid soft computing strategies to improve medical imaging performance for early diagnosis .
[40]	2018	Threshold optimization based on GA for fractional masks edge detection algorithms	**P** two table for each algorithm illustrate the parameters, noise density=0.02 **PL** MATLAB **MT**PSNR, BER, execution time	Different types of MRI and x-ray Images	Optimization technique based on fractional edge detection outperforms fractional edge detection due to ideal threshold values for various image types.	a- using soft computing for calculating crack, radiographic images depth and intensity. b- Using hybrid techniques for getting optimal threshold performance.

[41]	2020	Developing Cellular Automata Develop by GA	**P** 3x3 window, Survivor pool: 20% best survivor, 80% random survivor, Population JSON: 9 bit Binary window rule, *Parent pool*: 20% *Elite*, 20% *random*, Crossover: 1 point and 2- point, Mutation = type 1 and 2 **PL** - **MT**	Various images in various dimensions	Proposed strategy produced positive outcomes by utilizing 2-point crossover and mutation type 1, with execution time varying based on image array dimensions, and average fitness improving with each generation.	-
[42]	2020	improving edge detection based on GA	**P** k1 = 0.01 and k2 = 0.03 **PL** - **MT**FOM, SSIM, MSE, PSNR, Correlation, Mean, STD, Variance, and Entropy	Lena image, MR scan image	The proposed method achieves 99.09% accuracy in detecting brain tumours, outperforming classical methods, fractional, and threshold-optimized methods.	-
[43]	2023	adaptive threshold Sobel based on GA	**P** $k1.k2.k3$ and $f4.f5.f6$ are between 0 and 1, adaptive threshold is 118, 143, 88 for each example **PL** - **MT**-	Person image	Modified algorithm produced stronger edge continuity and improves detection and applicability compared to conventional Sobel.	-

TABLE 5. A survey of different methodologies based on Artificial Neural Network

Ref	year	TECHNIQUE\ Methodology	P (Parameters)\ PL (Programing language)\ MT (Performance Measurement tools)	Domain\ Data set	Recognition rate\ Result\ Cons
[44]	2015	HED	**P\ size of mini-batch** =10, **learning rate (1e)=** 6, **loss-weight =**1, **momentum**=0.9, **nested filters**= 0, **fusion layer weights**= 1/5, **weight decay**= 0.0002, **no. of training iterations**= (10,000; divide le by 10 after 5,000). **PL** - **MT** ODS,OIS, AP, FPS	Berkeley Segmentation Dataset and Benchmark (BSDS500) and the NYU Depth dataset	The proposed approach has score (ODS= 0.782) for BSD500 dataset and score (ODS= 0.746) for the NYU Depth dataset at a speed (0.4s per image) that is quicker than other recent CNN techniques.
[45]	2016	LVQNN	**P\ no. of layers:** 3 layers. **input and competition layer relationship**: fully connected. **Competition and output layer relationship:** partially connected**, weight value: 1.** **Training:** 300 edge and 300 non-edge points selected randomly, **max training step**: 300, **min training error** :0.001 **le** $\alpha = 0.01 \sim 0.9$ **Others:** $C: 3 \times 3. \theta: 0. \pi/4 . \pi/2 . 3\pi/4$, noise density: 0.05. **PL** MATLAB **MT**-	RGB image with size 400×300.	LVQNN improves classification speed, accuracy, and robustness, enhancing clear edge images with clear denoising effects compared to traditional methods.
[46]	2019	RCF-ResNet101-MS	**P\ stage 1-5 weights conv layers of 1 × 1**: 0.01std, **biases**:0, **fusion stage weights conv layer of the 1 × 1**: 0.2, **mini-batch** =10 random images in each iteration, **le=** 6; divided by 10 after every 10k iteration, **momentum**=0.9, **weight decay**= 0.0002, **SGD run**: 40k iterations **PL** Caffe framework **MT** ODS,OIS, FPS	Berkeley Segmentation Dataset and Benchmark (BSDS500)	the RCF version has achieved an ODS=0.806 while maintaining a quick frame rate= 30 FPS. Additionally, so it faster than other state-of-the-art performance.

[47]	2021	New VGG16-based DCNN and using RHN	**P\ no. of conv layers**= 19 **MaxPooling layers=** 4, **ConvTransposed layer=** 6**, feature Map Pooling=** 2**, loss function**= 6, **blocks**= 11. **mini-batch size**=10. **weight decay** =0.0002. **le** = 0.0001. **size of the training images** = 320×480, 480×480, and 500×500 **PL** - **MT**ODS,OIS, FPS, PFOM	Berkeley Segmentation Dataset and Benchmark (BSDS500), NYU Depth (NYUD), and Multicue datasets.	proposed technique outperforms other VGG16-based edge detection techniques and offer superior performance while maintaining low complexity.
[48]	2022	DF-CNN Based on (RCF and HED) and by using ResNet101	**P\ ResNet101:- conv** kernel size is 7×7, 1×1, 3×3. **MaxPooling layers:** 1 size 3×3 **DF:-** kernel size of conv1,2 layers: 3×3 and 128 come next ReLU. conv3 layer is 3×3 and 1 come next sigmoid. probability threshold= 0.25, $\gamma = 0.5$, **le** =2, **weight decay** =0.9 and 0.0005, train :30 epochs, $\lambda = 1.2$ **PL** - **MT** ODS,OIS, FPS	BSDS500, PASCAL, and NYUD. datasets	The proposed edge detector outperforms earlier methods. This model generates superior edge images and a corresponding distance field map **Cons** the speed is little slower than RCF

V. CONCLUSION

Edge detection is the initial step in the process of recognizing an image. The edge detection approaches in this study have been organized into traditional and soft computing approaches. Some types that fall under each approach have been reviewed. the accuracy of detection the right edge even under noise and minimization the time consuming in this process in efficient way is the main problem for all these methods. From all of these reviews in tables from 1 to 5, we can say that each approaches can apply to specific domain and under specific design and parameters. But we can say that from the classical approaches, only canny and improved canny detectors produce good accuracy even in the presence of noise than other classical operators but its main problem is in the execution time. the other approaches like (DoG, Multi-scale feature, Structured learning) also proved good results compared to classical approaches, but some of them have cons in time or false detection. While soft computing approaches like (Fuzzy, GA, Neural network), especially ANN shows superior results than all traditional approaches.

VI. REFERENCES

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