Novel Approach for Brain Tumor Detection Based on Naïve Bayes Classification

Gurkarandesh Kaur and Ashish Oberoi

Abstract The brain tumor detection is the approach which can detect the tumor portion from the MRI image. To detect tumor from the image various techniques has been proposed in the previous times. The technique which is adapted in research work is based upon morphological scanning, clustering, and Naïve Bayes classification. The morphological scanning will scan the input image and clustering will cluster similar and dissimilar patches from image then Naïve Bayes classifier spot the tumor portion from magnetic resonance imaging. The advance algorithm is implemented in MATLAB and results are analyzed in terms of PSNR, MSE accuracy, and fault detection and also calculate overlapping area with dice coef. The proposed method has been tested on data set with more than 25 slide scanned images. This proposed method achieved accuracy with 86% best cell detection.

Keywords Brain tumor · Clustering · MRI · Morphological scanning · Naïve Bayes NBC-BTD model

1 Introduction

Several lives have been affected because of a common brain disease known as brain tumor. The patients suffering from this disease have not survived in most of the cases. For fighting this disease, several techniques have been proposed such that the knowledge related to medicine can be expanded and one can understand calculations in a better manner such that the tumor can be detected. Due to the high complexity of brain images and the fact that only expert physicians can analyze the tumors, brain tumor detection is a challenging task within medical image processing [1]. To detect brain tumor from various images, the two most common tests that are

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applied are Magnetic Resonance Image (MRI) and Computer Tomography (CT) scan of brain. Further, to perform various treatments, the location of tumor is also identified through this technique. To heal brain tumor, several treatment techniques are proposed today such as radiation therapy, chemotherapy as well as surgery. On the basis of size, type of tumor as well as its grade, the treatment type is chosen. To check whether other parts are being affected by this tumor or not, it is also important to perform certain analysis. When the appropriate treatment method has to be chosen by the doctor, there are certain factors that are to be considered. The possible side effects of a treatment, consideration of complete health and checking whether the central nervous system is affected due to the tumor or not, are few of these factors. Radio imaging is the most commonly applied technique within MRI due to its dynamicity and flexibility [2]. Various pulse sequences and modification in imaging parameters that are based on Longitudinal Relaxation Time (LRT/T1) and Transverse Relaxation Time (TRT/T2) are used to perform acquisition of variable image contrast. Particular tissue properties are provided in relevance to signal intensities provided on the weighted images T1 and T2. On the basis of pulse sequence parameters, the contrast on MR images is provided. For knowing the details of structures of various organs of the body such as liver, chest, and brain, MRI imaging of the body is done. The treatment can be monitored in the patient efficiently with the help of this approach. There are certain steps performed in order to identify the tumor in the patient's body [3]. Preprocessing, segmentation, feature extraction as well as classification are the commonly applied steps. The MRI samples are gathered at the initial stage.

a. Preprocessing and Enhancement: The chances that a suspicious region can be detected can be improved through this initial step being performed in image processing. From the image, the noise is eliminated and finer details are extracted. The accuracy of an image is minimized when noise is present within the MRI image. The noise is removed by applying different filters on the image. The filters are also applied to sharpen the image. Since the detection of boundary of tumor can be done more effectively and easily, it is important to sharpen the image with the help of various low pass filters once the noise has been completely eliminated from the images.
b. Segmentation methods: The procedure where the image is broken down to smaller parts and segments is known as image segmentation. The analysis can be performed in easy manner through this step. Several image segmentation methods have been developed over the time. The approach in which the object boundaries are assumed to be defined by the detected edges and which further helps in recognizing these objects is known as edge-based segmentation approach [4]. There is a need to achieve very distinct and closed boundaries to perform direct segmentation which can be done through this approach. False edge detection can occur many times and the partial edges can be joined within an object boundary through edge linking process. The approach in which the bordering pixels present in one area assume to have similar values is known as region based approach. Instead of identifying the edges, the identification of

object region is more important in this case. The pixels are compared with the neighboring pixels. The pixels is said to belong to the cluster in the form of one or more of its neighbors in case when the congruence criteria is satisfied.

c. Feature Extraction: To detect brain tumor from images, the extraction of exact tumor image is very important since the structure of brain is very complex [5]. In order to extract certain features, it is important to consider few parameters. The tumor can easily be classified with the help of results achieved from feature extraction process.

2 Literature Review

Kaur et al. [11] analyze technique of Magnetic Resonance Image (MRI) for brain tumor detection. It shows difficult structure of brain cells with thin network. It also considers solid growth. If we want to study the growth we need to study the fragmentation process, which is a huge disadvantage. This disadvantage can be solved by clustering technique. For this extraction of segmented brain tumor from its area a sobel edge detection is used. In clustering technique, the no of clusters is counted by computing them on the peak of histogram. The size and location can be analyzed by the segmented part of the binary image. The final fragmented part is then use to analyze size and perimeter of the tumor. It concludes that. The brain tumor can be detected using MRI and clustering techniques. So, it is used on the nature of image and the number of peaks, the clusters can be computed.

Hazra et al. [12] reviewed detection and localization of tumor region present in the brain by using patient's MRI. It contain three levels namely, preprocessing, segmentation, and edge detection. Preprocessing converts the original image into grayscale image and eradicates noise if any which further followed by the edge detection using Sober and Canny algorithms with technique of image enhancement. The segmentation is applied to display the tumor affected region. Lastly, the clustering algorithm is used for the image clusters. It results identification of the brain tumor is done efficiently using MRI and K-means algorithms. In order to detect the tumor more accurately the algorithms can be improvised.

Chauhan et al. [13] proposed preprocessed median filtering MRI brain images. In order to separate the area from image- and color-based segmentation and edge detection is done. Histogram of oriented gradients and gray level co-occurrence matrix is used to represent the images. The respected extracted features are stored in the transactional database to classify the tumor into normal benign. The classified accuracy is being calculated 86/6%. This summarized that the proposed system help to know about the type of brain tumor and its further treatment. This system has been successfully tested on the large-sized brain scanned images of brain tumor.

Reema Mathew et al. analysed that the Magnetic Resonance Image (MRI) is effective technique of the brain tumor detection and classification. This classification is done in various steps like preprocessing, filtration of sound, feature

extraction, and segmentation. These methods preprocessed the MRI brain image using anisotropic diffusion filters. The discrete wavelet transforms are extracted in the feature extracted step. These features are further given as the input to the segmentation step. A support Vector Machine was used segmentation and tumor classification. Hence, it concludes that the accuracy of proposed system is 86%. The validation of this method with the recent results can be used in the future proposals.

3 Research Methodology

This research work is relies on brain tumor detection.

The technique to detect tumor are based on following steps:

Step 1: Morphological Operations:

The process through which the structure or shape of an object can be deformed or reconstructed is known as morphology. For the representation of shape of an object, the operations that are applied on binary images are known as morphological operations. While performing pre or post processing, these operations are applied such that the shape of objects or areas can be known in more appropriate way. Following are few of the most commonly used morphological operations:

a. Erosion: The operation with the help of which the boundaries of areas of front-end pixels are eroded from the binary images is known as erosion. In terms of size and holes present within it, the regions of foreground pixels are shrunk. There are two inputs given here [6]. The image is eroded within the initial input and the structuring element is given as the second input. The structuring element place upward of given image such that the erosion of binary image can be calculated. Thus, the origin of structuring element and input pixel coincide with each other.
b. Dilation: The approach through which the holes are filled by adding the pixels to the boundaries of objects present within the image is known as dilation. Two pieces of data are taken as input in this operator. Image is dilated in the initial one and elements are structured in the second one. On the input image, the structuring element is placed for every background pixel such that the given image pixel position and structuring element coincide [7]. Increase the area of foreground pixels is the basic effect of dilation on the binary image. There is a complete closing up of the operation however, in this operation which is its only demerit. There are several classifiers used in the process of detection brain tumor from images. A data structure in the form of a tree is created within a decision tree classifier. On the basis of one particular feature, each interior node that includes decision criteria is based. The entropy reduction that presents the purity of samples is used to calculate the features that are in relevance to classification [8]. The classifier through which two classes are separated using a hyper plane is known as Support Vector Machine (SVM). From the empirical data, an optical

function can be calculated in case when the classes are separated by hyper plane. A basic feed forward based artificial neural network classifier was introduced known as multi-layer perceptron classifier. For performing simple functions, a single hidden layer is used here at first. Further, to improve the classification performance, two hidden layers were included here. For every data set, different hidden units were selected. Across a number of trails, the numbers of hidden neurons were identified. Back propagation algorithm was used to train the neural network.

c. Clustering: In image processing is basically defined as the technique in which groups of identical image primitive are identified. Clustering is a method in which objects are unified into groups based on their characteristics. A cluster is basically an assembly of objects which are similar between them and are not similar to the objects fitting to additional clusters. C-mean clustering is mainly assigning points to cluster or class. In this clusters are mainly indentified by similarity measure, in terms of distance, connectivity and intensity. Moreover, in this technique, each data point belongs to more than one cluster.

Step 2: Naïve Bayes Classifier: Naive Bayes algorithm is effective method of text classification. It works on large training sample set and gives an accurate result. It is a probabilistic classifier based on Bayes theorem with independent assumption which assumes the presence of particular features of a class is unrelated to presence of other features.

Naive Bayes classifier is a simple probabilistic classifier based on applying Bayes' theorem (from Bayesian statistics) with strong (naive) independence assumptions. A more descriptive term for the underlying probability model would be "independent feature model". In simple terms, a naive Bayes classifier assumes that the presence (or absence) of a particular feature of a class is unrelated to the presence (or absence) of any other feature. The morphological scanning technique will scan the image and technique of Naïve Bayes is applied which mark the tumor in the image. The classifier that includes all independent attributes when the value of class variable is given is known as Naïve Bayes classifier. Conditional independence is another name for this classifier and it is known to be the easiest form of Bayesian network [9]. Here, the Bayes' theorem is applied along with the naïve assumption that shows the independence among every pair of features within the set of supervised learning algorithms. Following relationship is stated by the Bayes' theorem:

$$P(y|x_1, \ldots, x_n) = \frac{P(y)P(x_1, \ldots, x_n|y)}{P(x_1, \ldots, x_n)} \tag{1}$$

Here, y is a class of variable and from x_1 to x_n a dependent feature vector is included.

PSNR and MSE: The PSNR signal is used to measure the quality of loss and lossless compression (e.g., for image compression). The peek signal used original data. The noise is the error introduced by compression. When comparing

compression codecs, PSNR is an approximation to human perception of reconstruction quality. Although a higher PSNR generally indicates that the reconstruction is of higher quality. When PSNR signal is maximum, the MSE signal is minimum (Fig. 1).

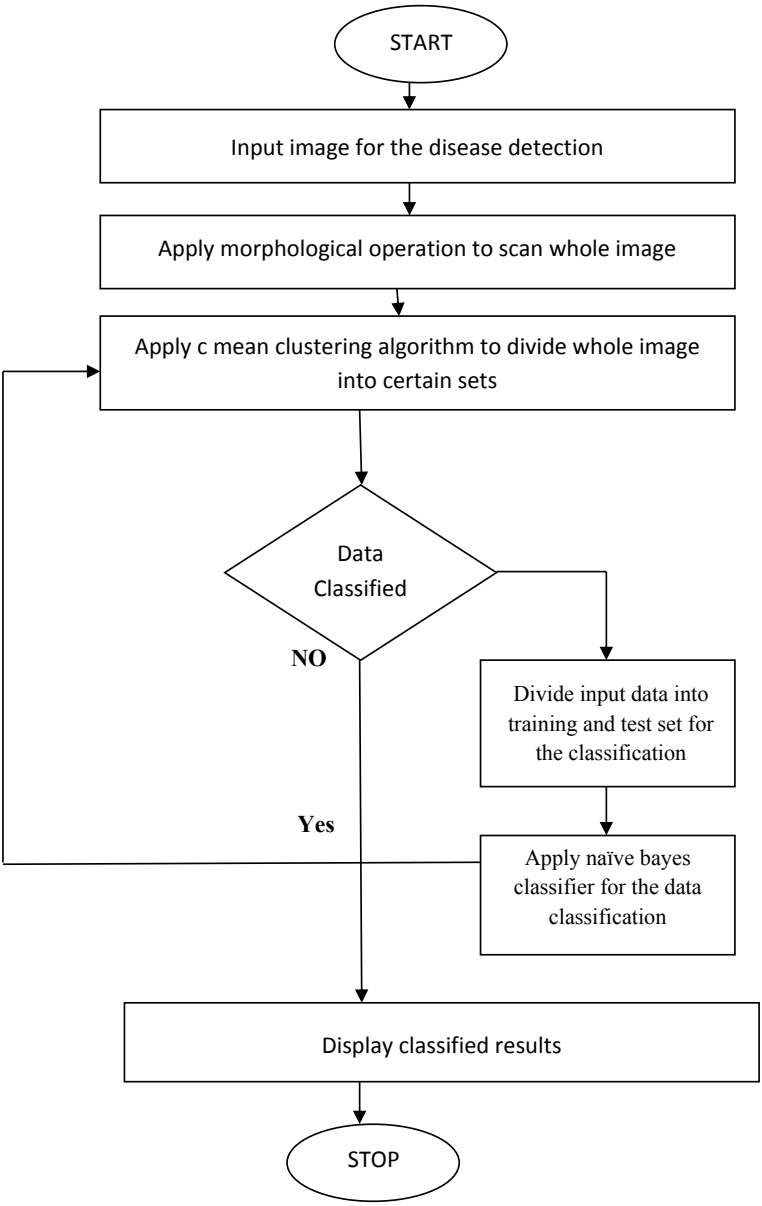

Fig. 1 Proposed flowchart NBC-BTD (brain tumor detection)

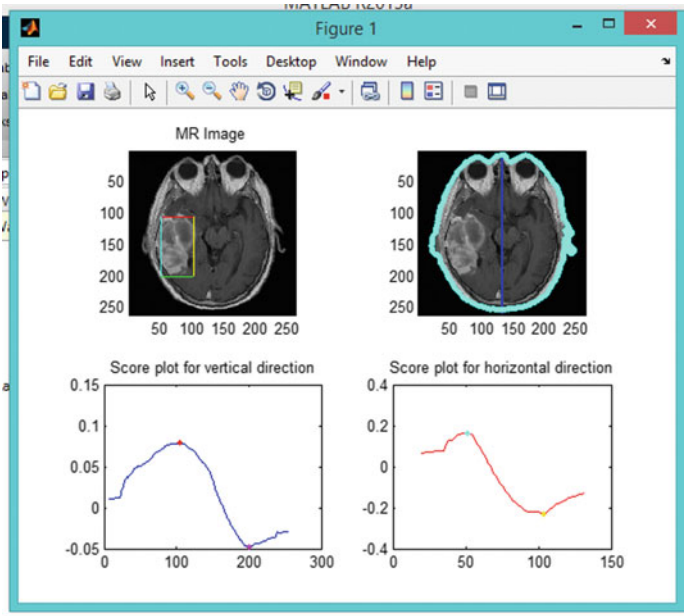

Fig. 2 Naïve Bayes classifier

Result and Discussion: This research work was based on the brain tumor detection; the 20 images taken from data respiratory set. To detect tumor from the MRI images technique of classification was applied. Input the test data for tumor detection, applied in the morphological operations; divided input class into training set; then classified the data. The technique of Naïve Bayes classifier NBC-BTD model marks the tumor portion in the image with horizontal and vertical plot with segmented tumor area. The tumor region grew which segmented tumor would portion from non-tumor region. That gave false positive and negative rate.

As shown in Fig. 2, the technique of Naïve Bayes classifier was applied which marked the tumor portion on the image. The vertical and horizontal position was also calculated from the input MRI Image (Fig. 3; Table 1).

The PSNR value of the Advance and previous research algorithm has compared for the performance analysis. It has analyzed that PSNR value of advance algorithm was high as that to previous research algorithm (Fig. 4; Table 2).

The MSE value of advance and previous research algorithm is compared for the performance analysis. It is analyzed that MSE value of advance algorithm is less as compared to previous research algorithm (Fig. 5; Table 3).

The accuracy value of the advance and previous research algorithm was compared for the performance analysis. It was analyzed that proposed algorithm has high accuracy as compared to previous research algorithm (Fig. 6; Table 4).

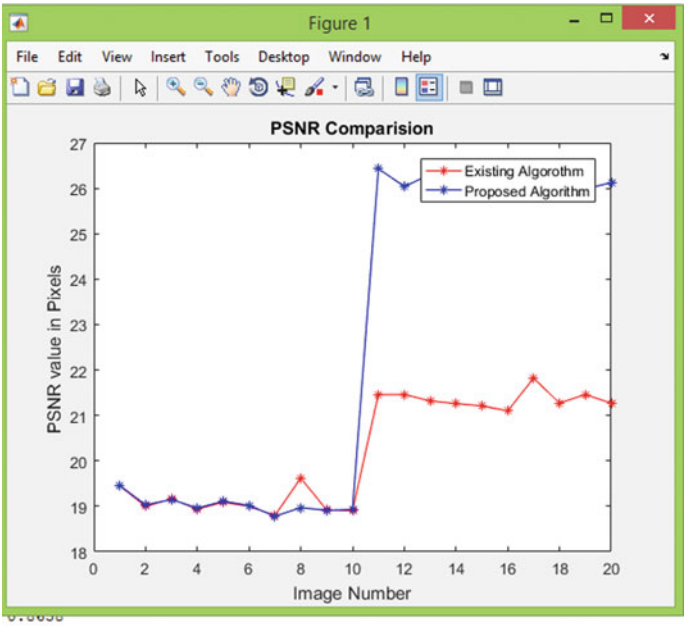

Fig. 3 PSNR comparison

Table 1 PSNR comparison

Image no.	Existing technique (S.V.M classifier)	Proposed technique NBC-BTD
1.	19.45	19.46
2.	19	19.03
3.	19.16	19.15
4.	18.94	18.96
5.	19.09	19.11
6.	19	19.02
7.	18.8	18.78
8.	19.62	18.97
9.	18.92	18.91
10.	18.9	18.93
11.	21.46	26.43
12.	21.46	26.04
13.	21.32	26.3
14.	21.26	26
15.	21.21	26.31
16.	21.1	26.14
17.	21.82	25.83
18.	21.27	26.05
19.	21.46	25.99
20.	21.27	26.12

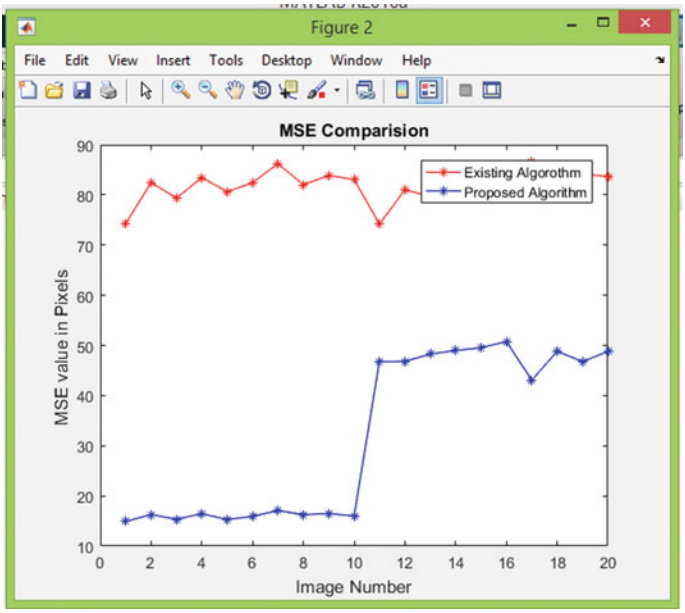

Fig. 4 MSE comparison

Table 2 MSE comparison

Image no.	Existing technique (S.V.M classifier)	Proposed technique NBC-BTD
1.	74.25	14.9
2.	82.45	16.29
3.	79.37	15.36
4.	83.46	16.45
5.	80.63	15.31
6.	82.44	15.92
7.	86.23	17.09
8.	82.03	16.25
9.	83.89	16.48
10.	83.05	16.01
11.	74.18	46.8
12.	81.03	46.81
13.	79.66	48.27
14.	83.19	48.99
15.	80.37	49.55
16.	81.98	50.76
17.	86.69	43.08
18.	83.05	48.83
19.	84.14	46.75
20.	83.68	48.81

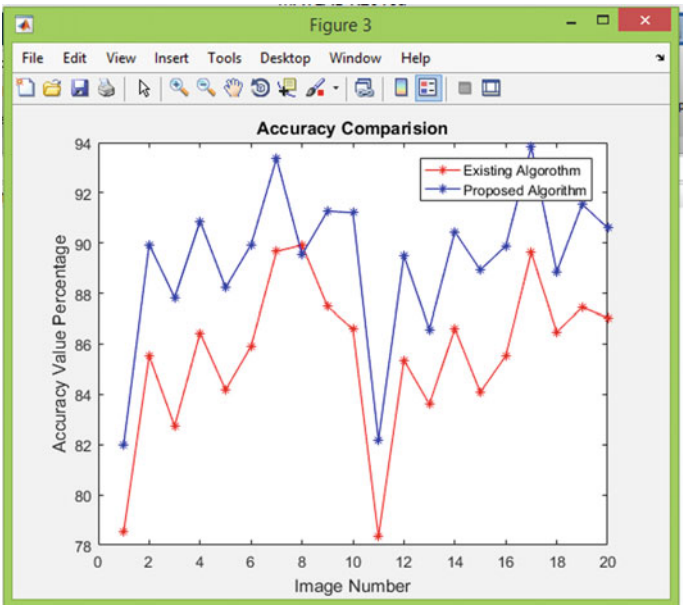

Fig. 5 Accuracy comparison

Table 3 Accuracy comparison

Image no.	Existing technique (S.V.M classifier)	Proposed technique NBC-BTD
1.	78.53	82
2.	85.53	89.94
3.	82.74	87.83
4.	86.44	90.87
5.	84.18	88.23
6.	85.91	89.93
7.	89.67	93.37
8.	89.92	89.54
9.	87.48	91.27
10.	86.59	91.21
11.	78.34	82.18
12.	85.36	89.5
13.	83.61	86.58
14.	86.61	90.45
15.	84.09	88.93
16.	85.53	89.89
17.	89.62	93.83
18.	86.48	88.86
19.	87.45	91.54
20.	87.04	90.6

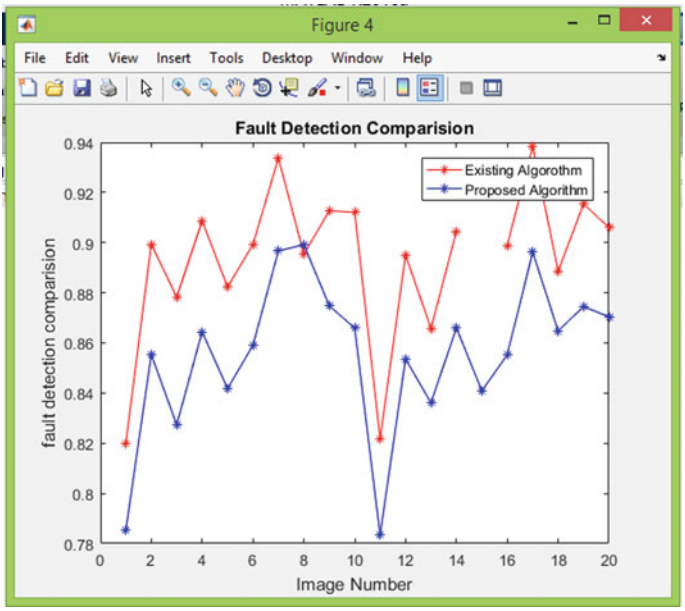

Fig. 6 Fault detection comparison

Table 4 Fault detection

Image no.	Existing technique (S.V.M classifier)	Proposed technique NBC-BTD
1.	0.7853	0.82
2.	0.8553	0.8994
3.	0.8274	0.8783
4.	0.8644	0.9087
5.	0.8418	0.8823
6.	0.8591	0.8993
7.	0.8967	0.9337
8.	0.8992	0.8954
9.	0.8748	0.9127
10.	0.8659	0.9121
11.	0.7834	0.8218
12.	0.8536	0.895
13.	0.8361	0.8658
14.	0.866	0.9045
15.	0.8409	0.8893
16.	0.8553	0.8989
17.	0.8962	0.9383
18.	0.8648	0.8886
19.	0.8745	0.9154
20.	0.8704	0.906

The fault detection rate value of the present and previous research algorithm was compared for the performance analysis. It was analyzed that present algorithm has high fault detection as compared to previous research algorithm.

4 Conclusion

In this work, it is concluded that image processing is the technique which can process information stored in the form of pixels. The brain tumor detection is the technology which can detect tumor portion from the MRI image of brain. In this research work, novel technique is proposed which is based on the morphological operation and Naïve Bayes classifier and clustering techniques. The performance of present algorithm is collate with past and it is analyzed that present algorithm performs well in terms of PSNR, MSE, and accuracy and fault detection with 86% ratio.

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