



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Special Issue 2, December 2021

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.569

Analysis of Edge Detection Based on Operators with SVM and FCM Classifications

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ABSTRACT: Edge detection is the process of identifying and locating sharp discontinuities in an image. The discontinuities are abrupt changes in pixel intensity which characterizes boundaries of objects in a scene. It's also the most important parts of image processing, especially in determining the image quality. Many operators are widely used to detect edges in images. However, as the size of the image dataset increases, the edge detection performance of the operator decreases and its runtime becomes excessive. The main disadvantage of edge detect operator is that it is time consuming, due to its complex computation. Attempting to resolve such problems, a new approach dealing with edge detection technique with SVM and Fuzzy C-Means Algorithms is addressed in this paper. In this paper two algorithms (SVM, Fuzzy C-Means), used for classification and Sobel, Prewitt, Canny operators for Edge detection, are implemented and compared in terms of two classes of cluster validity functions, fuzzy partition and feature structure, on the basis of their performance for the cancer infection images, and to find which algorithmic approach provides better results in image classification.

KEYWORDS: Support Vector Machine, Prewitt edge detector, Sobel edge detector, Canny edge detector, Filtering, Gradient, Classification and Multi-level Thresholding, Fuzzy C Means

I. INTRODUCTION

Edge Detection from colored images or gray scaled images belongs to the field of Digital Image Processing and Computer Vision. An edge defines the boundaries between or among regions or objects in an image therefore edge detection helps to identify objects from the given images and also assists in image classification [1]. It is a collection of pixels whose surrounding pixels have a grayscale step-like changes or changes in the roof. The edge widely exists between objects and background, objects and primitives. It contains rich information, step property, shape etc, which is able to describe the target object. There are two types of edge detection: one is step change edge whose pixels grayscale of two sides have significantly difference; the other one is roof edge that is the turning point from increase to decrease of gray value [2].

II. EDGE BASED IMAGE CLASSIFICATION TECHNIQUES

This section will discuss some of the popular edge based image classification techniques that are used for cancer infection image classification. In cancer infection image classification is classified based on its different morphological features. Some of the classification techniques used is Fuzzy C-Means and Support Vector Machine. Cancer Infection image classification has wide application in Medical.

A. Fuzzy C-Means Algorithm

The fuzzy c-mean algorithm is one of the common algorithms that used to image classification by dividing the space of image into various cluster regions with similar image's pixels values. For cancer infection images classification, the suitable clustering type is fuzzy clustering. The Fuzzy C-Means (FCM) clustering algorithm was first introduced by Dunn and later was extended by Bezdek. Unsupervised Fuzzy clustering is used for the analysis of data and image models. It is a little enhancement of K means clustering algorithms. The main purpose of the FCM algorithm is to make the vector

space of a sample point be divided into a number of sub-spaces in accordance with a distance measure. FCM has a wide domain of applications such as agricultural engineering, astronomy, chemistry, geology, image analysis, medical diagnosis, shape analysis, and target recognition.

Fuzzy C-means clustering is a soft clustering technique which allows partial belongingness of pixels into different clusters. This partial membership is calculated using membership functions. The sum of all membership degrees for any given data point is equal to 1. This method has better applicability to classification applications than hard clustering algorithm. The algorithm finds 'c' clusters by minimizing the objective function given by below equation.

$$J_{FCM} = \sum_{k=1}^n \sum_{i=1}^c (u_{ik})^q d^2(x_k, v_i)$$

where, $x_k = \{x_1, x_2, \dots, x_3\}$ are the data points, n is the number of data items, c represents the number of clusters, the degree of membership of x_k in the i^{th} cluster is represented as u_{ik} , q is the weighting exponent on each fuzzy membership, v_i represents the centre of cluster i, $d^2(x_k, v_i)$ is the distance between data point x_k and cluster centre v_i . FCM algorithms form a basis for clustering techniques that dependent on objective functions.

Algorithm:

Step 1: Let us consider that M-dimensional N data points represented by x_i ($i = 1, 2 \dots N$) are to be clustered.

Step 2: Assume the number of clusters to be made, that is, C, where $2 \leq C \leq N$.

Step 3: Choose an appropriate level of cluster fuzziness $f > 1$.

Step 4: Initialize the $N \times C \times M$ sized membership matrix U, at random, such that $U_{ijm} \in [0, 1]$ and $\sum U_{ijm} = 1.0$, for each i, j and a fixed value of m.

Step 5: Determine the cluster centers CC_{jm} , for j^{th} cluster and its m^{th} dimension by using the expression given below:

$$CC_{jm} = \frac{\sum_{i=1}^N U_{ijm}^f x_{im}}{\sum_{i=1}^N U_{ijm}^f}$$

Step 6: Calculate the Euclidean distance between i^{th} data point and j^{th} cluster center with respect to, say m^{th} dimension like the following:

$$D_{ijm} = ||(x_{ijm} - CC_{ijm})||$$

Step 7: Update fuzzy membership matrix U according to D_{ijm} . If $D_{ijm} > 0$, then

$$U_{ijm} = \frac{1}{\sum_{c=1}^C \left(\frac{D_{ijm}}{D_{icm}} \right)^{\frac{2}{f-1}}}$$

If $D_{ijm} = 0$, then the data point coincides with the corresponding data point of j^{th} cluster center CC_{jm} & it has the full membership value, that is, $U_{ijm} = 1.0$.

Step 8: Repeat from Step 5 to Step 7 until the changes in U $\leq \phi$, where ϕ is a pre-specified termination criterion.

III. EXPERIMENTAL RESULTS

The objective is to produce a clean edge map by extracting the principal edge features of the image. The edge detection based image classification techniques were implemented using MATLAB R2012a on a PC with Pentium-4 3.20 GHz CPU, 4GB of RAM running Windows 7, and tested with a Skin Cancer Test image. The images are in JPEG format. The input image is collected manually using scanning. The captured image is preprocessed. The preprocessed image and the image

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after Edge detection with **Canny, Sobel and Prewitt** the **pest infected region by using SVM and Fuzzy C –Means edge based image classification** technique are given. Then the image is segmented by SVM and Fuzzy C -Means and both are compared. It detects the infected part of the cancer. We have taken two data sets mainly named train dataset and training data set. Train data set contain images which already have been processed and cancer identity and feature extraction about them have been detected. Another dataset named training dataset contain the images which needed to be processed for detection of cancers. One image from training data set is taken and its features are matched to images in the training dataset by using SVM and Fuzzy C-Means. SVM and Fuzzy C-Means are used for the feature matching. Main thing in this work is that whole area which is infected by disease will be calculated in the terms of percentage %. And cancer is also detected. Now following are the results of the implemented work.

Experiment has defined three parameters to measure the success of Canny with SVM, Sobel with SVM, Prewitt with SVM, Canny with FCM, Sobel with FCM and Prewitt with FCM algorithms first is the Error Rate (ER), Detection Success Rate (DSR) and Accuracy. To evaluate the quality of classification using accuracy. The accuracy method uses quality evaluation for the measurement. The quality is a measure of the goodness of the result. The criterion is derived from the values of true positive (TP), true negative (TN) and false positive (FP), the values of which are defined in the following equations.

$$Quality = \frac{TP}{TP + FP + FN}$$

To optimum value for these criterions is 100 %. Here TP, TN, FP and FN are defined in the following equations

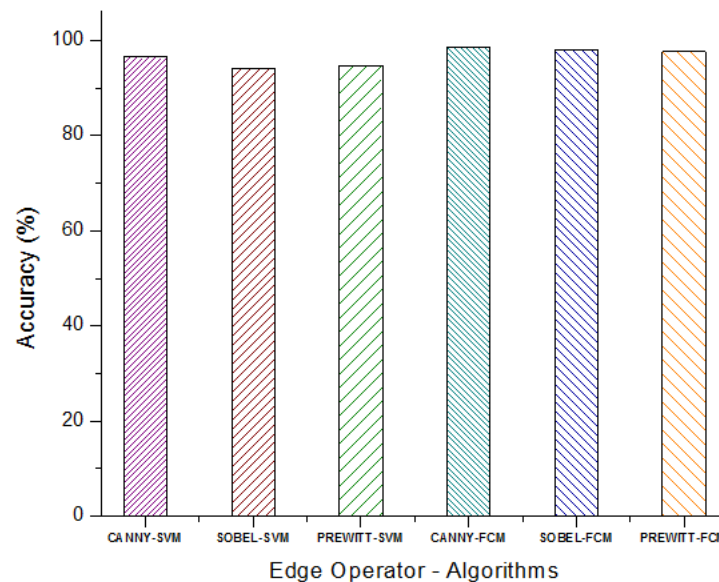
$$TP = m(S_t \cap S_e)$$

$$TN = m(\bar{S}_t \cap \bar{S}_e)$$

$$FP = m(\bar{S}_t \cap S_e)$$

$$FN = m(S_t \cap \bar{S}_e)$$

Here, m(A) is the number of pixels of region A. S_e means the detected interest object area and S_t means the true interest object area. TP and FP represent whether the detected area is an absolute interest object area. TN and FN represent whether a non-detected area is the background area or not, respectively.



(a) Accuracy

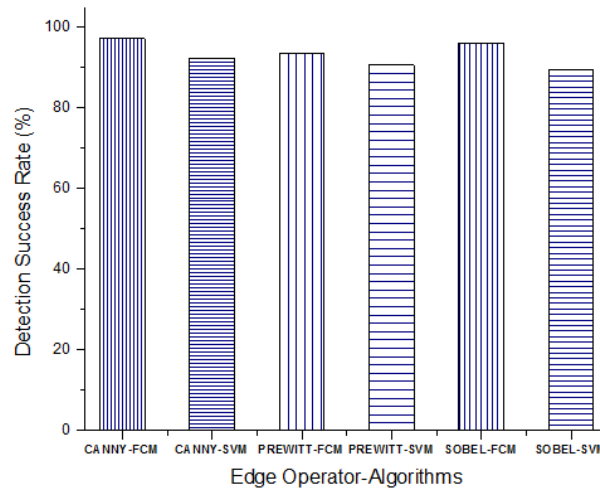
Detection Success Rate (DDSR) is defined as the number of cancer infection detected correctly over the total number of cancer infection.

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$$\text{Detection Success Rate(DDSR)} = \frac{\text{Number of cancer infection Detected}}{\text{Total Number of cancer infection}} \times 100\%$$

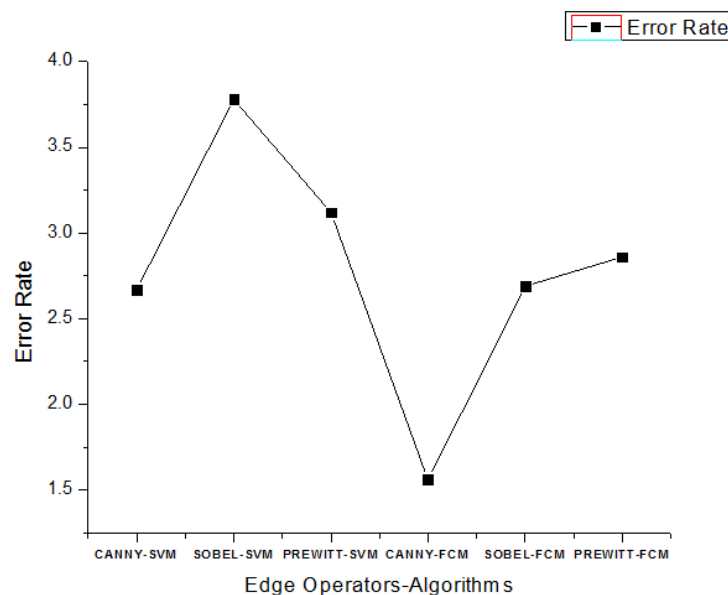


(b) Detection Success Rate

First is the Error Rate (ER) which is defined as number of false detection in the image divide by the total number of detections (disease and non-disease).

$$\text{Error Rate(ER)} = \frac{\text{Number of False Detection}}{\text{Total Number of Detections}} \times 100\%$$

Here, number of false detection means those objects that are identified as disease but are not disease. The total number of detections is the summation of cancer infection detected and non- object detected.



(c) Error Rate

Figure 5: Performance comparison chart of the Edge detection operators with classification algorithms for various cancer infection images from database for the performance metrics (a) Accuracy (b) Detection success rate and (c) Error rate.

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IV. CONCLUSION

The image classification is an important part of image processing and huge amount of research is done in this field. However, there is no algorithm that can segment all images equally and efficiently. In this paper edge based classification algorithms SVM and FCM are used with edge operators. Then, edge texture features are extracted and classification is done using Edge operators with SVM and FCM. In this paper, Fuzzy C-Means is compared with SVM for image classification, in which Fuzzy C-Means gives higher accuracy, detection rate than SVM.

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