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AN ARTICULATED BIO-DIVERSITY IN ASSESSING THE CONVENTIONAL FIRE DETECTION ALONG WITH CONTENT BASED IMAGE EXTRACTION THROUGH OBJECTS OF INTEREST USING KERNEL FUZZY C-MEANS ALGORITHM WITH VISION-BASED SYSTEM AND VISUAL PROCESSING TECHNIQUES

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Abstract---Since forest fire is considered as a significant environmental issue in causing prominent economical and ecological damage despite endangering the human lives. Fire represents a constant threat to ecological systems which affects the infrastructure of the human lives. The integral part of the ecological responsibility of the forest fire is formed by the controlling factors like the plant community development, soil nutrient availability and biological diversity. The foremost objective of this paper is to segment the forest fire which can cause serious issues to the human habitats. The taster is to be considered as image of forest fire in which it is processed under the technique entitled as preprocessing. Eradication of noise from the sample is done through various filters techniques in which median filter have a spat in a healthy mode. The prime objective of the segmentation is to facilitate content based representation by extracting objects of interest from an image. The region of partitioning is performed in an effective way using the Kernel Fuzzy C-Means Algorithm with K value at different propositions. The quality metrics have been measured so as to determine the statistical number for different K proportions in which the value for the processed image is the final outcome.

Keywords –*Forest fire, Segmentation, Kernel Fuzzy C Means Algorithm, Quality Metrics.*

1. INTRODUCTION

Image processing leads as a promising role in the effects of the natural disasters with the growth and development of the technologies. Computer vision based systems which utilize the digital technology by associating the image and video processing techniques plays a very important role to effectively replace conventional forest fire detection systems [1][2]. Due to the rapid growth and development of the electronics such as digital cameras it has been mentioned as it's the real motivation for an image processing based approach. On such panel, one of the natural

disaster which cause serious treats to the human habitations' is Forest fire. In which the Forest fire are severe conservational threats that results in corrosion of economy and environment apart from exposing human lives. Fire has been a source of trouble for a long time at present [4]. On the other hand, it has remarkable influence over the ecological and economic utilities of the forest being a principal constituent in a huge number of forest ecosystems. Forest fire is the most common hazard in the forest where they are as old as the forest themselves [3]. In the environmental perspective, the forest fire poses a threat not only to the forest wealth but also to the entire regime to fauna and flora seriously disturbing the Bio-diversity and the ecology and environmental regions.

2. LITREATURE REVIEW

Krull et al. [5] used low-cost CCD cameras to detect fires in the cargo bay of long range passenger aircraft. The method uses statistical features, based on grayscale video frames, including mean pixel intensity, standard deviation, and second-order moments, along with non-image features such as humidity and temperature to detect fire in the cargo compartment. The system is commercially used in parallel to standard smoke detectors to reduce the false alarms caused by the smoke detectors. The system also provides visual inspection capability which helps the aircraft crew to confirm the presence or absence of fire. However, the statistical image features are not considered to be used as part of a standalone fire detection system.

Florent Lafarge et al. [6], a fully automatic method of forest fire detection from TIR satellite images based on the random field theory has been presented. It is demonstrated that the results of the system rely only on the confidence coefficient. The values obtained for both detection rate and false alarm rate were convincing. The estimation of fire propagation direction provided interesting information related to the evolution of the fires, to the authors.

Young Gi Byun et al. [7], a graph-based forest fire detection algorithm on the basis of spatial outlier detection methods has been presented. The authors have performed spatial variation in their algorithm by the use of spatial statistics. When compared with the MODIS fire product provided by the NASA MODIS Science Team, the algorithm presented show higher user and producer accuracies. The authors prove that the ordinary scatter plot algorithm was inefficient owing to its insensitivity to small fires, while Moran's scatter plot was also weak owing to the absence of a numerical criterion for spatial variation which necessitated a more and less high commission error.

3. RESEARCH METHODOLOGY

The goal of segmentation is to divide the image into homogeneous regions. Here, the system architecture of our proposed work shown in the fig-6.

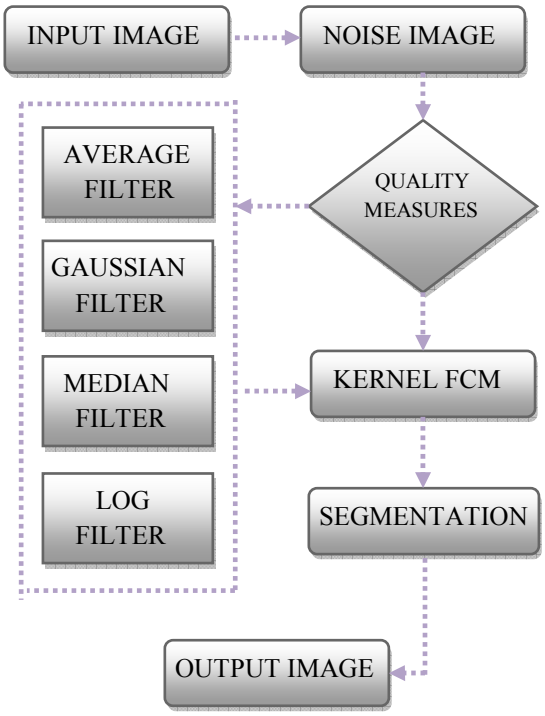

Fig 1: System Architecture

4. NOISE TYPES

The medical images are often degraded by some random errors – this degradation is usually called noise. Noise can occur during image capture, transmission, or processing, and may be dependent on, or independent of, the image content. Noise can be viewed in numerous ways. Some of the frequent noises that are encountered in image processing are categorized based on the criteria of distributions, correlation, nature and source. There are various types of noise in image that can corrupt images. Some of the noises are Gaussian noise, speckle noise and salt and pepper.

4.1 SALT & PEPPER NOISE

It represents itself as randomly occurring white and black pixels. An effective noise reduction method for this type of noise involves the usage of a median filter [10]. Salt and pepper noise creeps into images in situations where quick transients, such as faulty switching, take place. The image after distortion from salt and pepper noise looks like the image attached. This type of noise contains random occurrences of both black & white intensity values, and often caused by threshold of noise image. Salt & Pepper distribution noise can be expressed by

$$P(x) = \begin{cases} p1, & x = A \\ p2, & x = B \\ 0, & otherwise \end{cases}$$

Where P1, P2 are the Probabilities Density Function (PDF) p(x) is distribution salt and pepper noise in image and A, B are the array size image. In this paper salt & pepper noise in image is randomly occurred in white and black pixels of an image. The main challenge in removing salt & pepper noise from image is due to the fact that image data as well as the noise, share the same small set of values, which complicates the process of detecting and removing the noise.

5. FILTERING

Filtering in visual processing is a process that cleans up appearances and allows for selective highlighting of specific information [8]. A number of techniques are available and the best options can depend on the medical images and how it will be used. In all the visual processing may require filtering to yield a usable and attractive end result. This can be a routine part of the editing process used to prepare video frames for distribution.

5.1 GAUSSIAN FILTER

The Gaussian filter is arrived at by setting the weights equal to the ordinates of an appropriate Gaussian, or normal, probability density function. The Gaussian filter is particularly convenient because the standard deviation of the appropriate Gaussian distribution can be specified in terms of the 50% frequency response of the filter. Gaussian filters have the properties of having no overshoot to a step function input while minimizing the rise and fall time. This behavior is closely connected to the fact that the Gaussian filter has the minimum possible group delay. The one-dimensional Gaussian filter has an impulse response given by

$$g(x) = \sqrt{\frac{a}{\pi}} \cdot e^{-a \cdot x^2}$$

These equations can also be expressed with the standard deviation as parameter

$$g(x) - \frac{1}{\sqrt{2\pi} \cdot \sigma} \cdot e^{-\frac{x^2}{2\sigma^2}}$$

By writing a as a function of σ with the two equations for $g(x)$ and as a function of σf with the two equations for $\hat{g}(f)$ it can be shown that the product of the standard deviation.

5.2 AVERAGE FILTER

A moving average filter smoothes data by replacing each data point with the average of the neighboring data points defined within the span. This process is equivalent to low pass filtering with the response of the smoothing given by the difference equation

$$Y_s(i) = \frac{1}{2N+1}(y(i) + N) + y(i+N-1) + \ldots + y(i-N))$$

Where $Y_s(i)$ is the smoothed value for the ith data point, N is the number of neighboring data points on either side of $Y_s(i)$ and 2N+1 is the span. By comparing with the Gaussian filter, the average filter works effectively for the color video frames.

5.3 MEDIAN FILTER

The median filter sorts the surrounding pixels value in the window to an orderly set and replaces the center pixel within the define window with the middle value in the set [9].

$$f(x,y) = \underset{(s,t) \in S_{xy}}{median} \{g(s,t)\}$$

Median filtering is a non-linear technique that works best with impulse noise (salt & pepper noise) whilst retaining sharp edges in the image. The main disadvantage is the extra computation time needed to sort the intensity value of each set.

5.4 LOG FILTER

The log Filter each channel of input over time using static or time-varying log filter implementations. The log Filter block independently filters each channel of the input signal. Laplacian filters are derivative filters used to find areas of rapid change (edges) in images. Since derivative filters are very sensitive to noise, it is common to smooth the image (e.g., using a Gaussian filter) before applying the Laplacian. This two-step process is calling the Laplacian of Gaussian (LoG) operation.

$$\mathbf{L(x,y) = \nabla^2 f(x,y) = \frac{\partial^2 f(x,y)}{\partial x^2} + \frac{\partial^2 f(x,y)}{\partial y^2}}$$

There are different ways to find an approximate discrete convolution kernel that approximates the effect of the Laplacian. A possible kernel is

$$\begin{pmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{pmatrix}$$

This is called a negative Laplacian because the central peak is negative. It is just as appropriate to reverse the signs of the elements, using -1s and a +4, to get a positive Laplacian

6. KERNEL FUZZY C-MEANS ALGORITHM

KFCM algorithms demonstrate the flexibility in kernel selections and combinations, and therefore, they provide the potential of significant improvement over traditional methods on image segmentation [13] [14]. In Kernel Fuzzy C-Means algorithm each point has a degree of belonging to clusters in the fuzzy logic. Kernel fuzzy segmentation methods are of considerable benefits, because they retain much more information from the original image than segmentation methods [15][16].

KCM Algorithm

Step 1: Fix c, $t_{max,}$ m > 1 and Є = 0 for some positive constant;

Step 2: Initialize **the** membership u^0_{ik}

$$J_m = \sum_{i=1}^{c} \sum_{k=1}^{N} u_{ik}^m \|X_k - V_i\|^2$$

Step 3: For t =1, 2, ….. ,t_{max} , do;

(a) Update all prototypes V^t_i

(b) Update all memberships U^t_{ik}

(c) Compute $E^T = \max_{i,\,k}|u^t_{ik} - u^{t-1}_{ik}|$, if ET ≤ ∈,

$$U \in \{u_{ik} \in [0,1] \,|\, \sum_{i=1}^{c} u_{ik} = 1 \;\forall k \quad \text{and}$$

$$0 < \sum_{k=1}^{N} u_{ik} < N, \forall i\}$$

Step 4: Calculate the centroids

Step 5: Stop: else t=t+1.

They are both defined over Rn × Rn. Clearly, due to the fact that we only know the kernel functions, we need to solve the problems in the kernel space by only using kernel functions, i.e., the inner product of the transform function ϕ. Usually this is called "kernel trick". There are two types of KFCM. If the prototypes are constructed in the kernel space, this type of KFCM is referred as KFCM-k (with K standing for the kernel space).

Step 6: Another type of KFCM confines that the prototype in the kernel space are actually mapped from the original data space or the features space. That is, the objective function is defined as

$$Q = \sum_{i=1}^{c} \sum_{j}^{n} u_{ij}^m \|\varphi(x_j) - \varphi(o_i)\|^2$$

Step 7: Here, K ($X_{j,}$ O_i) can be considered as a robust distance measurement derived in the kernel space. For these KFCM applying Gaussian kernel, we iteratively update the prototype and membership as

$$Q = \sum_{i=1}^{c} \sum_{j=1}^{n} u_{ij}^m (1 - k(x_j, o_i))$$

Step 8: Final step is to segment the fire.

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7. SEGMENTATION

Segmentation is the process of partitioning a digital image into multiple regions and extracting meaningful regions known as regions of interest (ROI) for the future image analysis. Image segmentation has emerged as an important phase in image-based applications. Thresholding is a very important technique for image processing. It produces

uniform regions based on the threshold criterion T. The thresholding operation can be thought of as an operation, such as

$$T=T\{x, y, A(x, y), f(x, y)\}$$

In which the particular region is detected using this segmentation technique along with the thresholding operation. Edge plays a very important role in image processing application in which they provide an outline of the object. In the physical plane, edges correspond to the discontinuities in depth, surface orientation, changes in material properties, and light variations. When an edge is detected, the unnecessary details are removed, while only important structural information is retained.

8. PERFORMANCE MEASURES

8.1 MEAN SQUARE ERROR (MSE)

The simplest of image quality measurement is Mean Square Error (MSE) [11]. The large value of MSE means that image is poor quality. MSE is defined as follow

$$MSE = \frac{1}{MN} \sum_{j=1}^{M} \sum_{k=1}^{N} \left(x_{j,k} - x'_{j,k} \right)^2$$

8.2 PEAK SIGNAL TO NOISE RATIO (PSNR)

The small value of Peak Signal to Noise Ratio (PSNR) means that image is poor quality [12]. In general, a good reconstructed image is one with low MSE and high PSNR. PSNR is defined as follow

$$PSNR = 10 \log \frac{(2^n - 1)^2}{MSE} = 10 \log \frac{255^2}{MSE}$$

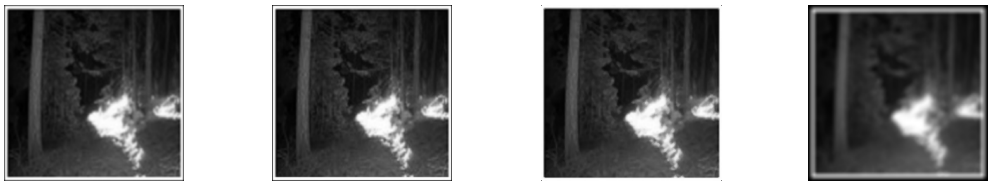
IX. RESULT AND DISCUSSION

The proposed work is done using MATLAB.2010 version. The images which are considered as input for the work are

(a) **(b)**

Fig 2: (a) Original color image and (b) gray scale image

The samples are introduced with a noise (called salt & pepper noise) and filtered using various filters. In which the median filter performed well by comparing with the other filters. The filtered images are



(c) (d) (e) (f)

Fig 3: (c) Average filter image, (d) Gaussian filter image, (e) median filter image, and (f) Log filter image.

IMAGES	PSNR	MSE
AVERAGE FILTER	23.36	299.81
GAUSSIAN FILTER	24.70	220.09
MEDIAN FILTER	28.36	94.70
LOG FILTER	25.04	203.66

Table 1: Filtered images.

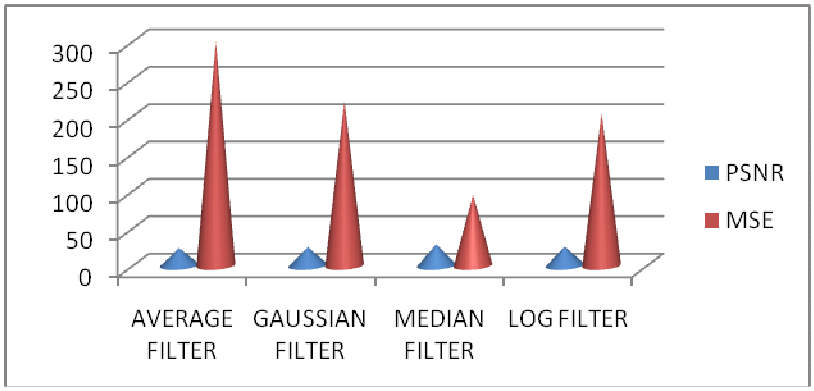
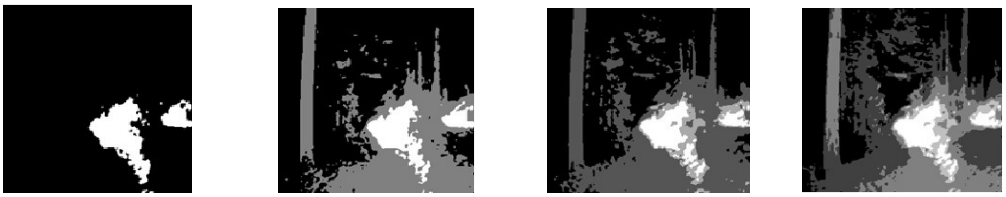


Fig 4: Comparison of filters.

The filtered image is processed under the segmentation technique by using the Kernel Fuzzy C Means Algorithm with different proportions of K value.



(g) **(h)** **(i)** **(j)**

Fig 5: The segmented images at different proportions, (g) K = 2.5 , (h) K = 3.5, (i) K=4.5 and (j) K=5.5

K-VALUE	PSNR	MSE
K=2.5	13.34	3.01
K=3.5	15.04	2.03
K=4.5	18.21	1.16
K=5.5	16.88	1.33

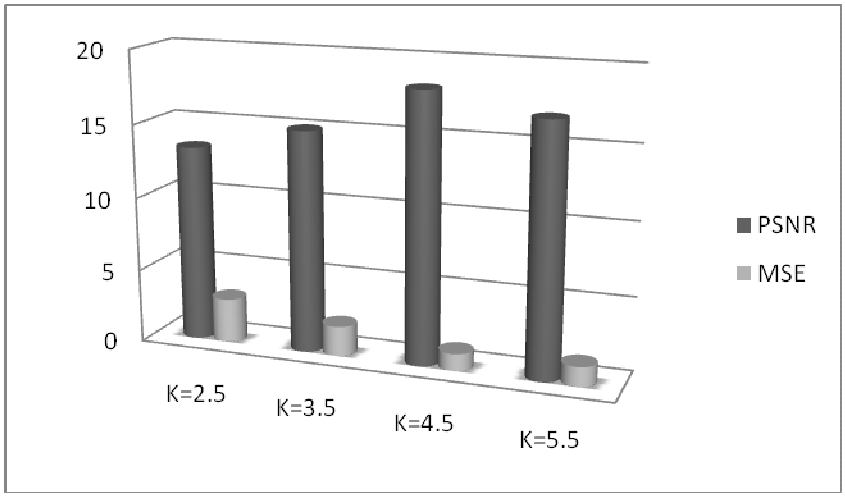


Fig 5: Comparison of Segmented images.

X. CONCLUSION

The biggest trend to replace conventional fire detection is through vision-based system where fire plays a pre-dominant role in a majority of the forest ecosystems. Due to the rapid development in image processing technologies detection of fire in the forest has been effortlessly estimated. In order to avoid the hazardous crisis with instant reaction, the fire should be detected in the early stage so as to react in a very fast pace to prevent the spread of fire. It is the only viable and effective option to reduce the damage. To carry out the assessment of fire segmentation is one of the hygienic process in which Kernel FCM Algorithm has been used to detect the forest fire from the images which has been performed using visual processing techniques.

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