

Automated System for Computation of Burnt Forest Region using Image Processing

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Abstract—Fire is one of the major problems that are causing great loss to property and ecosystem in today's world. Fires not only affect the characteristics of forests but it also affects human lives and livelihood. Due to the lack of specific techniques for calculation of burnt regions of forests, researchers use different methods. In this research, an automated approach is developed to determine the significant burnt area of forest using different image processing techniques. The proposed method is compared with other existing methods and is found to be capable in more precise measurement of the burnt area.

Keywords – Thresholding, Erosion, Dilation, Region leveling.

I. INTRODUCTION

Forest fires are a major threat to the ecosystem, property, lives and livelihood. Forest fires maybe man made or natural. In the modern era a cheap and effective burnt area detection technique is very necessary to take immediate action. India has a forest cover of 76.4 million hectares but approximately 50% of it is fire prone. During the summer of 1995, a massive area of about 677,700 hectares were affected by forest fires in the hills of UP and HP and many more such drastic events are occurring throughout the world every year. Hence, it is clearly understandable that proper measures to prevent forest fires are a necessity in today's world.

Usage of digital image processing techniques has so widely been used in recent times due to the availability of cheap CCD and CMOS cameras which provide a decently high resolution. Three types of situations are encountered in case of forest fires:

1. *Before the occurrence of forest fire:* Figure 1 below shows an image of a forest before it has been affected by the fire.



Fig 1: Forest before being affected by fire.

2. *Live occurrence of forest fire*: In this situation, researchers have currently focused on smoke detection.



Fig 2: Forest during the fire.

3. After the occurrence of forest fire: If fire fighting is performed then and then only, the calculation of significantly burnt region is carried out to take immediate action.



Fig 3: Forest after being affected by fire.

II. PREVIOUS WORKS

Hamidreza, Hamud and Asadollah[2] proposed a method which uses a hit and trial method using median filters. This method is basically a brute force method to search for a proper median filter that serves the purpose of detecting the actual burnt region. After binarizing the image using the thresholding technique, median filters are being applied. Firstly a median filter of 3×3 dimensions have been used followed with filters of 5×5 , 7×7 dimensions and finally a proper result is obtained using a filter of 9×9 dimensions.

A similar sort of brute force method has also been used by Pragatipawar, Deshkar and Rokade[3]. In this method they have used the median filter of 3×3 , 5×5 and of 7×7 dimensions. The results that have been obtained imply that quite a good amount of noise have been cancelled when filters of higher dimensions are being used.

III. PROPOSED METHOD

Filters are generally useful when the salt and pepper noise has a uniform spread of black and white pixels, but if the sample image has a greater amount of inter connected black pixels as noise, then rather than removing the insignificant regions, these regions become more prominent in the picture. Furthermore, this method of using median filters is a hit and trial method which might result into a number of trials to extract the significant burnt region from the picture. The proposed method uses morphological processing algorithms to determine only the significant regions that have been affected by the fire by examining the major patches of black pixels and determines the result in a single trial without utilizing any concept of brute force search for a proper filter.

The proposed algorithm can be described by the following steps.

A. *Thresholding*: the gray scale image of the burnt forest is binarized using Otsu's [1] method which is used to automatically perform clustering-based image thresholding. On the gray scale image, after obtaining the threshold 't', the image is binarized

as follows. If $G(i, j) > t$ then $B(i, j) = 0$ otherwise $B(i, j) = 255$. $G(i, j)$ and $B(i, j)$ represents the intensity value of pixel at (i, j) location of the image before and after binarization respectively.

B. Removal of noise using morphological technique: The binarized image might contain a large amount of noise due to the vegetation surrounding the affected area and thus, some morphological processing have been used to remove this unwanted noise. Erosion [5, 7] is a morphological processing technique which uses a small structuring element that shrinks an image by stripping away a layer of pixels from both the inner and outer boundaries of regions. A 3×3 structural element and its application on a black and white image is shown in Figure 4.

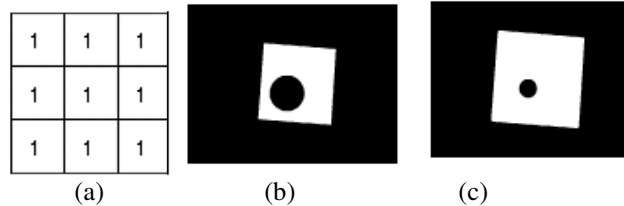


Fig 4: (a) Structural element (b) Image before erosion and (c) Image after erosion.

C. Determining the significant region: After the unnecessary noise and small insignificant regions have been removed, the next step is to determine the significant regions that are primarily affected by the fire. This has been done using the region labeling [4] algorithm. The algorithm is given below by the following steps:

Step 1: An arbitrary black pixel (i, j) is selected from the image. This pixel is called the seed pixel.

Step 2: This pixel is marked with a unique label L

Step 3: 8 – neighboring pixels of the seed pixel are examined. If the neighbors of this seed pixel also turn out to be black then those neighboring pixels are also assigned the same label. Once a new pixel is accepted as a member, the neighbors of this pixel are also examined. This labeling process continues until no more pixels are accepted. All the pixels of the current region are marked with L .

Step 4: Steps 1 to 4 are repeated until every pixel in the image has been assigned to a particular region.

After leveling, number of pixels in each region is calculated. Then the average number of pixels per region (A) is determined. If the number of pixels in a region is less than 10% of the average area (A) then those regions are considered as insignificant.

D. Reconstructing the significant area: After the significant regions are determined using the region labeling technique, now the need is to reconstruct the significant areas, as much of it was lost due to the application of erosion. To achieve this, the morphological process of dilation is used. Dilation [6] is a morphological processing technique which uses a small structuring element that enlarges an image by adding up a layer of pixels from both the inner and outer boundaries of regions. A 3×3 structural element and its application on a black and white image is shown in Figure 5.

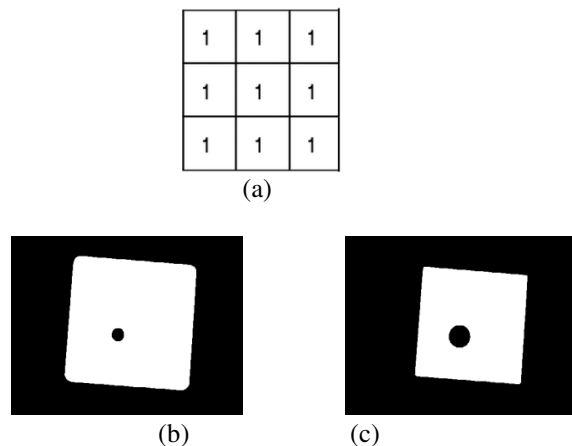


Fig 5: (a) Structural element (b) Image before erosion and (c) Image after erosion.

E. Removing erroneous data within the significant region: After identifying the significant regions, it is observed that some small white patches are embedded within the significant black regions. These small white patches are removed by applying the region filling [4] algorithm. The steps of the algorithm are given below:

For each significant area S ,

Step 1: Label each white patch within S using region labeling algorithm by considering white pixel as seed.

Step 2: Average number of pixel A in each label is calculated.

Step 3: If number of pixels in each level is less than 5% of the average A ; the pixels with label L is converted to black.

The above steps are followed for all significant area.

F. Computing the primary area: The primary area of the burnt area can be calculated by measuring the number of black pixels in the resultant image. As the image consists only of pixels having values 0 or 255 hence the fire affected region is denoted by the black pixels.

G. Computing the actual area: After computing the primary area (N), a factor 'm' needs to be calculated to determine the actual burnt area. This factor 'm' is calculated using equations (1) and (2) as given below and the real area can be calculated using equation (3).

$$I = f \times a \quad (1)$$

$$m = I/I \quad (2)$$

$$R = N \times m \quad (3)$$

Where, 'I' denotes the Imaging scale and 'f' and 'a' represent the focal length of camera and the altitude of flight respectively. Actual area affected by the wild fire is represented by R

In the sample image, if 'f' is in millimeters and 'a' is in meters then the actual area that will be obtained is in hectares.

IV. RESULTS

The proposed method is applied on the burnt forest images and the result is compared with the method described by Hamidreza et al. [2]. The result obtained by applying the method of Hamidreza et al. is given in Figure 6. From the result it is observed that with the increment of the size of the median filter, more insignificant areas are merged with the significant area and make it impossible to distinguish between them.

The result of applying proposed method is shown in Figure 7. It is quite easily observable that the proposed method extracts the exact significant region that is affected by the wild fire whereas the median filter instead of removing the noise and the other insignificant regions surrounding the significant region, increases the area covered by the insignificant region which makes it difficult to determine the exact amount of area that has been affected by the wild fire.

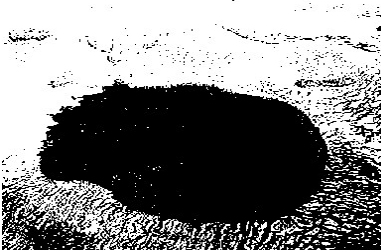
The primary area of the burnt region and the percentage of primary area with respect to total area are measured for both method and shown in Table 1.

		Primary Area	Percentage of Primary Area
Method proposed by Hamidreza et al	3×3 filter	49641	47.13%
	5×5 filter	49574	47.07%
	7×7 filter	52879	50.21%
	9×9 filter	53742	51.025%
Proposed Method		33375	31.69%

Table 1: Comparison of proposed method with Hamidreza et al.



(a) Original Image.



(b) Image after binarization.



(c) Image after applying 3x3 median filter.



(d) Image after applying 5x5 median filter.



(e) Image after applying 7x7 median filter.



(f) Image after applying 9x9 median filter.

Fig 6: Result obtained by applying the method of Hamidreza et al.



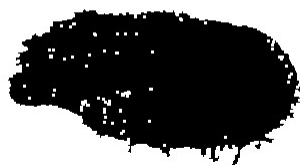
(a) Original Image.



(b) Image after binarization.



(c) Image after noise removal.



(d) Image after significant area extraction.



(e) Image after reconstructing significant area.



(f) Image after removal of white patch.

Fig 6(a-f): Result obtained by applying proposed method.

V. CONCLUSION

The proposed method suggests an automated approach to determine the significant burnt area that is affected by the wild fire using morphological techniques of image processing. This method turns out to be much better than the methods that have used median filters. Using median filters of higher dimensions results into the increase of the insignificant area rather than removing it. But in our method, the insignificant area is completely removed and only the significant area is extracted out of the original image. Thus, the proposed method produces much more exact results at a single trial and uses no brute force method to determine a proper filter to determine the exact region affected by the wild fire.

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