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Smart Fire Detection Using Wireless Sensors and Networks for Forest

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Abstract

We all know forest is very important resource of oxygen. Saving our environmental resources is human beings responsibility. One of the techniques to save forests is forest fire detection. This is a technique used to detect the fire and prevent them in less time. Forest fire leads to death of wild life and trees. There are other techniques used to detect fire in forests like cameras, satellite system, manual monitoring but they take time to detect the fire whereas Forest fire detection system detects the fire within seconds and triggers the alarms. In this way we can save tress and wildlife in very less time.

Keywords: Object detection model, Neural network, Deep learning, Python.

1 | Introduction

The Forest fire detection is one of the most researched topics. Forest is a natural resource with hundreds of trees, thousands of plants and wildlife animals. Forests provide nearly 260 pounds of oxygen globally every year [1]. Some hundreds and millions of forests area is destroyed due to fire and some hundreds of wildlife are dead. Forests provide us food, wood, livelihood, shelter etc. [2]. Amazon forest is one of the biggest forests in the world caught fire in year 2019, nearly 80,000 trees are destroyed and some billions of wildlife are dead due to fire [3]. Sensor technology is used worldwide to avoid all the fire accidents in the forests. To detect the fire accident some parameters such as temperature, humidity, pressure and some of chemical parameters like carbon dioxide percentage [4]. Sometimes false alarms are triggered due to some glitches in sensors [5]. These days fire detection is based on image processing because there is rapid development of digital camera technology and CCD [6]. These days image quality is increased and cost is decreased. This algorithm depends on fire and smoke colour properties to identify fire [7]. This system is very good; nevertheless, it is very expensive because it consists of infrared cameras and other technologies such as GPS and telemetry sensors [8]. Forest fire detection algorithm is proposed, and it consists of the following stages. Firstly, background subtraction is applied to movement containing region detection [9]. Secondly, converting the segmented moving regions from RGB to YCbCr colour space and applying five fire detection rules for separating candidate fire pixels were undertaken [10].

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1.1 | Forest Fire Detection Method

This method is used to detect the fire in forests using sensors. Algorithm uses YCbCr colour space because it is shows much difference between luminance from chrominance and also separates high temperature [11].

Advantage

I. No need for complicated gas boards and specialized devices or connect the network to databases and applying complicated models to detect fires. Only simple cheap temperature sensor required on each node [12].
II. Helps in decision making by distinguishing between peaceful fire, fault alarms and potential danger require immediate reaction [13].
III. Low possibility of false alarms.
IV. Provide some information about the fire behaviour for fire fighters to help in team work organising [14].

Disadvantage

I. Sensitive to dust particles and insects, meaning that regular maintenance is needed [15].
II. Expensive to maintain.
III. Require more current to operate (they are typically wired to a 110-volt power source) [16].

1.2 | Discussion of Existing System

The sensor readings for each parameter are checked with a present threshold ratio and a ratio that is calculated continuously in the node in real time, and only the ratios that exceed the present ratio are sent from the sensor node to the base station for further analytical processing [17]. The network utilized for this transmission is in the architecture of tree topology considering facts such as low power consumption, reduced latency, less complexity, etc [18]. Cluster heads are used in this network to gather data from several sensor nodes and pass them on to the base station or the gateway node [19].

Disadvantage of existing system

I. Some times due to some glitches in the sensor, false alarms are triggered.
II. Viewer cannot have clear view of affected and unaffected region of forests.
III. Partial information is passed to viewer because of the smoke caused by smoke.

2 | Proposed System

Devices are placed in various places of forests. These devices sense the temperature, smoke, temperature digitally [20]. If the value of temperature is more than the usual temperature then the alarm is triggered and information is passed to manual monitors [21]. Affected and Unaffected areas of forest can be seen clearly through the YCbCr colour space technique and viewer can have clear picture of the affected areas and can easily differentiate the smoke fire and trees [22].

This section presents the proposed forest fire detection algorithm. It consists of the following main stages: the first step receives the input video from the input device; the second step applies Movement containing Region Detection based on Background (MRDB) subtraction; the third step converts the input image sequence from RGB to YCbCr colour space; and the fourth step applies the fire detection rules, and

temporal variation. A fire alarm is activated if all detection conditions are satisfied [23]. The proposed algorithm stages will be described in detail. *Fig. 1.* shows the proposed algorithm flowchart.

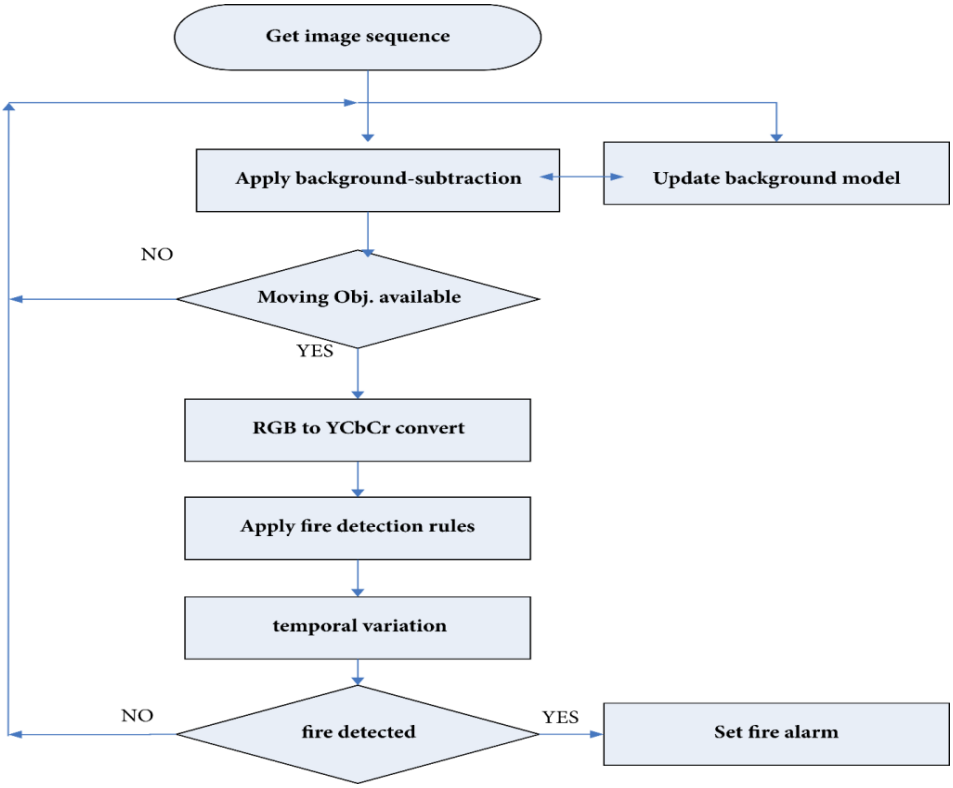

Fig. 1. Flow chart of algorithm for forest fire identification.

MRDB

Detecting moving regions is a key factor in most of the video based fire detection systems because fire boundaries continuously fluctuate. So background subtraction is used to select candidate regions of fire. A pixel located at (x, y) is supposed to be moving if the following condition is satisfied using *Eq. (1)*:

$$\left|I_n\ x,y) - B_n\ x,y)\right| > \text{thr}. \tag{1}$$

I(x, y) represents the intensity value of the pixel at location (x, y) in the nth gray-level for the current frame and Bn (x, y) represent the background intensity value at the same pixel location, and *"*thr*"* is a threshold value experimentally set to 3. The background is continuously updated using *Eq. (2)*:

$$B_{n+1}\ i,j) = \begin{cases} B_n\ x,y) + 1, & \text{if} I_n\ x,y) > B_n\ x,y), \\ B_n\ x,y) - 1, & \text{if} I_n\ x,y) < B_n\ x,y), \\ B_n\ x,y), & \text{if} I_n\ x,y) = B_n\ x,y). \end{cases} \tag{2}$$

Then Converting RGB Images to YCbCr

Due to the fact that different kinds of moving objects can be included after applying background subtraction, such as trees, animals, birds, and people, therefore images from the background subtraction stage are converted to YCbCr. Then fire color pixel detection rules are applied. The proposed intelligent system for effective detection of forest fires is presented in this section. The spatial data collected from forest regions are utilized by the presented intelligent system. With the aid of the images in the spatial data, forest fire detection is performed.

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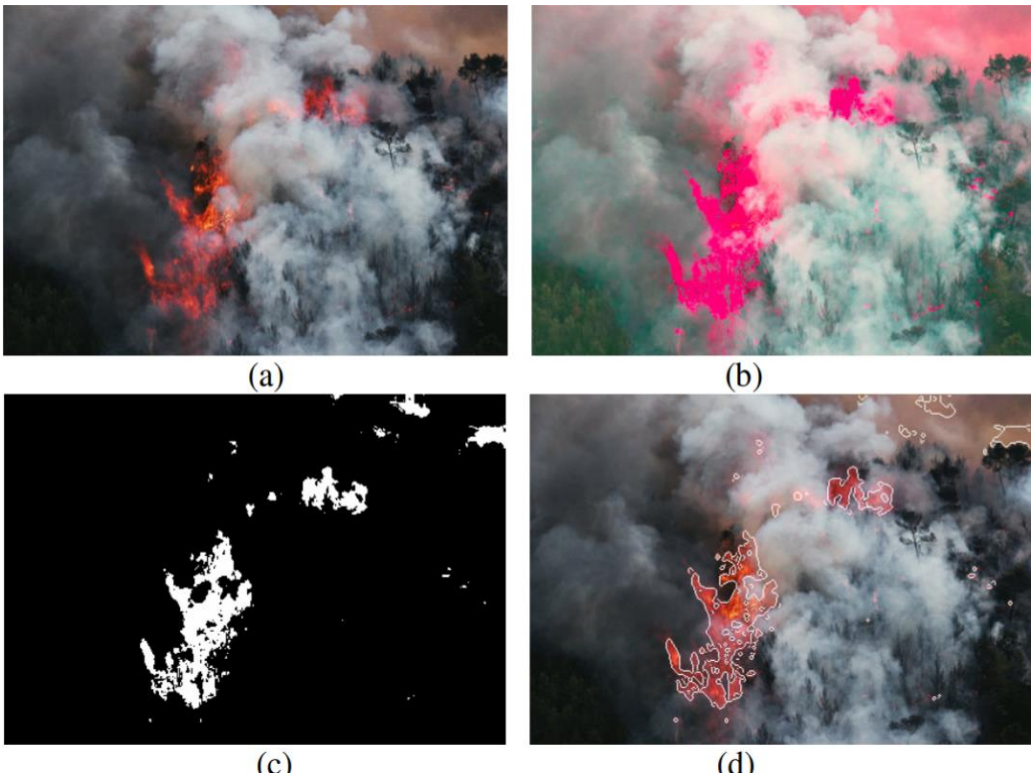

Fig. 2. Base classification for colour identification.

The radial basis function neural network is employed in the design of the presented intelligent system. The images in the forest spatial data with the presence of fires are employed in training the radial basis function neural network. Initially, the images with the presence of fires are converted from RGB to XYZ color space. Afterwards, the XYZ color space converted image is segmented using anisotropic diffusion segmentation, which locates the regions of fire. The regions of fire obtained using the segmentation is utilized in training the radial basis function neural network. The radial basis function neural network is trained with the XYZ color space values of the pixels that belong to fire regions. With the help of the trained neural network, we can effectively. Detect the presence of forest fires in an image. The presence of forest fire in an image is detected using the following steps. Initially the image is converted from RGB to XYZ color space. Then, the color space converted image is segmented using anisotropic diffusion segmentation. Subsequently, the XYZ color space values of pixels in the segmented regions are fed as input to the trained neural network for detecting the presence of fires. The designed intelligent system will aid the people in surveillance to detect forest fires and to take appropriate actions.

2.1 | Result and Discussion

The presence of fires is detected effectively by the presented intelligent system with the aid of the trained neural network. The intermediate results of the presented system are depicted in *Fig. 2*. From the results we can conclude that the presented intelligent system can be used for effectively detecting forest fires in the spatial data using artificial intelligence techniques.

3 | Conclusion

In this paper, we have presented an intelligent system for effective forest fire detection using spatial data. The proposed system made use of image processing and artificial intelligence techniques. The images in the spatial data, obtained from remote sensing, have been utilized by the presented system for the detection of forest fires. The color space conversion, anisotropic diffusion segmentation and radial basis function neural networks have been employed in the presented intelligent system. The experimental results have demonstrated the effectiveness of the proposed intelligent system in detecting forest fires using spatial data.

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