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Forest Fire Detection Using Wireless Sensors and Networks

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Abstract

Wireless sensor network technologies normally deploy a large number of small, low cost sensors, fairly densely that can observe and influence the physical world around them by gathering physical information, transform it into electrical signals, send it to a remote location to do some analysis and deploy the results in different applications. This means there is no need to build towers or set up complicated communication links such as; microwave and satellite. It can be deployed anywhere, even in inaccessible places. This technology can provide a real time monitoring for forest fire, where it can provide information at the ignition instance or at very small delay, depends on the node used wake up/sleep schedule. It's more reliable because it can influence the world in the surrounded area, if it is used in appropriate methods, rather than expecting events over large distances and long delay like other satellite and camera towers techniques. In this work, all nodes only use temperature sensors and they are programmed on a certain threshold temperature, above it the node will send an alarm message to the sink. This concept relies solely on the node behavior to alert of crises possibility using simple node components to provide detection and information on whether this is a peaceful fire, or the beginning of wild fire. The key in this method is to make decisions by tracking the fire propagation and check the logic behind it.

Keywords: Object detection model, Deep learning, Python.

1 | Introduction

Forests are part of the important resources for human survival and social development that protect the balance of the earth ecosystem. However, because of some uncontrolled anthropological activities and irregular natural conditions, forest fires happen frequently [1]. These fires are the most uncontrollable disasters to forest resources and the human environment condition. In this scenario, the frequency of forest fires has increased considerably due to climate change, human activities and other factors [2]. The detection and monitoring of forest fires has become a global concern in forest fire prevention organizations [3]. Currently, forest fire detection methods largely consist of vigils, observation from watch towers and lately satellite monitoring. Although observation from watch towers is easy and realizable, it has several obstructions. In the first place, this method needs many financial and material resources and a up skill labor force [4]. Second, many problems with fire protection manpower abound, such as inattentiveness, absence from the post, lack of ability for real-time monitoring and the limited area [5].

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For example, a satellite monitoring system has a long scanning cycle and the resolution of its saturated pixel dots of images is low. Another problem is cloud layers may mask images during the scanning period and the real-time mathematical quantification of fire parameters is very difficult to achieve [6]. Given these shortcomings of traditional monitoring, we suggest the ZigBee wireless sensor network technology and explain its application as a monitoring system [7]. This system can monitor real-time related parameters, e.g., temperature, relative humidity, and send the data immediately to the computer of the monitoring center. The collected data will be analyzed and managed by the computer [8]. Compared with the normal baroscopic information and basic forest resource data, the system can make an immediate assessment of a potential fire danger. The analytical results will then be sent to the relevant department as the policy-making basis by which the department will make the decision of firefighting or fire prevention [9].

2 | Forest Fire Detection Method from Literature Review

The most frequently used fire detection and suppression techniques employed by authorities can be summarized as follows [10]:

I. Controlled burning.
II. Fire weather forecasts and estimates of fuel and moisture.
III. Watch towers.
IV. Optical smoke detection.
V. Lightning detectors which detect the coordinates of the strike.
VI. Infrared.
VII. Spotter planes.
VIII. Water tankers.
IX. Mobile/smart phone calls becoming increasingly common for detecting fires early.
X. Education through fire watch or similar schemes for house owners.

2.1 | Detection and Monitoring Systems Are Divided into the Following Two Basic Groups

Volunteer reporting: public reporting of fires, public aircraft, and ground based field staff [11].

Operational detection systems: fire towers, aerial patrols, electronic lightning detectors, and automatic detection systems [12].

Some of the techniques used in fire suppression include burning dry areas under the management of fire fighters rather than having a crisis later or using flying water tankers like in Canada. Interestingly, others sweep away everything within a planned wide line to surround the fire with a dead end of unfuelled areas like in the Middle East. In some parts of Australia, providing the fire does not harm any humans or properties, it is left to burn, until it dies alone [13].

3 | Proposed System

The presences of fire in video streams are indicated by semantic events. Most of the existing systems can only be used for the videos obtained from stationary cameras and videos obtained from the controlled lightening conditions [14]. These existing automatic fire detection systems cannot be used for video streams obtained from mobile phones or any hand held devices. The KILLFIRE method is proposed to overcome these limitations [15].

The KILLFIRE method works on three sections:

I. To improve the accuracy, the fire-like pixel detector colour model is used [16].

II. To avoid the problem occurring in stationary videos, the new technique of motion compensation is used [17].
III. To identify and segment the fire in video streams, the segmentation method is used. The KILLFIRE is implemented over the two video set with different characteristics [18].

3.1 | Requirement of the System

Existing systems uses electronic sensors to detect fire or smoke. The change in temperature indicates the presence of fire or smoke in a region which can be detected by the sensors using radiation heat [19]. As forests are in a remote location, installation and maintenance of sensors over large area is difficult. So the sensors cannot be used to deploy over large area such as forests, petrochemical plant, and saw mills etc. [20]. The other consequence is, the sensor would detect heat or smoke only when it reaches nearer. Nowadays, the vision based fire detection technique is used widely to detect fires [21]. Along with the surveillance systems the vision based fire detection technique can be incorporated at relatively low additional cost [22]. The advantages of vision based fire detection techniques are listed here:

I. The fast response to fires.
II. The location of fire is sensed using this method not just the radiation.
III. The captured images can be analyzed and it can be used for future purposes and storage.
IV. It can be used for outdoor places which covers large area.

The components of KILLFIRE method are:

- *A colour spatial segmentation is used to pre-select the region that is expected as fire pixels.*
- *The extraction of sparse flow in the fire region and extraction of dense flow in the background is done by temporal segmentation [23].*
- *A global motion compensation using a block-based motion estimation.*
- *A SVM classification uses experimental motion patterns to classify the region is fire or not.*

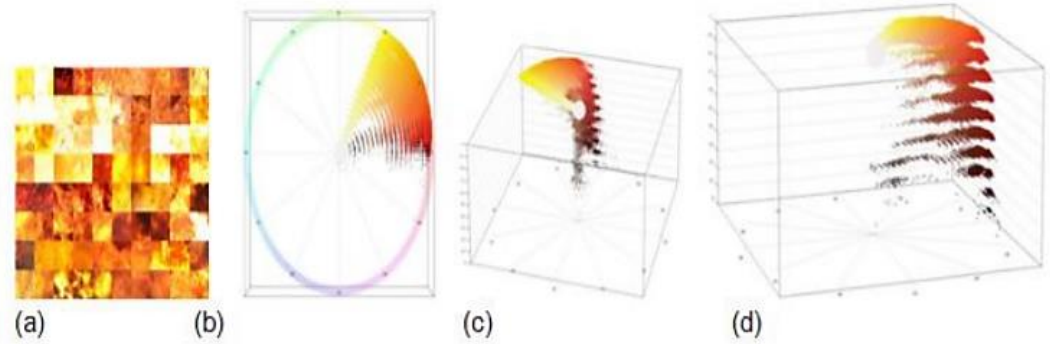

Fig. 1. Fire color pixels visualization on HSV color space.

3.2 | Discussion

Wildfires are high on the political agenda of all the main continents. There are key debates concerning prevention through reduction of forest fuel, managed burnings, and suppression by effectively putting out fires as they occur [12]. Coupled with climate change, resources over the last decade, mainly due to budget cuts and reorganization of departments, have been focused on "suppression" which in turn allows fuel levels to continue to increase, thus providing the basis for catastrophic fires to occur [13]. Through contacting a cross section of stake holders and influencers across Australia, Canada, USA, and Europe covering government, forestry management groups, fire chiefs, wild land fire research organizations, international trade association for wildfire, press/conference organizers, insurance trade associations catastrophic events, and sensor suppliers, it actually turned out that each country has many separate organizations, each of them responsible for a certain territory, with its own budget [14]. These authorities'

techniques are based on the probability of human observation or the forecast predictions for forest fires, but it is not a reliable solution that can stop this problem or reduce it [15]. They do not interfere with the fire as long as it does not pose a danger to humans or properties [16]. They believe if they received any warning from public figures, only then it might endanger human life; they do not consider the environmental impact as a priority [17].

4 | Conclusion

The proposed KILLFIRE method uses spatial segmentation and motion flow estimations to detect fire from moving videos. By the use of motion compensation techniques, high accuracy is achieved in the results [18]. The temporal video segmentation adds the extra advantage in the proposed system which segments the fire regions. The proposed system is implemented with the real time datasets which signifies that the KILLFIRE method is more appropriate for real-time unconstrained motion videos.

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Wang | Big. Data. Comp. Vis. 2(3) (2022) 107-111

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