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FIRE DETECTION WITH SURVILENCE CAMERA USING DEEP LEARNING

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***Abstract*— In order to improve the accuracy of fifire identifification based on video in the Internet-of-Things environment, this article proposes a new fifire identifification algorithm by merging fifire segmentation and multifeature fusion of fifire. First, according to the relationship between R and Y channels, the improved YCbCr models are established for initial fifire segmentation under reflection and nonreflflection conditions, respectively. Second, an improved region growing algorithm is proposed for fifine fifire segmentation by making use of the relationship between the seed point and its adjacent points. Finally, the quantitative indicators of fifire identifification are given according to the variation coeffificient of fifire area, the dispersion of centroid, and the circularity. Extensive experiments were conducted, and the experimental results demonstrate that the proposed fifire detection method considerably outperforms the traditional methods on average in terms of three performance indexes: precision, recall, and *F*1-score.*Index Terms*— Fire detection, multifeature fusion, regional growth, YCbCr model.**

INTRODUCTION

Fire detection mainly makes use of the chemical, ionizing, or thermal sensor. One drawback of such fifire detectors is that they are expensive and not able to pinpoint the place of fifire formation. In recent years, with the popularization of smarter surveillance cameras in the fifield of real-time video analysis, i.e., objects detection [1] and object tracking [2], Manuscript received March 19, 2021; accepted April 4, 2021. Date of publication April 26, 2021; date of current version May 6, 2021. This work was supported in part by the Chongqing Technological Innovation and Application Development under Program cstc2019jscx-msxmX0051 and in part by the CRSRI Open Research Program under Program CKWV2019758/KY. The Associate Editor coordinating the review process was Dr. Lei Zhang. Xijiang Chen is with the School of Artifificial Intelligence, Wuchang University of Technology, Wuhan 430223, China, and also with the School of Safety Science and Emergency Management, Wuhan University of Technology, Wuhan 430070, China (e-mail: cxj_0421@163.com). Qing An is with the School of Artifificial Intelligence, Wuchang University of Technology, Wuhan 430223, China (e-mail: 490756729@qq.com). Kegen Yu is with the School of Environment Science and Spatial Informatics, China University of Mining and Technology, Xuzhou 221116, China (e-mail: kegen.yu@cumt.edu.cn). Ya Ban is with the Chongqing Academy of Metrology and Quality Inspection, Chongqing 401121, China (e-mail: 573469578@qq.com). Digital Object Identififier 10.1109/TIM.2021.3075380 many scholars investigated the use of video camera images for fifire detection [3]. The shape of the fifire and the rate of fifire spread c/an be obtained by using the cameras distributed at ground stations or mounted on unmanned aerial systems (UASs) [4]. Literature [5]

introduced several fifire detection methods, mainly based on color detection and moving object detection. The color-based fifire detection is the most popular detection technique, including the algorithms based on color spaces [6], [7], HSV [8], $L*a*b$ [9], YUV [10], and YCbCr [11]. The shortcoming of this method is that it can be easily affected by the fifire-like objects. Due to the moving characteristic of the fifire, the moving object detection is also used in the fifire detection, including background subtraction method [12], [13], optical flflow analysis method [14], and temporal differencing method [15]. The foreground information is extracted using an adaptive background subtraction algorithm, which is then verifified using a statistical fifire color model. For the background subtraction method, the Gaussian mixture model was often used to perform the background modeling [16]. However, the background subtraction method requires the contrast between the background and the moving object to be greater than a certain threshold. The optical flflow analysis and the temporal differencing method can only detect the dynamic fifire under the ideal condition. Even when the object does not move, the optical flflow can be detected when the external light changes, and then, the object will be detected as fifire. Also, the dynamic fifire cannot be detected when lacking suffificient gray gradient variation area. In addition, there are many dynamic fifire-like objects in outdoor scene, so they are not suitable for outdoor fifire detection. The flflame flflickering of uncontrolled fifire can be used to distinguish the fifire from ordinary objects according to the variation characteristics of flflame flflicker [13]. A lot of smoke will be produced in the presence of fifire, so the fifire can be detected through analysis of the temporal behavior of smoke by the wavelet domain energy [17]. However, this approach cannot distinguish objects that appear gray in color from smoke or provide objective experimental results in dynamic fifire situations. Meanwhile, if the fifire does not produce a lot of smoke, the method cannot accurately detect it.

OBJECTIVE

Classification and detection of objects have been the state-of-art approach for many areas in computervision. In the domain of video surveillance classification of objects have been a majorbreakthrough.The proposed system is able to detect fire and showed that the fire detection performance was greatly improved with higher accuracy and robustness. Our project is detection of flames in a video by using CNN - YOLO technique. This is an improved method over all the existing ones. This method detects the edges of the flames properly by removing the noises in the flames. This paper focus is on identifying gray cycle pixels for the detection of flame. Its optimizing technique to detection of the flame, which generated because of spreading of fire pixel and the area spread of flame. These systems can be used to reduce false detection fire.

LITERATURE SURVEY

1. Title : Experimental Study on Kitchen Fire Accidents in Different Scenarios Author : Xiaoyuan Xu; Pengfei Wang; Nianhao Yu; Hongya Zhu Year : 2019

Abstract:In this paper, a real-sized fire test platform for home kitchen is built, and oil pan fire, kitchen flue fire and cabinet fire tests are carried out on this platform. The evolution characteristics of different fire accidents in home kitchen are studied through the change and development of temperature, smoke and fire situation. The following conclusions are drawn from the experiment: the time of igniting 0.5L, 1.0L and 2.5L cooking oil by using gas stove fire is 200, 480 and 742s, respectively.

2. Title : Using Popular Object Detection Methods for Real Time Forest Fire Detection Author : Shixiao Wu; Libing Zhang Year : 2018

Abstract:In this paper, we focus on three problems that surrounded forest fire detection, real-time, early fire detection, and false detection. For the first time, we use

classical objective detection methods to detect forest fire: Faster R-CNN, YOLO (tiny-yolo-voc, tiny-yolo-voc 1, yolo-voc.2.0, and YOLOv3), and SSD, among them SSD has better real-time property, higher detection accuracy and early fire detection ability. We make the fire and smoke benchmark, utilize the new added smoke class and fire area changes to minimize the wrong detection.

3. Title :The Application of Water Mist Fire Extinguishing System in Bus Author : Shuchao Li; Dongxing Yu; Zongyu Ling; Wei Ding Year : 2019

Abstract:Based on the characteristics of bus fire, the applicability of water mist extinguishing bus fire was analyzed. The structures of self-contained water mist fire extinguishing system and pump supplied system were summarized. Taking a 12-meter bus as an example, the application of pump supplied water mist fire extinguishing system using in bus cabin was introduced in detail. The fire extinguishing efficiency of water mist using in buses was verified by full scale fire test. The flame was extinguished 11 seconds after the system started and the average temperature of cabin was 39.9° 58 seconds later. Technical guidance for the application and design of water mist system using in bus is provided in this paper.

4. Title :Research on Image Fire Detection Based on Support Vector Machine Author : Ke Chen; Yanying Cheng; Hui Bai; Chunjie Mou; Yuchun Zhang Year : 2019

Abstract:In order to detect and alarm early fire timely and effectively, traditional temperature and smoke fire detectors are vulnerable to environmental factors such as the height of monitoring space, air velocity, dust. An image fire detection algorithm based on support vector machine is proposed by studying the features of fire in digital image. Firstly, the motion region is extracted by the inter-frame difference method and regarded as the Suspected fire area. Then, the uniform size is sampled again.

5. Title :Study of Diesel Residues from Fire Debris in a Bus Arson Experiment Author : Yi Zhang; Xinghua Zhu; Changzheng Zhao; Bo Peng; Shiqun Yang; Letao Xie Year : 2019

Abstract:In suspicious bus arson cases, what is important to evaluate the fire behavior and conduct fire investigations is to simulate bus arson and perform chemical analysis on ignitable liquids in fire debris. In this study, a bus fire test has been carried out to investigate the effect of diesel on the development of a bus fire and to ensure the suitability of analytical methods. The commercial bus was equipped with several rows of foam seats, and the diesel was applied under one of the seats. The fire growth and the heat release process were determined during the experiment.

6. Title :A Comprehensive Study on Fire Detection Author : Sneha Wilson; Shyni P Varghese; G A Nikhil; I Manolekshmi; P G Raji Year : 2018

Abstract:Accidents due to undetected afire have caused the great cost to the world. The need for efficient fire detection system is rising. Existing fire, smoke detectors are failing because of the inefficiency of the system. A vision based system with the video surveillance fire detection system is proposed to have high detection rate and low fault alert rate. Real-time fire detection is achieved by analyzing live camera footage. The fire flame features are studied and using edge detection, thresholding methods fire is detected, thus establishing a fire detection model. It uses color, motion, shape, and texture of the fire to detect hazardous fire. Color models like HSV, YCbCr are used in the system for more effective detection. It can be used for both indoor and outdoor scenes.

7. Title :Prototype of fire symptom detection system Author :Oxsy Giandi; Riyanarto Sarno Year : 2018

Abstract:One of smart home function is fire alert detection. The symptom detection of fire in the house is important action to prevent the mass fire and save many things. This research applies the new system of fire detection using gas leak concentration to predict the explosion and fire earlier called fire predictor and the fire appearance detector. The fire predictor just show the gas leak concentration and make an alarm rang. The fire detector use fuzzy system to make the fire detector classification. The output simulation system can send the data to MFC, but the MFC reader cannot parse it in real time.

8. Title :Fire Smoke Detection Based on Contextual Object Detection Author :Xuan Zhaa; Hang Ji; Dengyin Zhang; Huanhuan Bao Year : 2018

Abstract:Smoke detection based on automatic visual system has been applied to fire alarm in open spaces where traditional smoke detection system is not suitable for it. However, detecting the course of smoke posed great challenges for both systems. To address this problem, we propose a new method that combines context-aware framework with automatic visual smoke detection. The strategy is evaluated on dataset and the results demonstrate the effectiveness of the proposed method.

9. Title : A new fire detection method based on the centroid variety of consecutive frames Author :Shi Lei; Shi Fangfei; Wang Teng; Bu Leping; Hou Xinguo Year : 2018

Abstract:In the field of video fire detection, traditional fire color models have the poor adaptability and week robustness to interference. Therefore, a new fire detection method referring to the centroid variety of fire in consecutive frames is proposed in this paper. Firstly, the areas similar to fire are detected out through RGB-HIS color model. Then, the centroid movement of these areas are calculated with video tracking algorithm and a new fire detection model is proposed. A series of experiment results show that the proposed method can eliminate the influence of common interferences and prompt the fire warning correctly, which has a certain practical significance for indoor fire detection.

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EXISTING SYSTEM

- Fire detection is crucial task for the safety of people. To prevent damages caused by fire, several fire detection systems were developed. One can find different technical solutions.
- Most of them are based on sensors, which is also generally limited to indoors. However, those methods have a fatal flaw where they will only work on reaching a certain condition.
- In the worst-case scenario, the sensors are damaged or not being configured properly can cause heavy casualty in case of real fire.
- Those sensors detect the particles produced by smoke and fire by ionization, which requires a close

proximity to the fire. Consequently, they cannot be used for covering large area.

PROPOSED SYSTEM

• Due to rapid developments in digital cameras and video processing techniques, there is a significant tendency to switch to traditional fire detection methods with computer vision based systems.

• Video-based fire detection techniques are well suited for detecting fire in large and open spaces.Nowadays, closed circuit television surveillance systems are installed in most of the places monitoring indoors and outdoors. Under this circumstance, it would be an advantage to develop a video-based fire detection system, which could use these existing surveillance cameras without spending any extra cost.

• This system proposed the intelligent feature map selection algorithm is proposed for choose appropriate feature maps from the convolutional layers of the trained CNN, which are sensitive to fire regions.These feature maps allow a more accurate segmentation of fire compared to other handcrafted methods.

CNN ALGORITHM:

In purely mathematical terms, convolution is a function derived from two given functions by integration which expresses how the shape of one is modified by the other. That can sound baffling as it is, but to make matters worse, we can take a look at the convolution formula:

Feature Extractions: Feature Extraction aims to reduce the number of features in a dataset by creating new features from the existing ones (and then discarding the original features). These new reduced set of features should then be able to summarize most of the information contained in the original set of features. This depends on the classification. It will detect the features in the image and classify the image accordingly.

Model Creation - It is an iterative phase where a data are continually train and test using machine learning algorithms to create a models to discover the best one for the
given task.

Classification: Once the image is classified, it will assign the image to a specific category. Post Processing: This is the place where the machine will decide if there are any other processing needed. Thereafter, the final result is displayed.

REQUIREMENT SPECIFICATION

HARDWARE REQUIREMENTS

The most common set of requirements defined by any operating system or software application is the physical computer resources, also known as hardware. The minimal hardware requirements are as follows,

1. Processor : Pentium IV
2. RAM : 8 GB
3. Processor : 2.4 GHz
4. Main Memory : 8GB RAM
5. Hard Disk Drive : 1tb
6. Keyboard : 104 Keys

SOFTWARE REQUIREMENTS

Software requirements deals with defining resource requirements and prerequisites that needs to be installed on a computer to provide functioning of an application. The minimal software requirements are as follows,

1. Front end : python
2. Dataset : csv
3. IDE : anaconda
4. Operating System : Windows 10

MODULES

- Data Collection
- Data preprocessing
- Segmentation
- Feature Extractions
- Classification
- Post Processing

Data Collection - Collect fire image data from internet, mobile or from website. Quantity and auality of the data will define the final output.

Data preprocessing - Data preprocessing is the process of cleaning and converting raw data into a useable format. It is the process of cleaning the data, selecting the variable to use, and transforming the data in a proper format to make it more suitable for analysis.

Feature Extractions: Feature Extraction aims to reduce the number of features in a dataset by creating new features from the existing ones (and then discarding the original features). These new reduced set of features should then be able to summarize most of the information contained in the original set of features. This depends on the classification. It will detect the features in the image and classify the image accordingly.

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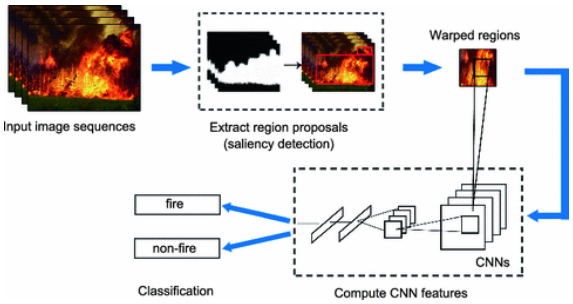
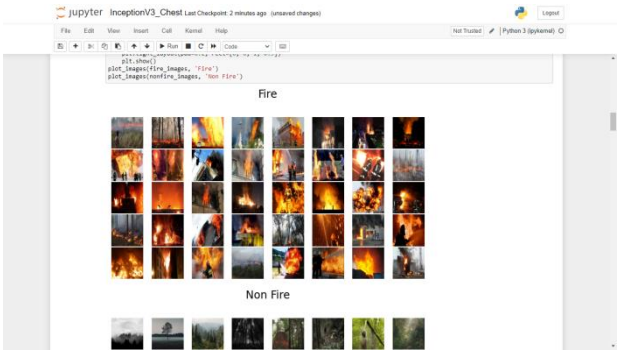
ARCHITECTURE :



SCREENSHOT:



CONCLUSION:

Fire is the most dangerous abnormal event, as failing to control it at an early stage can result in huge disasters leading to human, ecological and economic losses. Fire accidents can be detected using the cameras. So that, here we proposed a CNN approach for fire detection using cameras. Our approach can identify the fire under the camera surveillance. Furthermore, our proposed system balances the accuracy of fire

detection and the size of the model using fine-tuning of datasets. We have obtained an accuracy of 94%. Also the F-measure value is 0.95. These values shows that the model gives a better prediction. We conduct experiments using datasets collected from recording of fire and verified it to our proposed system. In view of the CNN model's reasonable accuracy for fire detection, its size, and the rate of false alarms, the system can be helpful to disaster management teams in controlling fire disasters in a short time. Thus, avoiding huge losses. This work mainly focuses on the detection of fire scenes under observation. Future studies may focus on deploying the model into raspberry pi and using necessary support packages to detect the real time fire by making challenging and specific scene understanding datasets for fire detection methods and detailed experiments.

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