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FOREST FIRE DETECTION USING CONVOLUTIONAL NEURAL NETWORK AND YOLO MODEL

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A B S T R A C T

From sprawling urbans to dense jungles, fire accidents pose a major threat to the world. These could be prevented by deploying fire detection systems, but the prohibitive cost, false alarms, need for dedicated infrastructure, and the overall lack of robustness of the present hardware and software-based detection systems have served as roadblocks in this direction. In this work, we endeavor to make a stride towards detection of fire in videos using Deep learning. Deep learning is an emerging concept based on artificial neural networks and has achieved exceptional resultsin various fields including computer vision. We plan to overcome the shortcomings of the present systems and provide an accurate and precise system to detect fires as early as possible and capable of working in various environments thereby saving innumerable lives and resources. We proposed a fire detection algorithm using Convolutional Neural Networks using YOLO model to achieve high-accuracy fire image detection, which is compatible in detection of fire by training with datasets.

Keywords: Image Captioning, Convolutional Neural Networks, LSTMs, Deep Learning, Computer Vision, Natural Language Processing, MSCOCO Dataset, Data Pre-processing, Model Architecture, Training, Evaluation Metrics, Encoder-Decoder, Cross-Entropy Loss, Metric-Based Evaluation, BLEU, METEOR, CIDEr, ROUGE, Multimodal AI, Visual Understanding, Image Description, Machine Learning, Deep Neural Networks

1.Introduction

In warehouses, a surveillance network consisting of cameras exist due to security and insurance needs. Warehouses usually also contain an expensive hazard detection system consisting of fire detection and smoke detection devices. These devices may or may not be too reliable in case of a fire. Also, these devices cause plenty of false alarms due to cigarette smoke or incense smoke etc. This led us to developing an algorithm which could be using the already existing surveillance system so as to detect fire from a live video feed by processing it. This also reduces the cost of purchase and maintenance of the expensive and unreliable fire detection systems. Firstly, the image frame is acquired from the live video feed. The RGB color model is then applied to the frame. The resultant RGB frame is then converted to a HSV frame. This frame is then passed through thresholding, median blurring (to remove noise), Background Subtraction, Sobel edge detection, and motion detection windows. The resultants of all these are then combined using Bitwise AND operation. Segmentation techniques are applied on this resultant to produce the final result, i.e. detection of the absence or presence of fire in the frame. A suitable response is displayed on the window monitor, and an alarm buzzer is sounded.

1.1 Machine Learning

Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. Machine learning focuses on the development of computer programs that can access data and use it learn for themselves. The process of learning begins with observations or data, such as examples, direct experience, or instruction, in order to look for patterns in data and make better decisions in the future based on the examples that we provide. The primary aim is to allow the computers learn automatically without human intervention or assistance and adjust actions accordingly.

Machine Learning Methods

Machine learning algorithms are often categorized as supervised or unsupervised. **Supervised machine learning algorithms** can apply what has been learned in the past to new data using labeled examples to predict future events. Starting from the analysis of a known training dataset, the learning algorithm produces an inferredfunction to make predictions about the output values. The system is able to provide targets for any new input after sufficient training. The learning algorithm can also compare its output with the correct, intended output and find errors in order to modify the model accordingly.

In contrast, **unsupervised machine learning algorithms** are used when the information used to train is neither classified nor labeled. Unsupervised learning studies how systems can infer a function to describe a hidden structure from unlabeled data. The system doesn't figure out the right output, but it explores the data and can draw inferences from datasets to describe hidden structures from unlabeled data.

Semi-supervised machine learning algorithms fall somewhere in between supervised and unsupervised learning, since they use both labeled and unlabeled data for training – typically a small amount of labeled dataand a large amount of unlabeled data. The systems that use this method are able to considerably improve learning accuracy. Usually, semi-supervised learning is chosen when the acquired labeled data requires skilled and relevant resources in order to train it / learn from it. Otherwise, acquiring unlabeled data generally doesn't require additional resources.

Reinforcement machine learning algorithms is a learning method that interacts with its environment by producing actions and discovers errors or rewards. Trial and error search and delayed reward are the most relevant characteristics of reinforcement learning. This method allows machines and software agents to automatically determine the ideal behavior within a specific context in order to maximize its performance. Simple reward feedback is required for the agent to learn which action is best; this is known as the reinforcement signal.

Advantages of Machine Learning

Machine Learning undoubtedly helps people to work more creatively and efficiently. Basically, you too can delegate quite complex or monotonous work to the computer through Machine Learning - starting with scanning, saving and filing paper documents such as invoices up to organizing and editing images.

In addition to these rather simple tasks, self-learning machines can also perform complex tasks. These include, for example, the recognition of error patterns. This is a major advantage, especially in areas such as the manufacturing industry: the industry relies on continuous and error-free production. While even experts often cannot be sure where and by which correlation a production error in a plant fleet arises, Machine Learning offers the possibility to identify the error early this saves down times and money. Self-learning programs are now also used in the medical field. In the future, after "consuming" huge amounts of data (medical publications, studies, etc.), apps will be able to warn a in case his doctor wants to prescribe a drug that he cannot tolerate. This "knowledge" also means that the app can propose alternative options which for example also take into account the genetic requirements of the respective patient.

2.Literature Survey

1. Title: Experimental Study on Kitchen Fire Accidents in Different Scenarios Author: XiaoyuanXu; 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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3.Existing System and Proposed System

3.1 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.

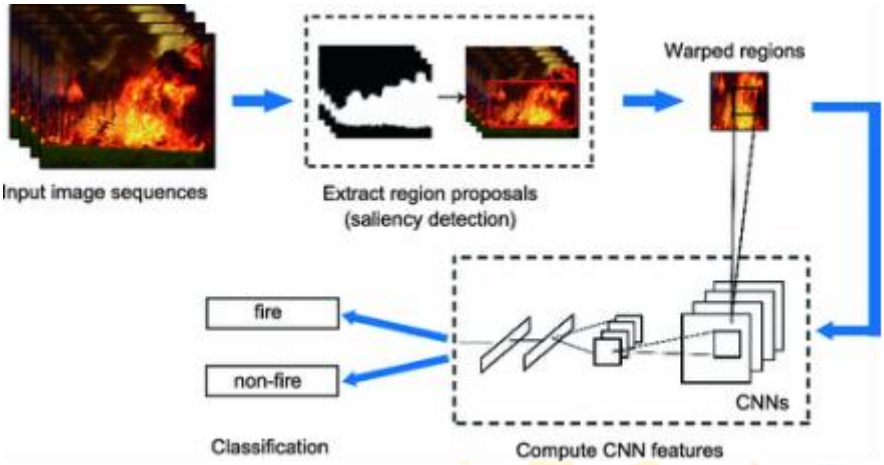
3.2 Proposed System

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.

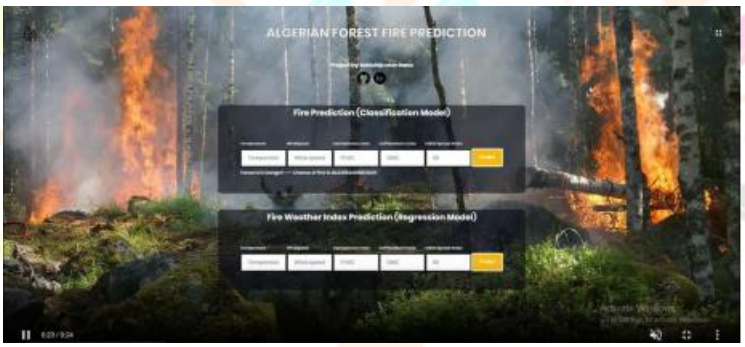
Video-based fire detection techniques are well suited for detecting fire in large and open spaces. Nowadays, closed circuit television surveillance systems are installed in most of the places monitoring indoors and outdoors. Under this circumstance, it would be an advantage to develop a video-based fire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

This system proposed the intelligent feature map selection algorithm is proposedfor choose appropriate feature maps from the convolutional layers of the trained CNN.

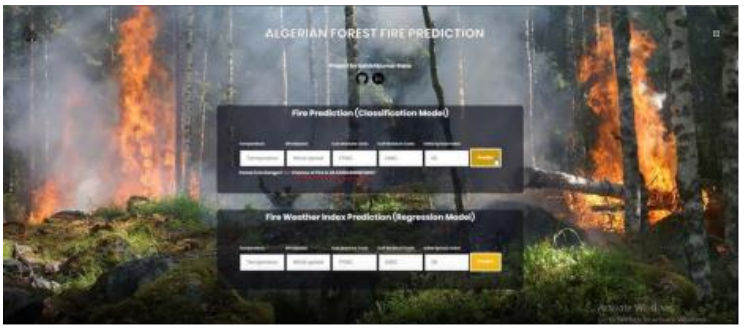
4 .Architecture



5.Result and AnalysisINPUT



OUTPUT



6.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.

REFERENCES

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

2. Using Popular Object Detection Methods for Real Time Forest Fire Detection, Shixiao Wu; LibingZhang, 2018

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