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CAMPUS FIRE DETECTION USING THERMAL CAMERA

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Abstract : In a fire, engineering , in a time of swift technological progress, it is more important than ever to improve safety protocols. The current project, "Fire Detection Using Thermal Camera," is an innovative investigation into state-of-the-art tools for fire detection early on. Conventional fire detection systems frequently depend on smoke or visual sensors, which can be insufficient in some difficult situations. By utilizing the sophisticated features of thermal cameras, this project seeks to transform fire detection and provide a more dependable and effective way to spot possible fire threats. techniques are crucial for putting out a fire before it reaches full development, but there is a catch: by the time the fire reaches this point, it has already started to spread or become more responsive. Thus, this study attempts to address this issue by using an image-based fire detection method. Detecting all possible flame and smoke in the very beginning stages of a fire is one of its main objectives to respond appropriately to one. Finding smoke in a fire is crucial, not just identifying the flames, especially since smoke generally causes more harm to people's health than flames do. These kinds of fires can produce smoke that is harmful to human health because it contains carbon monoxide, low oxygen content, and high temperatures.

INTRODUCTION

Thermal imagers can provide first responders with critical information to size up the fire incident, track fire growth, and to locate other first responders. While these devices represent a significant investment, typically on the order of $20k per camera, first responders have little guidance on instrument performance beyond manufacturer literature and recommendations from other users. Because thermal imager requirements vary depending on the application, these problems are made even more complex. While high contrast images might be adequate for fighting fires, sophisticated fire detection systems might need to gather quantitative information from infrared imagers. The end users might have very distinct thoughts about which imaging characteristics are most crucial.

There aren't any performance guidelines available now to help end users decide what to buy. The ability to detect heat signatures linked to fires is a unique advantage of thermal cameras, which are sensitive to infrared radiation. The goal of this project is to reduce response times and mitigate potential damage by optimizing the speed and accuracy of fire detection using thermal imaging technology. Because thermal cameras are used, the system can function well in a variety of situations where traditional methods might not be able to, such as low visibility, complete darkness, or environments with a lot of smoke.

LITERATURE SURVEY

1. Sreesruthi Ramasubramanian in "Fire Detection using AI for Fire-Detecting Robots' 'has said that Indoor environments employ fire-fighting robots to identify fire in firefighting robots . Using sensors has the drawback of not being able to detect fires over a specific distance. Techniques for artificial intelligence enable a wider range of fire detection. The machine learning algorithm known as the Haar Cascade Classifier was first applied to object detection. When multiple fires needed to be detected, the accuracy of the results produced by the Haar Cascade Classifier was particularly low.

2. Abolfazl Zargari Khuzani , Rakshit Agarwal, Najmeh Mashhadi ,suggested a real-time fire detection system that can be used to distinguish between video sequences with and without fire. The four steps that made up the suggested method were: (1) Creating three-second video clips out of video sequences.(2) Segmenting each frame's fire and fire-like areas using a color space

model . (3) Utilizing a feature extraction strategy to build a spatial and temporal frequency domain feature pool while taking motion and time variation into account.(4)Kernel-PCA shrinking the feature pool's size,(5)Sorting 411 video clips into categories that include fire and non-fire using a multi-layer neural network. The outcomes demonstrated that the suggested framework could produce accurate predictions with an acceptable false rate.

3. Aneesh R P, Jubeena B. Maheen, and Building automation systems frequently include camera surveillance systems, so OpenCV based systems for fire investigation are developing to integrate cameras. Blaze edge identification is the process of identifying the distance between a thermal response region. A unique method is suggested to use the color correlogram feature to separate the blaze zone from the video frame. Saliency-based features are also removed from this section. The feature vector is trained via the implementation of the color probability algorithm. The suggested system could test the Fire 2018 dataset and achieve 94.76% accuracy using the naive bayes classifier.

4. Jareerat Seebamrungsat, Panomkhawn Riyamongkol, and Spachai Praising. The study suggests an alarm system for fires that uses light analysis and detection. To distinguish orange, yellow, as well as high intensity light from backdrop and ambient light, this system makes use of HSV and YCbCr hue models under specific conditions. Frame differences are used to analyze and compute the growth of fire. HSV color model is used to detect color and brightness information. Because the YCbCr color model can distinguish images that are bright more effectively than other color models, it is employed to identify brightness-related data. The experiments have yielded results with an accuracy rate of over 90% overall.

PROPOSED SYSTEM

Designing a campus fire detection system using thermal cameras involves several key components and considerations to ensure effective detection and response to potential fire incidents. Here's a proposed system outline:

1. Deploy thermal cameras strategically across the campus to cover key areas prone to fire hazards such as laboratories, kitchens, electrical rooms, and other high-risk zones. Thermal cameras detect infrared radiation emitted by objects, allowing them to identify heat signatures associated with fires even in low-light conditions.

2. Determine optimal locations for installing thermal cameras based on the campus layout, building structures, and potential fire risks. Consider factors such as line of sight, coverage area, and obstacles that may obstruct the camera's view.

3. Integrate the thermal cameras with the campus fire alarm system to enable automatic triggering of alarms upon detection of fire or abnormal temperature increases. This integration facilitates quick response and evacuation procedures in the event of a fire emergency.

4. Implement image processing algorithms to analyze the thermal images captured by the cameras in real-time. These algorithms can detect patterns indicative of fire, such as rapid temperature rises, flame shapes, and smoke formations.

5. Upon detection of a potential fire hazard, activate the alarm system to alert occupants and relevant authorities immediately. Notifications can be sent via audible alarms, visual indicators, email alerts, and mobile notifications to ensure timely response and evacuation.

6. Enable remote monitoring and control capabilities to allow security personnel or designated administrators to access live camera feeds, monitor temperature fluctuations, and respond to emergencies from a centralized control center or mobile devices.

7. Integrate the fire detection system with the campus BMS to enable automated responses such as HVAC shutdown, door access control, and sprinkler activation in the affected areas to contain the fire and minimize damage.

8. to record historical temperature data, alarm events, and system performance metrics for analysis and audit purposes. Analyzing this data can help identify trends, assess system effectiveness, and improve fire prevention measures over time.

9. Ensure redundancy and reliability in the system design by incorporating backup power supplies, redundant data storage, and failover mechanisms to prevent system failures during critical situations.

10. Establish regular maintenance schedules and conduct periodic testing of the fire detection system to ensure all components are functioning correctly and meet regulatory standards for fire safety compliance.

By implementing these components and considerations, a campus fire detection system using thermal cameras can effectively enhance fire safety measures, minimize risks, and facilitate rapid response to fire emergencies on campus grounds. The below flowchart depicts the overall design of the proposed system.

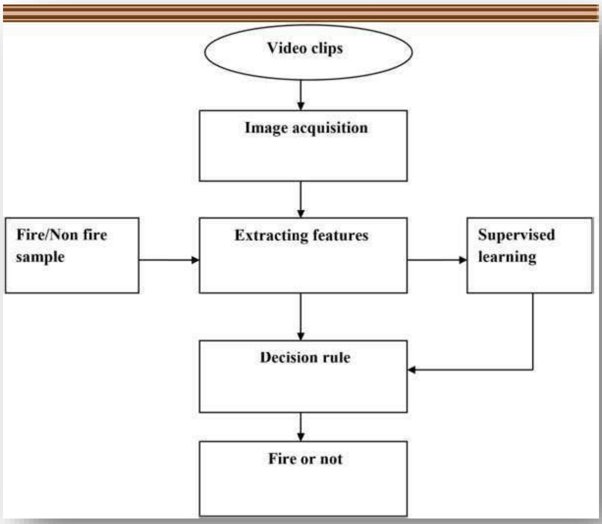

Fig. Proposed Methodology Implement data logging functionalities.

IMPLEMENTATION AND RESULT

The Campus Fire Detection using Thermal Camera is demonstrated on videos of controlled fire demonstrated to verify the working of our proposed model. Before we start implementing data feed to our model we start by labeling images. The labeling of images is done to get .xml files of the same name as the input images using the labeling package. In this package we get an interface where we can open our project's image directory where input images are stored. After opening the directory, we go for save directory i.e. where to save the resultant xml files (generally the same folder as the image directory). Now after making these minor changes, we go to View then select option Auto Save Mode to save the changes we are going to do in the labeling of images. To create a bounding box around the hand sign we use the key 'W' and then specify the object label with each bounding box.

After assigning labels to each image in the directory we get the .xml files clustered along with the source images. Now we just select a few images as a pair i.e. the image with its xml file and move them to the test and train folders respectively. We can decide on images to be kept in either of the folders for accuracy purposes. After assigning images to test and train folders respectively we run the configuration.

Step 1: Update the label map for all our assigned labels and a unique id is given to each of the labels.

Step 2: Define the TF records which are meant for running the scripts that will help the model to train.

Step 3: Download TF Models Pretrained from Tensorflow Model Zoo .

Step 4: Copy Model Config to Training Folder.

Step 5: Update Config for Transfer Learning.

Step 6: Train the model.

Step 7: Load Train Model from Checkpoint Step 8: Detect in Real-Time.

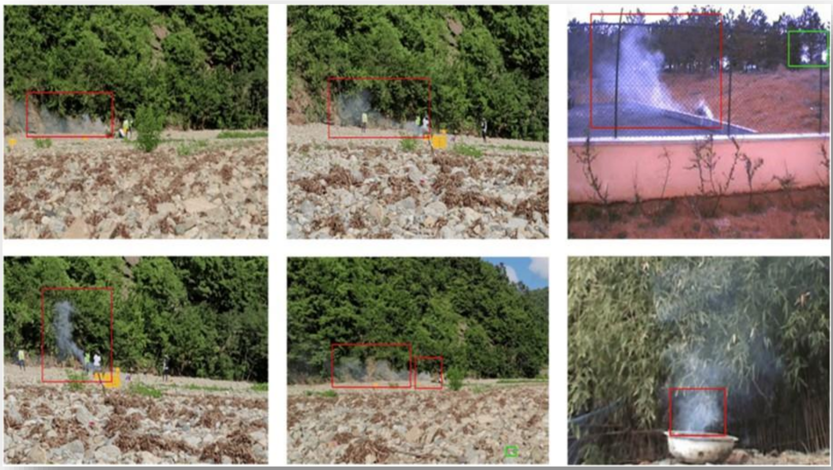

Fig. Output of our model

CONCLUSION

In conclusion, the implementation of a campus fire detection system using thermal cameras offers a proactive and efficient approach to enhance fire safety measures within educational institutions. By leveraging advanced thermal imaging technology, such a system serves as a proactive and effective means to mitigate fire risks, protect campus occupants, and safeguard valuable assets.

By implementing comprehensive monitoring, early detection, and rapid response capabilities, educational institutions can significantly enhance fire safety measures and foster a secure learning environment for students, faculty, and staff. It was established that the suggested model could greatly enhance the ability to detect various scaled flame images. According to the trained results, the suggested YOLOv4-F model had a consensus detection reliability of 6.11%, which was higher than that of the existing models.

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