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Computer Vision-Based Early Fire Detection Using Machine Learning

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Abstract - *The project aimed to detect fire by using the image processing technology will alert people by early detection of fire. The automatic fire alarm systems already existed the sensor method has limitations and designed to sense fire with the smoke, limited areas. To reduce limitations and to optimize with present technology, Computer Vision Based Early Fire Detection using machine learning is proposed. The implementation is done by using PyCharm IDE and primary or secondary camera is used. Webcam is taken as an input source, which captures the video feed from the surrounding and feeds into the system for analysis. The code is written in python language using the open CV2 library for image processing. The theoretical parts emphasize more in computer vision, machine learning, image processing, color model, and the working algorithm of the project to detect the fire. The project uses algorithms such as Morphological Transformation, Simple Thresholding and Image Processing which is used in the object detection through the image or video. Morphological transformation is used for the accuracy of detecting the fire. Simple Thresholding is used in the detection of intensity of the fire .The libraries and operators in OpenCV such as Matplot library is used to convert the color forms , comparison operators and bitwise operators are used to mask the layers of the fire.*

Key Words: Fire Detection, Image Processing, Color Model, Alarm, Notification Mail

1. INTRODUCTION

Computer Vision based fire detection using image processing has the potential to be useful in conditions in which conventional methods cannot be adopted. The fire detection algorithm uses visual characteristics of fires like brightness, color, spectral texture, spectral flicker, and edge trembling to discriminate them from other visible stimuli. There are various fire detection techniques such as infrared sensor, a thermal detector, smoke detector, flame detector, and optical smoke detector. These methods are not always reliable as they do not always detect the fire itself but detect one or more phenomena resulting from fire, such as smoke, heat, infrared, ultraviolet light radiation or gas, which could be produced in other ways and hence, produces many false alarms. By the help of computer vision and image processing techniques, it is possible to get better results than conventional systems because images can provide more reliable information.

2. LITERATURE SURVEY

This proposed system has gone through various references and research over different journals and conference papers that are evolved for the past 10 years. The research and referrals of survey is conducted on different domains like AI, NLP, Home environments that helped to develop the proposed system of AI based Control AAS.

Those references and the detailed report on the references are listed as follows.

1. KB Deve, GP Hancke and BJ Silva , (2016), "Design of a Smart Fire Detection System." The problem that was addressed by this work was to detect fires and reduce the occurrence of false positives in a kitchen environment.

2. Khan Muhammad, Jamil Ahmad, Zhihan ,Paolo Bellavist, Transactions on Systems, Man, and Cybernetics: "Systems Efficient Deep CNN-Based Fire Detection and Localization in Video Surveillance Applications." Their application in fire detection systems will substantially improve detection accuracy, which will eventually minimize fire disasters and reduce the ecological and social ramifications.

3. Avi Bar-Massada , Todd J. Hawbaker, Susan I. Stewart, and Volker C. Radeloff "Combining Satellite-Based Fire Observations and Ground-Based Lightning Detections to Identify Lightning Fires Across the Conterminous USA." The algorithm searches for spatiotemporal conjunctions of MODIS fire clusters and NLDN detected lightning strikes, given a spatiotemporal lag between lightning strike and fire ignition. The algorithm revealed distinctive spatial patterns of lightning fires in the conterminous US While a sensitivity analysis revealed that the algorithm is highly sensitive to the two thresholds that are used to determine conjunction.

4. Tian Qiu, Yong Yan, Gang Lu "An Auto adaptive Edge-Detection Algorithm for Flame and Fire Image Processing". The algorithm detects the coarse and superfluous edges in a flame/fire image first and then identifies the edges of the flame/fire and removes the irrelevant artifacts. The auto adaptive feature of the algorithm ensures that the primary symbolic flame/fire edges are identified for different scenarios. Experimental results for different flame images and video frames proved the effectiveness and robustness of the algorithm.

3. PROPOSED WORK

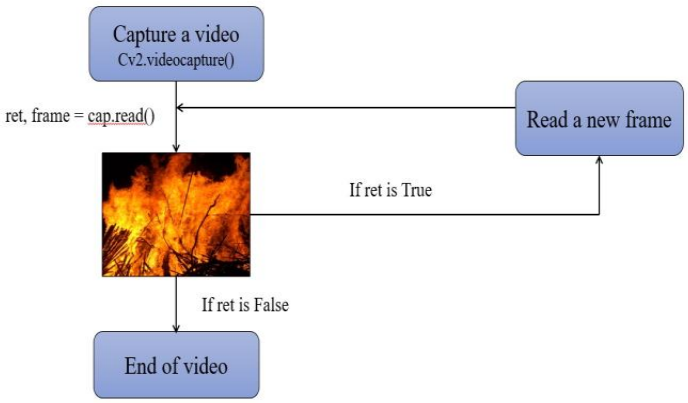
The proposed system is based on the Image Processing, Morphological Transformation, Simple Thresholding and OpenCV which is very popular in object detection through the image or any other video feeds.

The process is divided into 3 different phases which employs various algorithms and methods for implementation.

3.1 FIRE DETECTION MODULE

The procedure for detecting fire classifies images based on the value of simple features from an image. To detect the fire the image have to be converted to RGB. As the OpenCV as the ability to convert the image to BGR, Matplot library is used to convert the image to RGB. The flow of detection is shown in fig-2.1.The captured video is converted into 2D images using imshow module. The captured pixels are arranged in rows and columns. Then in order to convert the image to BGR the pixels are arranged in the x,y,z matrix. Then the matrix pixels are compared with each other and the layers are masked using bitwise_ AND. Using Morphological transformation the imperfections are corrected by the process of Dilation and Erosion. The Absolute difference of the color models are found. The Simple thresholding is applied to find the intensity.

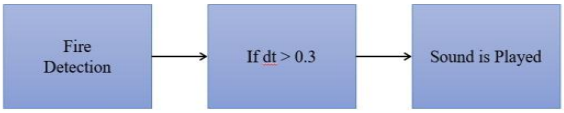
Fig-2.1: Flow of detection process



3.2 ALARM MODULE

A siren is a noisy noise-making device. Civil protection sirens Are established in constant places and used to warn of natural failures or attacks. If the hearth place is detected the alarm is performed and notifies the monitor. Putting ahead a while loop which takes the argument of the time, the consumer wants to set the alarm on and routinely breaks while the time is up, with sound refer fig-2.2.

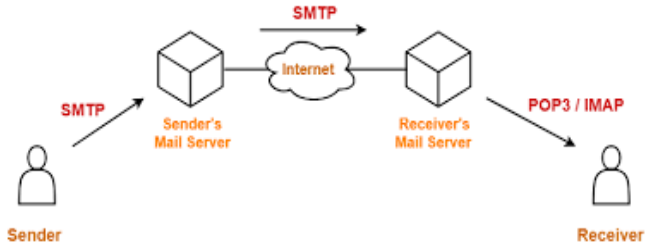
Fig-2.2: Alarm



3.3 NOTIFICATION MAIL

When you click on send, the message is transmitted from your laptop to the server related to the recipient's address. This procedure generally takes place thru numerous other Servers earlier than the message receives to its supposed recipient's mailbox. The flow of notification mail is shown in fig-2.3. Electronic mailboxes are imperative to how emails paintings for the end-user. The well-known protocol used for sending Internet e mail is referred to as SMTP (Simple Mail Transfer Protocol). The SMTP protocol is used to each send and acquire e-mail messages over the Internet. When a message is sent, the e-mail patron sends the message to the SMTP server.

Fig-2.3: Shows the flow of E-Mail

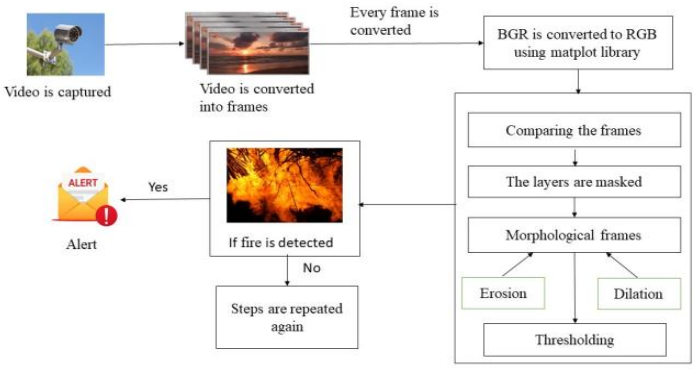


4. SYSTEM ARCHITECTURE

The first step is the surrounding cameras will capture the video in real time refer fig-3 for the flow of system architecture. Then in the next step the video is converted into frames and the frames are sent for conversion, each and every frames are converted into BGR using CV2. To convert into RGB Matplot library is used. Imshow module of Matplot library is used to convert the raw data's into 2D images. The Image Processing algorithms are used. And next step is comparison of the frames using CV comparison. Then the mask is layered using Bitwise_AND. The image is compared using the operators of CV2, i.e. source 1 is greater than source 2. The Morphological Transformation is used to remove the imperfections from the images. It is carried out by Erosion and Dilation. It adds or removes the pixels from object to boundaries. The removal and addition of pixels depends on the size of the Structuring Elements. The BGR is converted to YCR_CB, the Luma component and Blue-Red

difference of the chroma components. The frame is splitted as Y,C_r,C_b . After splitting the frames the mean of those elements is found. The Absolute difference between the pixels of two images are calculated. Simple Thresholding technique is also a Binary Thresholding. If the pixel intensity is greater than the set threshold, value set to 255, else set to zero (black). In the final step if the value of dt is greater than 0.3 then the fire is detected and if it is less than 0.2, then the fire is not detected. After the detection the mail is sent with an image with fire.

Fig-3: System Architecture



5. METHODOLOGY

5.1 DETECTION

The procedure for detecting fire classifies pics primarily based totally at the value of easy features from an picture. The frames are then converted into BGR using CV2 and with using Matplot library the image is converted into RGB. The detected fire images are stored in a folder and the fire images are sent via mail. Along with small steps, the box detects the features like edges, brightness level from the image of fire, and then data collected by pixels are put together, which helps to determine where the fire is located.

5.2 MATPLOT

OpenCV has the ability to change the image into BGR but to process the frames the image has to be converted into RGB. In order to work on the color models the Matplaot library is used. First of all the frames are converted to BGR. The BGR is then converted to YCR_CB, the luma component and the C_b,C_r are the blue-red difference of the chroma components. In the final stage the YCR_CB is converted to RGB. Comparing the source1 and source 2 of the images. If the source1 is greater than source2 then the operations are proceeded.

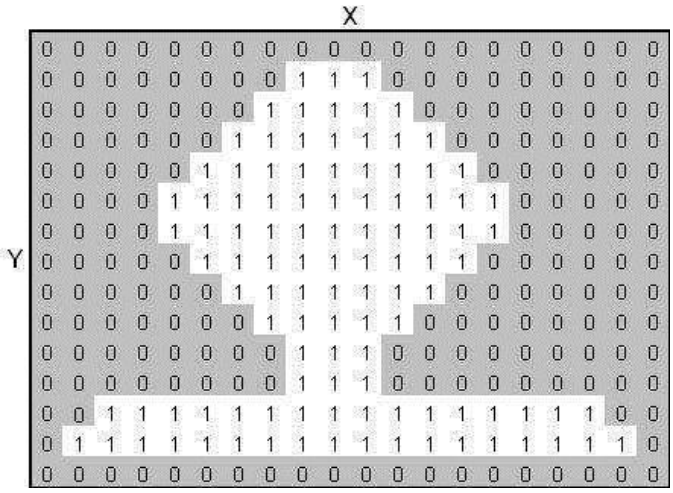
5.3 MASKING THE LAYERS

Masking means limiting a certain layer or adjustment is visible areas. A mask allows an image to adjust a certain portion of your image while leaving the rest completely aside. It is masking a brighter subject while leaving the background unedited. The bitwise_AND operator computes bitwise conjunction of the two arrays**.**

5.4 MORPHOLOGICAL TRANSFORMATION

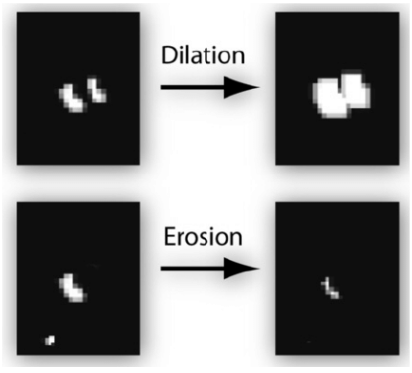
Morphological transformation is used to remove all the imperfections from the binary image. It helps to achieve the smoothness in the image. The two operations are Opening operation and Closing operations. Morphological transformation is shown in fig-4.1. The operations are carried away in two steps i.e. Erode and Dilation refer fig 4.2

Fig-4.1: Morphological Transformation



- ERODE: The Erode operation removes the pixels from the edge of the objects.
- DILATE: The Dilate operation adds extra pixels to the edges.

Fig-4.2: Erode and Dilate



5.5 THRESHOLDING

The basic thresholding is the technique is known as Binary thresholding. For every pixel, the same threshold value is applied. If the pixel value is smaller than the threshold it is set to zero, otherwise it is to the maximum value i.e. 255.

6. RESULTS

Fire is detected and the output is displayed in the application. The result is shown in fig-5

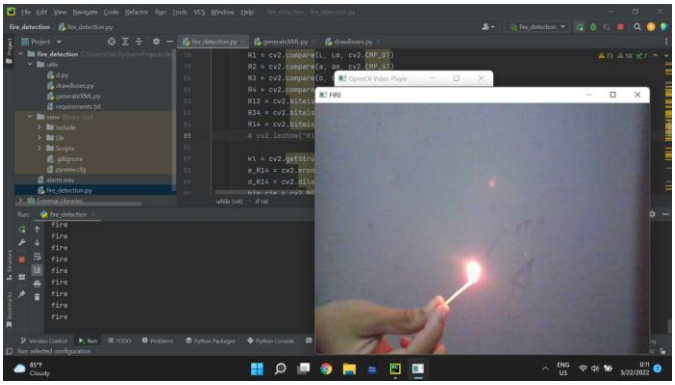


Fig-5: Fire is detected

7. CONCLUSIONS AND FUTURE ENHANCEMENT

The project aimed to detect fire with a different approach rather than using an existing system. As technology is getting better and better as to keep it up with the technology and to minimize the limitations also, the new system has created. By using image processing technology for detecting the fire, these limitations can be reduced because in this system camera acts like a human eye, as it detects a fire, the video is captured, and the image is processed using the software alert user. It can be used everywhere e.g. Hospital, railway station, forest etc. The designed prototype successfully detects fire gives the review analysis, designing system, and algorithm, test, and result. Currently, we not used the systems like a smoke detector and sprinkler water discharge systems, but in future it can be included.

Quantitative evaluation to evaluate the overall performance of various strategies. We in comparison our technique with famous fire detection algorithms, which might be primarily based totally on YOLO networks and DL approaches. We used the consequences of their papers for comparison, however we aren't positive whether or not they're real due to the fact supply codes and datasets of those techniques aren't publicly to be had to test the actual overall performance. We computed metrics which includes F-measure (FM), precision, and consider, as in our in advance study. The FM rating is the weighted common that balances measurements among the manner of precision and consider rates. Hence, this rating considers each false positives and false negatives. Intuitively, it isn't always smooth to apprehend accuracy, however FM is greater not unusual place than accuracy. Accuracy works quality if false positives and false negatives have comparable charges. If the charges of false positives and false negatives are different, it's far higher to don't forget each precision and recall Precision is the ratio of correctly predicted positive observations to total predicted positive observations. Recall is the ratio o correctly predicted positive observations to all observations withinside the real class. The proposed technique's common of FM, consider, and precision became 98.9%. False detection took place in 1.1% of cases, attributable to the blurring of gadgets at night.

8. REFERENCES

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