ADAPTIVE EDGE DETECTION ALGORITHM FOR FLAME AND FIRE IMAGES

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ABSTRACT

Conventional fire detection systems are generally limited to indoors and they usually fail when detection in open area needed. A system that is able to detect fire by processing real-time video images would both work in open area and it doesn't need a high budget. It can also be used in accordance with surveillance cameras for better performance. This type of detection systems can provide improved detection and fewer false alarms since they detect the combustion itself instead of its byproducts. Additional descriptive information about fire location and size is possible, and these can be useful for preventing fire scattering efficiency and success of those methods. With increasing emphasis on security, the automated flame detection using edge analysis has extensive usage. In general, an algorithm of edge detection finds the sharp intensity variation of an image and in this way it obtains the edges of the objects contained on the image. Through the pictures obtained by the experiment, we can see very clearly that, compared to the traditional edge detection methods, the method proposed in this paper has a more obvious effect on edge detection.

1 INTRODUCTION

Automatic flame or fire detection systems play a major role in the early detection and response of an unexpected fire hazard. Most sensor based fire alarms are designed for indoor use and are not applicable in outdoor scenarios, forests and in large infrastructure settings such as aircraft hangers, large tunnels and exhibition building etc. The determination of flame or fire edges is the process of identifying a boundary between the area where there is thermo chemical reaction and those without. It is a pre-cursor to image-based flame monitoring, early fire detection, fire evaluation, and the determination of flame and fire parameters.

1.1 Fire & its properties

Fire is the rapid oxidation of a material in the exothermic chemical process of combustion, releasing heat, light, and various reaction products. The flame is the visible portion of the fire. If hot enough, the gases may become ionized to produce plasma. Depending on the substances alight, and any impurities outside, the color of the flame and the fire's intensity will be different. Fires start when a flammable material, in combination with a sufficient quantity of an oxidizer such as oxygen gas or another oxygen-rich, is exposed to a source of heat or ambient temperature above the flash point for the fuel mix, and is able to sustain a rate of rapid oxidation that produces a chain reaction. Fire cannot exist without all of these elements in place and in the right proportions. Once ignited, a chain reaction must take place whereby fires can sustain their own heat by the further release of heat energy in the process of combustion and may propagate, provided there is a continuous supply of an oxidizer and fuel.

1.2 Flame Edges

During the process of heat up, the rising carbon atoms emit light. This heat produces light effect is called incandescence which causes the visible flame. Flame colour varies depending on what is being burned and how hot it is. Color variation within in a flame is caused by uneven temperature. The hottest part of a flame glows blue, and the cooler parts at the top glow orange or yellow.

Earth gravity determines how the flame burns. All the hot gases in the flame are much hotter and less dense than the surrounding air, so they move upward toward lower pressure. This is why fire typically spreads upward, and it's also why flames are always pointed at the top.

1.3 Flame Edge Detection

The determination of flame or fire edges is the process of identifying a boundary between the area where there is thermo chemical reaction and those without. It is a pre-cursor to image-based flame monitoring, early detection, fire evaluation, and the determination of flame and fire parameters.

A computing algorithm is thus proposed to define flame and fire edges clearly and continuously. The algorithm detects the coarse and superfluous edges in a flame 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 edges are identified for different scenarios. The methods do not emphasize the continuity and clarity of the flame and fire edges.

1.4 Importance of Flame Edge Detection

To meet the stringent standards on combustion efficiency and pollutant emissions, quantitative flame monitoring is becoming increasingly important. This has led to a wave of research on advanced flame imaging technologies, both in industry and laboratory research. In fire safety engineering, flame image processing is also emphasized as image-based flame detectors are increasingly applied in fire detection systems. Compared to conventional flame detectors such as those based on optical sensing, ionization current detection, and thermocouple, image-based flame detectors are deemed more appropriate in fire detection because of their capability for remote detection of a small-sized fire, as well as having other advantages. As one of the important steps in flame and fire image processing, edge detection is often the precursor and lays a foundation for other processing.

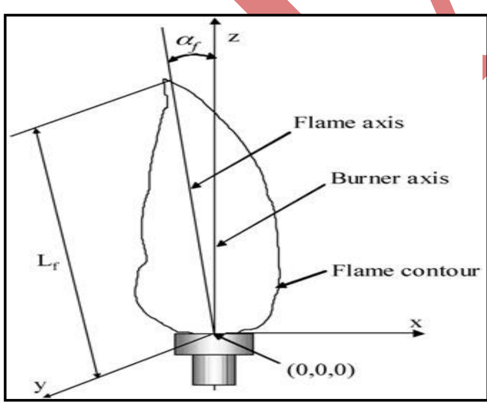
The flame edges form a basis for the quantitative determination of a range of flame characteristic parameters such as shape, size, location, and stability. The definition of flame edges can reduce the amount of data processing and filter out unwanted information such as background noise within the image.Edge detection can preserve the important structural properties of the flame and meanwhile shorten the processing time. Edge detection can be used to segment a group of flames. This is helpful for multiple flames monitoring in some industrial furnaces where a multi-burner system is used. Timely determination of flame edges can trigger a fire alarm and provide the fire fighters with information on fire type, combustible substances, exterior of the flame, etc. The movement of a detected flame edge can be used to distinguish real and false fire alarms.

II ANALYSIS OF EXPERIMENTAL RESULTS

This project is demonstrated using the low-cost sensors which are commonly used as indoor and outdoor motion detectors. It can be utilized as fire sensors when coupled with appropriate processing. The main advantage of image based fire detection system over conventional sensors is its ability to detect the presence of fire from a distance which results in a faster response time.

2.1 Experimental conditions

In the first step of the proposed method moving object boundaries are estimated. The method does not require very accurate boundaries of moving regions. After a post-processing stage comprising of connecting the pixels, moving regions are encapsulated with their minimum bounding rectangles. To evaluate the performance of the system, a series of experiments were conducted on a candle light, serving to create a desirable and safe experimental environment. Air is supplied by a compressor. For each condition, the three-dimensional flame model was reconstructed for 50 times and the flame parameters were determined from each model. The average values of the parameters are then computed and their uncertainties calculated. Characterization of the flame after the contour extraction operation had been performed on the images of the flame; a three-dimensional model of the flame was reconstructed from its instantaneous images captured at each particular condition. It is evident that the flame shape is very dynamic, although there is a decrease in the flame size.



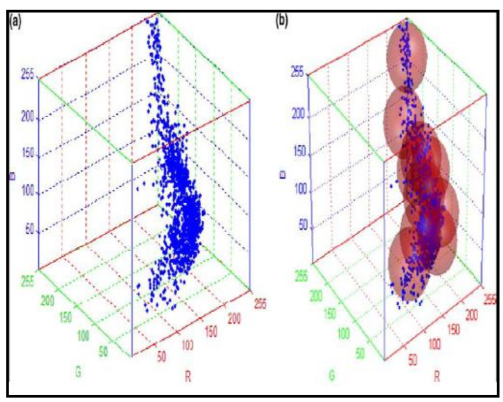


Fig 2.1 Definition of Flame Parameters **Fig. 2.2 Moving Pixels in Video and Their Minimum Bounding Box**

During the recognition phase the state history of length 20 image frames are determined for the moving object detected in the viewing range of the camera. This state sequence is fed to the walking and falling models. The model yielding higher probability is determined as the result of the analysis for video track data. Edges extracted from non-trivial images are often hampered by fragmentation, meaning that the edge curves are not connected, edge segments are melted, or false edges that do not correspond to significant phenomena in the images shown in fig. 5.3. Hence a dedicated edge detection method for flame image processing is developed.

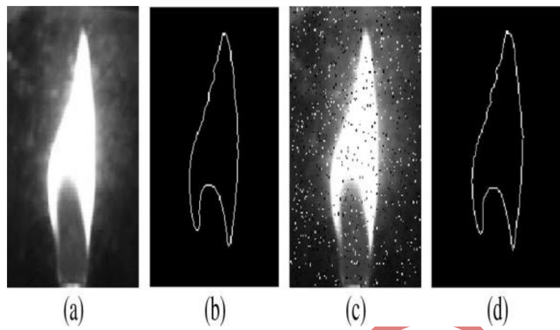


Fig. 2.3 Example of noisy and processed flame images. (a) Original image.(b) Processed image of (a). (c) Original image with salt and pepper noise added.(d) Processed image of (c).

III FLAME IMAGE PROCESSING USING MATLAB

The developed algorithm can successfully detect clear edges of the flame and disregard unrelated artifacts, which common edge-detection methods cannot achieve. The proposed method makes it much easier to distinguish the flame region from the background. The algorithm can also be used to extract the edges of more complex flames such as turbulent diffusion flames or flames of pool.

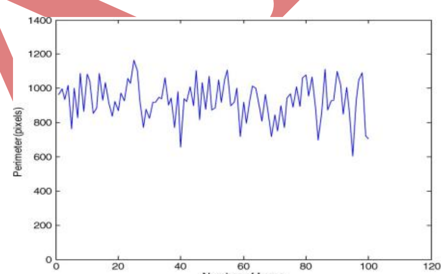


Fig 3.1 Uninterrupted Computing of Flame Perimeters from a Flame Video

Fig. 3.1 is an example of the uninterrupted computing of the flame perimeters from a flame video. It would be difficult to obtain this result without the clear edge detection. Using the edge-detection algorithm, further work can be done to characterize the geometric features of flames and, consequently, establish their relationship with combustion conditions such as air/fuel inputs and emissions. The clearly defined flame edges will form a basis for subsequent processing of the flame images. Many flame videos are also tested for continuous edge detection so as to evaluate the robustness of the system. In Fig 2: Flame image processing for luminance image, adjusting grey level, smoothened image, horizontal edge, vertical edge, pre-threshold image, and final edge. It is clear that the flame edges detected using the Canny edge-detection method are unclear and discontinuous, while the results obtained using the Sobel operator show clear and continuous edges with parameters automatically adapted.

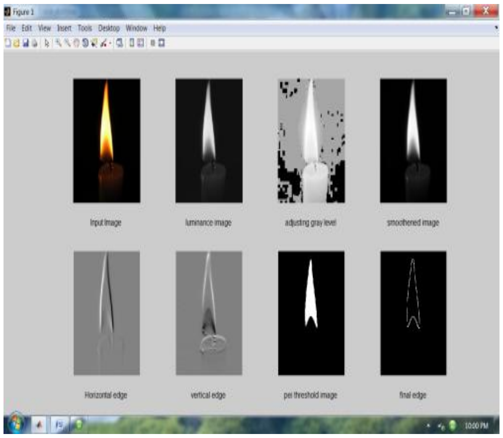


Fig 3. 2 Flame Image Processing.

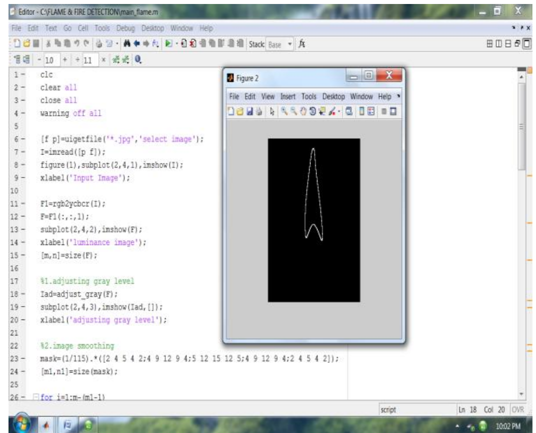


Fig 3.3Flame Image Processing – Output.

With a clearly defined flame edge, as shown in Fig 5.6, various flame parameters can be easily computed for the shape description. For instance, the flame area can be counted by the number of pixels inside the flame edge; the chain coding of a flame edge can be used to describe a 2-D flame/fire shape; the perimeter of a flame can be achieved by the total number of pixels of the detected flame edge boundary.

IV APPLICATIONS OF FLAME EDGE DETECTION

In modern technology, flame analysis has various applications in industrial, medical, environmental engineering, automation of plants etc.

4.1 Industrial Applications

In new generation industries automation plays a big role for increasing production and efficiency. The safety level is improved using surveillance camera. The same images obtained from camera can be processed for analysing any fire accident using this algorithm and a 24 hour monitoring is obtained without additional expense. Real-time video codec component integrates the proposed fast and real-time monitoring video compression and decompression technique. Isotropic property of gradient magnitude. The magnitude of gradient is an isotropic operator which detects edges in any direction.

V CONCLUSION

Nowadays fire detection and control in industrial sectors and commercial buildings are becoming a more important requirement due to the increased and intensive use of resources. The project on flame detection using edge search helps in identifying the flame image in video using Matlab software. After the flame characteristics are analyzed, a new flame edge-detection method has been developed and evaluated in comparison with conventional methods. Experimental results have demonstrated that the algorithm developed is effective in identifying the edges of irregular flames. The advantage of this method is that the flame edges in images detected are clear and continuous. Furthermore, with the change of scenarios, the parameters in the algorithm can be automatically adjusted. The clearly defined combustion region lays a good foundation for subsequent quantification of flame parameters, such as flame volume, surface area, flame spread speed, and so on. It is envisaged that this effective flame edge-detection algorithm can contribute to the in-depth understanding and advanced monitoring of combustion flames. The algorithm provides a useful addition to fire image processing and analysis in fire safety engineering.

VI FUTURE ENHANCEMENT

The project can be extended to handle different flame videos simultaneously. The system implemented was able to perform accurately, however there are some issues to be addressed. An optimization whose feasibility could be analyzed using the videos recorded at different climatic condition will give a better result for the program used.

Further work is required to evaluate the performance of the algorithm in real-life flame detection scenarios. No fire detection experiments were carried out using other sensing modalities such as ultra-violet (UV) sensors, near infrared (NIR) or middle wave-length infrared (MWIR) cameras, in this project.

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