Hot Topics In Video Fire Analysis

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Fire is one of the most powerful forces of nature. Nowadays it is the leading hazard affecting everyday life around the world. The sooner the fire is detected, the better the chances are for survival. Today's fire alarm systems, such as smoke and heat sensors, however still pose many problems. They are generally limited to indoors; require a close proximity to the fire; and most of them cannot provide additional information about fire circumstances. In order to provide faster, more complete and more reliable information, video fire detection (VFD) is becoming more and more interesting.

As recent research has already shown, vision-based detection of smoke and flames promises fast detection and can be a viable alternative or complement to the more traditional techniques. Especially in large and open spaces, such as shopping malls, parking lots, and airports, video fire detection (VFD) can make the difference. The reason for this expected success is that the majority of detection systems that are used in these places today suffer with a lot of problems which VFD do not have, e.g., a transport- and threshold delay. As soon as smoke or flames occur in one of the camera views, fire can be detected.

In order to actually understand and interpret the fire, however, detection is not enough. It is also important to have a clear understanding of the fire development and the location. Where did the fire start? What is the size of the fire? What is the direction of smoke propagation? How is the fire growing? The answer to each of these questions plays an important role in safety analysis and fire fighting/mitigation, and is essential in assessing the risk of escalation. Nevertheless, the majority of the detectors that are currently in use just ring the bell and are not able to model fire evolution.

Recently, video fire detection in non-visible light is also gaining importance. While ordinary video promises good fire detection and analysis results, the use of IR cameras in the long wave IR range (LWIR) can be of added value. The reason for this is that existing VFD algorithms have inherent limitations, such as the need for sufficient and specific lighting conditions. Thermal IR imaging sensors image emitted light, not reflected light, and so do not have those limitations, providing a 24 hour, 365 day availability. Also, due to the variability of shape, motion, colors, and patterns of smoke and flames, many of the existing VFD approaches are still vulnerable to false alarms. Since it is possible to integrate IR cameras into existing CCTV networks, the combination of both technologies can be used to reduce these false alarms.

Our research focuses on the evaluation of video fire detection techniques in visible and non-visible light using a performance evaluation framework. Based on this evaluation, an improved multi-sensor detector is created. This detector combines the most distinctive fire features of ordinary video and thermal infrared video (Fig. 1). The set of features is based on the distinctive geometric, temporal and spatial disorder characteristics of flame regions, which are easily detectable. By combining the probabilities of these fast retrievable local flame features we are able to detect the fire at an early stage. Experiments with different sequences of fire and non-fire real case scenarios show good results. Further, we also propose a multi-view fire localization framework (Fig. 2). The framework merges the single-view detection results of multiple cameras by homographic projection onto multiple horizontal and vertical planes, which slice the scene. The crossings of these slices create a 3D grid of virtual sensor points, called the FireCube. Using this grid and subsequent spatial and temporal 3D clean-up filters, fire localization, growth analysis, detection of smoke propagation, and retrieval of other valuable fire characteristics becomes possible.

Figure 1: multi-sensor fire detection by fusing visual and non-visual flame features

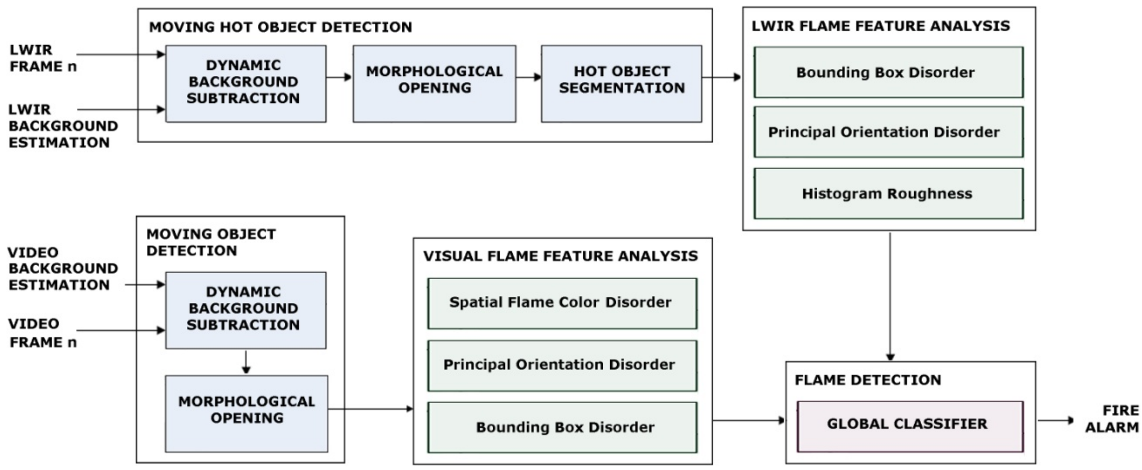

Figure 2: multi-view localization framework for 3D fire analysis