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VIDEO FIRE DETECTION USING NON-VISIBLE LIGHT

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ABSTRACT - *Based on related work in visible and non-visible light, a set of features to detect flames in long wave infrared (LWIR) thermal images is proposed in this paper. The set of features is based on the distinctive geometric, temporal and spatial disorder characteristics of bright flame regions, which are easily detectable in LWIR thermal images. 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 LWIR sequences of fire and non-fire real case scenarios show good results. At the end, some related LWIR applications such as looking through smoke and detection of hot spots are discussed.*

INTRODUCTION

Detection of fire and smoke until now is largely a matter of sensors that either detect light, especially in the IR or UV spectrum, or smoke particles, detected by so called point detectors, or by active IR detectors. These systems are of course very useful, but they have some limitations when used in large and open spaces. For example, due to the transport delay they are not always very fast in detecting the fire. They also provide little or no data about the fire location and propagation, i.e., very useful fire progress information.

Recently, a large number of vision-based detection techniques in visible light have been proposed to solve the above mentioned problems associated with traditional sensors [1]. These video fire detection (VFD) systems promise fast and accurate detection and as such they can become a viable alternative or complement for the more traditional sensors. We also believe that 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 do not have those limitations, providing a 24 hour, 365 day capability.

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.

In spite of the already numerous and successful uses of IR video in video surveillance, there is not much to find in the domain of early fire detection [2-4]. In our paper, a set of LWIR fire features is proposed to fill the lack in appropriate fire detection in this domain. By combining the detected probabilities of this set of features, a detector is created which yields comparable results as ordinary VFD approaches.

IR VIDEO FIRE DETECTION

Based on the related research and our own findings, a LWIR-based flame detector is proposed which consists of an automatically histogram-based hot object segmentation and a set of features that analyze the flame-related characteristics of these objects. By combining the probabilities of the bounding box disorder, the principal orientation disorder, the turbulence variance, and the histogram roughness, an overall flame probability is calculated which gives an indication about the presence of flames. If this indication is high enough, a fire alarm is given.

Experimental results have shown that the proposed LWIR-based flame detector already yields good results, but further testing on a broader range of video sequences is necessary for an adequate performance evaluation. At the moment, however, we can already say that LWIR-based fire analysis is very promising.

As the evolution of infrared technology tends to decrease the cameras' cost and maintenance requirements, it is expected that more and more approaches will follow the LWIR-based fire analysis trend. Since it is possible to integrate IR cameras into an existing CCTV network, we could even benefit of the combination of both technologies. A system that combines visible and LWIR may be more accurate and sensitive than either alone.

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