


Efficient Detection of Humans in Flames Using HOG as a Feature Criterion in Machine Learning

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ABSTRACT

Detection of humans in flames is a challenging task. The task in this work is classified into two stages. The first is detection of fire, and the second is detection of human. The proposed method involves fire detection based on colour format YCbCr for image preprocessing. It further uses a histogram of oriented gradient (HOG) and support vector machine (SVM) to detect a human in the fire. It evaluates several motion-based feature sets for human detection in the form of videos. In this work, both modules were integrated to make them work together. For the detection of fire, four different rules involving colour thresholding were used and background differencing was used for moving object detection. The main objective of this work is to spot the humans in the flames who are trapped in it so they can be rescued quickly. This can help the firefighters in rapid planning and serious zone detection. The proposed model has 81% efficiency, which has outperformed the existing models for detection of humans in flames.

KEYWORDS

Histogram of Oriented Gradient, Local Binary Pattern, Machine Learning, Support Vector Machine

INTRODUCTION

The current trends of research have drawn attention to the research area that is combined for both fire detection and human detection and trying to develop new technology for saving lives caused by the fire. The evolution in technologies in the field of computer vision (Szeliski, 2010) led to much new advancement in digital image processing. Schalkoff (2020) presented an idea to supplant the traditional and typical fire detection alarms with computer vision-based systems using image processing. It comprises three basic steps: the classification of the fire pixel, segmentation of moving objects, and then analyzing candidates region as the algorithm is based on image processing then there is less chance of raising false alarms. To distinguish moving pixels from non-moving pixels, a backdrop subtraction breakthrough with a frame differencing algorithm is applied to the frame buffer

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filled with successive frames of the input video. To raise a fire alarm, the moving pixels that are also detected as fire pixels are further studied in subsequent frames.

It is difficult to detect humans due to the differences in outfits, motion background, illumination, clutter, noise, and other factors that add to the complexity of human detection. There are so many algorithms exist like (Viola & Jones, 2001) for human identification, which are accurate enough to detect humans but had a few limitations that cause failure in real-time operation as stuck into high false detection rate (Dalal and Triggs, 2005). Later, a new approach called Histogram of Oriented Gradient was developed to extract features from local cells. It is unaffected by geometric and photometric changes (HOG) except for object orientation (Dalal and Triggs, 2005). On the other hand, Viola-Jones is reliant on geometric modification yet produces better results and is commonly used for facial recognition and detection. (Barnouti et al., 2016) applied this technology in Autobots and surveillance to save lives and avoid fatalities, the technology may be advanced and used much more efficiently.

Due to unexpected failures in the intended deliverables of the present fire security management system, our idea of detecting humans in fire using modern machine learning algorithms forms its shape. The objective of this work is to serve a great purpose of saving lives, although currently, this work has some limited boundaries it has a great future scope ahead if it gets incorporated with modern tools like robots and drones. The proposed model in this work, is a result of a complete cycle of collecting data, training a model and testing over multiple examples to achieve better efficiency at each step.

Fires are posing an increasingly severe threat to people's lives and property. For the detection of fire, a combination of methods of motion detection and color detection of the flame was used as preprocessing step. In screening the fire candidate pixels, this strategy saves a significant amount of computing time. Second, despite its irregularity, the flame has a significant resemblance to the image's sequence. Many fire detection sensors are available nowadays to quickly detect fire and trigger fire alarms. Still, they can also generate false alarms as in case of cigarette smoke which generate chemical particles in the air that the sensors pick up. In order to overcome from this problem, computer vision and image processing based methodology was used to identify fire using the YCbCr color standard and to recognize humans in real-time, the Histogram of Oriented Gradient (HOG) and Support Vector Machine (SVM) based classifier was utilized. This strategy, however, can be improved by incorporating this technology into a robot that can rescue persons trapped in a fire and save them from destruction. The proposed methodology in this work has two phases, one is detection of fire more precisely than the conventional systems available and other is majorly focusing on rescuing human beings stuck in a fire, which is very common to observe. Experimental results show that it could improve the accuracy and reduce the false alarm rate when compared to conventional method.

The authors (Jaradat & Valles, 2018) proposed a model to detect human drastically trapped in burning sites/ buildings. This approach tries to ensure the safety of firefighters and live savers and help in accelerating the process of rescue of humans trapped in fire. In this work, Infrared (IR) cameras were used to capture thermal images of human with fire from the burning site which in turn help in overcoming the problem of distortion due to smoke. Convolution Neural Network (CNN) based deep learning technique was applied on thermal images of the victims inside the fire to detect them for rescue operation. In this work, no method of calculating detection efficiency was mentioned. Ma et al., (2020) proposed a smart efficient fire alarm system especially used in kitchen as a representative scenario. In this approach, the model captures both thermal and optical videos in order to monitor the temperature and helps in detection of human inside the fire. Further this model can be used to predict the event of fire accident and tries to avoid false alarm. The authors proposed a high-efficiency regulated neural network based inference computing framework named as TuringNN. This model lacks the computation of detection efficiency. Tsai et al., (2022) proposed a detection model using a deep learning method and thermal imaging camera (TIC). This model acts as intelligent human detection system to detect human inside fire during emergency evacuations in a smoky fire scenarios with low-visibility.

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