Ph.D. Research Proposal

Doctoral Program in "Department Name"

Semantically Meaningful Frames Extraction and Classification from Video Clips: Optimized Deep Belief Networks

by

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I. INTRODUCTION / BACKGROUND

Advancing from the popularization of the audio and visual equipment's, various video contents transmitted by video providers spread widely. To transmit or store videos conveniently and efficiently, the original videos with the need of large memory space will be compressed, which leads to the original video quality decreasing. Thus, figuring out whether the video receivers are satisfied with the degraded. The most common application in current days is Forest Fire Detection. This forest fire heavily affects the animals and people who are lives in the forest surrounding. So, it is necessary to detect the forest fire in their early stages. Because once a fire becomes large it is difficult to control. Thus the fire is must detected in its early stages. Many algorithms attempt to realize the forest fire detection based on images or videos. They can be divided in to two methods: (a) fire detection (b) smoke detection. In fire detection method, the image sequence is taken as input. Then background subtraction method is used to find the moving region in image [3]. In this, the color conversion process is performed in RGB image to extract the color features. Here, five rules are applied to detect the fire in image and temporal variations are calculated. Based on these temporal variation values the fire is detected. In this, five rules only not efficient to detect the fire regions. However if the fire is too small then this fire detection method alone not enough to detect the fire. Thus, we have to move on another method is smoke detection process.

Because, maximum of the fire regions have smoke. If we detect the smoke first then it is possible to detect the fire region accurately. Forest fire smoke is detected by spatio-temporal variations [1]. Here, candidate smoke regions are segmented by kalman filtering process. Then dynamic features are extracted by local binary pattern (LBP) method. This LBP method is not effective method when the large data base is used. Then the learning based smoke detection is applied to the unmanned aerial vehicles [5]. Here, fuzzy smoke detection algorithm and color features of smokes are proposed. The smoke has various different color depends on the fire temperature. Here the smoke is detected based on RGB differences and color features. Then the extended kalman filter is used to smoke detection region. Here, the smoke is detected based on

color intensity only. This is not efficient to detect the fire region exactly. However, the fire regions have some fire color objects like red color ball and fire color moving objects like red color t-shirt moving man and red color moving bird. Thus, if we don't consider these types of features in fire detection then we get poor result. Thus the forest fire is detected based on static (color) and dynamic (texture variability, shape variability and spatial variability) characteristics of fire. Forest fire is detected based on static and dynamic features analysis [4].

1.1 Research Outline & Scope

Extract semantically and visually meaningful frames for events video classification. The main aim and scope is to classify events accurately from large scale video database. It reduces the processing time and error rate.

1.2 Research Objectives

- To discover and segment a primary object (event) in a video
- To clearly identify three kinds of information as visual features, semantic features and motion features
- To choose frame that difference from its temporal behaviors

II. RESEARCH GAPS

2.1 Common Problem Statement

Video Quality Assessment (VQA) is an initial problem to video processing and classification. From collection of dataset, corrupted and clean frame pairs are used to train a specialized to form events classification. Given a noisy and corrupted video, clear frames are obtained to form a video classification.

2.2 Problem Definition

In this paper [17], forest fire smoke video is detected based on spatio temporal and dynamic texture features. At first, Kalman filtering is used to segment the candidate smoke regions. Then candidate smoke region is divided into small blocks. Spatio temporal feature of each block is extracted by computing energy feature of its 8 neighboring blocks and 2 adjacent

blocks. Flutter direction angle is determined by analyzing the centroid motion of segmented regions in one candidate smoke video clip. Dynamic texture feature is extracted by Local Binary Pattern (LBP). Finally, smoke video is recognized by using Adaboost algorithm.

Problems

- Generally, video has noises such as Gaussian noise and salt and pepper noise. So, removal of these noises (preprocessing) gives accurate output. In this paper, doesn't achieves any method for preprocessing. So, it doesn't produce accurate output. Local Binary Pattern is used in extract the dynamic features. When LBP is used in large scale database, it slows down the recognition speed. (For example, LBP pattern gives output by considering 8 neighboring blocks and centroid block. When the region is divided into 3*3 matrix it works fast and when the region is divided into 128*128* matrix it slows down the process speed.)
- Adaboost algorithm is used to recognition of smoke video. This adaboost algorithm is not working properly when the input data has noises.

Proposed Solutions

- Main preprocessing tasks are performed which does not meet the video quality (blockiness removal, blurriness removal, noisiness removal) in first step. So, it provides accurate output.
- Deep Belief Network is proposed to extract features and classify events from video

Convolutional neural network (CNN) is [18] used in image recognition tasks to identify smoke on video. Here, authors develop a joint frame work for image recognition by using Region CNN (RCNN) and 3D CNN. An improved RCNN is used for image recognition and 3D CNN used for smoke region by combining dynamic texture features. 3D CNN improve accuracy of smoke detection process.

Problems

- In smoke detection process, it is necessary to consider about fog detection process. Because, heavy fog is look like a smoke. Thus it is possible to detect the fog as smoke.
- In this paper, RCNN and 3D CNN are used in developing of joint frame work for image recognition. By using these RCNN and 3D CNN for image recognition provides time complexity.

Proposed Solutions

- In our proposed work, we concentrate on fog detection also. Here, we detect the fog by pixel density (Air density) low for smoke, high for fog. Thus, it produces accurate output.
- In this, three frame difference method is proposed to image recognition. This type of image recognition process saves time.

In this paper, Background subtraction method [19] is used to find moving region from sequences of images. This method is used to remove tree, animal, birds and people in input image. Then color conversion process perform in RGB image and it convert to YCbCr. Five fire detection rules are used to identify the fire detection region.

Problems

- Generally, video has noises such as Gaussian white noises and Salt and pepper noises. Here, also the author doesn't concentrate on preprocessing. So, the author doesn't produce accurate result.
- Here, features are extracted based on pixel intensity only. But texture feature is also important to find the fire detected region. So, texture feature is (spatial arrangement of colors in image and their intensities) also need to be produce accurate fire detection region.
- This paper detects the fire region based on five rules only. These five rules are not sufficient to identify the fire region.

Proposed Solutions

- In proposed work, we perform preprocessing (noise removing) process. Thus, our proposed method provides accurate output.
- Here, we consider static feature (color), dynamic features (spatial variability, space variability and texture variability) to detect the fire region.

In some cases, fire detection region has fire color moving object. In this paper, author concentrates also on fire color objects. Here, fire color objects are detected based on color intensity. Flame color objects and sky has color intensity level is Y>Cb. If the color density in region Y>Cb and Cb-Cr is greater than threshold thus the region has fire[4]. Here, static features are extracted by LBP, Gray level co-occurrence matrix and Gabor transform. Dynamic features are extracted by 2D spatial wavelet and 3D volumetric wavelet decomposition. Extreme learning machine is used in classification.

Problems

- Preprocessing is important in fire detection to produce accurate output. In this paper, doesn't concentrate on preprocessing and author doesn't produce accurate output.
- Discrete wavelet transform is used in feature extraction. Here, decomposition is performed based on mother wavelet. So, mother wavelet is correctly chosen is a major issue to produce decomposition. It is also time consuming process.
- ELM classifier supports in small set thus large training set it takes more time.

Proposed Solutions

- In proposed work, we propose DBN to extract the dynamic features. It provides output accurately and also saves the time.
- In classification process, we propose entropy function thresholding method with simulated annealing in DBN to optimize and tune the performance of event classification. It classifies the fire region in to initial state, medium state and severe state.

III. RESEARCH CONTRIBUTIONS

In order to overcome these above mentioned challenges, proposed a novel method to detect the video of events by three kinds of information as Visual, Semantic and Motion features. This proposal handles Forest Fire Detection from Surveillance Camera. Propose a deep belief network (DBN) entropy function thresholding method with simulated annealing in DBN to optimize and tune the performance of event classification. It classifies the fire region in to three states as initial state, medium state and severe state. We divide our proposed method in to five steps as

1) Video Quality Assessment
2) Video Quality Enrichment
3) Motion Detection
4) Bi- Feature Extraction
5) Event Classification

Video Quality Assessment

- Today, video has the quality range up to 4K UHD. Thus, first we have to check the quality of the video. In first step, we have to check the quality of the video. Here at first assess Blockiness, Blurriness and Noisiness of the video.
- In blockiness checking, calculate the difference of entropies across the blocks and variations of block boundary pixel values in images. Here we use sobel operator to calculate the blockiness of the image. Here, Gaussian white noise and salt and pepper noise are calculated to calculate noisiness of the video.
- If the video has no blockings, blurriness and noisiness then the video is best quality video. Then we have to move on motion detection step. If the video quality of the video is poor then we have to enrich video quality at first step.

Video Quality Enrichment

In video quality enrichment step, proposed a method to remove those Blockiness, Blurriness And Noisiness of the video. “Complexly flattening filter” is used to remove the blockiness of the

video. Wiener spatial filtering operation is performed to remove noisiness of the video. Radon transform is used to calculate blurriness of the video.

Motion Detection

In motion detection step, Three Frame Difference Method is proposed to calculate the motion in frames. Here we use Histogram Equalities with Manhattan distance formula to calculate the distance between the frames. In this step, we calculate density of the pixels in an image. Horizontal and vertical resolutions of the pixels are used to calculate the density of the pixel. If the density is low, then we perform smoke detection operation. In smoke detection step, we perform Haze Removal process by fast color prior attention method. In our proposed method, we perform a Key Frame Extraction Method to extract the fire images exactly by absolute difference method. In this method, mean and standard deviation (SD) of histogram of absolute differences of consecutive images are calculated. Then threshold is calculated by using mean and SD of histogram of images. Once the key frame extraction method is completed then we have to move on feature extraction step.

Bi-Feature Extraction

In feature extraction step, we extract the static and dynamic features of an image. In static feature extraction step, we extract the Color Feature of an image. In RGB fire image, the red color has high value compare to blue channel and green channel. Based on this concept, we extract the color feature. Here, RGB color model is converted into YCbCr model. Here the condition is "Y>Cb and Cb-Cr > threshold". If the conditions are satisfied then the region contains red color (i.e., fire). However we extract the static feature in image it also contains fire color moving objects. Fire has certain characteristics such as shape irregularity. Based on this characteristic we differentiate the fire color moving objects in an image. In dynamic feature extraction method, we propose a Deep Belief Network" to extract the dynamic features of an image. Here "Texture Variability, Area Variability, Shape Variability And Spatial Variability" are considered as dynamic features of image. After static and dynamic feature extraction step, we need to perform classification of an image.

Event Classification

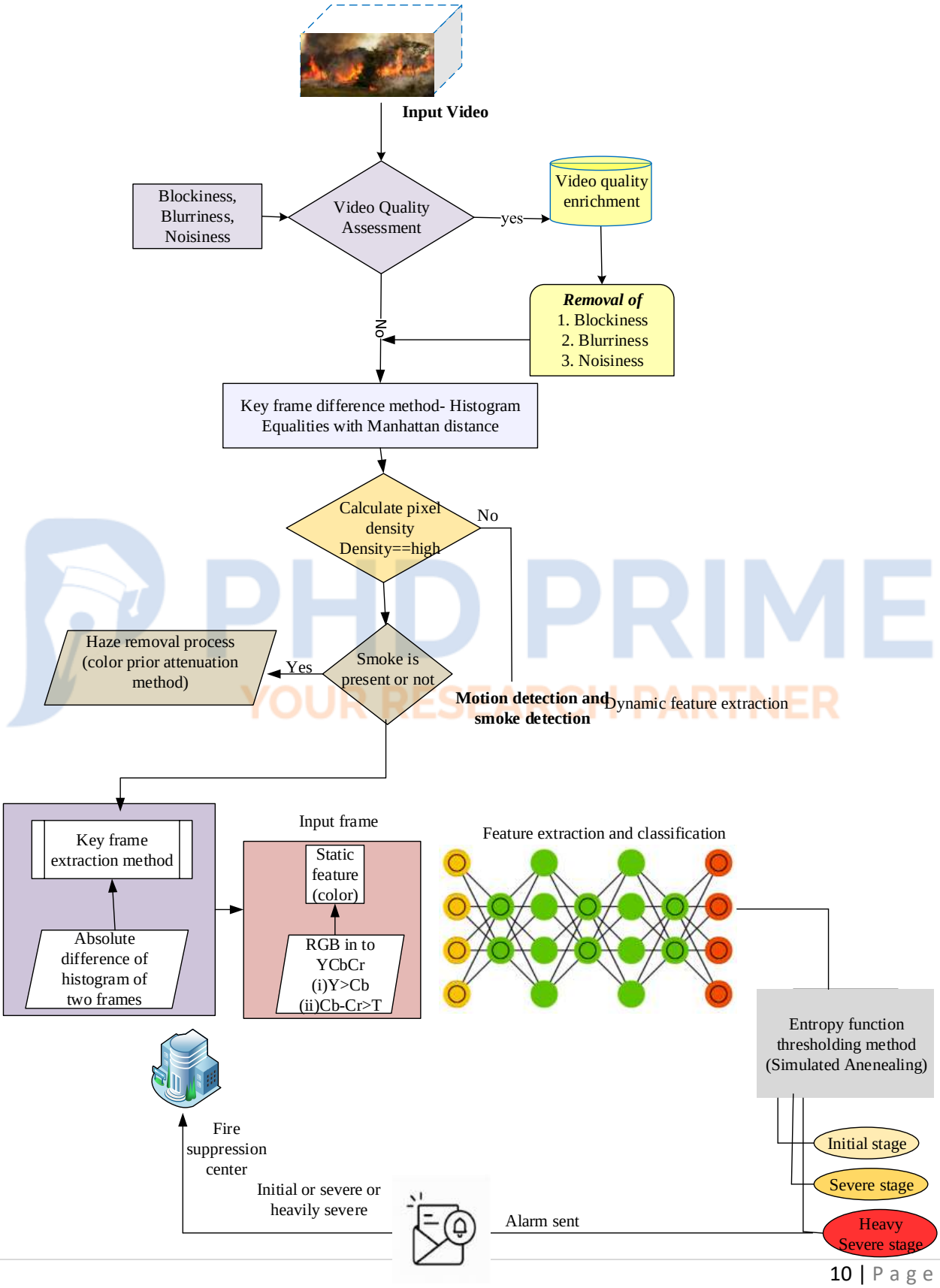
In classification step, we perform "Entropy Function Thresholding with Simulated Annealing" method in soft max layer to classify the fire images with their ranges as Initial, Severe And Heavily Severe. In Entropy Function Thresholding are calculated. Based on this member ship functions the threshold value is calculated. If the fire range is less than threshold then it is initial state. If the fire range is less than or equal to threshold then it is severe stage. If the fire image is greater than threshold then it is severe stage. Here, the alert mail sent to the fire suppression center which the mail contains the information as range of fire as initial or severe or heavily severe.

Performance Evaluation

Finally, analyzed the proposed method with other existing methods in terms of following metrics

- Precision
- Recall
- Accuracy
- F- Measures
- Execution time

SYSTEM ARCHITECTURE


Input Video
Blockiness, Blurriness, Noisiness
Video Quality Assessment
yes
Video quality enrichment
NO
Removal of
1. Blockiness
2. Blurriness
3. Noisiness
Key frame difference method- Histogram Equalities with Manhattan distance
Calculate pixel density Density==high
No
Haze removal process (color prior attenuation method)
Yes
Smoke is present or not
Motion detection and smoke detection
Dynamic feature extraction
Key frame extraction method
Absolute difference of histogram of two frames
Input frame
Static feature (color)
RGB in to YCbCr (i)Y>Cb (ii)Cb-Cr>T
Feature extraction and classification
Entropy function thresholding method (Simulated Anenealing)
Initial stage
Severe stage
Heavy Severe stage
Alarm sent
Fire suppression center
Initial or severe or heavily severe

V. PREVIOUS WORKS & LIMITATIONS

Paper 1

Title - Blind Video Quality Assessment with Weakly Supervised Learning and Resampling Strategy

Concept

In this, video quality is assessed with the use of hybrid algorithms such as resampling and weakly supervised learning. In convolutional neural network (CNN), input video is processed and frames are extracted from video clips and the spatial, spectral, and color features are extracted in frame wise. Temporal difference is estimated between two frames and quality is assessed accordingly.

Limitations

- In CNN, pooling layer performance is very worst and still better quality assessment is absent.

Paper 2

Title – Objective Video Quality Assessment Combining Transfer Learning With CNN

Concept

This paper proposes hybrid video quality estimation technique such as transfer learning and CNN. At first, feature learning based transfer technique was proposed and secondly 6 layers CNN is implemented for pre-tune and fine-tune of most common features in two functional blocks as distorted image and video blocks. In particular, authors present a preprocessing and a post processing to reduce the impact of inaccurate labels predicted by the transfer learning and CNN metric.

Limitations

- Suited for large scale video databases and low level feature representations are only considered

Paper 3

Title – Video Classification with CNNs: Using the Codec As a Spatio-Temporal Activity Sensor

Concept

In this paper, two stream CNN is proposed that extracts information from compressed video bitstreams. In order to evaluate the accuracy of a video classification framework based on such activity data, independently train two CNN architectures on MB texture and motion vector correspondences and then fuse their scores to derive the final classification of each test video.

Limitations

- Time consumption for two stream CNN is very high

Paper 4

Title -Video smoke detection based on deep saliency network

Concept

In this paper, authors have proposed a novel video smoke detection method on deep saliency network. This visual saliency detection method is proposed to highlight the important object in the region. The pixel-level and object-level salient CNN are combined to extract the smoke saliency map. Then a deep feature map is combined with a saliency map to predict the existence of smoke in an image.

Limitations

- In this pixel level, region level and object level saliency map is generated. This makes the time complexity. In smoke detection, smoke saliency map is used in this proposed method. Here authors perform any methods to extract the spatio-temporal features which are important to extract the fire regions in an image. CNN has a drawback such as

translation invariance in pooling layer. Thus CNN is not suitable for classification process.

Paper 5

Title- A video based fire smoke detection using robust algorithm.

Concept

In this work, authors have considers camera sensors to detect the fire smoke. Here texture, wavelet, color, edge orientation histogram and irregularity of the fire are extracted as static features. Motion direction and motion speed are extracted as dynamic features. Then the robust classifier is proposed to improve the accuracy of this proposed method.

Limitations

- Here, edge orientation histogram is obtained by canny operators. It is time consuming process.
- These features are not enough to identify the fire region.

Paper 6

Title – Learning from Web Videos for Event Classification

Concept

In this paper, some manual annotation is implemented for generating relevant queries based on videos. Firstly, video dataset with queries are constructed from textual and semantic description of events and irrelevant videos are pruned from the database. Finally, event classifiers are used to classify the videos

Limitations

- SVM is higher processing time algorithm for event classification

Paper 7

Title – Robust Learning-Based Camera Motion Characterization Scheme With Applications to Video Stabilization

Concept

In this paper authors presented Characterizations Scheme, which represents the compressed domain block motion vectors using polar angle and magnitude histograms. Discriminative features from these two histograms are extracted and fed to a supervised learning based hierarchical classifier for recognizing the six camera motion patterns. Comparative analysis with an existing scheme is carried out to support and validate the proposed characterization scheme. The proposed scheme works at the frame level by classifying the inter-frame camera motion patterns which is extended to classify the video segments and a novel application to video stabilization is investigated. Experimental analysis on a number of test sequences captured using a hand held video camera shows that by characterizing the smooth and jittery motions, selective video stabilization could be carried out only on those video segments which have been degraded.

Limitations

- Complexity is high when deal with intra frame camera motion features

Paper 8

Title – The fire recognition algorithm using dynamic feature fusion and IV-SVM classifier

Concept –

In this paper, authors have proposed a new fast recognition method for fire image. Here, scale invariant feature transform (SIFT) algorithm is used for color space information. The feature descriptors of fire are extracted by SIFT algorithm. Then, the local noisy feature points are filtered by feature information of fire color space. Then the feature descriptors are transformed into feature vectors then the incremental vector support vector machine classifier is used to establish the fast fire recognition model.

Limitations

- SIFT algorithm is a time consuming algorithm and it is complicated process.
- Texture feature is important feature to extract the fire images. Here authors do not perform any method to extract this feature.

Paper 9

Title – Modeling Multimodal Clues in a Hybrid Deep Learning Framework for Video Classification

Concept –

Authors introduced a Hybrid Deep Learning Framework that integrates useful clues from multiple modalities, including static spatial appearance information, motion patterns within a short time window, audio information, as well as long-range temporal dynamics. More specifically, we utilize three Convolutional Neural Networks (CNNs) operating on appearance, motion and audio signals to extract their corresponding features. Then, authors employed a feature fusion network with unified representation to capture the relationships among features. Additionally, to exploit the long-range temporal dynamics in videos, two Long Short Term Memory networks with extracted appearance and motion features as inputs. Finally, we also propose to refine the prediction scores by leveraging contextual relationships among video semantics.

Paper 10

Title – Forest Fire Smoke Video Detection Using Spatiotemporal and Dynamic Texture Features

Concept –

This paper concept is computed as three phases. In first phase, a robust ICA (Imperialist competitive algorithm) K-medoids based color model is developed to detect all candidate fire regions. Then motion-intensity-aware technique is used to extract the movement regions which are used to analyze the characteristics of fire. Then the spatio-temporal features are extracted

from the fire region which has different characteristics of fire flame. In classification process SVM classifier is used to classify the images either fire images or non-fire images.

Limitations

- Here, ICA-K-medoids method is used to detect the candidate fire regions and it is a time consuming process.
- SVM classifier is not effective classifier to classify the images. This method provides the output only as either fire image or non-fire image. This method doesn't provide level of the fire.

Paper 11

Title – Automatic Forest Fire Detection Based on a Machine Learning and Image Analysis Pipeline

Concept –

In this paper, authors have proposed an automatic fire detection system to identify the fire images in their early stages. Here, the pipeline processes the images of forest fire environment and it is able to detect the presence of smoke or flames. Then the system is able to produce an estimation of area under ignition. Thus the size can be evaluated. In classification stage, one deep convolutional neural network is used to extract the features from images. Then the logistic classifier is used to classify the images as fire or non-fire. In pipeline process image analysis and preprocessing techniques are applied to access the area under ignition. This proposed method is well suited for day time and night time.

Limitations

- Here, the authors present a logistic regression classifier to classify the images as fire or non-fire images. This classifier is not effective unless the predefined values are exactly predicted. In this proposed method, preprocessing is performed at the last stage of pipeline process. It doesn't provide the output accurately.

Paper 12

Title – Convolutional neural networks based fire detection in surveillance videos

Concept –

In this paper, authors propose cost-effective fire detection CNN architecture for surveillance videos. This method is based on GoogleNet architecture for its reasonable computational complexity and it is suitable for the intended problem compared to other expensive networks such as AlexNet. Then the model is fine tuned for considering the nature of the target problem and fire data and it is used to balance the efficiency and accuracy.

Limitations

- Here, the Googlenet architecture based CNN is used for fire detection. Here the CNN layer output is fire or non-fire. This method is not enough to detect the fire region accurately.
- However, the CNN architecture is not effective architecture to detect the fire region because of its irregular property.

Paper 13

Title – A Real-Time Fire Detection Method from Video with Multifeature Fusion

Concept – The main objective of this paper is to reduce the false alarm rate. In this paper, first motion detection and color detections are performed as first time which is saves the computation time. In this paper, authors have considered although the flame is irregular, but it has some similarity in the sequence of images. Based on this feature, a novel algorithm is a flame centroid stabilization based on spatial temporal relations is proposed. Here, authors calculate centroid of the each flame region of each frame and temporal information is added to obtain spatial temporal information. Here, spatial variability, shape variability and area variability of the flame are extracted which is improve the accuracy of recognition. Support vector machine is used for training then completed the analysis of fire images and achieve automatic fire monitoring.

Limitations

- In this paper, authors don't concentrates on any noise removal process in image. If the image with noises then the output provides poor results.
- SVM classifier is not effective classifier to extract the dynamic features such as shape variability, area variability and spatial variability,
- Texture variability is also an important dynamic feature to extract the fire image.

Paper 14

Title – Learning based smoke detection for unmanned aerial vehicles applied to forest fire detection

Concept –

In this paper, new learning method is proposed based on Fuzzy smoke detection algorithm and color feature. Here, visual images are captured by cameras. In this, color feature of smoke is also considered. Smoke has white color to bluish when temperature is low and when temperature is high it produces black to grayish. Based on these colors segmentation of frame is done. Then fuzzy smoke detection rule is designed based on RGB differences and their intensity. Extended Kaman filter is used to reshaping the inputs and outputs of fuzzy smoke detection rule on line and it is expected to provide with additional regularity flexibility adapting to variations of environmental conditions and reliable automatic detection performance. Morphological operations are applied as final step to removing the noises

Limitations

- Here, noises are removed at the last step. It affects the accuracy of result. Thus, noises are removed at beginning of the process provides accurate output.
- Extended kalman filter is used in smoke detection process. This filter fails when the functions are highly nonlinear. So, it is not suitable for smoke detection process.

Paper 15

Title – Favorite Video Classification Based on Multimodal Bidirectional LSTM

Concept –

In this paper, long short term memory (LSTM) is proposed which is a bi-directional LSTM for multi-modal analysis. Here has been no study on WUL-based video classification using video features and EEG signals collaboratively with LSTM. First, we newly apply transfer learning to the WUL-based video classification since the number of labels (liked or not liked) attached to videos by users is small, and it is difficult to classify videos based on WUL.

Limitations

- Matching between two frames is very poor. For videos different in scale will not be suited by using Bi-LSTM

Paper 16

Title – Multi-Scale Deep Alternative Neural Network for Large-Scale Video Classification

Concept – Authors introduced the multi-scale deep alternative neural network (DANN), a novel architecture combining the strengths of both CNN and RNN to achieve a deep network that can collect rich context hierarchies for video classification. In particular, the DANN is stacked with alternative layers (ALs), each of which consists of a volumetric convolutional layer followed by are current layer. Compared with popular deep feed-forward neural networks, the DANN learns local features and their contexts from the very beginning.

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