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Unusual Events Detection via Global Optical Flow and SVM

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***Abstract*—**Detection of unusual events in video streams, for the purpose of investigation and security is a challenging technology in crowded scenes. To address this issues, an algorithm is proposed, which is based on Histogram of Optical Flow Orientation image descriptor and nonlinear one-class SVM classification method. The optical flow method is computed at each pixel to extract the low-level features. Histogram of Optical Flow Orientation descriptor encoding the global moving information of each frame and one-class support vector machine classifier detects the unusual events in the current frame, after learning period distinguishing the common behaviors of the training frame. k nearest neighbor classifier is used to classify the abnormal frames in video streams. Further, by combining the background subtraction step and optical flow computation, a improved version of the detection algorithm is designed. This proposed method works on several benchmark datasets to detect unusual events. Histogram of optical flow orientation with nonlinear one-class SVM classifier shows the high performance result than, k nearest neighbor classifier with histogram of optical flow orientation.

***Keywords*—**Unusual event detection, Optical Flow, Histogram of Optical Flow Orientation (HOFO), one-class SVM, k nearest neighbor (kNN).

I. INTRODUCTION

Visual surveillance is one of the major research area in image processing. For obtaining clear information about the behavior of groups and individuals, needs implementation of automatic system, it's a scientific challenge in this area. Detecting unusual events in public scenes is a challenging technology in public safety.

Literature has other names for unusual event detection problems such as irregular behavior, uncommon behavior, anomaly, abnormal behavior/event, etc [1]. The research concentrates on conference video, surveillance video of the areas including museum, plaza, traffic, parking lot etc. Abstraction and event modeling are the two main components of the unusual event detection. Pixel-based abstraction, logical-based abstraction, object-based abstractions are the three main categories of the abstraction [2], [3]. The properties of pixel features in the input are described by pixel-based abstraction. Input is organized into statement of semantic knowledge in logic-based abstraction. Input is described in terms of semantic objects in object based abstraction. In order to describe and recognize events in a particular domain, event modeling seeks formal ways. Pattern-recognition, semantic event models and state event models are the three main categories of event modeling.

A pattern-recognition unusual event detection method combined with pixel-based abstraction is proposed in this work.

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A feature-based unusual event detection method is presented in this work. The proposed algorithm is comprised of two parts namely low-level visual feature extraction, and event classification by nonlinear one-class support vector machine [4]. In the proposed algorithm a histogram of optical flow orientation image descriptor encodes the global moving information of the frame and one-class SVM classifier is adopted to distinguish the unusual event from the reference model. In section 2 Literature survey is presented. In section 3 features selection by using optical flow method is described. In section 4 one-class support vector machine classification method is described. In section 5 k nearest neighbor classification method is introduced. In section 6 unusual event detection method is proposed. In section 7 system architecture is presented. Finally section 8 concludes the work.

II. LITERATURE SURVEY

In [5]-[8], to detect foreground pixels an adaptive background subtraction method was utilized. Bayesian models are utilized to represent pixel change history. Optical flow method was computed at each pixel to detect the motion and these motions are represented by semantic word. In [9], delta dual hierarchical Dirichlet processes (dDHCP) were utilized to detect unusual events in field of visual features. In [10], to detect unusual activities in video, a space-time Markov random field model was proposed. Features were extracted at each frame by using optical flow method and typical patterns were recognized by using mixture of probabilistic principal component analyzer (MPPCA). These methods achieved successful results on

several scenes. An accurate statistical model of the scenes cannot be extracted, in various situations this rises a need for model free method.

Some researches concentrate on spatio-temporal models. In [11], the motions was depicted by co-occurrence matrix, Markov random field model was utilized to narrate the co-occurrence matrix built based on three dimensional spatiotemporal foreground features. Unusual activities, which were the significant changes in speed, direction and size of the object were detected. The work was similar to foreground subtraction method, when the background is unstable.

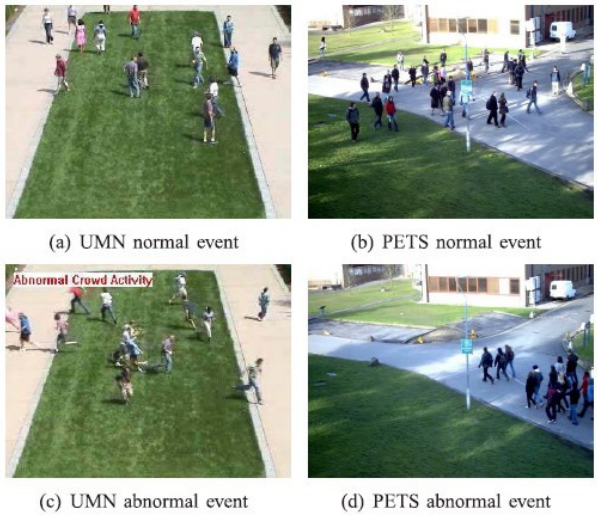
Unusual event detection problems also involve personal gesture recognition. In [12]-[15], a parametric model of varied behavior was utilized, in order to identify and characterize the set of actions. In [16], an algorithm built video representation in terms of nearby space-time features and concentrated on the gestures of individuals, such as hand-waving, walking, running, jogging, clapping, boxing, etc. These works not concentrate on the global scene, but concentrate only on the individual.

In [17], key frame extraction is done in light of visual consideration which will connect crevice between low level components and semantic of video. The current visual consideration models can be gathered into two classifications: base up, saliency-driven and undertaking free models and top-down, volition-controlled and errand subordinate. The primary strides for key casing extraction include, demonstrating visual consideration, melding consideration models and bunching video outlines models.

The proposed unusual event detection method based on the optical flow feature descriptor and the pattern classification. Two datasets are utilized in our work, those are Performance Evaluation of Tracking and Surveillance (PETS2009) [18] and University of Minnesota (UMN) [19] dataset as shown in Figure 1. The contribution of this paper comprised of two parts. First, the low-level movement features are extricated without object tracking. Second, unusual events are detected by grouping the features extracted, by using one-class support vector machine classification method.

III. FEATURES SELECTION BY USING OPTICAL FLOW

Optical flow method gives key information regarding the spatial arrangement and the change rate of this arrangement of the object [20]. Because actions can be showed by both the amplitude and direction of object motion on the scene, optical flow descriptor is selected to extract the features of the scene. In [20], the Horn-Schunck optical flow method is adopted in our work.



(a) UMN normal event (b) PETS normal event

(c) UMN abnormal event (d) PETS abnormal event

Fig 1[1]: Normal and abnormal scenes. (a) A normal frame in UMN dataset lawn scene; the individual are walking in different directions. (b) A normal frame in PETS2009 dataset; the individuals are walking in different directions. (c) An abnormal frame in lawn scene; the individuals are running in different directions. (d) An abnormal frame in PETS2009 dataset; all the individuals are walking in the same direction.

The Horn-Schunck optical flow method combines the spatial term with a data term, the anticipated flow variation is modeled by the spatial term and the data term assumes fidelity of the same image property. The image descriptor computes the histogram of optical flow orientation of the foreground image or original image acquired after applying background subtraction method. The histogram of optical flow orientation descriptor is calculated over overlapping grids and dense of the spatial blocks, with optical flow features extricated at fixed resolution and congregated into high dimensional feature vector to depict the motion information of the frame. The computing procedures of HOFO in foreground image and original image is alike.

IV. ONE-CLASS SUPPORT VECTOR MACHINE CLASSIFICATION

Support Vector Machine is proposed by Vapnik and Lerner [21], is a method based on statistical learning theory. Support vector machine recognizes patterns and analyses data, utilized for classification and regression. Support vector machine classification method was extended to non-linear classification by adopting kernel methods. The support vector machine can perform non-linear classification problems efficiently by utilizing this kernel method [22]-[24]. Aim of the non-linear one-class support vector machine is to find out an suitable region in data space which containing most of the data drawn from an concealed probability distribution. This target can be accomplished by piercing for a decision hyper plane in the feature space, which amplifies its distance from the origin,

while only a small-scale fraction of data drops between the hyper plane and the origin [25].

V. K NEAREST NEIGHBOR CLASSIFIER

In [26], Classification utilizing an instance based classifier can be a straightforward matter of finding the nearest neighbor in occasion space and labeling the obscure instance with the same class name as that of the found (known) neighbor. This methodology is often referred to as a closest neighbor classifier. The drawback of this straightforward methodology is the lack of the robustness that portray the subsequent classifiers. The high level of local affectibility makes nearest neighbor classifiers exceptionally helpless to noise in the training data. More robust models can be accomplished by finding k, where k>1, neighbors what's more, giving the lion's share a chance to vote choose the result of the class labeling. A higher estimation of k results in a smoother, less locally delicate capacity. The nearest neighbor classifier can be viewed as a unique instance of the more general k nearest neighbors classifier, from this point referred to as a k nearest neighbor classifier.

In pattern recognition, the k nearest neighbor calculation (kNN, in short) is a non-parametric strategy utilized for regression and classification. In both cases, the input comprises of the k nearest training example in the feature space. The output relies on upon whether kNN is utilized for regression or classification.

- In k nearest neighbor classification, yield is a class participation. An object is classified by a greater part vote of its neighbors, with the item being doled out the class most normal among its k nearest neighbors. If k=1, then the item is just relegated to the class of that single nearest neighbor.
- In k nearest neighbor regression, the yield is the properly estimation for the object. This value is the normal of the estimations of its k closest neighbor.

kNN is a kind of lazy learning or instance based learning, here the function is just approximated locally and all calculation is conceded until classification. The kNN algorithm is among the least difficult of all machine learning algorithm.

Both for regression and classification, it can be helpful to weight the commitments of the neighbors, so that the closest neighbors contribute more to the normal than the more inaccessible ones. The neighbors are taken from an arrangement of articles for which the class is known. This can be considered as the training set for the algorithm, though no obvious training step is needed.

The training samples are vectors in a multidimensional highlight space, each with a class mark. The training phase of the algorithm only of storing the class labels and feature vectors of the training examples. In the classification phase, k is a client characterized constant, and an unlabeled vector is classified by allocating the mark which is most recurrent among the k training tests closest to that inquiry point.

VI. PROPOSED METHOD

A method for usual event detection in video streams is described in this section. Consider a set of training frames describing the normal behaviors, such as person is loitering or walking as shown in Fig 1(a) and 1(b), and the frames in which individual is running or walking with sudden split are considered as unusual events, as shown in Fig1(c) and 1(d). Events deviating from the training set behaviors are considered as unusual behavior. Aim of this is to detect unusual events based on training examples through one-class support vector machine.

- Step1: First step comprises of calculating the optical flow at gray scale. The optical flow method is applied at each pixel to extract the low level motion features of the training frames.
- Step2: Second step consists of calculating the histogram of optical flow orientation of the training frames. when histogram of optical flow orientation of the global foreground image is being calculated in that time the background subtraction method is not considered.
- Step3: In the third step to one-class SVM classification method is applied to the histogram of optical flow orientation of the training frames to acquire the support vector.
- Step4: In the testing phase, each frame is classified based on the support vectors obtained from training frames.
- Step5: The decision of global frame abnormality is made, after obtaining detected results of each block or point by presetting the number as threshold. If the number of abnormal points is larger then the threshold N in the normal states, then the normal forecast labels are converted into abnormal.

For classification of abnormal frames, k nearest neighbor classifier algorithm is utilized. First step comprises of calculating the optical flow feature at the gray scale. To acquire the low level motion features, horn-Schunck optical flow method is applied at each pixel of the training frames. Next step comprises of calculating the histogram of optical flow orientation (HOFO) of the training frames, and applying k nearest neighbor classifier to acquire the kNN vectors. Each frame is classified based on the kNN vectors obtained from training frames in testing phase, after acquiring detected results of each point or block. Then preset the number as threshold, if the number of abnormal states is larger than the threshold N within normal states, then the normal forecast labels are considered as abnormal.

Both the support vector machine classification method and k nearest neighbor classification method is utilized to detect the unusual events in video streams.

VII. SYSTEM ARCHITECTURE

An architectural diagram of proposed unusual events detection method as shown in Fig 2. To detect the unusual events in the video frames it is important to convert the video frames in to image. First we convert the video frames into RGB(color) image and next this RGB(color) image is converted into Gray scale image and this Gray scale image is converted into block and white image.

Median filter method is applied on this block and white image, it preserves the positions of limits in an picture, furthermore preserves brightness difference bringing about insignificant obscuring of local limits, making this technique helpful for visual examination. Median filter is utilized to remove noise from the images. In [27], Median filter is used in preprocessing step for noise reduction to improve the result of later processing. Median filter is broadly utilized in image processing because it preserves edges while removing noise. Erode function is applied on this filtered image, it removes the connected components in the image.

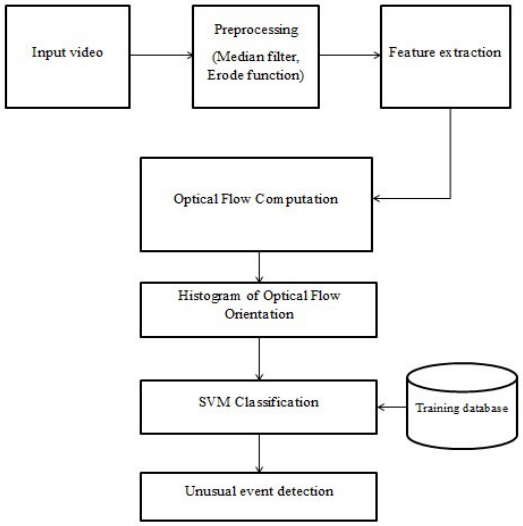


Fig 2: System Architecture

Features are extracted by applying the optical flow method. Feature extraction computes features on the premise of which image can be easily categorized as usual or unusual one. Feature extraction includes decreasing the amount of data required to depict a large set of data precisely. Features are utilized as inputs to classifiers. The purpose of feature extrication is to decrease the original data by measuring positive features, or properties that differentiate one input test from another test. Feature vectors are generated for the extracted features by using optical flow descriptor, histogram of optical flow orientation shows the global moving information of each frame.

Support vector machine classification algorithm is introduced by Vapnik and Lerner in 1963. Support vector machine classification method, it's a method of statistical learning theory which gives enhanced result than other classification algorithm. SVM groups between two classes by developing a hyper plane in high-dimensional component space which can be utilized for classification. One-class SVM classification algorithm is a model free method that distinguishes the unusual events from the reference model.

VIII. CONCLUSION

A method for unusual events detection is proposed, which is based on two components, calculating the histogram of optical flow orientation and applying one-class support vector machine for classification. The histogram of optical flow orientation (HOFO) descriptor is calculated on the original image and also foreground image, which is acquired after applying background subtraction method for quick implementation. Proposed algorithm is compared with the k nearest neighbor classification algorithm, the result is better obtained with the proposed algorithm. The proposed method is applied on several benchmark datasets, yielding successful results in detecting unusual events.

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