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High Efficiency Video Coding based Bag of Words for Moving Object Detection

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ABSTRACT: This research paper proposes a novel method of high efficiency video coding bag of words for moving object detection in the digital videos. One of the main advantages of the work done in this paper is the simplicity of the algo developed. The proposed framework consists of 2 processes, namely, segmentation of the moving body & the classification of either person or vehicle in a moving video. The classification and segmentation of the moving body from the compressed video requires the removal of non-moving parts from the frame and refining the rest of the frame for better quality for this motion vector interpolation & futher used for the outlier removal. The frames with cardinal (non-zero) motion vectors are taken into consideration and these cardinal motion vectors are combined into panorama regions using high end algorithm known frame join labeling. For the classification, our main focus is to categorize the moving objects into segments which then can be identified as persons or vehicles using high efficiency video coding bag of words. A system of Matlab with all the robot and camera controls is developed in this work using Histogram of Oriented Gradients (HOG) and Local Binary Pattern (LBP). A database of all the images of the objects are created and preserved. The HOG descriptor technique counts occurrences of gradient orientation in localized portions of an image detection window. LBP & SVM concepts are used to classify the identified objects. Thus, the proposed method shows the efficacy of the methodology developed by us which can be verified from the simulated results, both in graphical form as well as in the form of quantitative results depicted in the form of numerical tables.

KEYWORDS: Image, Object, Multiple, Video, Detection, Surveillance, Cluster, CNN, KNN, HOG, SVM, Identification, Tracking, Shadow, Logical Reasoning, Multiple Objects, k-means, Segmentation, Histogram, Foreground, Background.

I. ORGANIZATION OF THE RESEARCH PAPER

The organization of the paper is developed as follows. A brief introduction to the related work is presented in the introductory section II. The section III presents an overview of the literature related to the work done by various others in the relevant field till date along with their advantages & dis-advantages. The section IV explains the proposed methodology, whereas the phases of object identification technique of detection is depicted in the section V. The moving object detection is explained in section VI followed by the extraction of features in section VII. The section VIII gives the classification theory followed by the feature extraction concepts of HOG & LBP in section IX. The pre-processing of objects is explained in section X followed by the development of HOG algorithm in section XI. The section XII & XIII gives a overview of the classification schemes using LBP & SVM classifiers. Finally, the graphical & quantitative results are displayed in section XIV. The summary of the work done & The concluding remarks of the research work done is presented in the Section XV. This is followed by an exhaustive number of references that were used in the development of this review paper.

II. INTRODUCTION

Bag of Visual Words is an extension to the NLP algorithm Bag of Words used for image classification. Other than CNN, it is quite widely used. BOV was developed by Surka et.al. essentially creates a vocabulary that can best describe the image in terms of extrapolable features. It follows 4 simple steps - Determination of Image features of a given label - Construction of visual vocabulary by clustering, followed by frequency analysis - Classification of images based on vocabulary generated - Obtain most optimum class for query image. Bag of Visual Words is a supervised learning model. There will be a training set and a testing set. One can split the dataset into training and testing & use the 70-30 ratio or 80-20 or 60-40 also max. But if the training data is not good, there will be definitely lot of discrepancies in the output.

BOVW is an example of supervised learning. It's always better to keep a mapping of which images belong to what classification label (a label can be defined as a key/value for identifying to what class/category does the object belongs). Extract features from the training image sets. One can use OpenCV files such as the SIFT or SURF & can generate the output. This essentially converts the image into a feature vector. The final step is codebook generation. A codebook can be thought of as a dictionary that registers corresponding mappings between features and their definition in the object. We need to define set of words (essentially the features marked by words) that provides an analogous relation of an object (being trained) w.r.t. a set of features.

III. LITERATURE SURVEY

A large number of researchers have worked on the chosen topic [1]-[100]. In this research paper, some relevant ones which have been used are being cited & referenced. high efficiency video coding bag of words for moving object detection in the videos & its identification with tracking plays a very important role in the modern-day surveillance mission, especially in the country's security point of view to identify the terrorists as it will be very difficult to identify from black & white scenes [1]-[100].

The classification and segmentation of moving body from surveillance video is one of the advanced tasks. Present methods take pixel by pixel domain for the detection of moving object as frames. Video which is taken from the surveillance videos are mostly in encrypted form with international coding ? To use these encrypted videos for our purpose we need to perform decrypting of videos. For doing this in huge scale requires lots of decryption of videos which is a major problem. To overcome this problem compression of video approach is used which takes features from the stream. The most important advantage of compressed video technique is its low computational complexity because the decryption and reforming are avoided of all the pixels [77].

Video object segmentation and tracking framework with improved threshold decision & diffusion distance algorithm development was carried out by Chien et.al. in [77]. Video-based tracking, learning, and recognition method for multiple moving objects, their tracking & other subsidiary process was developed by Sakaino et.al. in [78]. Pulare et.al. [79] worked on the hardware implementation of real time multiple object detection and classification of HEVC Videos on the real time platform. An hybrid video object tracking in H.265/HEVC video streaming was developed by Giil et.al. in [80].

In [81], an interference alignment technique for the MIMO multicell based on relay interference in the broadcast channels was proposed by Manikanthan. Padmapriya et.al. [82] also worked on the inter-cell load balancing technique for multi class traffic in MIMO - LTE networks and proposed novel load balancing schemes that could be used for any type of generalized videos & images. Shih-Yao Juang et.al. [83] did some implementation on the real-time indoor surveillance based on smartphone and mobile robots' movements using the videos captured inside the building. An application of image processing & distance computations to WMR obstacle avoidances in a workspace area cluttered with obstacles and parking control was put forward by Zhan et.al. [84].

A people posture recognition and tracking of home-care assistant in the context of robotic scenario was worked upon by Jhang et.al. in [85]. Dynamic window-based approach to mobile robot motion control in the presence of moving obstacles in a 3D environment was designed & developed by Seder et.al. in [86] which could be used for any type of machine vision applications doing a particular job. Improving the path following performance of mobile robots using an hybrid genetic algorithm was coined by Cai et.al. in [87]. Intelligent path planning & parking control of a wheeled mobile robot using the videos of the moving robots in a 3D environment was demonstrated by the group of Chen et.al. in [88].

Integrated person tracking using the stereo, colour & detection of patterns in the mobile robotics technology was developed by Darrell et.al. in [89]. Kshitij Dhoble et.al. proposed an online spatio-temporal pattern recognition with evolving spiking neural networks utilizing an address event representation, rank order & temporal spike learning in [90].

Nimish Kale et.al. studied on the impact of sensor misplacement on the dynamic time warping based human activity recognition using wearable computers in [91] & used it for machine vision concepts for detection of objects in the 3D videos. Soumitra Samanta et.al. proposed a new method for the detection & description of the space-time interest points for the human activity classification in the captured videos and named it as the FaSTIP technology in [92]. Recognition of the objects in the videos using the discriminative parts was developed by Liu et.al. in [93]. Yang & Jingjing et.al. [94] conceptualized a new group-sensitive multiple kernel learning algorithm for the recognition of objects in a crowded environment video.

A review / survey paper on the moving of the objects & its detection in video surveillance world was written very nicely by the team of Aqsa Khan & Janwe et.al. in [96]. Identification of the fast & slow movements of humans in a video surveillance system was developed in Divya et.al. in [97]. Swati Gossain et.al. proposed a novel approach to enhance object detection using integrated detection algorithm and used it for object detection in videos in their research paper in [98]. Tomasz et.al. did the real-time implementation of the moving object detection in video surveillance environment using the FPGA Spartran Kit and was successful in demonstrating both at the simulation level & at the hardware implementation level in [99].

The classification and segmentation of moving body from surveillance video is one of the advanced tasks. Present methods take pixel by pixel domain for the detection of moving object as frames. Video which is taken from the surveillance videos are mostly in encrypted form with international coding ? To use these encrypted videos for our purpose we need to perform decrypting of videos. For doing this in huge scale requires lots of decryption of videos which is a major problem. To overcome this problem compression of video approach is used which takes features from the stream. The most important advantage of compressed video technique is its low computational complexity because the decryption and reforming is avoided of all the pixels [77].

IV. PROPOSED METHOD

The proposed framework consists of 2 processes, namely,
1. Segmentation of moving body.
2. Classification of either person or vehicle.

The classification and segmentation of moving body from the compressed video requires the removal of non-moving parts from the frame and refining the rest of the frame for better quality for this motion vector interpolation is used for the outlier removal. The frames with cardinal (non-zero) motion vectors are taken into consideration and these cardinal motion vectors are combined into panorama regions using high end algorithm known frame join labeling. After this the blur region is removed. One of the major parts of this process is the classification of either person or vehicle for this high efficiency video coding is done using a 'bag of words' this is also called as testing phase. A code book is created which has all the information of the description which is required for the identification of person or vehicle, after defining the code book a classifier is trained which uses this code book for the accurate identification of person or vehicle [78].

V. PHASES OF OBJECT IDENTIFICATION DETECTION

First phase is preprocessing in which high efficiency video coding on compressed video is done. Each frame has different motion vector, each motion vector is connected with another using intra coded prediction unit. The motion vectors are kept disorganized is such a way to make them independent of different frames [79]. To carry out the above process we've to divide the motion vectors in accordance to the difference between corresponding frame number and the reference frame number in the order of display. Prior to the segmentation and classification of the moving body the removal of blur region and motion vector interpolation on blocks are done.

VI. MOVING OBJECT DETECTION

After the process of preprocessing is completed of motion vectors, the cardinal (non-zero) is marked as panorama blocks. These panorama blocks are joined using an algorithm know as frame join labeling. In next step we need to check over the time-related consistency of each panorama block using the tracing of body method. Lastly, we've to re-define the boundary of body in motion which can be done using either by checking size of code unit or size of prediction unit.

VII. FEATURE EXTRACTION

Till now we've identified 3 features w.r.t. the motion, i.e.,
1. Size of motion vectors.
2. Difference between motion vectors.
3. Modes of prediction.

The speed with which a body travels is directly proportional to the length of the motion vectors which is one of the important aspects in identifying weather the moving body is person or vehicle as most of the times vehicles travel much faster than person [80]. It is very difficult to find good match for the prediction units for persons as human body undergo soft distortion. For this reason more framesets are taken into consideration for the accurate identification of person or vehicle.

VIII. CLASSIFICATION

For the classification, our main focus is to categorize the moving objects into segments which then can be identified as persons or vehicles using high efficiency video coding bag of words [81]. The steps involved in classifying the moving objects into persons or vehicles are:
1. For moving object region we've to describe the segment using high efficiency video coding.
2. Creating code book using integration method.
3. For each moving object, represent it using a proper code word from code book.
4. For moving persons or vehicles training a classifier for identification.

The correctness of the segmented panorama and background blocks is measured by comparing them with the correct values calculated from the below formulas. It is evaluated in terms of precision, recall and F1-measure. The representation TPV, FPV and FNV are the total number of true positives value, false positives value, and false negatives value as given by the equations (1) to (3) as

$$\text{Precision value} = \frac{TPV}{TPV + FPV} \qquad (1)$$

$$\text{Recall value} = \frac{TPV}{TPV + FNV} \qquad (2)$$

$$\text{FI} - \text{measure value} = \left(\frac{2 \times \text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}} \right) \qquad (3)$$

IX. HOG & LBP FEATURES BASED OBJECT DETECTION

A system of MATLAB with all the robot and camera controls is developed in this work using Histogram of Oriented Gradients (HOG) and Local Binary Pattern (LBP). A database of all the images of the objects are created and preserved. This database is interfaced with MATLAB. The images of objects were assigned with different object ID. These images can be accessed using that ID nos. when the system operator wants to get one object, the inputs the corresponding object ID no. Then the MATLAB process matches the product ID with its image in database and it sends a start command [82]. The MATLAB process running on the PC collects each image and compares with the image extracted from the database using Real Time HOG algorithm, until a match is found. If there is any match, the MATLAB process sends a stop command, which will end the surveillance process. If not, it issues a new start command, extending the surveillance. The block diagram of the proposed system is shown in the Fig. 1.

X. PREPROCESSING

The above block diagram of the proposed system it is understood that how the recognition of the object is done. Here the image recognition starts with the help of trained images from the training image set. The image in that training dataset will be preprocessed. The preprocessing is done by performing the action of noise reduction by removing the unwanted noise from the dataset images. This preprocessing will be done before the extraction of LBP features with the help of HOG algorithm. By the same way the live image will be taken in real time and it will be preprocessed. After this step the image will be processed with the help of HOG algorithm [83]-[85].

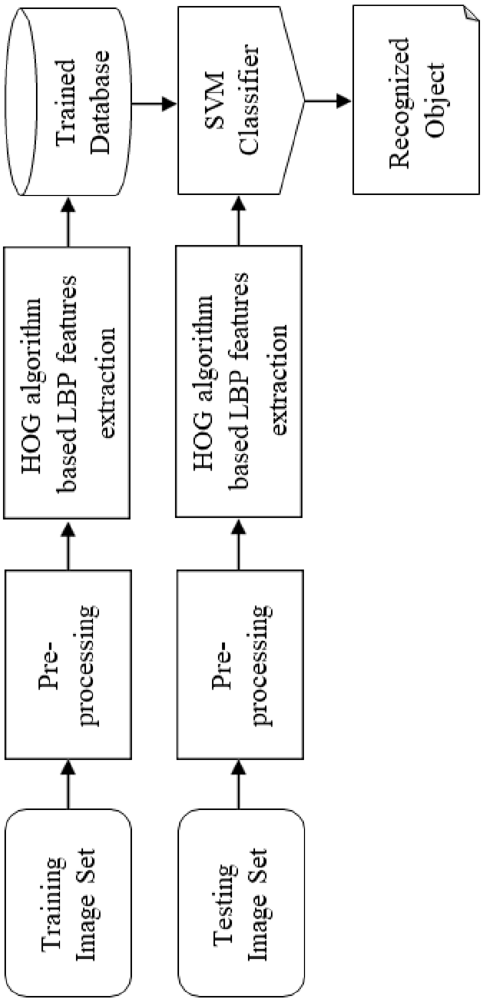

Fig. 1 : HOG Algorithm Based Object Recognition System

XI. HOG ALGORITHM

Histogram of oriented gradients is a feature descriptor used to detect objects in computer vision and image processing. The HOG descriptor technique counts occurrences of gradient orientation in localized portions of an image detection window, or region of interest implementation of the HOG descriptor algorithm is as follows:

1. Divide the image into small connected regions called cells, and for each cell compute a histogram of gradient directions or edge orientations for the pixels within the cell.
2. Discrete each cell into angular bins according to the gradient orientation.
3. Each cell's pixel contributes weighted gradient to its corresponding angular bin.
4. Groups of adjacent cells are considered as spatial regions called blocks. The grouping of cells into a block is the basis for grouping and normalization of histograms.
5. Normalized group of histograms represents the block histogram. The set of these block histograms represents the descriptor.

To calculate a HOG descriptor, we need to first calculate the horizontal and vertical gradients; after all, we want to calculate the histogram of gradients. This is easily achieved by filtering the image with the following kernels [84].

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-1	0	1

-1
0
1

Fig. 2 : Horizontal and vertical calculation model of gradient in an image

Next, w.r.t. the Fig. 2, we can find the magnitude and direction of gradient using the following formula in equation (4) & (5) given as

$$g = \sqrt{g_x^2 + g_y^2} \tag{4}$$

$$\theta = \arctan\left(\frac{g_y}{g_x}\right) \tag{5}$$

XII. LOCAL BINARY PATTERN

Local binary patterns are a type of visual descriptor used for classification in computer vision. It has since been found to be a powerful feature for texture classification; it has further been determined that when LBP is combined with the histogram of oriented gradients descriptor, it improves the detection performance considerably on some datasets [86]-[89]. The LBP feature vector, in its simplest form, is created in the following manner as a 10-step algorithm given by

1. Divide the examined window into cells (e.g., 16 × 16 pixels for each cell).
2. For each pixel in a cell, compare the pixel to each of its 8 neighbors (on its left-top, left- middle, left-bottom, right-top, etc.).
3. Follow the pixels along a circle, i.e. clockwise or counter-clockwise.
4. Where the center pixel's value is greater than the neighbour's value, write "0". Otherwise, write "1"
5. This gives an 8-digit binary number (which is usually converted to decimal for convenience).
6. Compute the histogram, over the cell, of the frequency of each "number" occurring (i.e., each combination of which pixels are smaller and which are greater than the center).
7. This histogram can be seen as a 256-dimensional feature vector.
8. Optionally normalize the histogram.
9. Concatenate (normalized) histograms of all cells.
10. This gives a feature vector for the entire window.

After this process is done features are stored as the trained database and the features are used as an input for the SVM classifier later.

XIII. SUPPORT VECTOR MACHINE CLASSIFIER

In machine learning, support vector machines SVMs, (also support vector networks) are supervised learning models with associated learning algorithms that analyze data and recognize patterns, used for classification and regression analysis. Given a set of training examples, each marked for belonging to one of two categories, an SVM training algorithm builds a model that assigns new examples into one category or the other, making it a non-probabilistic binary linear classifier. An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall on [90]-[93].

In addition to performing linear classification, SVMs can efficiently perform a non-linear classification using what is called the kernel trick, implicitly mapping their inputs into high-dimensional feature spaces. In this chapter SVM is used to compare and classify the stored database image and the real time image that will be from the HOG algorithm output. PC collects each image and compares with the image extracted from the database using Real Time HOG algorithm, until a match is found. According to the image comparison if the object is found correct then the stop command will be executed and the mat lab will receive the command and the execution will be stopped [93]-[95].

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XIV. RESULTS AND DISCUSSION

The coding is developed in the Matlab & in OpenCV environment. The developed code is run & the simulation results are observed. In fact, two methodologies are presented here in this context, viz., method 1 & the method 2, which are explained one after the other as follows.

Method 1 :
In this table no. 1, we present the estimated speed of moving object when the object is segmented.

Order	Resoluteness	Motion Speed (feet / second)
Room surveillance	300 × 280	321
Ring way person on	332 × 252	620
Foot	382 × 290	546
1st sequence	620 × 360	289
2nd sequence	720 × 1080	80
3rd sequence	480 × 380	500
4th sequence	480 × 640	301
5th sequence	1080 × 1990	92
6th sequence	240 × 360	283

Table 1 : Estimated Speed of Moving Object When Segmented

In this table no. 2, we present the comparison of precision, recall & F1-measure

Procedure	Precision	Recall	FI-measure
Prefer	57.2	82.1	72.1
	80.9	82.6	80
	37.5	100.2	40.3
	27.1	87.4	33.9

Table 2 : Comparison of Precision, Recall & F1-Measure

Method 2 :
This work is implemented on real time object images that include the industrial appliances and materials etc. This real time complete image set is collected from external web source. From this input set, the partial objects are obtained by performing the object level segmentation. This segmented partial object is extracted using the image processing tool. Different sample sets are composed using the complete and partial images. The previously stored image set is considered as the training set and the real time image set is considered as the testing set. The table no. 3 gives the description of the datasets that are being used in our research work.

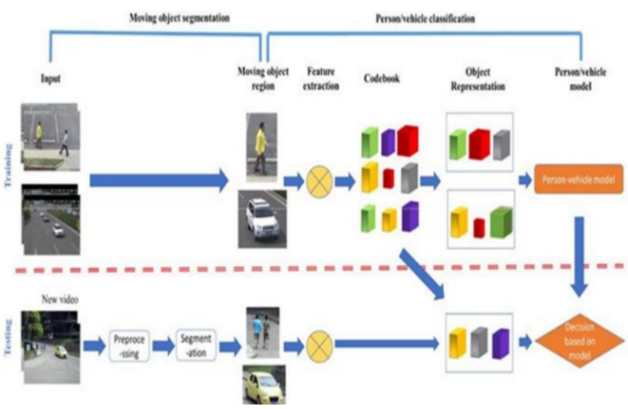

Fig. 3 : Proposed method training and testing

Properties	Values
Resolution (Training)	256x256
Resolution (Testing)	Random
Type	Grayscale
Type of Images (Training)	Real Time Object Images
Type of Images (Training)	Real Time Object Images
Type of Images (Testing)	Real time Partial Object Image
Number of Training Instances	50
Number of Testing instances	30

Table 3 : Description of Dataset

The results of our proposed system are obtained, in the form of recognition rate. When the complete object dataset is considered as the input image for same size sample set, all the images provided the true recognition and it gives about 100 % recognition rate. When the partial object at the same orientation is considered with a sample set of 30 images, 27 images provided the effective accurate recognition. It shows that the work has provided good recognition rate for such sample set. When the partial set is taken from different orientation and a sample set of 30 images is considered for recognition, it provided the accurate recognition for 25 images. The table no. 4 gives the performance of the HOG algorithm-based object recognition for different accuracies in percentage for varied degrees from ranging from 10 to 90°.

Average accuracy in percentage (%)				
10°	30°	45°	60°	90°
87.19	79.87	64.45	58.89	50.44
87.22	74.22	64.11	55.55	50.11
88.44	82.55	80.22	79.66	77.69
96.22	89.88	87.55	71.22	66.55

Table 4 : Performance of HOG algo based object recognition

XV. SUMMARY & CONCLUSIONS

In this research paper, we have exhibited a novel way to deal with portion what's more, group the moving articles from HEVC packed reconnaissance video. Just the movement vectors and the related coding modes from the packed stream are utilized as a part of the proposed technique. In the proposed technique, right off the bat, MV interjection for intra-coded PU and MV anomaly evacuation are utilized for preprocessing. Furthermore, obstructs with non-zero movement vectors are bunched into associated forefront locales by the four-availability segment naming calculation. Thirdly, protest locale following in view of worldly consistency is connected to the associated frontal area districts to expel the commotion areas. The limit of moving item area is additionally refined by the coding unit size and forecast unit estimate. At last, a man vehicle characterization demonstrate utilizing packs of spatial-transient HEVC grammar words is prepared to arrange the moving articles, either people or vehicles. The proposed technique has a genuinely low handling time, yet still gives high exactness. In this research paper, an approach for the recognition of objects from real time images using HOG algorithm-based LBP feature extraction is presented. As HOG algorithm-based LBP gives a better approximation of images, it produces an excellent performance for object recognition. The features from both the training and the testing phases are fused together and given as the inputs to the SVM classifier where the recognition of object is done. Experimental results show that the proposed fusion approach produces 97.81% accuracy. The graphical & the quantitative results presented here shows the power & efficacy of the methodology developed by us.

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