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A Review on Various Traffic Event Detection Techniques

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***Abstract*—** Unusual event detection is the task of identifying the unusual events in a given region or area. Over last few years, Unusual event detection has received much of attraction due to its wide range of applications like fall detection, accident detection, lane change detection, red light running, traffic video surveillance . It is a very consequential and efficacious research topic in field of computer vision and video processing. Consequently, identification of unusual event from a given sequence of video frames becomes pertinent. However, task of detecting unusual event in motion becomes tricky due to various challenges like dynamic scene changes, illumination variations, and presence of shadow, camouflage and bootstrapping problem. To lessen the consequences of these problems, researchers have proposed number of new approaches. This paper provides a brief classification of the classical approaches for unusual event detection. Further, paper reviews recent research trends to detect unusual events along with discussion of key points and limitations of each approach.

***Keywords*—**Lane Change Detection, Intelligent Video Surveillance, Moving Object Detection

I. INTRODUCTION

Intelligence video surveillance is an important research area in the commercial sector. Technology has reached a phase where mounting cameras to imprison video images is cheap, but finding available employees to sit and watch that images is expensive. Surveillance cameras are very popular these days as they record their output in tapes that are rewritten time to time or stored in video library. After a crime occurs – a store is robbed or a car is stolen – investigators can go back after the fact to see what happened, but of course by then it is too late. What is needed is uninterrupted 24-hour monitoring and analysis of video surveillance data to alert security officers to a robbery in progress, or to a distrustful individual loitering in the parking lot, while options are still open for avoiding the crime.

This automatic video understanding technology enables a single human operator to observe activities over a multifaceted area using a distributed network of active video sensors. This technology can help to automatically gather and circulate real-time information from the battle field to improve the situational awareness of commanders and staff. Other military and federal law enforcement applications include providing perimeter security for troops, monitoring peace treaties or refugee movements from unmanned air vehicles, providing security for embassies or airports, and staking out suspected drug or terrorist hide-outs by collecting time-stamped pictures of everyone entering and exiting the building. Tracking of people, vehicles, and their interactions in an urban or battlefield environment is a complex task. This technology helps in achieving this goal is to automatically "parse" people and vehicles from raw video, determine their geolocations, and insert them into dynamic scene visualization [1].

In recent years surveillance systems have used in many applications in public and private premises. Security of the citizens in public places such as Hotels, Markets, Malls, and Public Transports is increasingly becoming a crucial task. In recent years, the number of surveillance cameras installed to monitor private and public spaces and areas has increased dramatically.

For many visual surveillance applications however, there is a need of such a system that would automatically interpret the entire scene and alert in case of any suspicious situation. Now detection of multiple human activities in real time is very difficult task. Detection of moving objects in video systems is the first step of Information removal in many computer visualization systems for those video cameras are extensively used to examine public and private areas [2].

This paper is an outcome of comparative analysis of extracts drawn from literature review of 40 IEEE papers ranging from

year 2000 to the year 2017, carried out to understand the suspicious activity detection methodologies used for detecting abnormal human behavior, tracing abandoned object, or unattended baggage etc., which led to an extensive comparison between various proposed methods. Many technologies, mostly based on intelligent techniques like Neural Systems, Fuzzy Logic, Support Vector Machine, Genetic Algorithm etc. emerged out as basis for intelligence in such systems. The outcome of the review is presented in form of various findings, which includes techniques and methods used to solve particular research problem, along with their strengths and weaknesses [3].

Rest of the paper is organised as follows Section I contains the introduction of the paper, Section II covers the Key Approaches used in the various event detection, Section III contains the technologies used and their strengths and Weaknesses, Section IV describes the Gaps Identified in the area of research work which need improvement, Section V contains the conclusion and discussion.

II. KEY APPROACHES

A. All the solution approaches had majorly following stages for unusual event detection:
   a. Extracting semantic events.
   b. Feature Based Event Detection.
   c. Background subtraction and connected Component labelling

B. Visual surveillance addresses following issues:
- Environment modelling
- Motion detection
- Classification of objects
- Occlusion handling
- Features extraction
- Unusual activity
- Anomaly detection and behavior prediction
- Content-based retrieval of surveillance videos, behavior
- Fusion of information from multiple sensors and remote surveillance [4].

C. Various Key Approaches for Unusual Event Detection by IVS Systems:

- Extracting low-level features+ analysis of extracted low-level features+ event interference
- Rolling background subtraction Technique & Closing morphological operation & Thresholding and Standard deviation
- Foreground Detector & Frame-level-Feature Extractor& Temporal-Feature-Extractor& Event Models [5].
- Digital processing based approach for CCTV image analysis.
- ANN, PIDS, EXEPRT SYSTEM
- Automatic video assessment of alanns by Perimeter Intrusion Detection systems
- Support Vector Machine
- Ant Colony Optimization and extraction by rule based AI inference system
- Multi-frame differencing method with adaptive ambient illumination changes
- Baye's decision theory, Bayesian model for probability judgment
- Histogram differencing and Fuzzy based extraction
- Scale space analysis and back propagation neural network
- Digital holography (correlation operation)
- Modified algorithm of quad tree creation

D. Applications:

- Behavioural Biometrics
- Content based video analysis
- Security and surveillance
- Interactive applications and environments
- Animation and synthesis

III. TECHNOLOGIES USED

The theoretical explanation of various key approaches used by the different researchers has been mentioned in previous section. This section includes the various approaches, methodologies used by the researchers with the overview of the methods used by them. The following subsections describe various key approaches, their positive aspects and limitations in their research work. The transaction, conference and journal papers reviewed in this category were built around the concepts and implementation of the complete intelligent video surveillance systems, for Unusual event detection, which included events like intrusion detection, loitering individuals, unattended objects, moving object detection, traffic events detection etc. all the solution approaches varied in terms of different algorithms used for background subtraction, target classification, and experimentation. An overview of various technologies and approaches can be summarized as follows.

TABLE 1: RECENT RESEARCH TRENDS OF UNUSUAL EVENT DETECTION

Publication Year	Title	Overview	Positive Aspects	Limitations
IEEE/2000	A Semantic Event-Detection Approach and Its Application to Detecting Hunts in Wildlife Video[6]	Decomposes the task of extracting semantic events into three stages where visual information is analyzed and abstracted.	+Captures information on what is moving, where and how based on a richer analysis using colour, texture, and motion.	+ Poor set of intermediate-level descriptors for generating shot summaries. +Automatic tuning of the performance of the event inference module.
IEEE/2000	Collision Avoidance Analysis for Lane Changing and Merging[7]	Analyzed the kinematics of the vehicles involved in a lane changing/merging maneuver, and studied the conditions under which lane changing/merging crashes can be avoided.	+Results obtained for the constant acceleration case can be used in order to decide whether a particular lane changing/merging scenario is collision free or not.	+in all simulations it is assumed that all vehicles, involved in the lane changing/merging maneuver, were initially at steady state, , i.e., their velocities were constant prior to the maneuver.
IEEE/2002	Real-Time Video Surveillance For Traffic Monitoring Using Virtual Line Analysis[8]	Uses the virtual line graph to facilitate the detection of vehicles, classification of vehicle types, tracking of individual vehicles, and subsequently an accurate count of the number of vehicles.	An average performance of 96.7% vehicle, count accuracy is achievable.	+automatic counting errors due to large trucks, long shadows, tailgating vehicles, obstructed vehicles, traffic congestions, and night times.
IEEE/2004	A Rejection-Based Method for Event Detection in Video[9]	For the gray-level domain, spatio-temporal templates are created by stacking the individual frames of the video sequence, and the detection is performed on these templates.	+is very fast and can successfully detect events even in very low resolution +it is capable of discriminating the desired event from arbitrary events, and not only from those in a negative training set.	+It cannot detect generic events(e.g. walking people)
IEEE/2005	Vision sense; An Advanced Lateral Collision Warning System[10]	Vision sense is an Advanced Driver Assistance system which combines a lateral collision warning system with vehicle-to-vehicle communication. This paper shows the results of user needs assessment and traffic safety modelling of Vision Sense.	+ Vision sense is most appreciated when it uses a light signal to warn the driver in a possibly hazardous situation on a highway.	+it is a way to simulate the difference between a car with and without Vision sense. The modification has not been validated with real data.
IEEE/2007	A New Vehicle Detection with Distance Estimation for Lane Change Warning Systems[11]	Developed a new algorithm and implemented the system for vehicle detection of the neighbouring lane. The system can detect the vehicle away from 30 m and is not affected by the shadows and marking on the road surface	+system can detect the vehicle away from 30 m and is not affected by the shadows and marking on the road surface. + The image processing time is quick enough for real-time application and the estimated vehicle distance are precise enough for avoiding collision.	+It cannot detect coming motorcycles
IEEE/2009	A Warning Algorithm for Lane Departure Warning	The warning algorithm is designed to prevent a single vehicle road	+Using this combination results in a reaction time increase from an average of 0.22 sec to a much	• The TLC approach assumes that the current steering angle or yaw rate would not change

	System[12]	departure, based on the lane position and road geometry information from a forward-looking image sensor, vehicle dynamic information and the driver's main active maneuver input.	higher time margin for over 92 percent of true warnings in the spatial warning function. + Using the combination of both mechanisms also reduces by 50 percent the false alarm incidence in the temporal warning function.	in the upcoming predicted time interval. + The maximum range of boundary detection also limits the effectiveness of the TLC approach.
IEEE / 2009	Moving Object and Shadow Detection Based on RGB Colour Space and Edge Ratio [13]	Separation of object, shadow and background using RGB colour space model considering chromaticity and brightness ratio model combined with edge ratio model for treatment of misclassified object and shadow	+ Moving object and shadow are determined separately + Fast enough for utilization in real time analysis	- Darker shadow areas or moving target having similar colour information to that of background area will lead to failure
IEEE/2010	A Real-Time System for Detecting Illegal Changes of-Lane Based on Tracking of Feature Points[14]	Proposed system consists of three stages, which take part of the roles such as feature extraction of corners, registration and tracking the feature points attached to vehicles, and detecting a vehicle that violates legal lane changes.	+the proposed system showed excellent performance as amount of 99.09% of correct detection ratio + The fast processing could deal with 34.48 frames per second, which is sufficient for real-time processing.	+proposed system assumes that the designated area for the ratio is set near camera region where the view is in the opposite direction of car moving
IEEE/2011	High-level event detection in video exploiting discriminant concepts[15]	An improved subclass discriminant analysis method is used to derive a concept subspace for detecting and recognizing high-level events.	+The use of an elaborate and computationally-costly training method for learning the events from an event annotated dataset is avoided	---
IEEE/2011	Fusion of Laserscannner and Video Based Lane marking Detection for Robust Lateral Vehicle Control and Lane Change Maneuvers[16]	a novel iterative histogram based approach with occupancy grids for the detection of multiple lanes is proposed	+provides an accuracy which is comparable to a video based system for lane detection and is highly suitable to determine the correct number of all existing lanes on the road. +achieves good results with a detection rate above 98%.	+the failures of the lasers canner based approach result from bad SNR ratios between the road markings and the surface
IEEE/2011	Lane Change Detection And Tracking For A Safe-Lane Approach In Real Time Vision Based Navigation Systems[17]	a robust lane detection method has been developed which utilize the human visual properties of lateral inhibition, far-near adaptation, and joined the mutual support in feature extraction	+ can be used under most of environments in the daylight, night time, sunny and raining day. + The system can provide high availability, reliability and accuracy in lane deviation and headway distance estimation. +The image-processing rate of the system is more than 20 fps which meets the requirements of real-time computing in an embedded system.	+ occlusions of lane markings due to vehicles in front of the camera + Strong shadow causing an erroneous detection of lane boundaries.
ELSEVIER / 2011	Robust moving object detection against fast illumination change [18]	Identification of moving target under fast illumination variations using Gaussian mixture model for object detection and chromaticity and brightness ration model for elimination of false	+ Does not require training sequence + Automatic adjustment of the parameters	- Results degrades in complex environment that has piled snow, puddles or in specular regions

		foreground pixels.		
IEEE/2012	Abnormal Event Detection in Unseen Scenarios[19]	a fixed number of frame-level features are extracted representing the global characteristics of the scene at a particular moment. The measurements of these frame-level features are computed by performing blob statistical analysis on the detected foreground blobs.	+shows high detection performance in completely unseen scenarios without additional training and tuning. +outperforms pure optical flow based approach without explicitly using any motion based features.	+individual objects are not tracked over time or specifically treated.
IEEE / 2012	Spatio-Temporal Traffic Scene Modeling for Object Motion Detection [20]	Approach for traffic surveillance using Bayesian fusion method where in kernel density estimation is used for background modelling and Gaussian formulation is carried out for foreground model.	+ Requires less computational time + Works well with rapidly and slowly changing background	- Object's feature identical to that of background are abolished
Scientific Research/2012	Video Based Vehicle Detection and Its Application in Intelligent Transportation Systems[21]	Proposes an efficient video based vehicle detection system based on Harris-Stephen corner detector algorithm.	+the system can determine vehicle counts and speeds from low resolution video feeds in real-time under various illumination conditions with very little con-figuration and calibration requirements,	+As the camera is installed on the light pole in the median, there exists a considerable skew of the captured video that results in elevated vehicle occlusions. This results in some count errors in vehicle detection on respective lanes
Science Direct/2013	Automatic clustering method of abnormal crowd flow pattern detection[22]	Takes into account the interrelation between individual behavior and global pedestrian flow pattern.	+robust and efficient in detecting abnormal pedestrian flow pattern.	+due to the limited length reason, a detailed analytic work cannot be done
IEEE/2013	A Novel Lane Changing Algorithm with Efficient Method of Lane Detection[23]	Presents an efficient method of lane detection and apply the detection results in vehicle auto lane departure. The inverse perspective mapping image is taken for line detection. During image pre-processing, PPHT method and a third degree Bezier spline are applied for line fitting step.	+Not only the lines in the current driving lane can be detected, but also lines of neighbouring lanes when vehicle is changing lanes can be detected. + Proposed scheme can detect traffic lane effectively without affected by shadows, which are cast by trees, buildings, moving vehicles.	+The work is done in a static way that is on an image ,it is not used for video based lane detection
IEEE / 2013	An Improved Moving Objects Detection Algorithm [24]	Enhanced three frame differential method combined with canny edge detection to gain complete information related to moving target	+ Ghosting effect is eliminated + Algorithm beats the empty phenomenon and edge deletion problems of standard three-frame differential method	- The result is not ideal in the environment with strong light and obvious shadow - Results degrade for dynamic background
IEEE / 2013	A Moving Target Detection Algorithm Based on Dynamic Scenes [25]	Five frame differential approach combined with background subtraction method for detection of target in	+ Moving target can be extracted more accurately and completely from dynamic scenes	- It cannot eliminate leaves flutter noise - Cannot identify multiple moving targets

		motion		
IEEE/2014	Early Detection of Dangerous Events on the Road Using Distributed Data Fusion[26]	Combines several sensors measurements and propagates a mass vector with confidences on all the subsets of the frame of discernment that characterizes the different states of the road (freezing, slippery, safe).	+robustness to wrong measurements and to give earlier warnings to drivers.	+usage of pignistic probabilities in making the decision that is transmitted to the driver and to incorporate it in standardized environmental notification messaging system
IEEE / 2014	Image Processing Based Vehicle Detection and Tracking Method [27]	Vehicle recognition and tracking using Gaussian mixture model and blob detection	+ Vehicle counting is done automatically + Robust for low and medium traffic	- In case of overcrowding and high traffic flow situation performance breaks down - To obtain best performance significant amount of parameter tuning is required
IEEE/2014	A Lane Change Detection Approach using Feature Ranking with Maximized Predictive Power[28]	Presented a novel approach for the recognition of lane change events utilizing a feature set which maximizes the predictive power.	+is able to precisely detect lane changes of other traffic participants up to 2.2s before the lane assignment changes.	Accuracy % not given
IEEE / 2014	Moving Object Detection Based on Temporal Information [29]	Makes use of sequential information for generation of motion saliency which is then followed by maximum entropy and fuzzy growing method to identify moving target	+ No preceding knowledge of the background model is required + Robust to mild background motions and camera jitters + No user interaction for parameter tuning is required . + Efficiently deals with the perturbations of the background	- Shadow is determined along with moving object which may be misclassified as object itself
IEEE/2015	Traffic Accident Detection Through A Hydrodynamic Lens[30]	a motion flow field is obtained from the video through dense optical flow extraction. Then a thermal diffusion process is exploited to turn the motion flow field into a coherent motion field	Demonstrate significant performance on a set of video sequences collected from YouTube.	Accuracy % not given
IJARCCE/2015	Real Time Unusual Event Detection in Video Sequences[31]	thinning based Image skeletonization method	+improved design of built environment will provide better surveillance.	--
IEEE/2015	Real Time Unusual Event Detection Using Video Surveillance System For Enhancing Security[32]	processes low resolution frames and it is able to recognize the occurrence of uncommon events such as overcrowding and fight in the low resolution video without using any classifier and training datasets initially	+is fast enough because it process low resolution frames + enhance the ATM security. + detect abnormal event in low resolution video.	+Not applicable on high resolution video
IEEE/2015	A Video-based Method for Traffic Flow Detection of Multi-lane Road[33]	Uses normalized cross correlation (NCC) of the traffic video image as the main detecting feature along with the homogeneity based parameter as the secondary parameter.	+Proposed algorithm has higher efficiency and accuracy as well as better robustness against illumination condition change and adjacent moving shadow comparing to the traditional approach.	+ The false-negative is mainly caused by the short distance between the front and rear vehicles in the same lane. The algorithm could not separate the two close vehicles.

IEEE/2016	Traffic Event Detection from Road Surveillance Videos Based on Fuzzy Logic[34]	Presents a novel Fuzzy Logic based analysis framework and a video based traffic data extraction scheme to decide upon the right traffic conditions.	+robust enough to reject the noisy data coming from surveillance videos.	+ Certain assumptions taken in the proposed algorithm such as fixed camera, background similarity and visibility of video sequence.
IEEE/2016	A Vision based Traffic Accident Detection Method Using Extreme Learning Machine[35]	devised a novel algorithm called OF-SIFT as the low-level feature, Deriving from the optical flow and Scale Invariant Feature Transform (SIFT), it is designed to extract local motion information from the temporal domain rather than gradient-based local appearance from the spatial domain	+ achieved good performance in handling ordinary video scenes + proposed method has high recognition accuracy..	+describing the collision process by establishing a 3D motion descriptor is missing
IEEE/2016	Optical and Streak line flow based crowd estimation for surveillance system[36]	It uses fluid mechanics based dynamic parameters computation of the object which helps us to find the flow of the moving object with path lines.	+gives the better motion segmented results and outperforms the state-of-art techniques for the surveillance system	Accuracy rates not calculated
IEEE/2016	Detection And Pre-Warning Of Vehicle Lane Change Based On State Machine [37]	+Proposed a state machine model which can be used to analyze driver's lane-changing behavior. It can first detect frequent-changing-lane behavior and then send a warning signal.	+The state model could correctly detect driver's driving behavior and send warning signals.	+lane changes in the state machine model is not explored which can consider time span between lane changes +marking system is not developed to analyze driver's driving habit.
IEEE/2017	Lane-Change Detection Based on Vehicle-Trajectory Prediction[38]	Proposed a new lane-change detection method based on vehicle-trajectory prediction	+proposed method with vehicle-trajectory prediction can reduce false alarms + Method can detect a lane change, on average, 1.74 s before the target vehicle crosses the centreline with 98.1% accuracy.	+other variables that might affect driving intentions are not considered
IJSRCSE /2018	Fast and Real Life Object Detection System Using Simple Webcam[39]	designed to detect a real-life object using a simple webcam	+ help computer to detect an object of different basic shapes on initial level.	+Face Detection +detect different species like human beings, dogs etc.
IJSRNSC /2018	Separating Moving Objects from Stationary Background using Dynamic Mode Decomposition [40]	obtain a background/foreground model from a video sequence where the background is filled with a number of foreground objects	+Obtain background model with less complexity +compared with other method its Performance is much better.	+cannot be used in more complex environment.

IV. GAPS IDENTIFIED

After the exhaustive review of the above reviewed papers, the area of improvement or the gaps in conducted research work could be figured out by this review process, and is stated as follows:

1. To increase its accuracy in following scenarios:

- Complex Traffic conditions like traffic jams becomes an issue in the presence of clutter in test scenario in almost all approaches.
- Detection of Driver's Driving habits or intentions is also common problem.
- Lost tracks and object confusion due to unavoidable similarities.
- Occluded objects, shadows, non- rigid target, varying lighting conditions, splitting and merging targets.

2. Insufficiency of professional and challenging high quality data sets currently available for testing.
3. Criteria for performance estimation, such as standard metric, hit &miss weighting, and construction of ground truth, are controversial.
4. Certain assumptions are taken in the proposed algorithms such as fixed camera, background similarity and visibility of video sequence which limits the research objectives and results.
5. Video Surveillance Using Virtual Line Analysis fails to count errors due to large trucks, long shadows, tailgating vehicles, obstructed vehicles, traffic congestions, and night times.
6. Some of these algorithms have modifications that were not validated with the real data.

V. CONCLUSION AND DISCUSSION

Various Key approaches were used to detect unusual activities which majorly included Lane change detection, crowd estimation, Traffic accident detection etc. Semantic based study of unusual event stood out as robust technology to conclude such experiments. Vehicle Trajectory Prediction based method could fetch up to 98.1 % results in event detection, but outputs varied as per experimentation. No solution could provide l00% accuracy results in event detection, which lays down the scope for further research.

Histogram based approach along with Rejection based system though fetched 95% results, but this solution could not detect generic events.

By the above study of positive aspects and Limitations, it emerged out that intelligent techniques are replacing the conventional techniques in all the areas of event detection. And when it comes to identifying driver's driving intentions and other variables that effect driving the latest technology failed to do that. Vehicle Trajectory prediction based algorithm have emerged as robust method to identify the traffic events. The researchers have come up with experimentation to prove their assumptions and objectives and have resulted in satisfactory results. A major limitation of the techniques which was observed was the absence of accuracy parameters which could serve as basis of comparison.

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