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Object Detection and Tracking under Static and Dynamic environment: A Review

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Abstract: **V**ideos and images reveal many interesting and useful information which can serve the mankind in many ways. Researchers and professionals are motivated in studying and exploring the information in conditioned and unconditioned environment**.** In the literature there are many models built to detect and track the movement of the object, each one of the models built has its own advantages and limitations. A study has been made to know the problems encountered in static and dynamic environment. A review has been carried out to know the merits and demerits of the methods or techniques used in detection and tracking the objects in video frames.

Keywords: Detection, Tracking, feature extraction, frame difference, Illumination

I. INTRODUCTION

Automation of Detection and Tracking system is very useful in many applications like in biomedical, security, identification of threats, unauthorized intruders in defence and navy. If underwater videos are automated for detection then it will be used by marine biologist, ecologist, researchers, aqua culturist etc. who are always involved in the underwater study. Analysis of underwater videos opens a new direction in research and biomedical applications. Nevertheless, underwater video analyses can be used to determine the Health of the ocean, water quality, climatic change, biodiversity, endangered species, and impact of food chain, ocean pollution, invasive species, sustainability and biodiversity of the species surviving underwater.

Many algorithms are available to track the moving object in static and dynamic conditions. Static method does not pose major problem as compared to the dynamic condition. In static environment condition back ground will be stationary throughout the video and the fore ground goes on changing its position in the whole video frame. The fore ground can be a single or multiple objects, these objects can be detected and tracked from the initial frame. Videos with natural scenes are usually composed of several dynamic entities. Objects of interest often move along complicated backgrounds that are themselves moving in dynamic conditions. Hence both the back ground and the fore ground will have motion. The differentiation of both the back ground and the fore ground is very difficult. Many issues have to be considered before the object is decided as moving object in dynamic environment. A complete observation is to be made on the video frame sequence to acknowledge whether an object is moving or not. The other difficulty, to be tackled while tracking is the problem of object occlusion.

II. LITERATURE REVIEW

In the literature there exist many models to perform the object detection and to track the movement of object. In this section a brief review is made on the available model or algorithms to realize the merits and demerits of different algorithm.

An algorithm for the accurate extraction of video objects from color sequences is based on detecting color change [1]. The color difference between frames is modelled, to separate the contributions caused by sensor noise and illumination variations. Feature extraction, feature analysis, classification, and postprocessing are the different steps involved in the algorithm. Sensor noise is eliminated by using a probability-based classification, and local illumination variations are removed using a knowledge based approach that is formulated as a hypothesize-and-test scheme. *This approach Provides better contours and is computationally less expensive.*

The advantage of the Bi-dimensional Empirical Mode Decomposition (BEMD) algorithm and the phase congruency theory is used in the EP model (E denotes the EMD model and P denotes phase information) [2]. It extracts multi-pixels edge features at multiple scales by a sifting process. This shifting process is realized utilizing the BEMD method to decompose the given underwater image into several bi-dimensional intrinsic mode functions and mean. Phase congruency method is used to extract multi-pixel edge of the image. *Useful in image segmentation based on the principle of the multi-scale edge detection of image*.

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The major issue in visual target tracking system is variations in light illumination [3]. So in case of poor illuminance, these edges are either missing or weak. Hence, the strength of edges in a frame indicates the state of illuminance. In this technique transform every video frame from RGB to YUV plane where Y-plane represents the luminance parameter. Logarithmic transformation is applied on this Y-plane to separate luminance from reflectance followed by DCT (Discrete Cosine Transformation). Mean shift is then used for tracking the targets, in enhanced illumination invariant video. The mean shift algorithm is a fast and accurate object tracking algorithm .Advantages are it is robust to appearance and position changes of target. It is simple but effective tracking method for handling changing illumination condition. It works for sudden and drastic changes in the illumination in videos. *Limitations are it is not adaptive for handling the scaling and orientation of the target and occlusion*

Although several works aimed at detecting objects in video sequences have been reported but due to fast illumination change in a visual surveillance system, many may not be tolerant to dynamic background [4]. The method detects, the moving object at foreground, the background conditional environment can classify each pixel using a model of how, that pixel looks when it is part of video frame classes. Gaussians mixture classification model for each pixel using an unsupervised technique is an efficient, incremental version of Expectation Maximization (EM) is used. This method automatically updates the mixture component for each video frame class according to likelihood of membership; hence slow-moving objects and poor image quality of videos are also being handled perfectly. *This approach identifies and eliminates shadows much more effectively than other techniques, Robust against fast illumination change in video sequences.*

In many background subtraction methods, shadows were misclassified as foreground objects. Shadows of moving objects make it difficult to accurately eliminate background. Main difficulty with shadow is that intensity differences between shadows and background are often larger than differences between some foreground objects and background [5]. In order to address this problem, window-based decision rules is used. By comparing statistical characteristics of the window, several distance measures are explored. These measures are invariant against illumination changes, neural network is used for classification. *This method showed noticeable improvements compared to some existing methods.*

Automated system that detects, tracks, and classifies objects that are of potential interest for human video annotators [6] is proposed. By pre-selecting salient targets for track using a selective attention algorithm, the complexity of multi-target tracking is reduced. If an object(under water) is tracked in several frames, a visual event is created and passed to a Bayesian classifier utilizing a Gaussian mixture model to determine the object class. The foreground must be separated from the back ground in all frames. Every different frame is selected to detect salient objects. Detected object, that do not coincides with already present are initiated as new track. Objects are tracked over subsequent frames and their occurrences are verified in the predicted location, *finally the detected objects are marked in the video. It is unsupervised, and works in fully automated fashion.*

The performance of six object detection algorithms in the task of fish detection in unconstrained, underwater video footage is discussed [7]. The algorithms discussed are Gaussian Mixture Model (GMM), Adaptive Poisson Mixture Model (APMM), Intrinsic Model (IM) , Wave-back (WB), CodeBook (CB) , Video Background Extraction (ViBe). The algorithms, generally, performed well when the videos contained clear-water scenes and uniform backgrounds. When temporal phenomena, like tropical storms and hurricanes, were present, the performance of all the algorithms, in detecting objects invariably fails. By combining all the algorithms together by using Adaboost, a more reliable classifier is produced based on the best characteristics of each single detection algorithm. *Finally, MAP-MRF filter could be applied in order to diminish the number of false negatives and to better preserve the shapes of the detected objects.*

An intuitive and efficient method to monitor the water quality using the biological characteristics of aquatic organisms is presented in [8] based on vision-based perceptive. Vision-based perceptive is a framework for fish motion, moving objects detection and multiple objects tracking. The fish behaviour model, such as rapid starting, rapid stop, steady swimming, and avoidance reaction can be analyzed based on the motion data. A multi-object tracking using particle filter with interacting observing model is proposed, and some related kinematical data, i.e., velocity and acceleration, are defined and analyzed to represent the real-time fish activity. *The experimental results show that it is efficient and accurate.*

Refraction causes random dynamic distortions in atmospheric turbulence and in vision across a water interface [9]. This is encountered when surveying a scene by a submarine or divers while wishing to avoid the use of an attention-drawing periscope. Detecting and tracking objects does not require complete recover of the distorted scene. Deciding whether the motion of an image feature is solely due to refractive distortions or due to real object motion (compounded with distortion) is a classification problem.

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As the object and distortion motions are random and unknown, they are mutually independent. Being independent components, the location covariance due to object motion is additive to covariance stemming from medium dynamics. Hence, simple location covariance is a powerful classification feature. The moving objects can be detected very simply, with low false-positive rates, even when the distortions are very strong and dominate the object motion. Moreover, the moving object can be detected even if it has zero mean motion. While the object and distortion motions are random and unknown, they are mutually independent. *A classification failure is also likely to occur for very slow moving objects, aliasing as static in the temporal window.*

Fine-grained categorization of fish motion patterns in marine applications is revealed [10]. Fish detector is to be applied to identify and localize fish occurrences in each frame. Fish detection is defined in terms of fish appearance and motion properties; fish tracking is obtained transitively linking similar detections between every two consecutive frames, so as to maintain their unique track IDs. Finally, extract histograms of fish displacements along the estimated tracks. *The histograms are classified by the Random Forest technique to recognize distinct classes of fish motion patterns.*

Difficulties in recognition and tracking objects beneath the water surface open challenges to overcome. An efficient and accurate method of tracking texture-free objects in underwater environment and to segment out and to track interesting objects in the presence of camera motion and scale changes of the objects is proposed in [11]. In the detection phase, extract shape context descriptors that used for classifying objects into predetermined interesting targets. *In the tracking phase mean shift tracking algorithm based on Bhattacharyya coefficient measurement is used. The performance of the algorithm was excellent in most images.*

A different application is considered in model based approach [12] to detect and track underwater pipeline in complex marine environments. Vision guidance system for autonomous underwater pipeline tracking and navigation is proposed. The method uses unconventional gray scale conversion technique to enhance the image and then Perona Malik filter (PM) is used to reduce the noise effect and enhance the features of underwater pipeline. The PM filter is anisotropic filter that retains the much needed edges information which is essential in detecting the pipeline boundary edges .To detect the pipeline boundary in an image, Hough transform is used. After detecting the pipeline in an image, parameterized curve is used to represent the underwater pipeline and for feature extraction. Based on extracted feature, curve fitting is used to measure the current pose and orientation of underwater pipeline. *The system efficiently track the pipeline, when it is fully or partially covered by the sand or marine flora and even in clustering situations.*

When video frames are captured on water surface, components that affect video frames are reflections, splashes, random water movements and overall scene light changes on the water surface. The hue component of the HSV color space Segments, image area in determining water behaviour [13]. Foreground is extracted based on combination of temporal background estimation with spatial correction and inter-frame subtraction. The algorithm shows a very low variation of intensity values around its average value and very low dependency on splashes, ripples, random water movement and environmental light variations. This algorithm shows impressive results, extracting reliable and robust swimmers even with splashes, ripples and illumination changes. *This technique is computationally less expensive and obviously faster than currently available techniques.*

Many algorithm works well for slowly changing back ground or for the rigid back ground. A method, which does detection and segmentation of moving object in dynamic scene, is performed in [14]. Groups of pixels having similar motion and photometric features are extracted. Then segmentation of the object associated to a given cluster is performed in a MAP/MRF (maximum a posterior/ Markov Random Field) framework. As this method works only on a sub grid of pixels, modelling of the background is not required this method is not expensive computationally and in memory usage. *The use of spatial, dynamic and photometric features allows the extraction of moving foreground objects even in presence of illumination changes and fast variations in the background*

Clausius Entropy is used in detection and tracking of multiple moving objects [15].In this method entropy difference with adaptive threshold is used to detect the moving object in static environment. The result is then used to track the movement of the object using the fast level set method. Fast level set method combines the Fast Marching Method and the Smart Narrow Band. This technique detect moving object in indoor and outdoor video sequence. The drawback is clutter formation in outdoor images and in complex scenes.

Semantic regions are considered in counting the vehicles in the traffic scene [16]. Semantic regions are based on the cooccurrence of local motions. It do not require object detection and tracking. Fast marching algorithm is used to automatically connect local semantic regions into complete global paths. The models of sources and sinks of the paths

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are also estimated from semantic regions. Then, an algorithm is proposed to estimate the average vehicle sizes at different locations along each path and to cluster trajectories of feature points into objects, according to the estimated average vehicle sizes. Due to occlusions among objects, trajectories of features points on the same object may be broken into multiple parts. [16] Approach assigns trajectory clusters into different paths and connects them by integrating multiple cues, including the spatiotemporal features of trajectories, the spatial distributions of vehicle paths, and the models of sources and sinks. As limitations it has fewer misdetection occurrences. *It tends to over count the number of vehicles. Error happens if a vehicle is much larger than the normal size enters the scene, i.e., it may be counted as two.*

Object contour tracking general framework is used to track the movement of the object [17]. Firstly, utilization of temporal difference between the adjacent two frames to obtain the subtracted frame then Canny edge detector is applied on current frame, and a logic AND operation with differencing boundary image is used to obtain the final motion contour image. Set of Harris feature points are used to keep significant object contour information. *Advantage is that it can tolerate object scale and illumination changes during the whole tracking process, robust to the short occlusion, i.e. it can quickly re-obtain satisfactory tracking results even after a short, whole object occlusion.*

A very efficient and robust visual object tracking algorithm based on the particle filter, the tracked objects characterized using color and edge orientation histogram features [18]. The particle filter maintains multiple hypotheses about the state of the tracked objects the rectangle features and edge orientation histogram to evaluate the observation likelihood. They can be efficiently computed with integral images. To increase the discriminative capacity while speeding up the evaluation, a cascaded scheme is adopted which results in highly discriminative observation likelihood. *The above improvements make the tracking algorithm very efficient and robust against clutter, illumination changes and short period time occlusions*.

When there is abrupt motion, under occlusion or in low sample rate of video source, then there are two main issues mounting inevitably, one is the poor constraint of person motion model, and the other is the drastic variation of pose or incomplete appearance when the person reappears. This problem is over come in [19], with the help of particle filter based on probabilistic prediction and detection model framework. Data fusion with particle filters has been mostly restricted to skin color and edge cues inside and around shapes in the context of face and hand tracking. To deal with weak motion two layered sampling is used. In the first layer a coarse discriminative observer is used to eliminate non target and little similarity. In the high level stage a relatively fine discriminative observer is applied on smaller number of the left particles. Configuring of the observers is done by the application of Histogram Oriented Gradient (HOG) and color. Color is widely applied since it encodes the appearance of the object tracked in an efficient and robust way. *The experiments demonstrate that this method performs well in long-term tracking cases near real-time.*

The problem of tracking multiple objects poses a number of challenges due to the ambiguity of the observations [20] and the presence of partial or complete occlusions. The Particle Filter algorithm is explored for tracking multiple objects and explicitly handles partial and complete occlusion of objects, when new object enters instantiation of particles occurs and removal of filters occurs, in case when object leaves the scene. It attempts to approximate the joint distribution by estimating independent distributions for each target which are updated based on a joint observation model obtained by projecting observations into the image space.

The experimental results demonstrate that the Particle filters implemented using the proposed method effectively and precisely track multiple targets and can successfully instantiate and remove filters of objects that enter or leave the image area. Tracking moving object plays an important role in multimedia surveillance systems. In multimedia surveillance systems major types of data are video and audio captured by cameras and microphone arrays [21]. As the first step, algorithm performs the background subtraction on video data. Second, is modifying the video model to exclude the background from being transformed. Third, is extending the joint model to a dynamic Bayes net. The integration yield satisfactory results on single person tracking in noisy outdoor environment, background road traffic, and handle situations where the target is lost due to occlusions.

Color based particle filter [22] is used considering the single and multiple object in outdoor environment. Battacharya distance to measure the similarity between the color distribution of the target and particles is incorporated. Tracking frame work contains tracking system with particle filter based on color feature, color histogram in RGB space, state estimator to estimate the state of the target, target update, Initialization of samples is done by putting samples around the region and tracking the objects. *This algorithm successfully tracks the single moving object and multiple moving objects in the presence of occlusion, background clutter and appearance change.*

A method of motion detection and tracking based on multi-camera surveillance system [23] is presented. Detect moving

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blocks by dynamic template, and then check the moving blocks, get the elements of the blocks such as spatial characteristics and histogram. Then detect and track the moving objects according to characteristics of elements. Combining with the matching information of histogram, vehicle tracking can be done and it over comes the problem of partial appearance of object, disappearance and then appearance under temporary block. *This algorithm may not be applicable when there is too much distortion of vehicles*.

A visual tracking system must be able to track objects which are partially or even fully occluded. An approach is formulated for tracking multiple objects in dynamic scenes to handle objects partial occlusion .Objects in the world exhibit complex interactions when captured in a video sequence, some interactions manifest themselves as occlusions[24] . Algorithm consists of two steps first step uses Gaussian Mixture Model as an effective way to extract moving objects from a video sequence. Then shadow removal is performed. The second step is object tracking framework based on Kalman filtering which uses Stable Marriage Problem (SMP). In addition fast mean shift is used in tracking during occlusion. *This approach has the advantages of low cost and low complexity, and can be realized in real time system.* Experiments on outdoor environments show that the system can deal with difficult situations such as shadow and illumination changes. System is computationally cost effective.

In visual object tracking framework appearance is based on local steering kernel descriptors and color histogram. The frame work described in [25] takes as input the region of the target object in the previous video frame and stores instance of the target object, and tries to localize the object in the current frame by finding the frame region that best resembles the input. *As the object view changes over time, the object model is updated, incorporating these changes*.

Color histogram is used to find the similarity between the detected object and the surrounding background, employed for background subtraction. This scheme is successful in tracking objects, under scale and rotation variations. This algorithms works for partial occlusion, as well as in tracking slowly deformable articulated objects. However, the method has certain limitations, *it does not handle the case of full occlusion, and the tracking speed is low,* due to brute-force search, rendering it inapplicable in real time applications when there is a sudden change in the object direction or speed.

The problem of partial occlusion of object is addressed in Global and Local dynamic model detection and tracking [26]. Motion based particle filter is incorporated in the Global and Local dynamic model to obtain the state of the object. Global state of object is estimated by a rectangular bounding box to extract the feature of the object. Local state of the object is obtained by dividing the rectangular bounding box enclosing the object of interest in to specific parts. Size, location, and color feature of these blocks and the vectors from the center of blocks to the center of rectangular bounding box will be part of the local dynamics model, using transition probability transition estimation of each block of object is made and finally the local state of the object is estimated. Using both local and global state object motion is finally tracked. *This technique overcomes the problem of traditional particle filter. The object to be tracked is initialized by manually marking the bounding quadrilateral in the first image.*

III. METHODOLOGY

A general frame work for detection and tracking under dynamic condition can be formulated and can be given in the form of block diagram as shown in Fig 1 below.

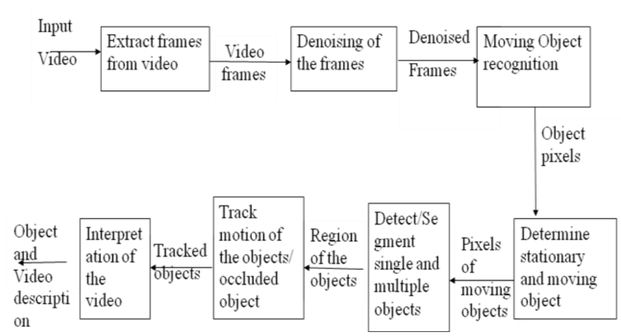

Fig 1 . Detection and tracking frame work.

Each block in the above figure 1 performs specific operation. The system can be broadly divided in to three major stages as given below.

Stage I: - frames Extraction and noise removal

- Frame extraction from video
- Denoising
- Edge enhancement

Stage II: - Moving Object detection/recognition

- The adaptive threshold applied to the eliminate the back ground completely
- Erosion and dilation operations are applied to get the entire object.

Stage III:-Track motion of the objects and overcome occlusion

- A study is to be made to choose a proper method to obtain optimistic way of tracking.
- Tackle and overcome the problem of occlusion

Finally the information can be used to analyze video.

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IV. CONCLUSION

. The model built has limitation in computational complexity, where time of detection and tracking is more, many models need prior knowledge of the scene and the camera position, used in background subtraction. Other models cannot handle the fast moving sequences, fast variation of background and change in illumination. Most of the models designed to handle occlusion will lose its track when occluded object completely disappears and reappear after some time. Under unconstrained condition moving object segmenting and tracking forms major task. A general framework has to be proposed for applications with dynamic background. Hence there has to be an optimistic way to overcome the above mentioned limitation.

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