# A Survey on Obstacle Detection and Tracking in UAVs

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*Abstract*— Obstacle detection and tracking is an important research topic in computer vision with numerous practical applications. Though an ample amount of research has been done in this area, implementing automatic obstacle detection and tracking in real-time is still a big challenge. To address this issue, this paper addresses fast and robust obstacle detection and tracking approaches. Because of its real life applications, researchers have shown great interest in automatic object detection and tracking. This paper, discussed about the problems that are being faced during object detection and tracking. This paper highlights latest methodologies related to object detection and tracking used by researchers for accurate real time object tracking.
***Key words:*** Obstacle Detection, Object Tracking

## I. INTRODUCTION

Image Processing is a technique to improve raw images taken from cameras or sensors placed on satellites, or pictures taken in normal day-today life for different applications. Different techniques have been developed in Image Processing during the last four to five decades. Most of the techniques are developed for improving images obtained from unmanned spacecrafts, space probes and military reconnaissance flights. Automating visual detection and tracking of moving objects by intelligent autonomous systems, such as unmanned aerial vehicles (UAVs), has been an active research area for the past decades in computer vision. The research has numerous applications extending from military, surveillance, security systems, aerial photography, search and rescue, object recognition, auto-navigation to human-machine interactions. Recently, computer vision is being extensively used in roadside vehicle positioning and tracking, also in intelligent transportation systems for the vehicle as well as the passengers' safety. Due to its emerging multidisciplinary usage, a handsome number of companies are developing their own UAV systems, such as Google's Project Wing, Amazon Prime Air and DHL's parcelcopter etc. So, a survey was done among different proposals and this survey paper includes survey among different methods for real time object detection and tracking.

## II. MOTIVATION

Among all recent advancements in technology, vision-based sense and avoid system is becoming a more popular choice since cameras are light-weight and low-cost as well as they provide richer information of the surrounding better than other available sensors, thus suitable for UAVs with limited payload capacity. A successful sense and avoid system should be able to automatically detect a possible obstacle which may be present in the path of the flying UAVs and track it for preventing a possible collision. Thus, method gives a practical solution for the vision-based sense and avoid problems in UAVs. Provided scenery or a landscape, human eyes tend to first watch the characteristic features they could sense from its view. These characteristic features, which help the human brain distinguish between a particular object and its background could be the basis for a sense and avoid algorithm that separates the object from its background. Real time object detection and tracking are important and challenging tasks in computer vision applications such as video surveillance, robot navigation and vehicle navigation. Object detection includes detecting the objects in sequence of videos. Every tracking mechanism requires object detection mechanism either in each frame or when an object is detected newly on the video sequence. Object tracking is the process of localizing an object or multiple objects using either static or dynamic camera. It results in a great deal of interest in object detection and tracking algorithms. Even though high power computers are used for object detection and effective tracking algorithms, most of the object detection algorithms such as background subtraction, temporal difference, foreground extraction and simple differencing takes long time to detect object, requires more storage space and no robustness against illumination changes.

## III. LITERATURE SURVEY

ZuWhan Kim [1] proposed Robust Lane Detection and Tracking in Challenging Scenarios tells lane-detection system is an important component of many intelligent transportation systems. Here presents a robust lane-detection-and-tracking algorithm to deal with challenging scenarios like a lane curvature, worn lane markings, lane changes, and emerging, ending, merging, and splitting lanes. Here presents a comparative study to find a good real-time lane marking classifier. Once detection is done, the lane markings are clustered into lane-boundary hypotheses. Then group left and right lane boundaries specifically to effectively handle merging and splitting lanes. A fast and robust algorithm, based on random-sample consensus and particle filtering, is proposed to create a large number of hypotheses in real time. The generated hypotheses are evaluated and grouped based on a probabilistic framework generated earlier. The proposed framework efficiently merges a likelihood-based object-identification algorithm with a Markov-style approach and can also be applied to general-part-based object-tracking situations.

Mao Shanet al.[2] proposed Probabilistic Long-Term Vehicle Motion Prediction and Tracking in Large Environments. Vehicle position tracking and prediction over huge areas is of more importance in many industrial applications, like mining operations. In a small area, this can easily be attained by giving vehicles with a stable communication link to a control center and having the vehicles broadcast their position. The problem significantly changes when vehicles works within a large environment of potentially hundreds of square kilometers and in difficult scenarios. This method presents algorithms for long-term

 

vehicle motion prediction and tracking based on a multiple-model approach. It associates a probabilistic vehicle model that involves the structure of the environment. The prediction algorithm checks the vehicle position using acceleration, speed, and timing profiles made for the specific environment and considers the probability that the vehicle will stop.

Yang Ruan and Zhenzhong [3] proposed Extended kernelised correlation filter tracking. Due to the attractive high-speed, correlation filters started to receive more attention. In this method, a real time target tracking framework based on the kernelised correlation filter is proposed. The framework involves two parts: a boosted fusion feature colour names-histograms of oriented gradients (CN-HOG) that involves CNs and HOG, and a fragments-based tracking algorithm that is robust to partial occlusion. Experiments with the evaluation of state-of-the-art single object trackers give the effectiveness and speed of the proposed approach. Although several trackers obtain good tracking results, appearance models have quite a complicated structure and some optimisation algorithms are used. Moreover, they pay the cost of lower frame-rates to insure their accuracy. Only a few algorithms can provide the speed over 25 fps (frames per second). Correlation filters which can provide high speed have recently been applied to vision problems, including object alignment, object recognition, and visual tracking.

Wenjing Kang B et al.[4] Corrected Continuous Correlation Filter for Long-Term Tracking. Recently, a huge number of visual tracking algorithms based on discriminative correlation filter have been suggested with impressive success. Hence, it is of high importance to design a robust long-term tracker that can effectively alleviate tracking drift and redetect the object in case of tracking failure. irstly, DCF-based trackers have demonstrated great superiority. These DCF trackers fully exploit the circulant structure of the training samples and compute the filters in Fourier domain to gain high computation efficiency. It is critical to design a correlation filter in continuous domain to reduce the locating error. Here propose continuous correlation filter by a new cost function to achieve sub-pixel object localization. This method first maps the training samples to continuous spatial domain using cubic spline interpolation model. Thereby, the correlation filter produces continuous response map to enable sub-pixel target position. The recent studies have found that the deep features from different CNN layers contain spatial details and semantic information, which are both necessary for robust tracker. What's more, the features from different CNN layers have different spatial resolution, and multi-resolution features can create response map of different spatial resolution. In the proposed method, we utilize deep CNN features to robustly encode appearance template. These methods construct target pyramid centered at the predicted target position to estimate object scale in every frame. In such case, the precision of the predicted target location will affect the accuracy of scale estimation, and tracking drift will bring instability to the scale model. With this observation, the proposed method trains 9 target pyramids and these target pyramids distribute in a chessboard pattern centered around the predicted target position.

Yao Sui, Guanghui Wang, and Li Zhanget al.[5] proposed Correlation Filter Learning Toward Peak Strength for Visual Tracking , a novel visual tracking approach to correlation filter learning toward peak strength of correlation response. This method aims at solving this issue and proposes a novel algorithm to learn the correlation filter. The proposed metthod, by imposing an elastic net constraint on the filter, can adaptively eliminate those distractive features in the correlation filtering. It shows that the proposed approach effectively strengthens the peak of the correlation response, leading to more discriminative performance than previous approaches. Visual tracking plays an important role in signal processing and computer vision with different applications, such as video processing, motion analysis, and unmanned control systems etc. They are associated with applications and many research techniques. This method aims at the single object tracking.

Yuanwei Wu et al. proposed Vision-Based Real-Time Aerial Object Localization and Tracking for UAV Sensing System [6] A real-time object localization and tracking strategy from monocular image sequences is developed by merging the object detection and tracking into a variable Kalman model. At the detection phase, the object is automatically detected and located from a saliency map found through the image background connectivity in all frame; in the tracking phase, a Kalman filter is employed to provide a fine prediction of the object state, which is further refined by a local detector incorporating the saliency map and the temporal information between two successive frames. The proposed approach does not require any manual intervention for tracking, goes much faster than the state-of-the-art trackers of its kind, and attains competitive tracking performance on a number of image sequences.

Real-Time Detection, Tracking and Classification of Multiple Moving Objects in UAV Videos proposed by Hüseyin Can Baykara et al.[7] tells Unnamed Aerial Vehicles (UAVs) are becoming increasingly popular and widely used for surveillance and reconnaissance.. This approach aims to fill this gap by presenting a framework that can robustly detect, track and classify multiple moving objects in real-time, using commercially available UAV systems and a common laptop computer. The framework can additionally deliver practical information about the detected objects, such as their coordinates and velocities. The performance of the proposed framework, which surpasses human capabilities for moving object detection, is reported and discussed. UAVs have become an essential part of surveillance and reconnaissance in recent years. Beside their widespread usage in the entertainment and media production industries, UAVs are used for many military and civil applications. These applications include search and rescue, traffic control, border patrol and security. The use of UAVs for security applications requires an operator that should be able to process the information rather quickly. Since human operators are generally quite behind these criteria, computers with the ability to meet these specifications with consistent reliability, accuracy, and precision, at quick rates and for a low cost, are expected to surpass human operators.

Multi-Target Detection and Tracking from a Single Camera in Unmanned Aerial Vehicles (UAVs) by Jing L, [8] states despite the recent flight control regulations, Unmanned Aerial Vehicles (UAVs) are still attaining popularity in civilian and military applications etc. Such kind of emerging

 

interest is pushing the development of effective collision avoidance systems. Such systems have a critical role UAVs operations especially in a crowded airspace settings. Due to cost and weight limitations associated with UAVs payload, camera based technologies are the de-facto choice for collision avoidance navigation systems. This needs multitarget detection and tracking algorithms from a video, which can be run on board effectively. While there has been a great deal of research on object detection and tracking from a stationary camera, few have attempted to detect and track small UAVs from a moving camera. To tackle these challenges, a new approach is presented in this method to detect and track small UAVs from a rapidly moving camera mounted on a UAV. Initially, the acquired video from the camera is parsed into a sequence of frames and the relative background motion between frames is estimated. The guiding principle is that UAVs and the background have very different motion patterns. A different methid relies on motion information from the moving object for further detection and tracking. Such method is suit for characterizing small moving objects since their motions can be estimated in local regions between frames.

A Real-Time Method to Detect and Track Moving Objects (DATMO) from Unmanned Aerial Vehicles (UAVs) Using a Single Camera proposed by Gonzalo R et al.[9] address the challenging characteristics of these vehicles, such as successive unrestricted pose variation and low-frequency vibrations. The main idea proposed in this method is to create an artificial optical flow field by estimating the camera motion between two subsequent video frames. The core of the methodology consists of comparing this artificial flow with the real optical flow directly calculated from the video feed. The movement of the UAV between frames is given with available parallel tracking and mapping techniques those identify good static characteristics in the images and follow them between frames. By comparing two optical flows, a list of dynamic pixels is collected and then grouped into dynamic objects. The algorithms have been tested with a quadrotor platform using a camera. The main problem to solve when trying to detect moving objects from a flying UAV is to seggregate the changes in the image caused by the movement of the vehicle from those caused by dynamic objects. Although this problem is not limited to aerial vehicles, it represents an additional difficulty with UAVs because they have more degrees of freedom. Here the input data adopts the form of a continuous flow of images produced by a single grayscale camera. From these images it have to obtain the position and velocity of the dynamic objects in the scene. his algorithm looks for small points of interest with variations in two dimensions.

Minimum barrier salient object detection at 80 fps by J. Zhang, S. Sclaroff, Z [10] tells the aim of salient object detection as to compute a saliency map that highlights the salient objects and suppresses the background in a scene. This problem got a lot of research interest owing to its usefulness in different computer vision applications, e.g. object detection, action recognition, face recognition and various image/video processing applications. With the emerging applications on mobile de vices and large scale datasets, a desirable salient object detection method should not only output high quality saliency maps, but should also be highly computationally efficient. Here address both the quality and speed requirements for salient object detection. A raster scanning algorithm to approximate the Minimum Barrier Distance (MBD) transform, which attains state-of-the-art accuracy while being about 100X faster than the exact algorithm. A theoretical error bound result was given to provide insight into the good performance of such Dijkstra-like algorithms. Based on FastMBD, proposes a fast salient object detection method that runs at about 80 FPS.

## IV. Conclusion

It is essential for an intelligent autonomous UAV to have an automatic, robust and real-time object tracking system built in it. In this paper recent works in the field of real time object detection and tracking were discussed. Many researches had conducted and are still going on. Here several methods discussed regarding detection and tracking including optical flow method, saliency map-based object detection, geodesic saliency map method, the minimum output sum of a squared error (MOSSE) filter for real time tracking. Some other detectors rely on deep learning techniques to improve the accuracy of the trackers and thus require largescale training database making them slower and unsuitable for real-time applications. Some of the experiments show that the discussed methods may not perform as expected in the presence of several dubious salient objects in a scene or the object is too tiny to detect and auto-initialize the tracker. So it is concluded that the real time object detection and tracking approaches have still room for improvement.

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