Effective Road Detection And Tracking For Automatic Aerial Vehicle In Urban Area

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Abstract- *The use of Unmanned aerial vehicle (UAV) natural resource application has increased considerably in recent years due to their greater availability and ability deploy a UAV relatively quickly. Road detection and tracking are important and challenging tasks in many computer vision applications such as surveillance, vehicle navigation. Detection and tracking of road in UAV videos play an important role in automatic UAV navigation, traffic monitoring, and ground vehicle tracking, observe conditions on network of roadways. In this paper, an efficient road detection and tracking framework in UAV videos is proposed***.** *In particular, a graph cut based for detect the road regions during initialize stage and homography based road tracking scheme developed to automatically track road areas. The proposed system works more efficiently as the road detection and tracking is performed. Thus, the implementation of UAVs in urban areas provides a more efficient of tracking and detection of road conditions and traffic situations in urban areas. Experiments are conducted on UAV videos of road scenes captured and downloaded from the Internet. The promising results indicate the effectiveness of of proposed framework.*

Keywords- Image processing, unmanned aerial vehicle (UAV), road detection and tracking, graph cut algorithm, homography alignment, parameter calculation.

I. INTRODUCTION

Image processing is processing of images using mathematical operations by using any form of signal processing for which the input is an image, a series of images, or a video such as a photograph or video frame; the output of images processing may be either an image or parameters related to the image. UAVs may be employed for a wide range of transportation operations and planning applications; traffic monitor, transportation, measurement of typical roadway usage, monitor parking lot utilization. UAV for surveillance is an active research topic in computer vision that tries to detect, recognize and track objects over a sequence of images and it also makes an attempt to the understand. Generally UAVs is used to follow roads, rivers, oil gas pipeline inspection, and the traffic parameter measurements. UAVs equipped with cameras are viewed as a kind of low cost platform that can provide efficient data for intelligent transport systems. With the increasing use of vehicles and their demands on traffic management, this kind of platform becomes more and more popular. Knowledge of road areas can provide users the regions of interest for further navigation, detection and data collection.

Automatic detection, tracking, and counting of a variable number of objects are crucial tasks for a wide range of applications such as security, surveillance, management of access points, urban planning, traffic control, etc. Road detection and tracking, most approaches use the color (texture) and/or structure (geometry) properties of roads. Among them, the combination of road color and boundary information have achieved more robust and accurate results than using only one of them in road detection, as shown in the work [1], [2]. To utilize Graphcut algorithm for road detection and homography for road tracking approach. In road detection, to utilize the Graphcut algorithm [3] because of its efficiency and powerful segmentation performance in 2-D color images. In road tracking, propose a fast road tracking approach. To utilize the Graph Cut algorithm because of its efficiency and powerful segmentation performance in 2-D color images. In road tracking, propose a fast road tracking approach. There are two facts that spur to implement road tracking. First, although Graph Cut is very efficient, it still cannot achieve a real-time performance when the UAV image resolution is high enough, and performing road detection frame by frame is not time efficient. Second, road appearance usually does not abruptly change in video; therefore, road tracking can make full use of continuous spatial– temporal information of roads in videos and thus can quickly infer road areas from previous results. Fig1, graph cut based for detect the road regions during initialize stage and homography based road tracking scheme developed to automatically track road areas.

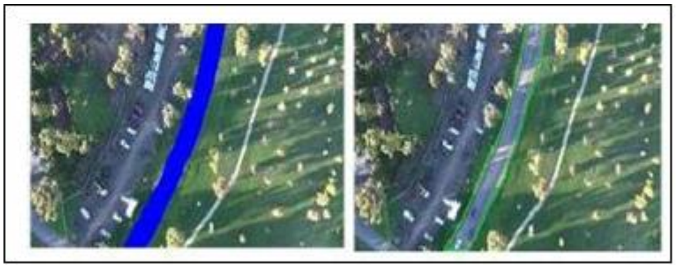

Fig.1; Detection and Tracking Road Image

In road tracking, aim to track the road border structure between two consecutive frames. Some earlier methods are largely depend on extracted road border and vanishing points of the road, it might not be easily adaptable to UAV because the road boundary or markings are usually not enough to be detected due to the altitude of UAV. Therefore adapting homoghraphy algorithm to develop tracking scheme over existent tracking technique. Homography is a transformation that can be used to align one image plane to the another when moving camera capturing the planer scene.

In comparison, UAV has advantages, including; there is a low cost to monitor over long distances, it is flexible for flying across broad spatial and temporal scales, and it is capable of carrying various types of sensors to collect abundant data. To collect information for the transportation system, it is important to know where the roads are in UAV videos . Knowledge of road areas can provide users the regions of interest for further navigation, detection, tracking and data collection procedures. Real time is required in many UAV based applications, major target is how to effectively combine both types of information for road detection and tracking in an efficient way. Intuitively, there are two rules to the making one integrated framework efficient. First, each component of the framework should be very fast and efficient. Second, if one component is faster than the others in achieving the same purpose, it would better make use of the fastest component as much as possible. It should be noted that these technique is not just limited to road detection and tracking. It can be also applicable to river, pipeline, or coastline detection and tracking in UAV videos.

II. RELATEDWORK

This literature survey basically focuses on different approaches for road detection and tracking for unmanned aerial vehicle videos in urban area. Road detection and tracking in UAVs, particularly low- and mid-altitude UAVs is our focus in this paper, which can be used for autonomous navigation [4] traffic surveillance and monitoring [5]. A monocular color camera is often equipped in this area, where UAVs usually fly up to 500 m. The camera can clearly capture each vehicle on the ground and also has large spatial view on traffic areas. The other research line in UAV- based road detection uses satellite or high-altitude UAVs [6], which aims to identify road network, including many junctions and roundabouts from an image. High-resolution cameras are generally utilized in the high-altitude UAV applications, where cameras are usually 1000 m away from ground.

The major applications include security surveillance, traffic monitoring, inspection of road construction, and survey of traffic, river, coastline, pipeline, etc. Relevant research can be traced back to the 2000s in the transportation departments of the Ohio [1]. UAV technologies in transportation applications specifically, the objectives of this paper are provide an assessment framework to assess the applicability and cost-effectiveness of UAV and sensing technologies in different transportation applications.

In the literature of road detection and tracking, most approaches use the color (texture) and/or structure (geometry) properties of roads. The combination of road color and boundary information have achieved more robust and accurate results than using only one of them in road detection. Analyze the characteristics of roads in color images of urban and campus environments and algorithm is proposed to extract the candidates of road boundaries and subsequently combining the results of boundary detection with the color information in the image captured, and then present a method to precisely extract the road areas [8]. A popular approach to the problem of road detection is the use of lane markings. Those markings are localized to acquire boundary information that facilitates the road detection process. Methods that rely on lane markings are usually fast and simple, using mainly grayscale images or videos. And second popular method in road detection applications is the use of color or brightness information to segment the road, which is enhanced by some feature extraction process such as edge detection to extract the road boundaries[2]. To improve road detection accuracy and robustness to shadows, many researchers have utilized more complex methods by processing information related to optical flow [10] and stereo vision acquired from camera pairs. In road detection, propose to utilize the GraphCut algorithm because of its efficiency and powerful segmentation performance in 2-D color images. And in road tracking, aim to track the road border structure between two consecutive frames.

In a computer vision society, most developed tracking techniques, such as particle filter, optical flow ,mean shift are appearance-based methods. Mean shift [11] this paper presents a new approach to the real-time tracking of non-rigid objects based on visual features such as color and/or texture, whose statistical distributions characterize the object of interest. The proposed tracking is appropriate for a large variety of objects with different color/texture patterns, being robust to partial occlusions, clutter, rotation in depth, and changes in camera position. It is a natural application to motion analysis of the mean shift procedure introduced earlier [12]. The mean shift iterations are employed the target candidate that is the most similar to a given target model, with the similarity being expressed by a metric based on the Bhattacharyya coefficient. Road detection and tracking in UAVs, particularly low- and mid-altitude UAVs in this paper, which can be used for autonomous navigation[13], and traffic surveillance and monitoring[14].

A monocular color camera is often equipped in this area, the camera can clearly capture each vehicle on the ground and also has large spatial view on traffic areas. The other research line in UAV-based road detection uses satellite or high altitude UAVs[6] which aims to identify road network, including many junctions and roundabouts from an image. In general, region color distributions and/or boundary structures are probably the important information utilized for road detection. In [4], they proposed to learn road color distributions using Gaussian mixture models (GMMs) from given sample images, and then determine road pixels in each frame by checking the probabilities of pixels that fit the gaussian mixture models.

In [15], [16], A histogram-based adaptive threshold algorithm is used to detect possible road regions in an image. A probabilistic hough transform based line segment detection combined with a clustering method is implemented to further extract the road. A simple intensity thresholding technique is used to obtain initial road regions, followed by refinements of local line segment detections, where the assumption is that roads intensities are very different from neighborhood regions and roads can be approximated locally by linear line segments. The proposed algorithm has been extensively tested on desert and urban images obtained using an Unmanned Aerial Vehicle, results indicate that are able to successfully and accurately detect roads. In [17], the clustering technique based on prior hue and texture information is used to classify each image pixel into target and background, and then boundary lines are fitted to refine the desired region.

III. IMPLEMENTATIONDETAIL

In this section, the road detection and tracking system is represented in the form of work flow structure illustrated in figure 2.

A. System Architecture:

The proposed system comprises data acquisition, preprocessing, graph cut segmentation, homography estimation, and parameter calculation shows in figure 2 system architecture of the proposed system.

Firstly, the input image is taken from the road image database. In data aquisition collect information about road images in urban area, then image is preprocessing using image preprocessing techniques. After preprocessing the next step is segmentation means, separate the objects from the background. Features are detected to classify the image accurately. Using graphcut for road detection and homography for road tracking for UAV videos in urban area.

A GraphCut-based road detection method, where the GMMs are used to model image color distributions, and structure tensors are employed to capture image edge features. Gaussian mixture models (GMMs) the problem of efficient, interactive foreground/background segmentation in still images is of great practical importance in image editing.

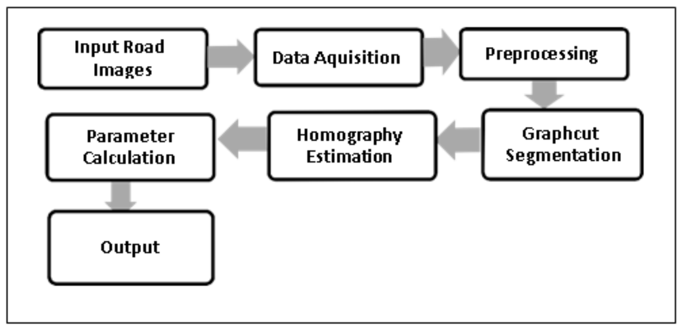

Fig. 2: System Architecture

In road tracking, aim to track the road border structure between two consecutive frames. Proposed system has following steps:

1) Preprocessing*:* In this phase, the original image is taken from dataset and the total number of pixel present in an image is counted.
2) Road Detection using Graphcut: Graphcut can be formulated in terms of energy minimization. Algorithms involve cutting a graph (e.g., normalized cuts), the term "graph cuts" is applied specifically to those models which employ min- cut optimization. The task for road detection is to find U minimizing the following energy function:
   $E(U) = Ec(U) + \gamma Es(U)$.
3) Road Tracking using Homography Estimation: Firstly to detect sets of interest points in two frames, then find correspondence between the two sets of interest points

through correlation-based matching, and finally estimate the homography matrix based on matched point pairs via a robust approach such as RANSAC. Generally, the homography estimation in this way is computationally complex when the image resolution is as high as in our application, where the two computationally high parts are the point (or corner) matching and the RANSAC steps.
t+1
Therefore, we propose to speed up these two steps to make homography-alignment-based tracking fast.

4) Parameter Calculation: The evaluation of system uses metrics such as precision, recall, Specificity, Sensitivity, F measure, time, error rate.
t+1

B. Algorithm:

The proposed system implements following algorithm for road detection. Algorithm1,Graphcut (Minimun cut) algorithm for road detection system.

- Set of points of the feature space represented as a weighted, undirected graph, G = (V,E).
- Weight on each edge, *w(i, j)*, is a function of the similarity between the nodes i and j.
- A cut in a graph is a set of edges whose removal disconnects the graph.
- Partition the set of vertices into disjoint sets.
- A minimum cut is a cut with a minimum number of edges. It is denoted by S. In the weighted graph cut(A,B) = ∑w(u,v)u € A,v € B where A & B are two partitioned disjoint sets.
- The graph is partitioned into clusters. Each cluster is considered as an image segment.

C. Mathematical Model:

The mathematical model for Road Detection and Tracking system is as follows:

Let S be the system represented as: S={I, F,O} Where, S=System for road detection and tracking, I=Set of Inputs O=Set of Outputs, F=Set of Functions

1) I= {M}
Where, M= Road Images in UAV Videos

2) F = {f1,f2,f3,f4}
Where,
f1= Preprocessing of input image f2= Segmentation with graphcuts;

The task for road detection is to find U minimizing the following energy function: E(U) = Ec(U) + ϒEs(U) where, U- Road areas, Ec- the energy function consists of a color, Es- the energy function consists of a structure

ϒ- Trade Off factor
f3= Homography Estimation Tracking
KC = *HCt*
Where,
H-homography matrix
Ct- Road contour in the previous frame is *Ct*.
The road contour tracked in the current frame is then
KC=*HCt*. The transformed contour achieves the road tracking in the current frame. f4=Parameter Calculation
The evaluation of system uses metrics such as precision and Time, sensitivity, F measure, recall, Specificity. These metrics are given mathematically as follows.

3) O= {O1, O2}
Where,
{O1 is a Road detect in UAV videos}
{O2 is a Road track in UAV videos}
O1 and O2 represent the output of the system.

D. Experimental Setup:

In this system, OpenCV and JavaCV are used on Windows operating system. OpenCV and JavaCV provides image processing toolbox in Java programming language. It requires the basic hardware constraints.

IV. RESULT

A. Dataset:

The data set is generated by collecting different urban images from unmanned aerial vehicle that are freely available online. Currently the system is using 500 images. The image sequences downloaded from the internet are also used for more evaluation on different scenarios. Roads used in experiments diverse situations such as slow/fast UAV movements, low/high-altitude flying, existence of a lot of shadows, and large variations on image scenes are included in the data set. The colors and shapes of road are different from eachother.

B. Result Set:

The system has been implemented for road detection and tracking system, to evaluate the proposed road detection technique, perform road detection frame by frame. The first experiment is to evaluate the technical components of the proposed detection approach such as GMM modeling and Graphcut. Compare their performances to road detection in terms of average error rates *ER*, precision *Q* and times *T*. Table1, shows comparison on road detection and tracking for rural and urban area using Graphcut and homography with time, error rate, precision, recall. We have calculated precision, recall, F measure, sensitivity, specificity, error rate, and time for urban area.

Table 1; Comparison on road detection and tracking results for urban and rural area.

Parameters	Rural Area	Urban Area
Precision	98.93%	76.9334%
Recall	-	99.9719%
F Measure	-	86.8728%
Sensitivity	-	99.9439%
Specificity	-	98.637%
Error Rate	4.39%	13.9271%
Detection Time	0.271 sec	2.372 sec
Tracking Time	0.004 sec	0.104 sec

V. CONCLUSION

Road detection and tracking system on road images for unmanned aerial vehicle videos in urban area is proposed. In this paper, presented on graphcut for road detection and homography for the road tracking in the urban area. The objective is to effectively combine both types of information for road detection and tracking in urban area in an efficient way for surveillance, transportation system.

For many fields, transportation, security surveillance, traffic monitoring these system performance and accuracy plays an important role. From the point of view of practical application, it is neccessary to consider the robustness of road image based on graphcut algorithm and homography to scale of dataset. The problem with existing system is that it gives less accuracy, time for the road tracking.

So, the proposed system is more effective than existing system. Since, it helps the solving drift problem. For the achieving accuracy, time and better performance, algorithm will be used. Also the performance of this approach will be compared with the performance of existing system. For Future work we intend to explore efficient river detection and tracking system for unmanned aerial vehicle and solving zigzag problem in urban area.

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