Vehicle Traffic and Routing Identification for Road Planning Optimization in Smart Cities Using UAV Videos

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Abstract. *Unmanned Aerial Vehicles (UAVs) can be used for several applications such as: precision agriculture, environmental monitoring and management, smart cities, planning, and others. Specifically for smart cities, a very desirable application is the identification and tracking of vehicles in roads for planning and traffic optimization. In this paper, a computational approach is proposed to address this problem. Our solution has the proposed pipeline: (a) background subtraction is applied to extract the vehicles in motion; (b) tracking method is used to keep a history of trajectories for each vehicle. The preliminary results were obtained from an UAV prototype, showing promising results for traffic counting and flow analysis.*

1. Introduction

Smart cities is characterized as an aggregation of interconnected components exchanging data and facilitating improved living for a nation's population. Some domains are currently being benefited by the smart city concept, such as transportation, health, tourism, home, energy management, safety and security (Zubair, et al., 2017). Unmanned Aerial Vehicles (UAV) can highly contribute for this concept, and during the past few years UAV images have been commonly used for several aerial monitoring purposes. A challenging application is the identification and routing of vehicle traffic, being helpful for numerous areas such as city planning strategies, transportation engineering and traffic flow optimization.

Over the literature several methods have been proposed for traffic counting and optimization based on UAV images. Traditional methods for vehicle tracking usually start with some object detection approach. When the scene is captured from the same position, techniques like background subtraction (BGS) or optical flow can be effectively used for this purpose. The detected object on the scene can be tracked based on its movement, shape or appearance, temporal information, and many others (Wu, Y., et al., 2015). In this abstract paper a vehicle tracking approach is proposed taking into account counting the number of vehicles and tracking them over the scene for road planning optimization.

2. Proposed Approach

The proposed approach for vehicle traffic and routing identification can be summarized according to Figure 1. From the left to right side, respectively: (i) data acquisition is performed by the UAV, which performs a static capture of data for a predefined area.

(ii), the Background Subtraction method (BGS) segments the objects of interest on the scene, more specifically object in motion. This step is done by firstly defining a background model, which is dynamically generated over the past few frames using the temporal mean algorithm, where the current frame being analyzed is subtracted. The step (iii) proceeds to a contours detection technique, having as main objective hierarchically store the set of objects in motion. Finally, step (iv) is the definition of the zones of control, i.e.: fixed polygons defined over the scene where counts will be performed. Statistics can be extracted from the controlled zones in order to estimate the number of vehicles crossing each predefined direction.

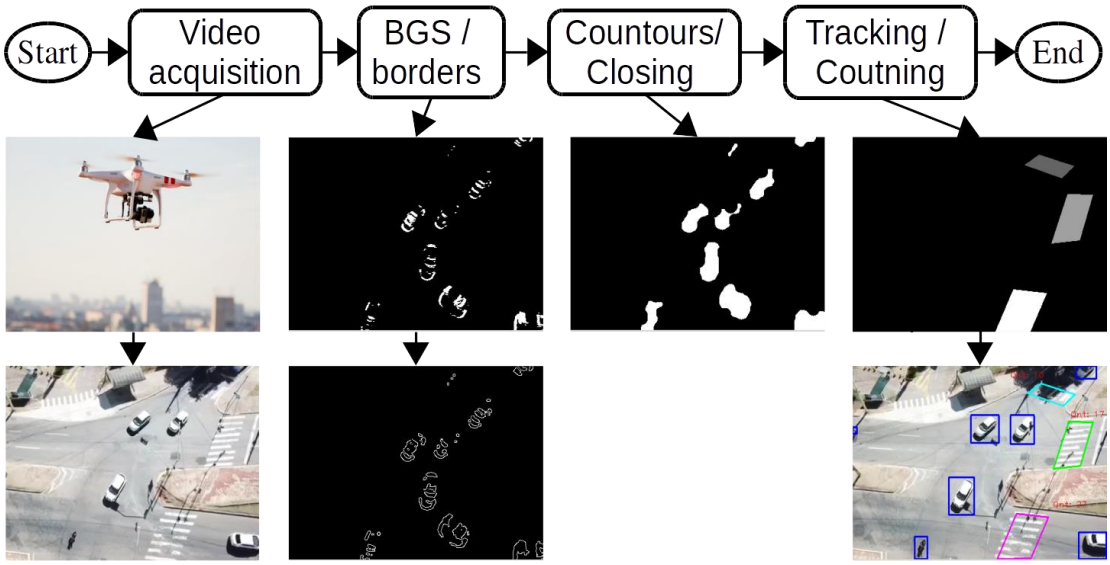

Figure 1. General overview of the proposed approach.

3. Preliminary Results

Figure 1 illustrates the general overview of the proposed approach for vehicle counting and tracking. At the right side of the figure (last column) the vehicles can be noted (bounding boxes marked in blue color) and the controlled zones (polygons with varied colors), responsible to count when a vehicle intercepts its area. We tested the proposed approach in a video acquired from an UAV containing 3 minutes with spatial resolution of 576x320 pixels – 30 frames per second. The proposed approach and set of algorithms have demonstrated effective results, while presenting adequate performance in terms of real time execution. For the tested video, a preliminary validation procedure was conducted in order to provide a quantitative evaluation. A preliminary validation shows a performance of 88.92% for correct classification of vehicles crossing the controlled areas over the inspected video. This validation was based on the absolute values corresponding to the number of vehicles. For more details, please verify our supporting information material and videos available online[1].

4. Final Remarks

This abstract paper demonstrated the use of an UAV approach, which is under development, specifically designed for vehicle traffic counting and tracking for smart cities. The computational pipeline shows promising results for traffic counting and tracking, being able to be used effectively for this purpose in real world scenarios. Further works should include the use of a digital stabilizer algorithm in order to

1 https://drive.google.com/open?id=1-rmvDAywP4OsFJa2Qj47PUC1YA4K2OU4

improve the background detection procedure, since the UAV is subjected to wind and other kind of vibrations that may difficult to obtain videos. Nonetheless, a large dataset with several videos must be constructed and used to validate the proposed approach in more realistic sense.

References

Wu, Y., Lim, J., Yang, M. (2015) “Object Tracking Benchmark”, IEEE Transactions On Pattern Analysis And Machine Intelligence Journal. 1834-1848.

Zubair A. Baig, et al. (2017), “Future challenges for smart cities: Cyber-security and digital forensics”, Digital Investigation Journal. 3 – 13.