

DETECTION OF TRAFFIC CONGESTION IN OPTICAL REMOTE SENSING IMAGERY

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1. INTRODUCTION

During the past years, increasing traffic appears to be one of the major problems in urban and sub-urban areas [1]. Traffic congestion and jams are one of the main reasons for immensely increasing transportation costs due to the wasted time and extra fuel. A new type of information is needed for a more efficient use of road networks.

Remote sensing sensors installed on aircrafts or satellites enable data collection on a large scale and thus seem to be very suitable for various traffic monitoring applications. Several airborne optical remote sensing systems are already in experimental use, e.g. 3K system [2], consisting of three digital cameras capable of acquiring three images per second, and LUMOS [3]. Automatic detection of vehicles and estimation of their velocities in the sequence of optical images is still a challenge and at present still results in a too low completeness thus being not yet suitable e.g. for the estimating of the traffic density.

2. METHOD

We approach the traffic congestion detection in time series of optical images in a different way. We don't try to detect each individual vehicle and then to estimate its velocity as e.g. in [4], but instead of that we model a traffic flow on the road segment and thus derive directly the required traffic parameters from the data. Thus our traffic congestion detection method is based on the combination of various techniques: change detection, image processing and incorporation of a priori information such as traffic model and road network. The change detection in two images with a short time lag is implemented using recently proposed change detection method [5] - Multivariate alteration detection (MAD) - resulting in a change image where the moving vehicles on the roads are highlighted. Image processing techniques can be applied to derive the vehicle density in the binarized change image. This estimated vehicle density can be related to the theoretical vehicle density, which can be acquired by modeling the traffic flow for a road segment. This model is derived from a priori information about the vehicle sizes and road parameters [6], the road network, e.g. NAVTEQ road data base [7], and the spacing between the vehicles. This modeled vehicle density is directly related to the average vehicle velocity on the road segment [8] and thus the information about the traffic situation, e.g. the existence of congestion, the beginning and end of congestion, the length of jam, actual travel times, and so on can be derived.

3. EXPERIMENTS AND CONCLUSIONS

To confirm our idea and to validate the method several flight campaigns with the DLR airborne experimental wide angle optical 3K digital camera system operated on a Do-228 aircraft were performed during the recent years. Preliminary results show the potential of the proposed method for the detection of traffic congestion on highways in along-track scenes (for the example see Figure 1). The following conclusions can be drawn. For the accurate vehicle density estimation the optimal time lag between the two images seems to be about 3 seconds and the range of the velocities between 10 km/h and 80 km/h (congested traffic situation). The problem occurring for very slow or stationary vehicles can be solved by incorporating other approaches, e.g. classification of the single image. Nadir acquisitions minimize the influence of shadowed areas. In total the method produces quite stable and robust results even for short road segments of up to 100 meters. The accuracy of produced parameter estimates seems to be sufficient, but needs to be investigated quantitatively.

4. REFERENCES

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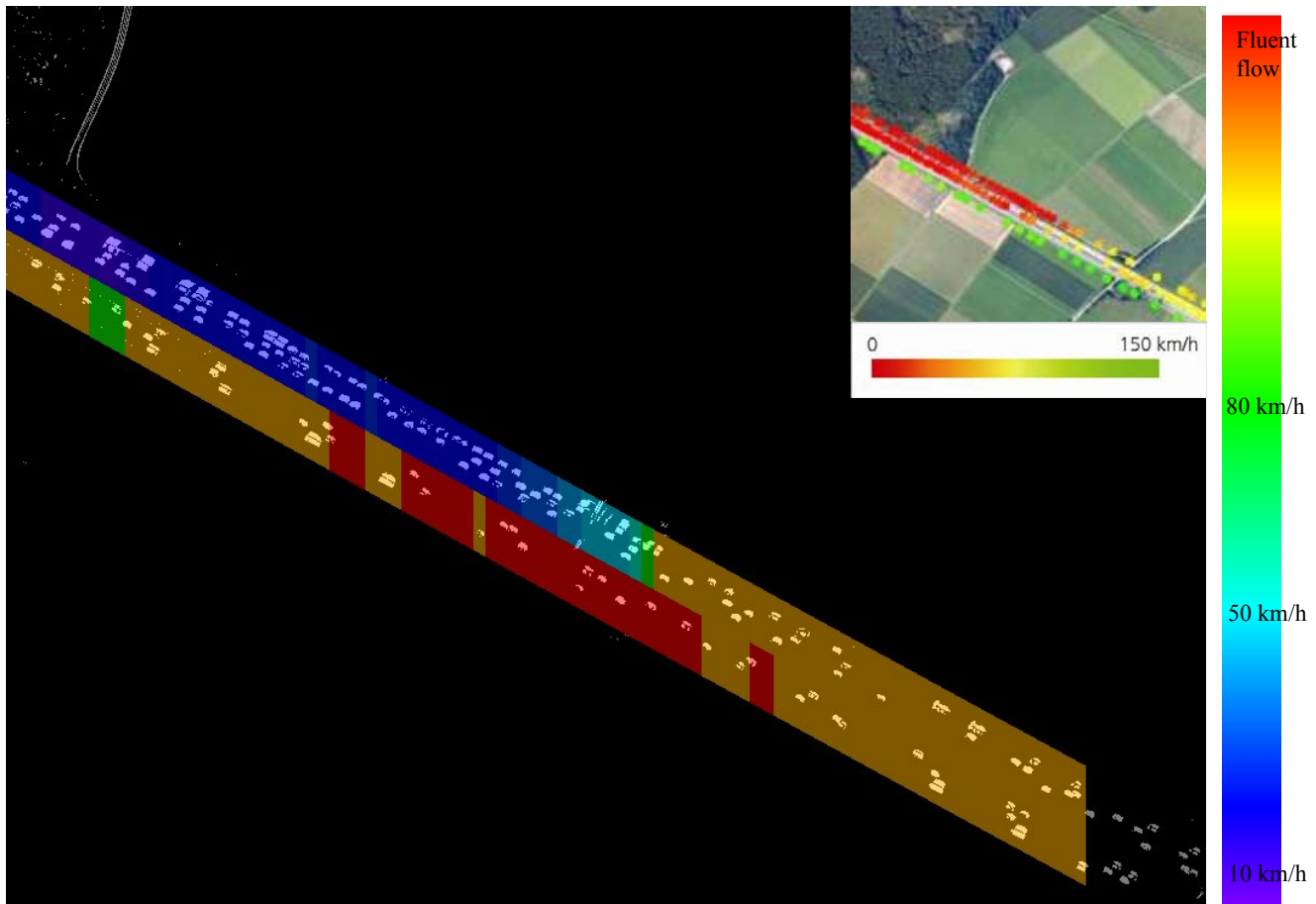


Figure 1. Example of the traffic congestion detection on A8 highway between Munich and Salzburg for 3K data acquired during ADAC flight campaign on 2.9.2006. In blue color the congestion area is marked exhibiting average velocity up to 80 km/h what corresponds quite well with reference data acquired simultaneously shown in upper right part of the image (here the red color shows the same congested area). The change image is used as a background.