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Traffic Violation Detection Using Multiple Trajectories Evaluation of Vehicles

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ABSTRACT:

Non-intrusive video-detection for traffic flow observation and surveillance is the primary alternative to conventional inductive loop detectors. Video Image Detection Systems (VIDS) can derive traffic parameters by means of image processing and pattern recognition methods. Existing VIDS emulate the inductive loops. We propose a trajectory based recognition algorithm to expand the common approach and to obtain new types of information (e.g. queue length or erratic movements). Different views of the same area by more than one camera sensor is necessary, because of the typical limitations of single camera systems, resulting from the occlusion effect of other cars, trees and traffic signs. A distributed cooperative multi-camera system enables a significant enlargement of the observation area. The trajectories are derived from multi-target tracking. The fusion of object data from different cameras is done using a tracking method. This approach opens up opportunities to identify and specify traffic objects, their location, speed and other characteristic object information. The system provides new derived and consolidated information about traffic participants. Thus, this approach is also beneficial for a description of individual traffic participants.

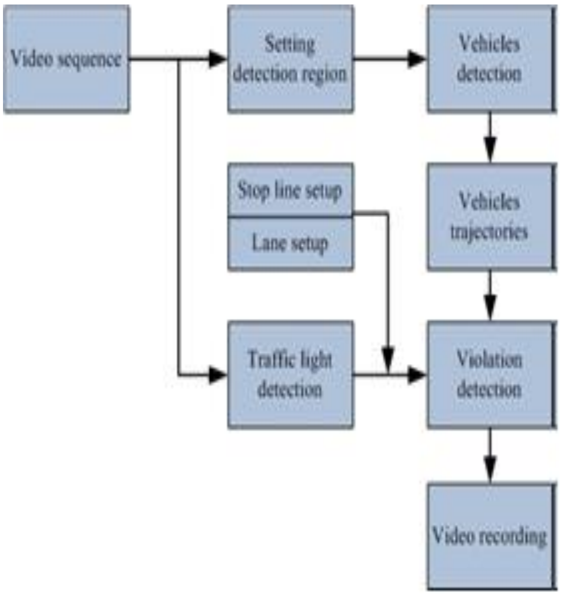
Keywords: ***Multi-camera system, fixed-viewpoint camera, cooperative distributed vision, multi-camera orientation, multi-target tracking.***

1. INTRODUCTION:

Exact knowledge of the traffic situation is essential for Intelligent Traffic Management. Therefore, a fundamental prerequisite for the implementation of an Intelligent Transportation System (ITS) is traffic monitoring at roads and intersections. Inductive loops and microwave radar systems are the most common detection and surveillance systems to measure traffic flow on public roads. An analysis can be found at [1] along with a comparison of different sensors. Over the last 15 years, VIDS using real time image processing techniques [2,3,4,5,6] have become more attractive. Besides traditional traffic parameters like presence, vehicle length, speed as well as time gap between two vehicles VIDS can also determine congestion length, source-destination matrices, blockage or accidents and estimate travel times [7,8,9,10]. In order to overcome limitations of single camera systems and to enlarge the field of view a multicamera system was used. This paper is organized as follows. First an overview of existing multiple-camera systems is given. Next the approach is introduced. Then, an example installation is described and the results are presented. The article concludes with a summary and an outlook.

2. METHODOLOGY:

We proposed a new system that detects lane-change violation by determining the vehicles movement in the region of interesting and using mean square displacement for evaluates the multiple vehicles trajectories in the video sequence. All vehicles moving behaviors will be known and recorded by aforementioned concept, then using the condition of the red-light time to catch violating vehicles when they transgress the red-light or change their lane in the forbidden area. The traffic light detection was determined with purely video processing using the brightness detection in the huesaturation- brightness (HSV) space. The experiment results showed that the method used is high accuracy, easy to implement and suitable for real-time violation detection.



There already exists a variety of solutions for multicamera observation and tracking, especially for surveillance tasks. A real-time cooperative multitarget tracking system for ITS-applications is presented in [11]. This system consists of Active Vision Agents (AVA), where AVA is a network of cameras and computers, which cooperatively track target objects. By means of this cooperative tracking capability, the system can permanently track multiple moving objects even in complicated dynamic realworld environments. A system for acquiring multiview videos of a person moving through the environment is described in [12]. There, a real-time tracking algorithm adjusts the pan, tilt, zoom and focus parameters of multiple active cameras in order to keep the moving person centred in each view. The output of the system is a set of synchronized, time

Generally, red-light and lane-change violations detection involves many equipment and devices, such as inductive

loop, laser-based motion detection devices and traffic light queue control system.. When the system detects that there is a vehicle in violation area, some signals will be sent to a high resolution video camera to record the motion of violating vehicle. The system then identifies license plate number and print penalty ticket to be sent to the violated

vehicles owner. Figure 1 illustrates an overview of a purely video processing for red-light violation detection system; an algorithm used for decision making was based on multiple trajectories evaluation. The complexity of the system was reduced because inductive loop and traffic light control system were not parts of the system, but only video image

processing was used for decision making. The system detects vehicle traffic offenses only. This traffic violation detection method makes the system easy to use even in the condition of road under repaired. Because traffic light does not affect this system therefore the system can continue running. The proposed method was been illustrated in the figure 2. We have video sequence from the camera which must be the digital and calculate vehicles detection under the detection region. Calculation of vehicles trajectories will be calculated in the next step. A decision for the transgression will be judgment under the traffic light condition which parallel detected. A stop line and lane coordinate which already setup first. If the system can be detected the violation, the video recording is the last process. The details of each step are described in section III.

3. IMPLEMENTATION

The existing tracking concept is based on extracted objects, which are georeferenced to a world coordinate system. This concept allows the integration or fusion of additional data sources. Therefore, a transformation between image and world coordinates is necessary. This is done by following equation: ( ) ( ) ( ) ( )( ) ( ) ( )( ) ( )( ) 11 0 21 0 31 0 0 13 0 23 0 33 12 0 22 0 32 0 0 13 0 23 0 33 ' ' ' ' ' ' ' ' r xx r y y rc X X ZZ r xx r y y rc

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r xx r y y rc YY ZZ r xx r y y rc · − +· − −· = +− · · − +· − −· ·− +· − −· =+ − · · − +· − −· with: X, Y world coordinates (to be calculated) Z Z-component in world coordinates (to be known) X0, Y0, Z0 position of the perspective centre in world coordinates (exterior orientation) r11, r12,…, r33 elements of the rotation matrix (exterior orientation) x', y' uncorrected image coordinates x0, y0 coordinates of the principal point (interior orientation) c focal length (interior orientation) The Z-component in world coordinates can be deduced from a dedicated ground plane. Additional input parameters needed are the interior and exterior orientation of the camera. The interior orientation (principal point, focal length and additional camera distortion) can be determined using a well known lab test field. The 10 parameter Brown camera model [15] is used for describing interior orientation. The parameters can be determined by bundle block adjustment [16].

The method for calculating the exterior orientation of a camera, hence determining its location and orientation in a well known world coordinate system is based on previously measured ground control points (GCPs) with differential GPS. The coordinates of these points achieve a precision better than 5 cm. An approximate orientation can be deduced from these coordinates using Direct Linear Transformation [17] Eventually, the exterior orientation is calculated using the spatial resection algorithm in order to improve precision and to eliminate erroneous GCPs.

The scenario has been tested on Rudower Chaussee/Wegedornstrasse, Berlin road intersection by observation via three cameras. The observed area extends to about 100·100 m². Figure 3 shows the original images taken from three different positions and the derived orthophoto. Each of the images was first orthorectified on a predefined street plane and displayed on a separate colour channel as seen in Figure 4. The good agreement between the three orthorectified pictures is obvious.

Figure 3: Original images of the example scene

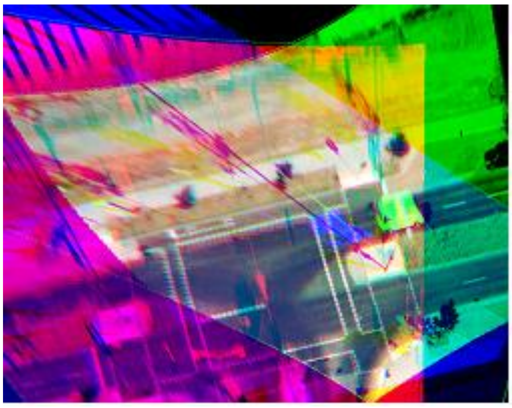
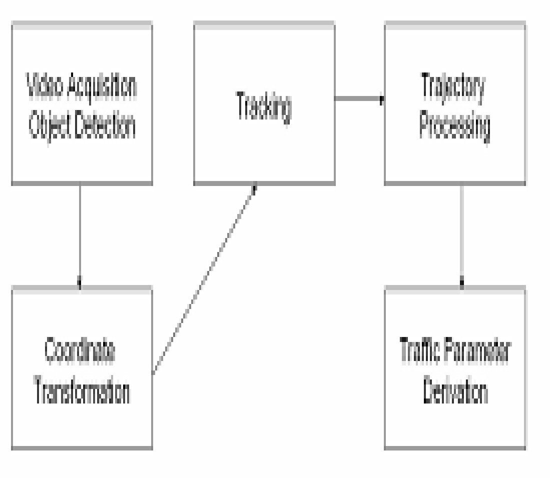


Figure 4: Orthophoto, generated from images of three different observation positions

4.DISCUSSION

The cameras are being used to monitor overlapping or adjacent observation areas. With it the same road user can be observed using different cameras from different positions and angles. The objects of interest are identified from that image data by means of automatic image processing methods. These image coordinates are then converted into a common world coordinate system in order to enable the object tracking and data fusion. High quality camera orientation parameters are required to transform image coordinates into real world coordinates to avoid misidentifications of the same object derived from different camera images. The approach presented here can be broken down into five steps (Figure 1). The first step is to extract all moving objects from each frame of a video sequence. Next, these traffic objects have to be transformed onto a georeferenced world plane. Afterwards, these objects are tracked and associated to trajectories. In the last step, different applications, like assessment of comprehensive traffic parameters can be attached.



6. Experimental Results:

In this approach, trajectories are used for computation of traffic parameters, by associating the trajectory with a detector structure. This structure can be a line or an area detector placed at distinctive places on roads or intersections. Detectors may detect and store trajectory interaction. The interaction between each trajectory and detector can be calculated from intersections using interpolations between pairs of points. Furthermore, trajectories can be stored in a source-destination matrix, giving advanced information about directions of trajectories and travel behaviour of the objects. These data can be aggregated over a predetermined interval. The described approach has been implemented and tested on a traffic intersection in Nurnberg, Germany. The coordinate transformation, multi-object-tracking and trajectory creation have worked together on a designated PC. Trajectories have been sent to a separate PC for analysis and computation of traffic parameters. Because this step is not complex, it has been done on a remote computer, as this could be the expected configuration for a real application.

Fig. 4. Control equipment

1.Gripper has an equivalent force of about 4.22 N.
2.The maximum tip force is 23.5N.
3.The maximum lifting force of the pitching joint was 4.41 N.

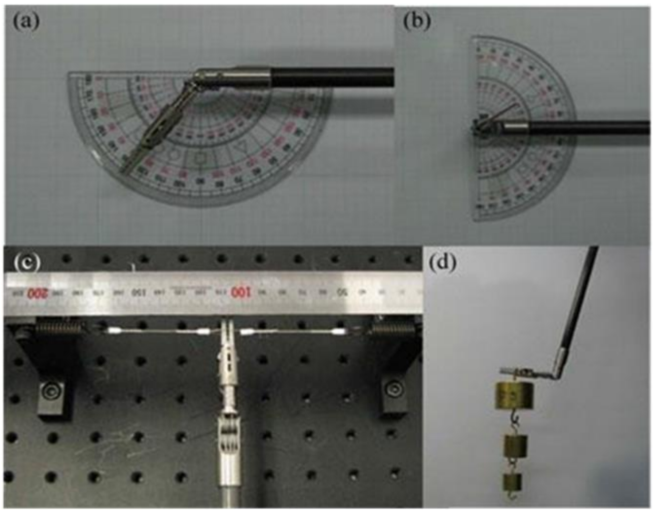


Fig. 6. (a) Measurement of the actual angle of the pitching joint.(b)Measurement of the actual angle of the distal rolling joint.(c)Measurement of the gripper force.(d)Measurement of the lifting force

The tracking algorithm described in [18] uses for each object a state vector consisting of position, velocity and acceleration in X-, Y- and Z-direction. Features like form, size and colour can be added. Firstly, the object identification in a video sequence through its predicted state vector is done by observation-objectassociation [5, 6]. The tracking of a single object is realized using a Kalman-filter. It estimates the state of an object for the time stamp of the following picture, thus allowing to compare the estimated state and the observed object data. They can be associated to the same object, if both are within a certain distance. The initialization of the Kalman-filter is an important problem. In order to derivate the initial object state, directly observable features like position, colour and size of objects are compared in two successive frames without any estimation process. Constraints like maximum velocity or size change are defined in order to limit the number of incorrect associations. The trajectory is finalized when the object is leaving the observed area. The trajectory is also finalized after a particular number of misses. At this moment, the object's internal occurrence memory is read out and a trajectory data structure is created. The format for trajectory data is given by a set of coordinates with corresponding time stamps. As soon as the trajectories are created they are submitted to the analysis module e.g. for derivation of traffic parameters

5. Concluding Remarks

The presented approach for a traffic surveillance system has been implemented and tested. Thus, it could be shown that standard traffic parameters and automatic scene description can be derived based on video detection, tracking and trajectory analysis. This step is a necessary one to take on the way to future traffic surveillance systems. However, detection errors and tracking problems can deteriorate the trajectory data. This leads to less usable trajectories for analysis or less reliable traffic parameters. Methods to detect object detection errors and deteriorated trajectories to stitch them together correctly are key factors in the current and future work

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