Description of the microscopic traffic dataset

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Summary: *The presented **microscopic traffic data** was obtained from **15 videos** recorded within project ESIMAS [3] in a single traffic direction, with **5 cameras** installed above the road, along a 1km tunnel section on the German motorway A3 nearby Frankfurt am Main. The videos were recorded in various traffic conditions **between 7:35 am and 8:00 am**. From this material **8305 vehicles** were extracted within the project "Unfallrisikoabschätzung" funded by the **German Research Foundation** (**DFG**, Project number: 280497386). Despite the sometimes occurring **dense traffic conditions**, the vehicle's **discrete trajectories** were determined with **high accuracy** using a software developed at the Institute of Highway Engineering (ISAC) at **RWTH Aachen University**. Studying the presented dataset, many **stop-and-go** situations can be seen at the macroscopic level of analysis, along with many **vehicle interactions** on the microscopic level.*

Location description

The motorway at this section of the tunnel, in the observed direction, has three traffic lanes, one exit and one entry lane. The speed limit is 100 km/h. The cameras are spaced between 155 to 340 m away from each other, and each of them covers approximately 100 m of road. For each of these sections, an individual right-handed coordinate system was used to determine the vehicle's position as shown in Figure 1. Note, that since the X axes lie on the right edge of the rightmost traffic lane pointing in the travel direction, the exit and entry lane have negative Y-coordinates in the dataset. We assumed that the road is a plane and its z-coordinate is zero.

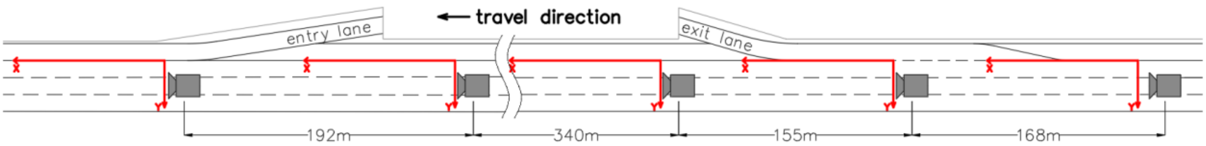

Figure 1. Schematic presentation of the road section

Data collection method

To collect the microscopic traffic data, a self-developed software was employed, which is composed of a graphical user interface along with a video player by which information was saved into a database. The data gathering process consisted of two steps for each vehicle. As first step, the user selected an appropriate 3D vehicle model. As second step, the user visually matched the selected 3D model with the chosen vehicle in the video frame (see Figure 2.a-b) to register the vehicle's position in the road-section's coordinate system (see Figure 2.c).

a) b) c)

Figure 2. a-b) The process of matching a vehicle with a 3D point cloud [1]. c) Vehicle matched with a 3D point cloud within the coordinate system of the road-section.

The position registration (tracking) could be performed at an arbitrary frequency, which means that several frames could be skipped in the video, before matching again the vehicle with the 3D vehicle model. After tracking the vehicle, its discrete trajectory was available. This process was repeated for each vehicle appearing in the videos.

The vehicle models are 3D point clouds of different vehicle types, previously generated with the help of a traffic monitoring laser scanner placed above the road, which recorded all the vehicles passing the sensor cross-section. From these point clouds, 29 vehicle models were included in the presented software, each of them referenced by an ID number from 1 to 29 (see Table 1). The selected 29 point clouds represented most of the vehicles in the videos.

3D model ID (template ID)	Vehicle category	3D model ID (template ID)	Vehicle category	3D model ID (template ID)	Vehicle category
1	Personal car	11	Single unit delivery truck	21	Semi-trailer truck
2	Personal car	12	Single unit truck	22	Semi-trailer dump truck
3	Personal car	13	Truck with trailer	23	Semi-trailer tanker truck
4	Personal car	14	Dump truck	24	Semi-trailer low loader
5	Personal car with trailer	15	Dump truck with trailer	25	Truck tractor
6	Van	16	Tanker truck	26	Bus
7	Van with trailer	17	Low loader	27	Semi-trailer truck
8	Pickup van	18	Low loader with trailer	28	Motorcycle
9	Pickup van with trailer	19	Vehicle transporter truck (full)	29	Motorcycle
10	Caravan	20	Vehicle transporter truck (empty)		

Table 1. Vehicle categories and their 3D model IDs included in the presented software

To enable the vehicle tracking within the 2D video frames, a projection matrix was used to create the back-projection of the 3D point clouds [1] [2]. For each 3D cloud, its points were projected on the surface of the road, from which the outside ones are called contour points. The convex hull of these contour points and the geometric centre point of the convex hull (later referred to as centre point) were determined as well. During the vehicle tracking, the X and Y road-coordinates of the centre point along with the current frame timestamp were saved in the database. The contour points are given with X and Y coordinates in a local coordinate system, the origin of which is the centre point (see Figure 3). The X and Y axes of the local coordinate system are on the plane of the road and are parallel to the X and Y axes of the road-coordinate systems.

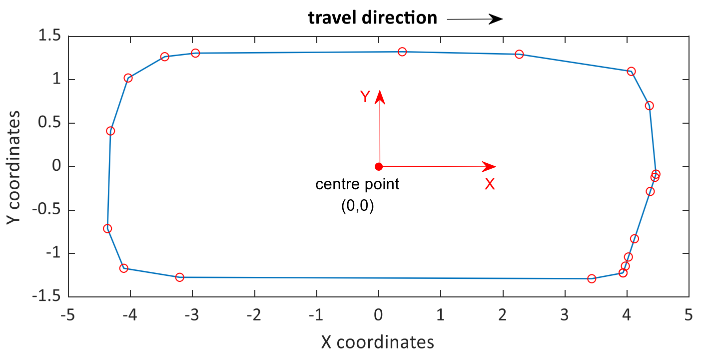

Figure 3. The centre point of the vehicle point cloud template ID=17 and its contour

Dataset

The recording time of the videos along with the camera number and video ID are listed in Table 2. Each video ID (#-#_#) is composed of the camera number (first number), the day of recording (second number) and sequence number (third number). From each video, we created a dataset in MATLAB, which contains the obtained microscopic traffic data. The name of the datasets are equal to the referred video IDs seen in Table 2.

Camera number	Day 1						Day 2	
	Video ID	Recording time	Video ID	Recording time	Video ID	Recording time	Video ID	Recording time
1	1-1_1	07:35:17 - 07:45:16	1-1_2	07:45:18 - 07:55:17	-	-	-	-
2	2-1_1	07:35:08 – 07:45:07	2-1_2	07:45:09 – 07:55:08	-	-	2-2_1	07:40:27 – 07:50:26
3	3-1_1	07:35:11 – 07:45:10	3-1_2	07:45:12 – 07:55:11	-	-	-	-
4	4-1_1	07:35:02 – 07:38:52	4-1_2	07:38:53 – 07:48:52	4-1_3	07:48:53 – 07:48:52	4-2_1	07:40:33 – 07:50:32
5	5-1_1	07:34:06– 07:37:56	5-1_2	07:37:56 – 07:47:55	5-1_3	07:47:56 – 07:57:55	5-2_1	07:40:34 – 07:50:33

Table 2. Overview of videos by camera number, video ID and recording time

In the dataset, each vehicle is represented by a cell with its structured information (see Figure 4). The structure consists of 4 fields: the *vehicle_id*, the *template_id*, the *discrete_trajectory* and the *contour*. The *vehicle_id* is the vehicle's unique ID number assigned to it during the tracking process. The *template_id* refers to the 3D point cloud with which the vehicle was tracked. The *discrete_trajectory* contains 4 columns. In the first column, the *vehicle ID* is registered, in the second and third columns the X and Y coordinates (*posX* and *posY*) of the centre point respectively, are given in *meters*. The fourth column contains the *timestamp*s of the video frames for every registration in *seconds*. The *contour* contains two columns. The *X* and *Y* local coordinates of the contour points (with respect to the centre point) in meters are listed in the first and second columns respectively.

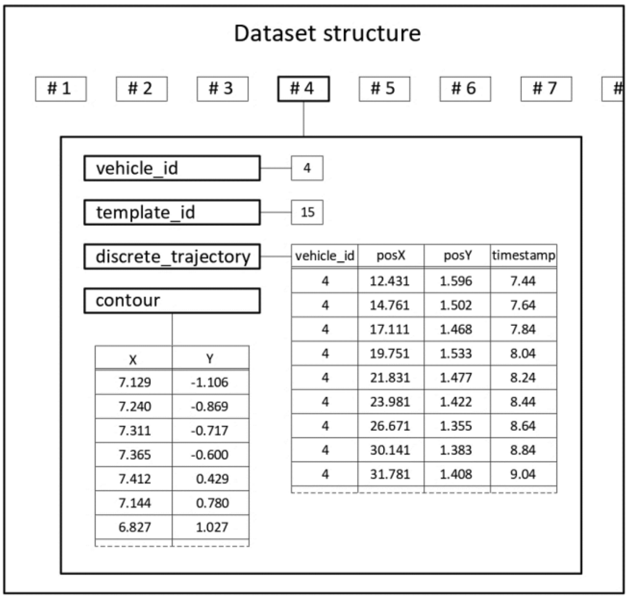

Figure 4. Dataset structure through the example of the vehicle with ID=4 in video 3-1_2

The sampling period of the tracking in our dataset was of 0.2 seconds in most cases. However, the slower the vehicle, the less frequent the vehicle position might have been registered. In stop-and-go situations where the vehicle stopped, the time gap between two recorded timestamps increased up to the duration of stopping.

The data collection method makes the dataset appropriate for both, macroscopic [4] and microscopic traffic analysis [3], by giving information not only from the position of the vehicles, but also from their length and width.

References

[1] A. Fazekas and M. Oeser. 2019. Performance Metrics and Validation Methods for Vehicle Position Estimators. *IEEE Transactions on Intelligent Transportation Systems*, 1–11.

[2] Fazekas, A., Hennecke, F., Kalló, E., and Oeser, M. 2017. A Novel Surrogate Safety Indicator Based on Constant Initial Acceleration and Reaction Time Assumption. *Journal of Advanced Transportation* 2017, 1318, 1–9.

[3] Fischer, M., Strehle, V., Dierken, A., and SPI Dresden GmbH. 2015. *Schlussbericht zum Projekt ESIMAS für das Teilvorhaben "Infrarot-Detektion überhitzter Fahrzeugteile im fließenden Verkehr"*. SPI Dresden GmbH, Dresden.

[4] Herty, M., Fazekas, A., and Visconti, G. 2017. *A two-dimensional data-driven model for traffic flow on highways*.