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ANALYZING AND COMPARING TRAFFIC NETWORK CONDITIONS WITH A QUALITY TOOL BASED ON FLOATING CAR AND STATIONARY DATA

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ABSTRACT

Cities with medium to high traffic volumes are expected to keep the traffic running in a most efficient way. Accidents, construction sites or large events are counteracting this effort. In addition, cities are facing the fact that traffic signal plans configured and optimized several years ago are no longer suitable for current traffic volumes. Expert knowledge of traffic engineers as well as reports from citizens may help to find out on irregular or inefficient traffic flow. However, in most cases it is fairly impossible to determine whether observed deviations from the expected traffic conditions occur only once, periodically or permanently. Therefore there is a need to explore the causes for the changed traffic flows, and also for evaluating the impacts of construction sites, events, or changed traffic signal control plans in a systematic manner. For tackling this task, a prototype of a traffic quality analysis tool (TQAT) is being developed by the German Aerospace Center (DLR). It is based on a tool which came into operation for the representation of recent traffic conditions during the soccer world championship 2006 in Germany in the police department of Cologne (1). The prototype of the TQAT is set up as an application for the City of Nuremberg within the project ORINOKO.

Keywords: traffic management; traffic information systems; road planning, incident detection; traffic data

DATA INTEGRATION AND TECHNICAL SYSTEM

The main components developing a tool for traffic data analysis are basically the data management and an intuitive user interface. On the data side, the developed analysis tool accepts different original or processed data as an input from any relational data base (by now, connections to MYSQL and ORACLE are implemented). Running the tool is simple, it only needs the specification of the columns in the traffic data tables, and a digital map as a common basis where the data are related to. On the user side, a graphical user interface is provided, on which key parameters relevant for the traffic system can be primarily presented in a GIS-map. The tool establishes the connections to the data bases and performs simple raw data requests as well as it aggregates data to time-intervals based on specifications by the user inputs.

From the view of traffic engineers, the main problem in integrating the traffic data from a whole city is - neglecting administrative and political general conditions - related to the different spatial and temporal resolution of the data. Different data sources may be available: Induction loops close to traffic signals as an input for signal control; although rarely used for the detection of traffic volumes and traffic flows, they are often the only available data source with several locations throughout the city area. (Double) induction loops at strategic locations, mainly on freeways or major streets; they provide the traffic parameters traffic flow and mostly local speed for each lane and driving direction and are used for dynamic traffic control. Additional, strategic infrared or radar sensors and sensors for continuous counting without any direct control input are used; they provide data on lane-specific traffic flow and are used as additional information for decisions in traffic management centres. Nowadays, video detection is adopted at specific, critical or strategic locations and will face further investments in future, mainly at critical intersections; they can provide traffic volumes, traffic flow and turn ratios depending on camera position and viewing angle. Besides these stationary detectors, mobile sensors which move within the traffic stream (floating car data, GPS-detection of PDAs, or data of cellular phones) are data sources with an upcoming perspective; the information is generated while moving along a route segment, and instead of local information spatially distributed information is gained, which may be timely invariant. For an area-wide detection of traffic the degree of availability is crucial for any data source. Having such data in one or more accessible data bases, the efficiency of analysis request statements - generated by some tool - relates to the extensiveness of pre-processing of the data, because the amount of raw data to handle is usually huge. With a request, the data must be loaded from the data base, transferred to the analysis tool and presented in the graphical user interface. With large data bases and elaborated filters applied to a request the data base may face serious processing challenges which hamper access for other processes. On the other hand, large amount of data may consume a lot of time for displaying. A special function included in the request module of the TQAT tool supports the user by pre-calculating the expected amount of data and time for a request.

Within the project ORINOKO, Nuremberg street traffic data are collected from strategic induction loops at 59 cross sections complemented by data from video detection at some important intersections and floating car data from a taxi fleet of about 500 vehicles. All data are transferred to and written to an ORACLE data base, which holds also all infrastructure data. An up-to-date digital map of Nuremberg is the common base for the exchange of data. All stationary and mobile detectors are matched onto the digital map with their exact geographical positions. The digital map serves also for the graphical representation of the historical data in the user interface. Data sources can be presented related to the street segments of the digital map, and according to the selected time period, traffic parameters etc. Figure 1 shows a sample screenshot of the tool with an example of mean speeds calculated from the taxi fleet over a period of one month.

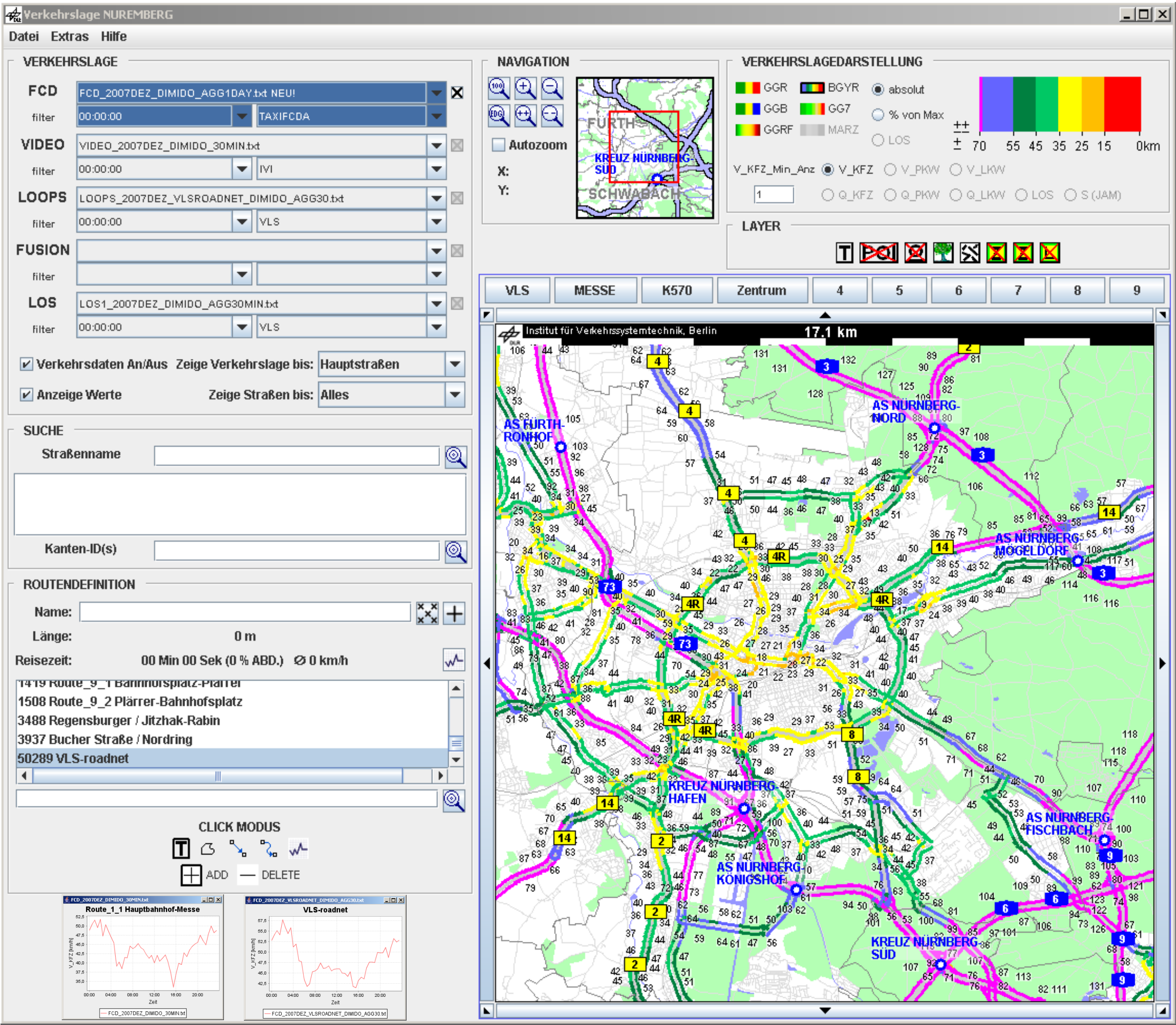

Figure 1: Graphical user interface of the traffic quality analysis tool.

RETROSPECTIVE ANALYSES

The central application of the tool is the analysis and the comparison of transport network conditions with respect to different time periods. Founded on the data base it is possible to detect variations from a predefined traffic state, where the traffic state can be described by one or more characteristic traffic parameters. The comparison with historical data allows the observance and reporting of changes of these parameters and, where applicable, further measures can be taken. One example application may be the aim to adapt traffic signal programs, when key parameters relevant for the signal control – the daily variation of flow e.g. - are observed to change over time.

For the application of retrospective analyses it can be chosen between all different data sources and additionally merged traffic states. Time filter functions for year, month, etc. may be applied. For a variety of applications it is quite reasonable to limit the analysis to certain week days, or a range of week days (e.g. Tuesday to Thursday). Further on, in analogy to the time-of-day dependent amount of traffic, an analysis using only time slices of peak hours for the selected period can give detailed information. The following characteristic traffic parameters can be viewed and analyzed, depending on the selected data source: mean local speed, mean local flow, calculated speed from floating car vehicles, congestion length in front of traffic signals, and Level-of-Service. Each data may be displayed in absolute values or relatively, e.g relating to the maximum allowed speed. For each of the parameters the tool provides a set of colour schemes to be chosen including the possibility to change the limits for the parameter values between the colours to get maximum possible visual distinct. This may be helpful especially under the aspect that detailed analyses for city traffic should be possible as well as analyses of highway traffic.

The graphical user interface includes a freely zoomable presentation of the digital map in combination with different options of graphical layers for the presentation. Traffic data can be included and presented in the map as described above. For a more detailed analysis of single street segments, important main routes, interesting network segments or even areas, it is possible to combine links to whole sets, which may be saved for later work. On the one hand the request of traffic data may be limited to such sets, on the other hand overall averaged values of each available traffic parameter are calculated and a comfortable display of time series for these sets is possible. The tool assists in building such sets by various built-in user-friendly routines such as a simple search function for street names, an origin-destination routing engine for fastest/shortest way, graphical selection with polygons and simple addition / subtraction of street segments.

This way, analyses of the traffic quality can be done for the complete transport network, or for smaller areas or corridors of special interest in detail.

SELECTED RESULTS

The tool is utilized by the "Stadtplanungsamt" (Department of Traffic Planning) of the City of Nuremberg, to which the tool was delivered in summer 2008. The tool is used by now in the analysis of selected intersections. Having a much greater demand than normal in the streets leading to the local zoo for example caused a detailed analysis of the video data collected at the main crossing. By analyzing the daily variations of recent data the traffic signal plans could be adjusted to maximize the throughput at this intersection. Another application of the tool was the analysis of average speeds in the whole street network of Nuremberg using travel time data from the taxi fleet of the complete year 2006. For traffic models used for planning purposes, the calculated demand has to be assigned to the existing network to gain resulting spatially distributed traffic volumes. Most important here is the street network and the capacity of the streets, which are primarily defined by the number of lanes and the average speeds which can be driven. The average speeds may be estimated by the information about the maximum speed and probably supplemented by measured speeds at some local measurement sections. With this, the average speeds on segments where no recent speed data are available, can typically be estimated according to similar street types for example. But most valuable are in this case the average speeds measured by the taxi fleet in Nuremberg. The TQAT was used here to make a plausibility check possible comparing the typically mainly estimated speed values to the measured speeds in the whole street network. This way, the simulation and assignment of traffic volumes could be made much more realistic.

REFERENCES

(1) Michael Bonert; Elmar Brockfeld; Ines Ernst; Daniel Krajzewicz; Martin Ruhé; Peter Wagner (2006): „SOCCER Verkehrslageerfassung und –prognose während der Fußball-WM“. *IMA 2006 Informationssysteme für mobile Anwendungen*, Wolfsburg, Germany, 2006-10-25