SOCCER - TRAFFIC SURVEILLANCE AND FORECAST FOR LARGE-SCALE EVENTS

Monitoring and Simulating the World Youth Day 2005 and the Soccer World Cup 2006

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1. Introduction

The traffic during big events like sport games is characterized by a huge exceptional travel demand during a very short time-span. Usually this demand exceeds by far the capacity of the transport system as a whole. Therefore, it is in the responsibility of the traffic management exerted by the relief units, e.g., the police, as well as of the local authorities, like the city administration together with public authorities of the surrounding region, to control and maintain traffic flow. To do this, existing traffic control and management centres need to have a fairly complete on-line traffic surveillance and monitoring of the region under consideration.

With emphasis on street bound traffic the challenges being posed to the traffic control centre are the safe and secure handling of the traffic related to the event itself, as well as its integration and harmonization with the normal traffic in this area. To aid this process, a thorough planning is needed beforehand, together with a prognosis of the expected traffic flows. During the event itself this should be a short-term prediction (30 to 60 minutes into the future) of the expected traffic states to help in reacting timely and correctly to emerging threats of a safe and smooth state of the transport system.

The World Youth Day in Cologne 2005 with approx. 1 million participants at its peak as well as the FIFA Soccer World Cup in different German cities 2006 were good opportunities to implement and test a system combining both necessary actions.

2. System Components

2.1 Description of the Traffic Surveillance and Monitoring System

The traffic surveillance is based on data from traditional loop detectors, travel times from Taxi-FCD (floating car data) in Stuttgart and Berlin (www.cityrouter.com), and a novel airborne system. Its sensor ANTAR (Airborne Traffic Analyzer), which monitors traffic flow, is mounted on-board of an airborne device such as a zeppelin (Cologne), helicopter (Stuttgart) or plane (Berlin). ANTAR itself consists of two camera systems (CCD and infrared), an inertial/GPS-system for knowing very precisely - within fractions of a

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meter - the actual position and the viewing direction of the cameras. The sampled image data, usually JPEGs in a resolution of 1024 x 1024 pixels with 5 frames per second, are sent to the ground station, where the video processing software “TrafficFinder” then does the automated traffic data extraction and analysis from the video pictures in near real-time. Taken a flying altitude of 800 m the images thus have a geometric resolution of about 0.1 to 0.2 m. Based on the precise navigation information of ANTAR, the images can be projected onto a digital street map. In this way, the pixels corresponding to the streets can be extracted from the image. These pieces now can be searched for vehicles, whose speeds can be determined by analysing two subsequent images. With this, almost any vehicle which drives along a road can be found, yielding an almost complete traffic state for the area the camera is looking upon. Transformation of the single car data into traditional measures like average speed, flow, and density - which usually cannot be measured - is done easily, and subsequently the information can be visualized in various representations. Additionally, this information can be forwarded to the traffic simulation.

Fig. 1 ANTAR – Airborne Traffic Analyzer

2.2 Traffic Prediction using Simulations

To predict the traffic into the future, two main approaches are possible:

- using stochastic models with input of previous events to calculate the most likely state
- using detailed mathematical models with parameters (data assimilation)

The first approach was used in Stuttgart, based on historic traffic load curves from which the most suitable was chosen.

Berlin and Cologne applied different simulation models; Berlin used an agent-based simulation from the TU, Cologne tested the mesoscopic simulation logic built into the microscopic traffic simulation programme SUMO [1] which is under constant development at the DLR. The simulation consists of three steps, of which the first two resemble traditional planing: processes: first, a travel demand matrix in time-slices is computed from different sources, mainly from socio-demographic data generating the normal traffic during a normal day in the area, as well as information from event organizers and the police for the additional demand created by the event (note: if the event is very well-known in the area, the normal demand usually slightly decreases). Second, a dynamics traffic assignment is computed with this travel demand information to yield a kind of ground-state of the traffic situation in the whole area. These two steps, of course, should be done off-line, before the event. In a third step, which has to be done online, this ground-state is corrected with the help of the online data stemming from the ground detection as well as from the airborne detection. It therefore compiles the different information sources into an integrated representation of the state of the traffic in the simulation area. Since this is a dynamical simulation, it needs to be fast enough, thus making a fully microscopic simulation difficult, especially for the city of Berlin. The renewing of data sets basically happens in five minutes steps, and these five minutes must be used to run the simulation ahead for 30 minutes into the future to generate the forecast.

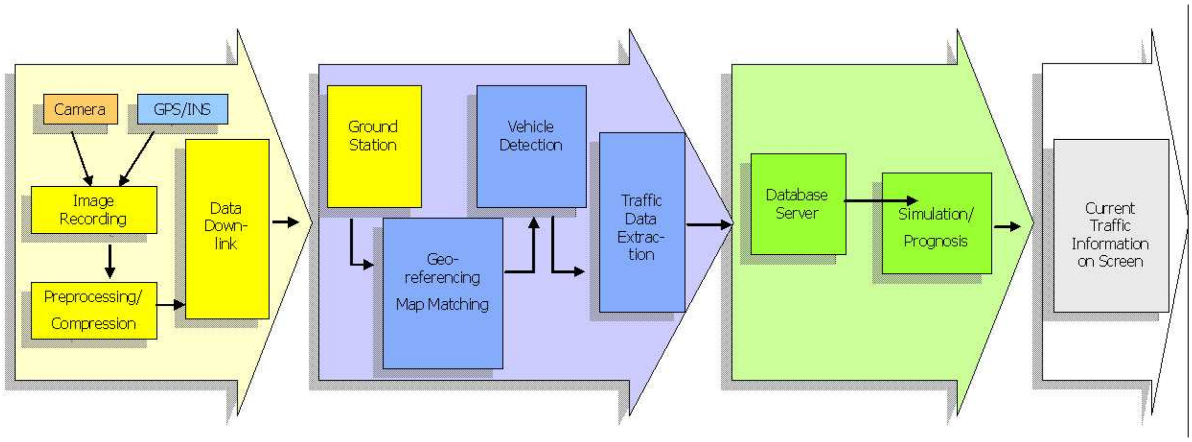

Fig. 2 Graphical representation of the different processing steps of the airborne traffic surveillance system

3. Applications

3.1. World Youth Day 2005 in Cologne

The World Youth Day (WYD) was not part of the SOCCER project, but similar technique was applied to cope with the 400,000 registered pilgrims, adding to the approx. 1,000,000 permanent inhabitants. The climax of the event was the weekend with the celebration of the final Mass with pope Benedikt XVI at the Marienfeld, a few kilometres west of Cologne. About 1,000,000 visitors were expected to attend this presentation. An especially interesting part was the fact that about 5,000 motor coaches transported the pilgrims to the Marienfeld. To handle this enormous demand, a part of the freeway system has been converted into a large parking area. The normal traffic demand has been computed by the tool TAPAS [2], the special travel demand by a model based on [3] and adapted to the specifics of this event.

3.2 FIFA Soccer World Cup 2006

The football games took place in 12 stadiums all over Germany with 3.36 million attendees and were watched by further millions gathering for public viewing on specially erected big screens.

Berlin, Cologne, and Stuttgart had all different systems with the primary objective to provide organizers, police and radio programs with up-to-date traffic information and predictions. Other projects show that also the automated broadcast service TMC (Traffic Message Channel) could distribute them to mobile navigation units.

In the case of Cologne the data from 77 municipal detection sites, 774 detectors on federal freeways in a radius of 30 kilometres around Cologne, and the airborne data were fused. During the event, about 36 GB of image data have been collected, an amount that is easily manageable. The representation of the network consisted of major roads only, being extracted from the underlying digital net by the provider NavTeq, to keep the computing times of the simulation manageable (<5 min, the renewing ratio of data sets). Finally, the study area had 25,000 links and 11,300 nodes. The traffic demand input of 3.4 million journeys per day into the following simulation was calculated on a 2-CPU machine with 2 GHz Opterons, leading to a maximum occupation of 2 GB RAM.

The evaluation shows that in principal the simulation maps the reality in a satisfying range of deviation, and that induction loops produce a considerable amount of failures as well.

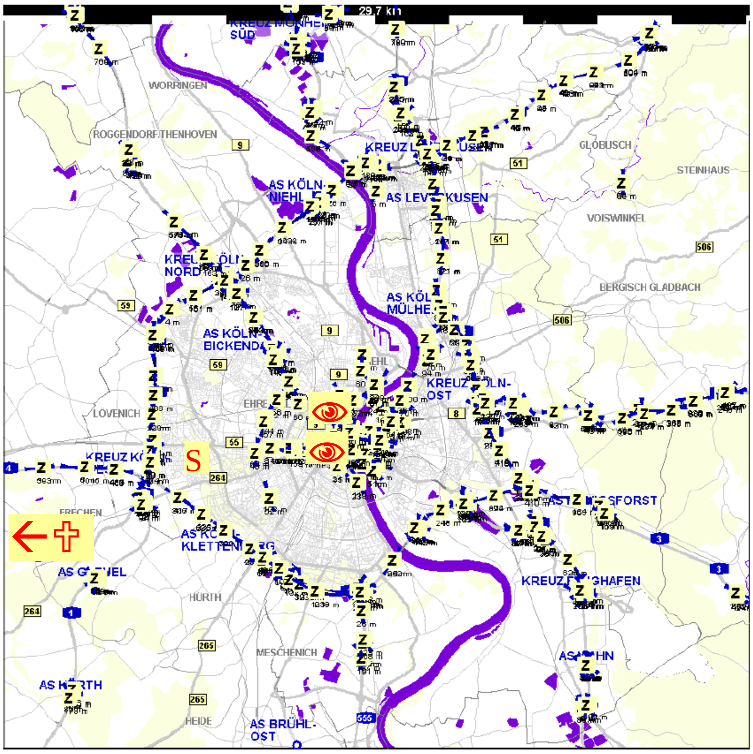

Fig. 3 Overview on the complete simulation area with all induction loops (Z) on the highways and the inner city streets, the stadium (S), 2 public viewing places (👁), and the WYD location (✞, outside the map).

References

[1] SUMO – an open source traffic simulation program. Download and further information on http://sumo.sourceforge.net, (07.05.2008)

[2] G. Hertkorn, *Mikroskopische Modellierung von zeitabhängiger Verkehrsnachfrage und von Verkehrsflussmustern*, Dissertation, Universität zu Köln 2004.

[3] M. Bonert, *Verkehrsbewältigung bei Großereignissen – Ein Erfolgskriterium für Veranstaltungen*. (Traffic Management at major events) In: Schiefelbusch, Martin (Ed.) *Erfolgreiche Eventverkehre – Analysen und Fallstudien,* Studien zur Mobilitäts- und Verkehrsforschung, Bd. 7, Mannheim 2004

Summary

It could be demonstrated, that this novel surveillance system integrating airborne traffic surveillance with traditional ground detection of traffic flow can yield valuable information needed for a better management of big events. The combination with a simulation-based approach to integrate a traditional travel demand forecast and the on-line data generated during the event itself leads not only to an almost complete coverage of the traffic system, it also delivers a short-term forecast for the action forces to react fast to developing aberrations. Still the methods need to be improved, e.g., data fusion between simulation and reality.