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INCREASE THE SAFETY OF ROAD TRAFFIC ACCIDENTS BY APPLYING CLUSTERING

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Abstract

In terms of continual increase of number of traffic accidents and alarming trend of increasing number of traffic accidents with catastrophic consequences for human life and health, it is necessary to actively research and develop methods to combat these trends. One of the measures is the implementation of advanced information systems in existing traffic environment. Accidents clusters, as databases of traffic accidents, introduce a new dimension in traffic systems in the form of experience, providing information on current accidents and the ones that have previously occurred in a given period. This paper proposes a new approach to predictive management of traffic processes, based on the collection of data in real time and is based on accidents clusters. The modern traffic information services collects road traffic status data from a wide variety of traffic sensing systems using modern ICT technologies, creating the most accurate road traffic situation awareness achieved so far. Road traffic situation awareness enhanced by accident clusters' data can be visualized and distributed in various ways (including the forms of dynamic heat maps) and on various information platforms, suiting the requirements of the end-users. Accent is placed on their significant features that are based on additional knowledge about existing traffic processes and distribution of important traffic information in order to prevent and reduce traffic accidents.

Keywords: accident cluster, traffic information system, road traffic safety

1. INTRODUCTION

Even though numerous measures are taken to decrease the number of accidents, it is still necessary to invent new approaches to tacking road safety. Based in essence on the Information and Communications Technologies (ICT), the Intelligent Transport Systems (ITS) collect the information on road traffic

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status from various sources, creating general situation awareness in near-real time.

Road accidents data is currently being collected with traditional methods for statistical prediction of irregularities and dangers on the roads. Traditional methods that are based on various detectors require additional infrastructure investment and maintenance along transport corridors. Ease of Internet information access on different platforms significantly expands the available information and the ultimate benefit is much higher.

Therefore, it is necessary to develop new methods of analysis to perform sanation of dangerous spots by changing driver's perspective. In this way, participants in traffic can promptly, clearly and unambiguously, in adverse conditions, spot the danger on the road and thus avoid accidents.

The development of information technology and the development of precise radio navigation systems have opened a wide range of possibilities of implementing geographic information systems and have made GIS-oriented applications available to a wider circle of users. GIS-oriented applications enable connecting of different types of data in order to realize complex analyses.

2. INFORMATION SYSTEMS FOR COLLECTING AND ANALYZING DATA ON TRAFFIC ACCIDENTS

The main purpose of the service for the collection and analysis of traffic and other information relevant to safe traffic is to make mobility safe and controlled traffic on all sequences.

Intelligent Transportation Systems inform participants about the upcoming traffic situation, such as tips for drivers or passengers, personal navigation, congestion on the road, information on incidents or toll. The primary purpose of the integration of information systems and the traffic itself is to increase safety of all participants in road traffic.

At the end of the process chain to raise awareness of passengers and / or drivers of the need for increased road safety is user focused distribution and visualization of traffic information.

Information systems for traffic management must be capable of adaptive activity in real time in order to be maximally effective. Good and dynamic adaptive control of traffic flow reduces the possibility of incidental events that significantly increases safety on the roads. Such information systems consist of the following components:

- The transmission system (the fiber optic transmission system)
- A system for collecting and processing information

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- Multimedia system for disseminating information
- Center management.

These components should support the process of collecting, processing and distributing traffic information. The system for collecting and processing the collected information gives accurate and relevant information on traffic accidents and adjusts format delivery information form to be useful and understanding to the end user. This system involves the availability of traffic information to end users through the following media:

- Television, radio and internet portals
- Mobile devices (WEB / WAP, SMS, MMS)
- Electronic displays.

3. DATA RELATED ACCIDENT CLUSTER ESTIMATION

Highway engineers and traffic police generally know of the tendency for road accidents to cluster together at certain locations, commonly termed “accident black spots”. Two common methods for tracking high risk sites are:

- List – based on accident statistics, a list is drafted indicating concentrations with the highest frequency of accidents involving injury. The list is then divided into junctions and road links, the latter specifying the number of accidents involving injury per kilometer.
- **Inventory map** – usually managed by the road owner or road authority, this is regularly updated map with a record of all accidents. Each new accident is located on the map with a color pin and the color of the pin varies according to the seriousness (injury/fatality) of the accident. This provides a quick way to visualize the most dangerous spots and sections of roads.

In the context of traffic management, an accident cluster is a group of clustered data points which are indicative of high accident locations. Accident clusters are used to present a group of geospatially organized traffic data based on traffic accident dataset. The main part of an accident cluster is based on historic traffic accident reports collected through defined time period. The cluster is constantly updated with new reports which are collected using the semantic web. It searches specified web sites which announces new traffic accidents daily and collects needed data; street address, accident description and type. The cluster is being updated with new data, latitude and longitude are matched and map is refreshed.

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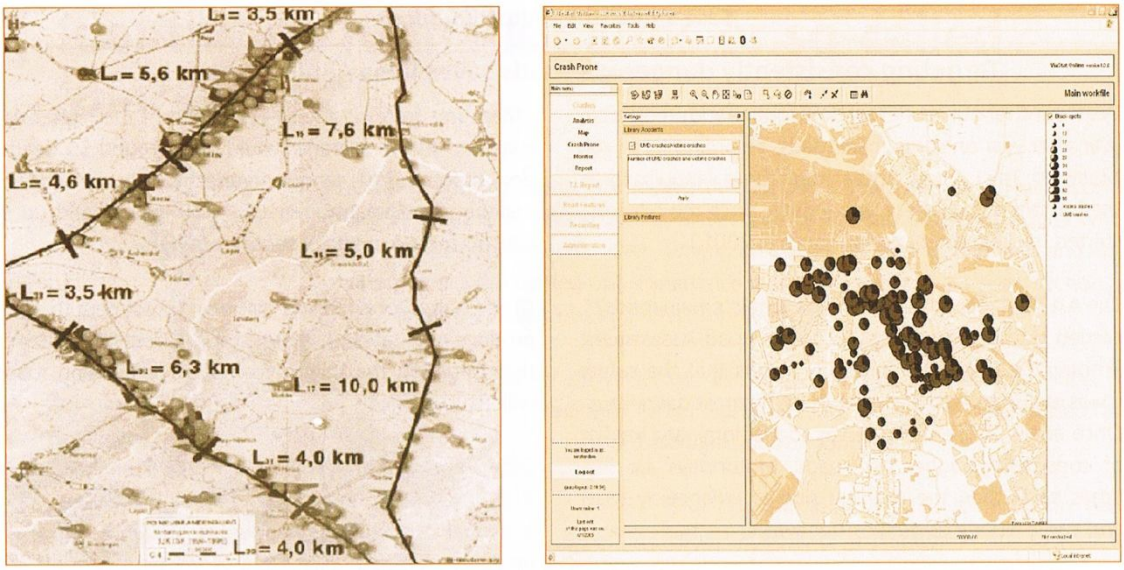

Figure 1. Inventory maps

The result is a constantly evolving map that can be visualized with markers or heat map (Fig 1) reflecting near real-time traffic conditions, which can considerably enhance spatial and situational awareness through the distribution in various ways and platforms, such as dynamic heat maps themselves, plain text, IPTV broadcasts, still images, location-based services based on mobile communication networks, RDS, electronic panels along the roads etc [4]. Accident cluster map can be visualized either using mobile devices or on desktop computers.

Heat maps are especially useful in presenting the results of cluster analysis where observations are assigned into subsets so that observations in the same cluster are similar in some sense. Accordingly, accident clusters are used to present a group of geospatially organized traffic data based on historic knowledge of traffic accidents. Accident clusters have been traditionally used alongside with heat maps to gradually improve traffic safety and increase the awareness my marking dangerous roads with road signs limiting speed, alerting to sharp turn and similar. Since accident clusters have always been considered a component of traffic statistics due to their long-term nature, their use in dynamic traffic conditions has been questionable due to ever evolving nature of traffic conditions [3].

Heat maps and accident clusters cannot predict potentially dangerous dynamic conditions based on historical statistics alone. Therefore it is necessary to include a variety of near real-time traffic data such as location of accident data received from various sources or the estimation of the accident clusters.

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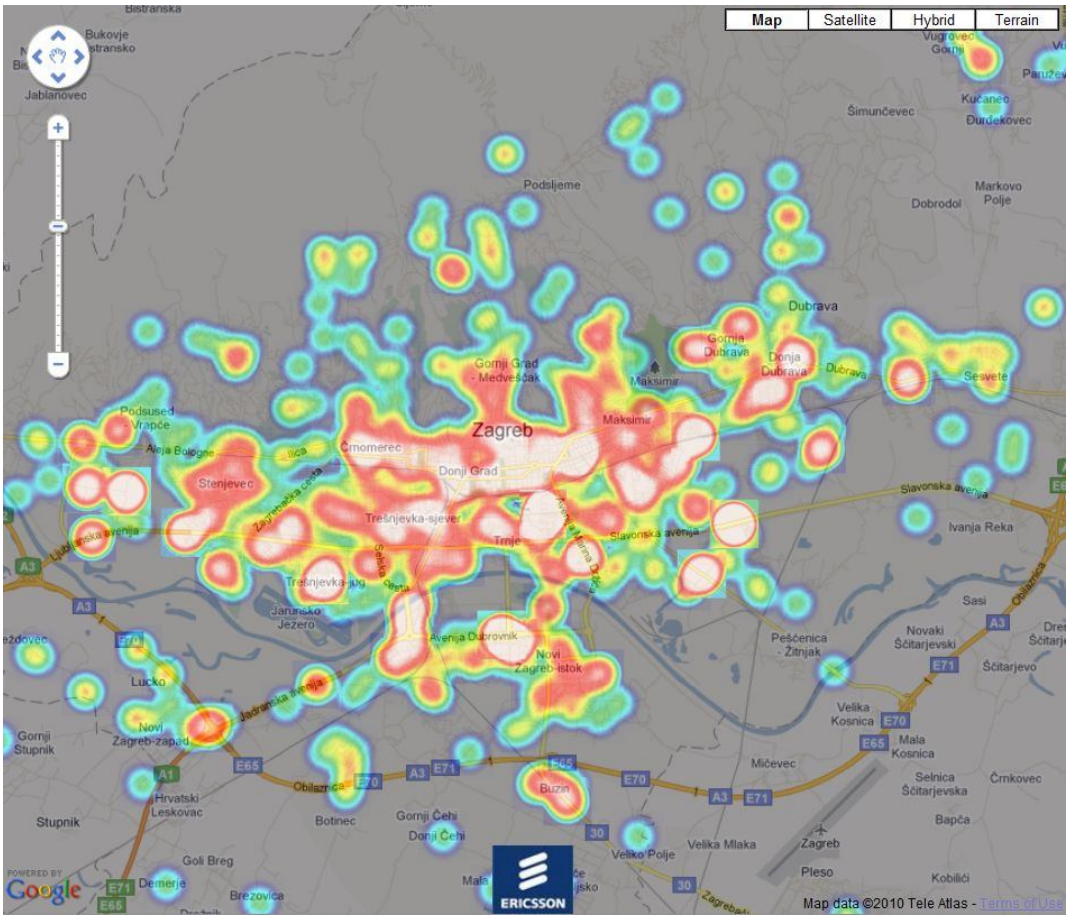

Figure 2. Accident cluster presented using heat map for the City of Zagreb

4. METHODS FOR SANATION OF DANGEROUS SPOTS

After collecting data on traffic accidents, it is necessary to choose a dangerous location and approach to it's sanation. If we look at the locations of accidents in relation to road locations, we observe the following:

- There are road sections with an extremely low accident rate (from the statistical point of view) in long periods of time;
- There are short road sections with maximum traffic accident rates, in relation to equal traffic intensity;
- Research of geometrical road components (situational elements: courses, curves, transitions, elements of longitudinal and transversal profiles) shows the presence of the same elements both on sections with low (zero) and on those with high accident rates).

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General perspective, based on the total road environment information, might not be in proportion with the information indicating danger. This mostly boils down to three characteristic situations:

1) The driver does not recognize clearly enough the road extension perspective, does not slow down and is a potential, or sometimes even the actual cause of the accident

2) The driver does not recognize, or does not recognize soon enough, a traffic priority situation at the crossroads, which causes an accident due to disrespecting of the right way, passing through the red light or sudden braking

3) Insufficient perceptibility of a moving vehicle (with bad or no lights at all, at night, at sunset, but also during the day), and various obstacles between a vehicle and a pedestrian.

Up to now, this problem has been solved with the use of mathematical, graphic, field and photographic method. The new sanation method, using geo-referenced video, lowers field costs, increases accuracy and raises safety.

To obtain the right information on a possible relationship between the driver and his environment, it is necessary to take video movie with GPS coordinates of the danger spot according to the prepared plan. A detailed analysis of the area outlook and the road environment from driver's point of view, point at the possible perception "defects", which prevent the driver from realizing a danger on the road clearly and on time. Modern computer technology theoretically enables simulation of the road's outlook and it's environment from the driver's point of view, based on the data gathered from the road project documentation.

Analysis of video, from various distances on accesses to the danger spot, from driver's point of view, provides the opportunity for impartial judgment on some or most of the probable causes of an accident.

These methods helped improve eight extremely dangerous spots on the main road network in Croatia. The improvements needed to make an entire road network or hazardous site safer often cost little but can result in huge benefits in terms of reduced incidence of road crash and injury. The injured rate and the total number of accidents were reduced by 30 - 70%.

5. CONCLUSION

On a wide range of transport systems, from road and public transportation to major traffic infrastructure systems, information systems play a very important role in the prevention, early warning, and reduce the effects of traffic accidents.

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The development of intelligent transport systems, as well as the application of information and communication technologies, will certainly contribute to the increase in road safety. In the near future it is necessary to consider wider use of modern safety systems such as the exchange of information between vehicles in motion, the exchange of information between vehicles and infrastructure and information exchange infrastructure and advanced support systems drivers (ADAS - *Advanced Driver Assistance Systems*).

The implementation of these systems will contribute to creation of database containing latest data on road conditions and accidents in real time. This would allow the development of algorithms that will automatically processed and distribute traffic information to end users.

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