# A GIS System for Managing and Analyzing Urban Road Traffic Accident

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**Abstract:** We develop a GIS database to store urban traffic accident data in digital style, and analyze these data in terms of their attribute and spatial characteristics to exploit the reasons of accidents and rank urban area with dangerous degrees. We establish a road network in MapInfo for a sample city. Second we collect three years' death traffic accidents data of the city and link these data with road network database with OLE connection between MapInfo and Visual Basic. We analyze reasons of traffic accidents to summarize major factors related to the accidents. Finally we create a hazard map to show the accident dangerous degree in the city.

**Keywords**: Traffic Accident, Hazard Map, MapInfo, Road Network and OLE

## 1. INTRODUCTION

As the soaring increment of car ownership in China's cities and the poor traffic control system, road traffic accidents have been increasing rapidly and induced lots of economic lose. For example, in year 2000 traffic accident per 10 thousand motor vehicles of Dalian city is 147.0, while 21.7% of them are death accidents. In order to handle traffic accidents, lots of information has been collected and large amount of documents are stored in police offices. However, works of systematic analyses of the data are hardly done. Almost all studies on traffic accident in China concentrated on theoretical and conceptual analyses. For example, Mao (Mao *et al*, 2002) gave some concept and structure to explain the causation of the accident, but no data or actual cases were used in the analysis. Based on system theory Zheng (Zheng, 2002) used macro data, namely statistic traffic accident data on motorway, to analyze reasons of the accident in terms of driver, pedestrian, vehicle road condition and traffic management. Since actual urban traffic data have not been analyzed based on city configuration, traffic and road condition and driver or pedestrian. Concrete reasons of the accident are not understood and effective counter-measure for decreasing traffic accidents have not been found. One of the main reasons is that almost all concerned documents are compiled and stored in analogue style. It is very difficult to search and analyze accident information systematically. Some studies in Japan (SHIRAISHI *et al*, 2000, SUGIURA *et al*, 2000) took city as study area and use GIS to analyze the urban traffic accidents and Danger

Perception, while they just used GIS as a platform for storing data and some spatial calculation.

Here we develops a GIS system to store urban traffic accident data in digital style, and analyze these data in terms of their spatial and attribute characteristics to exploit the reasons of accidents and rank urban area with dangerous degrees. Taking a China's middle size city (Panjin City) as the case study area, the system uses MapInfo to store urban road network, which contains names, widths, design speeds and levels of service of road and names of intersections. Traffic accidents information in the past 2.5 years is created as texture and photographic electric files. And link between road network database and traffic accident file is established with OLE connection between MapInfo and Visual Basic. Several command buttons and interfaces, which are used for searching and displaying accident information, are created with Visual Basic and are installed into MapInfo system. With them, users can easily find accident information in GIS windows through some query method. We further analyze the reasons of death traffic accidents in details to summarize the major reasons related to them. With above results we rank major urban area with accident dangerous degree. The rank results are created as thematic map in GIS, and then accident hazard map is displayed in GIS windows.

## 2. TRAFFIC ACCIDENT DATABASE

Traffic accidents data such as statement and pictures are often stored in straight sheet style. It is difficult for user to carry out management, maintenance and query. Therefore, management, query and analysis of traffic accidents data will be more convenience and efficiency if we combine them with road traffic database in GIS. Fig. 1 illustrates the structure of our road network database. In the system road and traffic information are store in MapInfo style, while MapBasic is used to handle attribute and graphic data in MapInfo and MS-VB is used to create the interfaces.

Even though MapBasic is powerful on operating objects in MapInfo, it cannot deal with external database, while MS-VB can easily operate database through standard database channel (Yang *et al*, 2002). Therefore, in traffic accident database we link MapInfo and MS-VB through OLE method. As Fi.2 shows road network database and Access tables of traffic accident are the main foundation of traffic accident data management system.

Based on the network and accident MS-Access tables, MapBasic manage graphic objects and tables in MapInfo in the backstage to transfer the data to MS-VB through global variables, while MS-VB responds communicate with external database to display and manage the external data, more over MS-VB is also used to show pictures. On the other hand, MS-VB can also transfer data through global variables from external data to MapInfo. Here traffic accidents data are stored in two MS-Access tables, which store traffic accident describing text and traffic accident pictures respectively. With unique ID code the two tables can be linked.

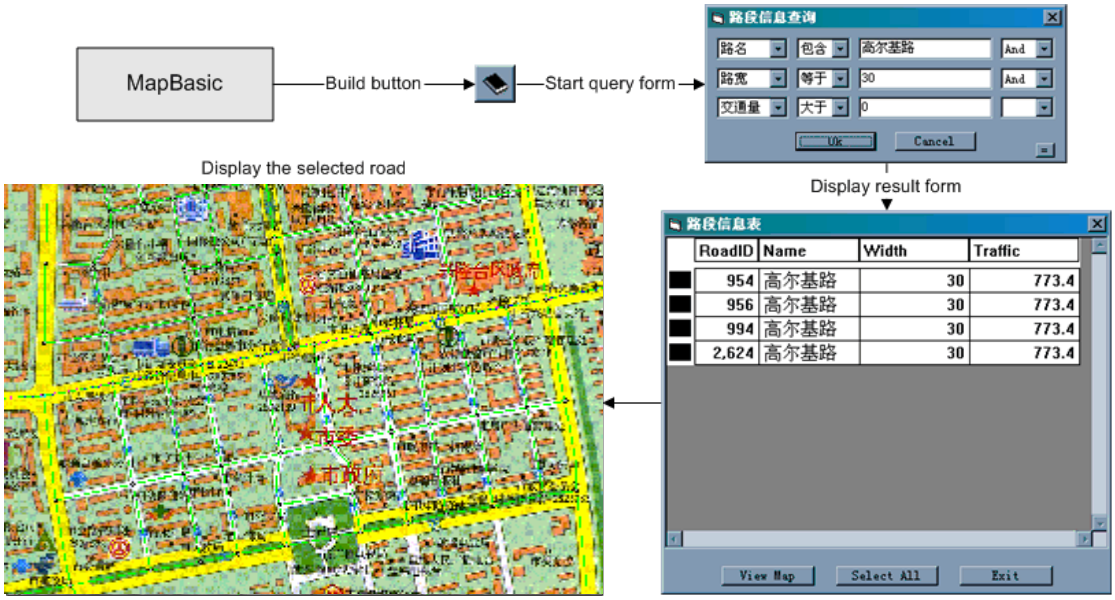


**Fig. 1** Interface of Road Crossing and Section Information Database

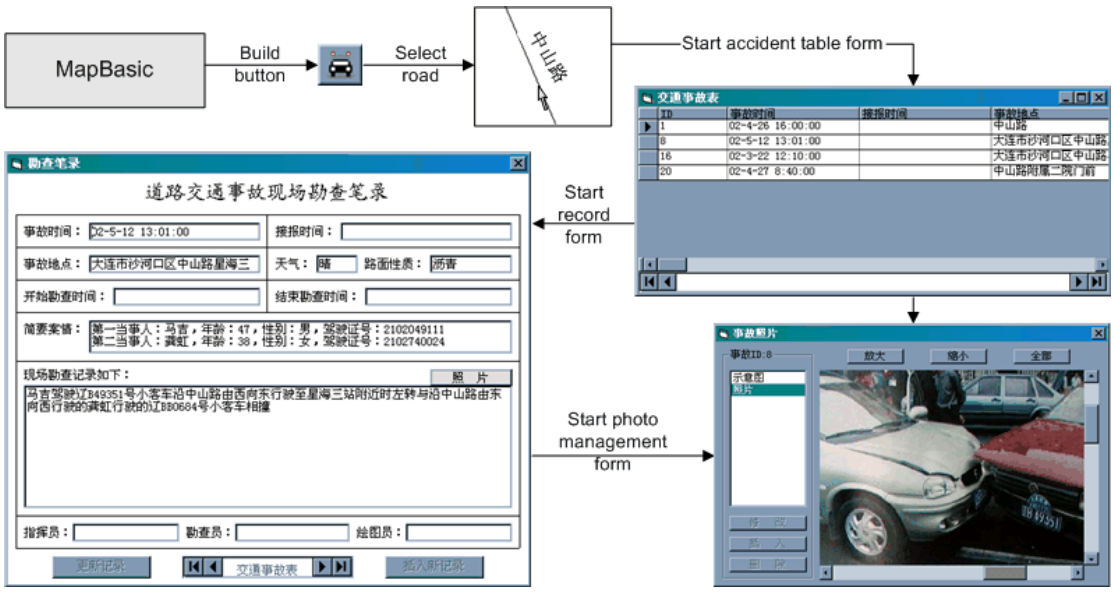


**Fig. 2** Interface of Traffic Accident Database

## 3. ANALYZING THE REASONS OF THE DEATH TRAFFIC ACCIDENTS

From traffic accident database we can pick up the death cases and read their situation and look in the pictures. There are totally 81 death accidents in the database, while 60% happened on roadway sections and 40% happened within intersections. This is some different from general realization of that intersection is the most potential site for traffic accident. Fig. 3 shown that the death traffic accidents happened mostly between motor vehicle and bike rider and pedestrian, this kinds of accidents account for 35% and 24% respectively. We sum up the main reasons of these accidents to get Table 1.

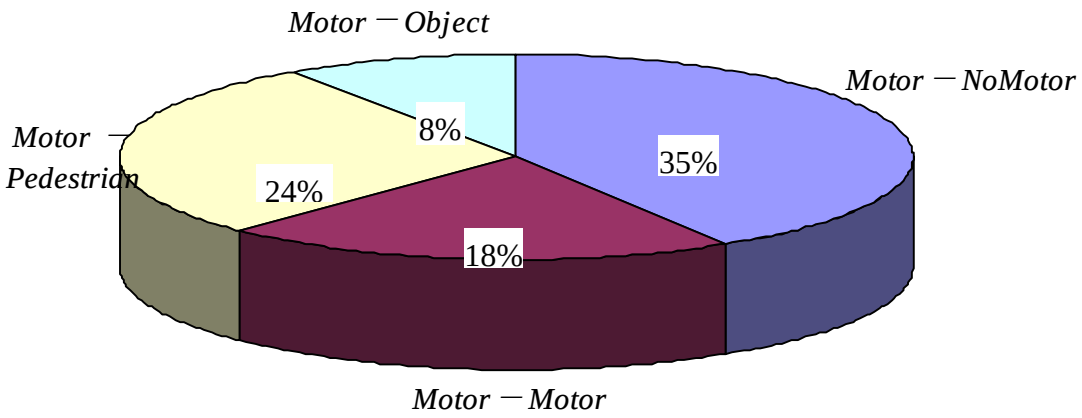


Fig. 3 Proportion of Bodies concerned in Death Traffic Accidents

Table 1 Main Reason for the Accidents

| Party Concerned | Road | Intersection |
|---|---|---|
| Motor-No Motor | No motor vehicles occupied motor lane | Left-turn of no motor vehicle |
| Motor-Motor | Overtaking | Left-turn of motor vehicle |
| Motor-Pedestrian | Pedestrian cross road on no zebra stripes | Pedestrian cross road on no zebra stripes |
| All Accidents | Drivers and pedestrian without safety coconscious, neglect traffic regulation, bad traffic management, no license drivers | |

We can see that the main reason of the accidents are drivers or pedestrian neglect the safety regulation and violate traffic regulation. Till now motorization in China's kept at a low level, persons there did not know the importance of traffic regulation and danger of the motor vehicle. Therefore, pedestrians often cross roads wantonly or during red single phase, and bicycles (no motor vehicles) often occupy motor vehicle lanes and neglect

single. There are also some problems in traffic control system, especially for the accident in the case of left-turn situation. Accident between motor vehicles happened in left-turn are mainly due to the shortage of left-turn lane or left-turn phase. Accidents between motor vehicle and bicycle happened in left-turn situation are mainly due to the shortage of mark for left turn vehicle to waiting in the intersection or regulation for bicycle to left-turn in two phases.

## 4. ANALYZING THE SPATIAL DISTRIBUTION OF THE DEATH TRAFFIC ACCIDENTS

Since we establish a database to manage the accident information, it is very easy to analyze the spatial distribution of the accidents. We also pick up death traffic accidents from the database and plot them in the road network layer. With traffic zone, road network, population and plotted accidents in GIS we made some spatial calculations. Fig. 4 and Fig. 5 illustrate road and intersection density based on traffic analysis zones respectively, while Fig. 6 and Fig. 7 shows the population density and death traffic accidents quantity with the same spatial units respectively. We can undersand that spatial distribution of death accident does not coincide with road density, intersection density and population density except in CBD area.

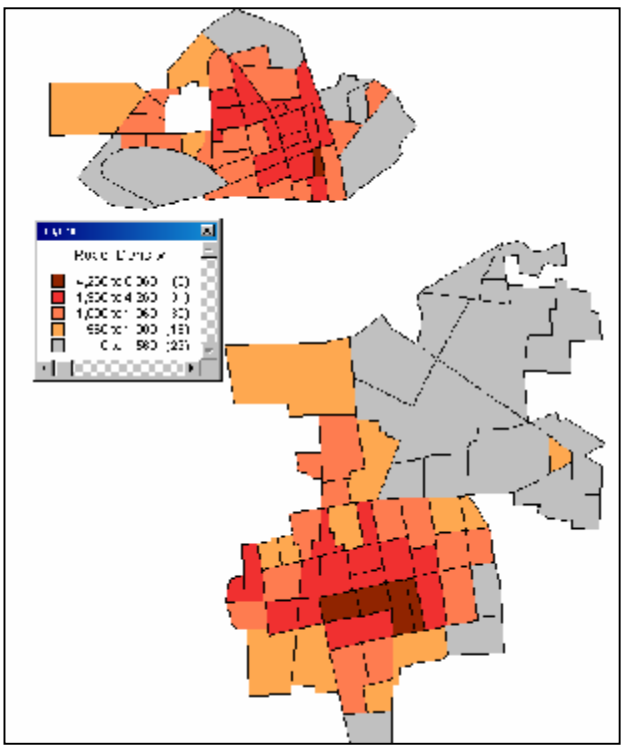

Fig.4 Road Density (Road Area/Zone Area)

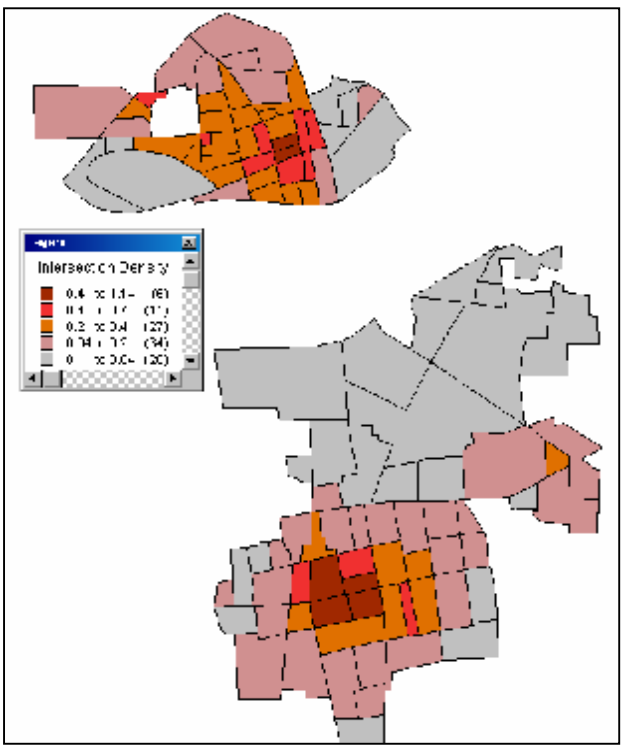

Fig.5 Intersection Density (Node Number/Zone Area)

In order to explain the characteristics of the spatial distribution of the death traffic accidents, we first describe the spatial configuration of the city. Panjin city is about 14 km long in south-north and 9 km wide in east-west. A river flows through the city in west-east direction and divides it into two districts. There are three artery roads connecting the two districts and traffic between districts is heavy. Moreover, main entrances of the city are in north and south tips. As the results, through traffic also goes in south-north direction. From Fig. 8 we can see that death traffic accidents first concentrated along the three north-south arteries, especially the south and north urban entrance areas. Another accident area is in the urban center, since there are dens road network and large traffic and pedestrian flows, and roads intersect each other, the central zone became a main traffic accident area. Interesting thing is that area around the arteries and a little far from the central zone is also a dangerous area. This is because that the middle area between south and north districts has a little residential and commercial infrastructures, then traffic and pedestrian there get less. Most traffic here are shuttled vehicle between the districts, especially traffic from south to north will accelerate there since they just escaped from a heavier traffic zone and face a good road and traffic conditions. However, signal lamps and zebra stripes in this area are less than in central area, therefore, death traffic accidents often happened in this area.

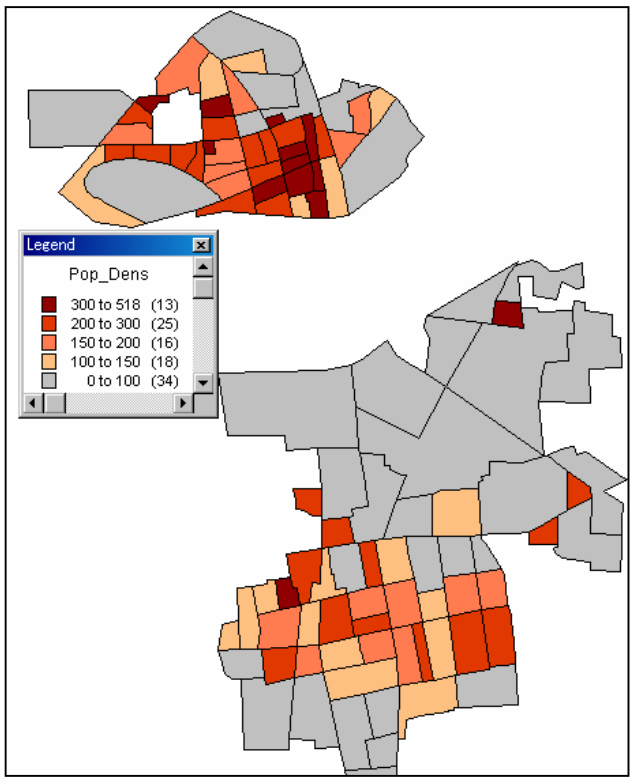


Fig. 6 Population Density (Populaton/Zone Area)

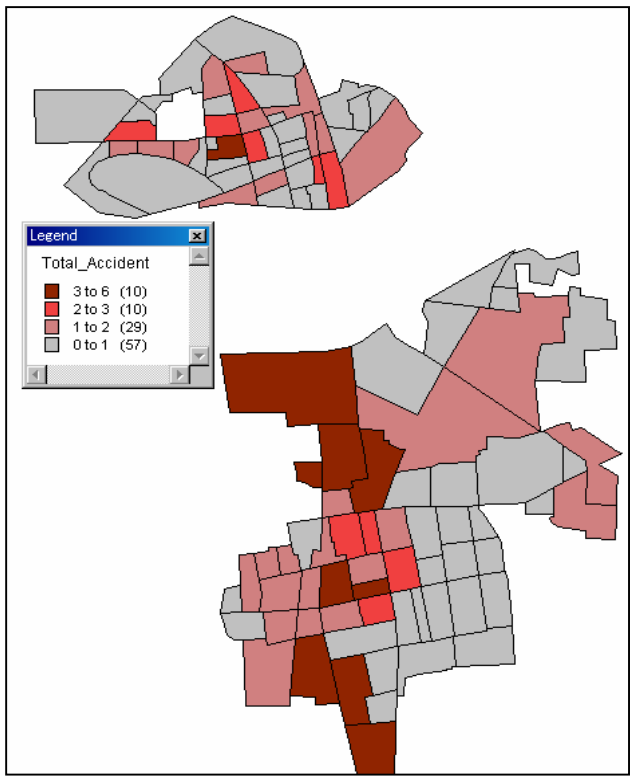


Fig. 7 Spatial Distribution of Death Accident

## 5. CONCLUSIONS

Taking a China's city as study object we developed a GIS system to store and manage its traffic accident data. In the system we can query, analyze and look in the accident information with GUI method. We further analyze and sum up the reasons and situations of the death traffic accidents to find that neglecting of traffic regulation, short of safety consciousness and bad traffic control method are the main reasons of the accident, while bike rider and pedestrians are most involved in the accidents. We finally analyze the spatial distribution of the death traffic accidents and find black point of the accident and make a traffic accident hazard map.

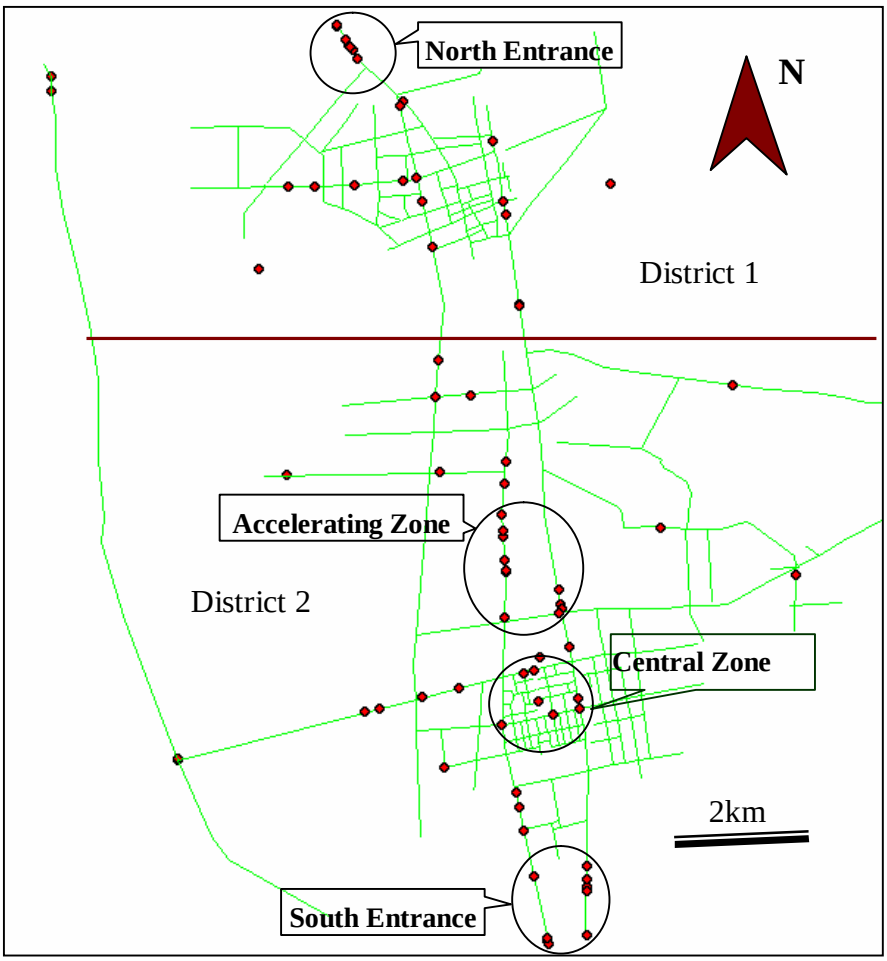


Fig. 8 Spatial Distribution of Death Traffic Accident in the City

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