

A NAVIGATION DATA MODEL BASED ON THE SYNCRETIC MULTI-LAYER ROADWAY NETWORK

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ABSTRACT:

The data model for navigable electronic map need to created based on an syncretic model of multi-layer roadway network, as the evolution of the navigation information technology, the rapid extension of the navigation application, and the development of the *Intelligent traffic system (ITS)* and *Advanced Driver Assistance Systems (ADAS)*. The basic ideas about the traffic roadway network and the syncretic data model based on the multi road network are presented in this paper. The principles for modeling the syncretic data are introduced. The validity and feasibility of this data model are also discussed.

1 INTRODUCTION

With the evolution of the navigation information technology, the consumed electronic product, the internet technology and the communication technology, the navigation mode extend quickly from the simple car navigation to the more complex navigation application such as pedestrian navigation and multi-mode navigation. The multi-mode navigation application is designed for the traveler with a rounded navigation function, which is integrated with all kinds of navigation related information, and providing more perfect plans and whole transport transfer information. The pedestrian navigation and multi-mode navigation need the navigation electronic map to provide more detailed, more integrated and more accurate road feature data. The current in-vehicle navigation electronic map data model can't meet the need of the pedestrian navigation and multi-mode navigation. So, it is need to develop a more perfect navigation data model for more complex navigation application. In this paper, a navigation data model based on the syncretic multi-layer roadway network is presented to meet the need of the pedestrian navigation and multi-mode navigation.

2 BASIC CONCEPTION

2.1 Travel manner

In the practical application, there are only two kinds of travel manner which are mostly be used. One is by walking; the other one is by vehicle. Usually, people will travels by walking cooperated by vehicle.

The vehicle by which people will travels also can be classified into two categories: public vehicle and private vehicle. Thereinto, public vehicle includes bus, subway, railway, ship, airplane, and so on. Private vehicle includes motor vehicle and non-motor vehicle.

2.2 Traffic Network

2.2.1 Overview of the traffic network

The actual traffic network covers the sky, the ground, and the aquatic. It is a coadjacent heterogeneous network as shows in figure 1.

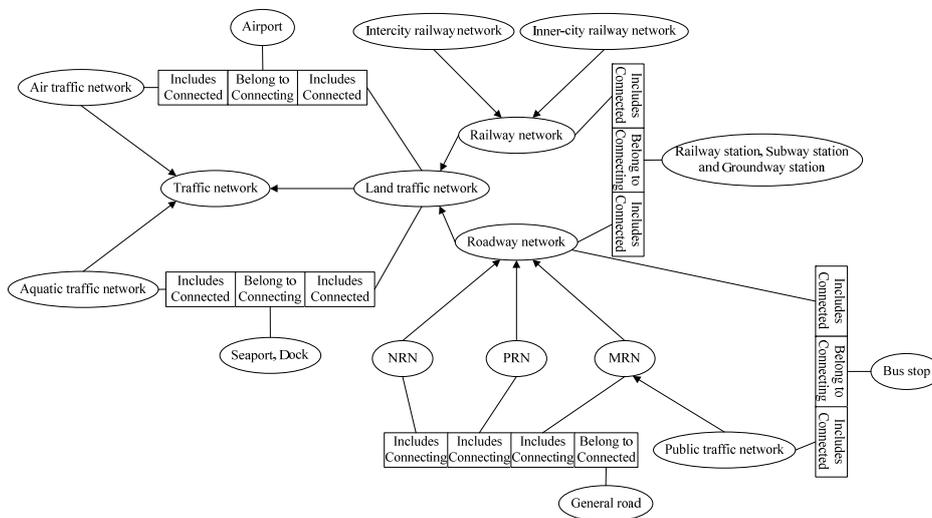


Figure 1: Traffic network model in NIAM

2.2.2 Category and Definition

The traffic network can be classified into three categories by its basic form: air traffic network, land traffic network and aquatic traffic network. Also it can be classified into two categories by its property: public traffic network and private traffic network.

2.2.3 Land traffic network

The land traffic network is composed of land traffic features. It includes railway network and roadway network.

2.2.4 Railway network

The railway network is composed of railway traffic features. It includes intercity railway features and inner-city railway features. Thereinto, inner-city railway includes subway and groundway.

2.2.5 Roadway network

The roadway network is composed of roadway traffic features. It includes Motor vehicle Roadway Network (MRN), Non-motor vehicle Roadway Network (NRN), and Pedestrian roadway Network (PRN).

2.2.6 Aquatic traffic network

The aquatic traffic network is composed of aquatic traffic features.

2.2.7 Air traffic network

The air traffic network is composed of sky traffic features such as airline.

2.2.8 Public traffic network

The public traffic network is composed of public traffic features on which public vehicle travels. The physical traffic network it may be involved includes: the land traffic network, the air traffic network and the aquatic traffic network.

2.2.9 Private traffic network

The private traffic network is composed of private traffic features on which private vehicle travels. The physical traffic network it may be involved only includes: the land traffic network and the aquatic traffic network.

2.2.10 Connectivity relationships between the traffic networks

The figure 1 shows the connectivity relations between the traffic networks:

- (1) The land traffic network and the aquatic traffic network are connected by seaport and dock;
- (2) The land traffic network and the air traffic network are connected by airport;
- (3) The railway network and the roadway network are connected by railway station, subway station and groundway station;
- (4) The public roadway network and the other roadway network are connected by bus stop.

3 PRINCIPLES FOR MODELING

To meet the needs of the multi-mode navigation and more advanced navigation application, some principles for modeling the syncretic data are introduced as follows show to build the new style roadway network data model.

- (1) Categorizing the roadway traffic features by using the transport object allowed to travel on them as the criterion;
- (2) Every roadway traffic network is independent each other relatively, which can meet the needs of the navigation application based on it;
- (3) The superposition is allowed and as the connected area between the roadway traffic networks.

The roadway network model built according to the above principles is called *Syncretic Multi-layer Roadway network Model* (SMRM).

4 ROADWAY NETWORK MODEL

4.1 Transport object in the roadway network

The transport object in the roadway network can be categorized as:

- (1) Motor vehicle;
- (2) Non-motor vehicle;
- (3) Pedestrian.

4.2 Road feature category and definition

The road feature in the roadway network maybe allows single kinds of transport to travel on, such as motorway/highway, which is only allowed the motor vehicle to travel on. It also maybe allows multi kinds of transport to travel on, such as general city road, which is allowed the motor vehicle, the non-motor vehicle and the pedestrian to travel on. So, the roadway traffic features can be categorized by the transport object allowed to travel on them:

- (1) A type road: namely motor vehicle road, which is only allowed motor vehicle to travel on;
- (2) AB type road: namely vehicle road, which is allowed motor vehicle and non-motor vehicle to travel on;
- (3) AC type road: namely motor vehicle and foot road, which is allowed motor vehicle and pedestrian to travel on;
- (4) ABC type road: namely general road, which is allowed motor vehicle, non-motor vehicle and pedestrian to travel on;
- (5) B type road: namely non-motor vehicle road, which is only allowed non-motor vehicle to travel on;
- (6) BC type road: namely non-motor vehicle and foot road, which is allowed non-motor vehicle and pedestrian to travel on;
- (7) C type road: namely footway, which is only allowed pedestrian to walk on;

4.3 Roadway network category and definition

Logically, the roadway network can be categorized into three kinds as shows in figure 2: Motor vehicle Roadway Network (MRN), Non-motor vehicle Roadway Network (NRN), and Pedestrian roadway Network (PRN).

- (1) MRN: Composed of the entire road feature allowed motor vehicle to travel on. Includes A type, AB type, AC type and ABC type road.
- (2) NRN: Composed of the entire road feature allowed non-motor vehicle to travel on. Includes B type, AB type, BC type and ABC type road.
- (3) PRN: Composed of the entire road feature allowed pedestrian to travel on. Includes AC type, BC type, C type and ABC type road.

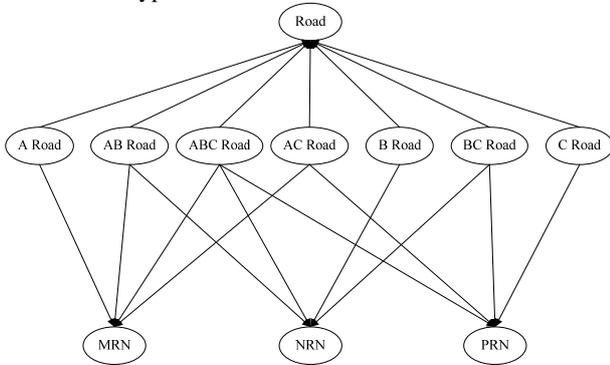


Figure 2: Roadway network model

4.4 Connectivity relationships between the roadway networks

As shows in figure 3, the roadway networks are connected by the superposition between them, such as general road.

- (1) The MRN and the NRN are connected by AB type and ABC type road;
- (2) The MRN and the PRN are connected by AC type and ABC type road;
- (3) The NRN and the PRN are connected by BC type and ABC type road.

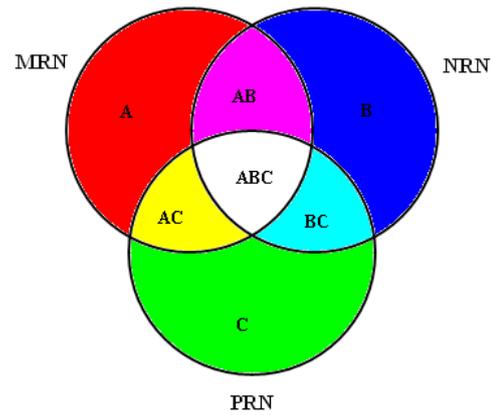


Figure 3: Connectivity relationships between the roadway networks

5 BRIEF SUMMARY

A legible and feasible *syncretic multi-layer roadway network model* (SMRM) is built by the above categories, definitions and relationships of all the kinds of traffic feature. Each traffic network is independent. Also they are connected each other. The road feature database created based on this model can meet the needs of the simple navigation application (such as motor vehicle navigation, pedestrian navigation, non-motor vehicle navigation, and so on) effectively. It also can meet the needs of advanced complex navigation application (such as multi-mode navigation).

