



# Relay navigation strategy study on intelligent drive on urban roads

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## Abstract

In order to solve navigation problem of intelligent vehicle driving on urban roads and to achieve the navigation in intersection area, intersection transition area and section area. The relay navigation strategy and algorithm can solve the navigation problem of intelligent vehicle driving in typical urban roads such as intersection area, intersection transition area and section area, realizing seamless handover among different typical areas. Bezier curve function model was introduced to different typical areas, which solved the self-adaption recognition problem in different typical areas and revised positional accuracy with the help of cloud computing positioning service. In order to explain the strategy implement, an instance based on the strategy was adopted. Instance analysis indicates that as for the navigation problem in intersection area, intersection transition area and section area, if the relay navigation strategy is utilized, the self-adaption recognition problem in different typical areas can be handled. Based on the relay navigation strategy, the drive of intelligent vehicle on urban roads can effectively solve the self-adaption recognition problem in different typical areas in urban and further solve driving problems of intelligent vehicle of the same category in urban roads.

**Keywords** intelligent vehicle, intelligent drive, urban roads, relay navigation, strategy

## 1 Introduction

Intelligent driving technology is an interdisciplinary research composed of various theories and technology, such as computer science, communication science, cognitive science, vehicle engineering, electric and electronic engineering, control science and engineering, science and technology of complex systems, ergonomics science, artificial intelligence, etc. Intelligent vehicle is an important index to measure a country's scientific research strength and industrial level. By virtue of the advanced sensor and information technology, regarding the vehicle control, and automatic completion of regular, enduring, low-level and repeated operations during driving, the intelligent vehicle has fundamentally transformed the traditional driving mode in the closed-loop system, namely, the man-vehicle-road mode. On one hand, the intelligent

driving technology can dramatically promote efficiency and safety of traffic system and upgrade people's quality of movement life. Therefore it possesses widespread pragmatic value for the society. On the other hand, research on the above mentioned technology will smartly enhance our core competitiveness with respect to vehicle initiative safety and will be strategically significant for the improvement of capability of independent innovation in our automotive electronics products and the whole automobile industry.

In early 1980s, United States Department of Defense invested considerable amount of money in the research on autonomous land vehicle (ALV) [1]. Navigation laboratory-5 (NavLab-5) intelligent vehicle developed by Carnegie Mellon University (CMU) utilized Ralph visual system for the environment perception [2]. Arcade detecting system at the road edge designed by University of Michigan (UMich) successfully introduced the overall information into the detection system [3]. Vamp unmanned

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driving system by the University of Bundeswehr Munich put vision into the inspection of roads and obstacles [4]. The intelligent vehicle Google Driverless Car by Google put sensors, including camera and radar, into the detection of roads and obstacles. The intelligent vehicle developed by University of Parma in Italy utilized 5 light amplification by stimulated emission of radiation (IASER) scanners, 7 cameras, global positioning system (GPS), inertia measurement equipment, 3 computers using Linux operating system and drive-by-wire driving system and even generated electricity by solar panel in the whole course [5].

The successive intelligent vehicle navigated by vision Jilin University Intelligent Vehicle-I (JLUIV-I), Jilin University Intelligent Vehicle-II (JLUIV-II) and Jilin University Intelligent Vehicle-III (JLUIV-III) have been designed domestically by Jilin University [6]. The intelligent vehicle Tsinghua Mobile Robot V (THMR-V) put visual navigation system and on-the-spot sensing remote control system [7]. CA7460 developed by the national University of Defense Technology (NUDT) allows the safe overtaking capability [8]. Shanghai Jiaotong University (SJTU) has developed the unmanned electric car, realizing autonomous navigation and vehicle and pedestrians avoidance system [9]. The unmanned car developed by Tongji University (TJU) utilized photoelectric sensors to detect reflected signals and automatically drive according to traces [10]. The intelligent vehicle spring robot by Xi'an Jiaotong University visually accomplished the detection of roads, pedestrians and vehicles [11]. Hunan University carried out the research on adaptive information collection, cognitive mechanism and control veracity of unmanned vehicles [12–13]. The intelligent vehicle by Military Transportation University realized the horizontal and vertical control of vehicles through visual perception calculation and advanced quasi-human control algorithm in Ref. [14].

In sum, the intelligent driving technology is autonomous navigation technology based on multiple sensors. It realized navigation and obstacle avoidance by using the traditional mode ‘perception-modeling-scheme-execution’ [15]. Though preliminary progress has been made by the intelligent vehicles in the field of enclosed roads like expressway, the intelligent driving technology in urban semi-structured roads under the condition of normal transportation has not been successfully tested. In the light of the semi-structured

urban road network, the road structure, including side pavement, overpass and intersection, is rather complicated, so are the traffic lights, traffic signs and ground marks. Besides, motor vehicles are mixed with non-motor vehicles and people mingle with vehicles. There are numerous obstacles and disturbance. The traffic condition is changing and always heavy. Therefore, the semi-structured urban road network poses great challenges to intelligent vehicles’ capability of environmental perception, positioning and navigation and comprehensive decision. Intelligent driving consists of autonomous driving, integrated navigation and manual intervention.

This paper combines the previous achievements with the practical urban road condition and puts forward the idea carrying out different navigation strategy and calculation according to different typical areas, with the aim to make intelligent vehicles adaptive to various road conditions and people’s cognitive habits of driving. I hope it could provide references and help for the relevant research on the intelligent vehicles.

## 2 Preliminaries and problem definition

In this section, we briefly introduce some concepts related to intelligent vehicles and operational definition of main terminology.

**Definition 1** The intelligent vehicle (IV) is also called unmanned ground vehicle (UGV) or automated guided vehicle (AGV), which is a comprehensive system with computing system as the main part and also possessing capabilities of environmental perception, scheme and decision-making and multilevel intelligent driving mechanism. It is a typical high and new technology complex because of the utilized multiple technology, such as that of computer, modern sensor, information fusion, communications, artificial intelligence and automatic control. It is the important application of wheeled mobile robot (WMR) in the field of traffic [16].

**Definition 2** Structural roads refer to a kind of driving road, whose ground is flat without obstacles and edges are regular and with obvious lane lines and other forms of artificial marks. This kind of roads has obvious lane lines and road boundaries. Lane lines are shown with white or yellow continuous lines or dashed lines and the accessible area is marked with a white line or two. For example, expressway [17].

**Definition 3** Semi-structured roads refer to roads

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