



Original article

A study on key technologies of unmanned driving

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Abstract

Although the development of machine intelligence is far from simulating all the cognitive competence of our brains, still it is absolutely possible to peel the driving activity from people's cognitive activities and then make the machine finish some low-level, complicated and lasting driving cognition by simulating our brains. The goal of driving is to replace drivers and free them from boring driving activities. Based on some studies on unmanned driving, this paper summarizes and analyzes the background, significance, research status and key technology of unmanned driving and the research group also introduces some research on brain cognition of driving and sensor placement of intelligent vehicles, which offers more meaningful reference to push the study of unmanned driving.

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Keywords: Unmanned driving; Brain cognition of driving; Sensor placement; Formalization of brain cognition

1. Introduction

The development of cars has experienced three different stages, which is shown in Fig. 1 [1]. The first stage relied totally on manual work without standardized parts and assembling process. The cars of this stage had high prices and their qualities were out of effective control. The second stage was characterized by standardized and streamlined production. Since the middle and later periods of the 1990s, the automobile industry has entered into the third stage. The technologies of comfort and intelligent safety have become the point of automobile industry. According to the statistics, from 1989 to 2010, the ratio of the costs of electronic equipments among the whole costs has increased from 16% to 23%. It is said that this ration may rise to 40% in 2015. In some luxury vehicles, the quantity of the single chip microcomputers has reached to 48

and the cost of the electronic equipments has accounted for more than 50% of the total cost of the cars [2].

In recent years, the rapid development of artificial intelligence, cognitive science, automatic control, ground mapping, sensor technology and other fields promotes the essential change of automobile industry. The symbol of wheeled mobile robots in the subversive creation of cars is ready to go ahead. The wheeled mobile robots would rather realize the goal of intelligent driving and free human drivers from low-level, complicated and lasting driving activities and change the interactive mode between cars and drivers fundamentally not emphasize the change of vehicle dynamics properties. Thus, cars will become personal mobile sharing tools.

There are two main routes to realize wheeled mobile robots: the intelligent route and the Network route. The intelligent route considers cars as intelligent individuals with perception, cognition and decision-making abilities, which emphasizes autonomous driving while the Network route considers cars as an adjustable node of the whole traffic system, which emphasizes overall coordination. The two routes cross with each other and form the future intelligent traffic system together.

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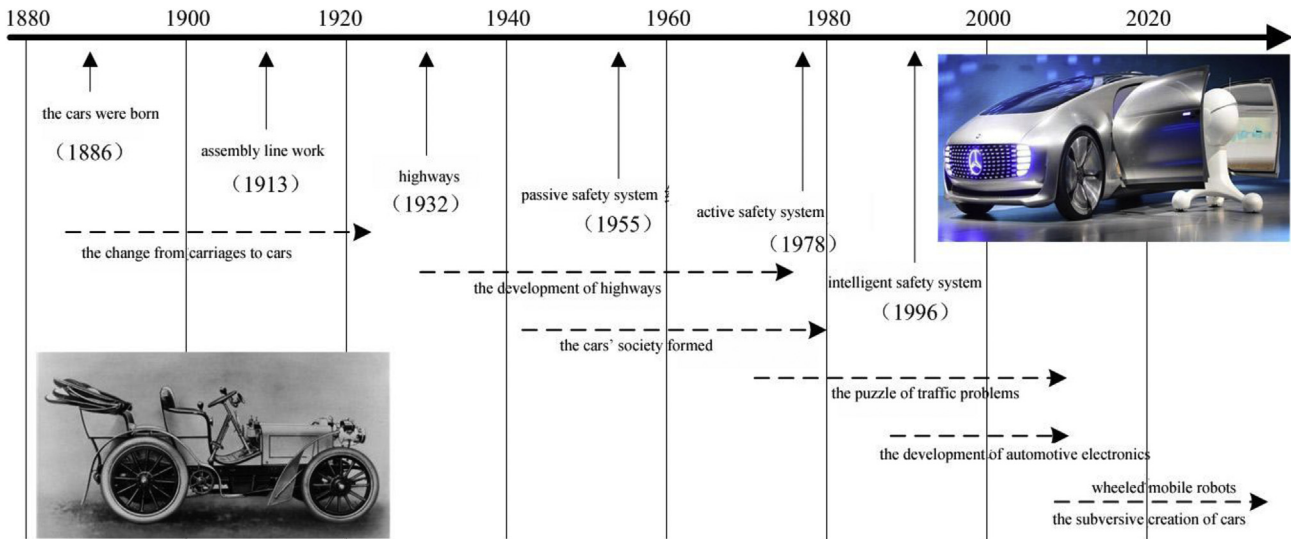


Fig. 1. A hundred years of the developmental process of automobile industry.

In 2013, McKinsey Company listed twelve subversive technologies that can decide the future economy, among which advanced robot technologies and unmanned driving technologies are included [3]. The research and development of unmanned cars rely on the newest research results of artificial intelligence, cognitive science, automatic control, sensor technology and other research fields, which is the best stage for tests. Unmanned driving technologies have become a research hotspot that attracts the attention of governments both at home and abroad, scientific research institutions and enterprises because of its great significance in civil use, military use and research fields.

2. The research status of unmanned driving

The US National Highway Traffic Safety Administration released the regulations of traffic policies of intelligent driving cars in May, 2013 [4]. The regulations divided the automatic degree of cars into five levels (Fig. 2): level zero was no autonomous control, level one was intelligent driving with independent functions, level two was intelligent driving with cooperative control, level three was autonomous driving with limits and level four was total autonomous driving.

2.1. The research status of unmanned driving cars in US

The US is the first one to study unmanned driving cars in the world. In the 1980s, DARPA established special funds to support the research of autonomous land vehicles and held three DARPA challenge matches in 2004, 2005 and 2007, which raised a great mass fervor of unmanned driving research [5] (see Figs. 3 and 4).

Google began to research unmanned driving in 2009 and it has finished designing several kinds of sample cars and a on-road test of nearly one million kilometers [6]. Under the promotion of Google, Nevada, Florida, California and Michigan allow unmanned driving cars to test on public highways one after another [7].

Besides, GM, Ford and other American motor companies have assembled some driving assistance systems on the newest products such as self-adaptive cruise control, automatic parking, blind area alarm that derive from unmanned driving technologies.

2.2. The research status of unmanned driving cars in Europe

Europe began to research unmanned driving cars in the middle of the 1980s. Its research emphasized the unmanned driving cars as independent individuals and its normal travel in the traffic stream instead of the cooperation of cars and roads. Since 1987 Europe has carried out a program called PROMETHEUS (Programme for a European Traffic of Highest Efficiency and Unprecedented Safety) [12]. In 1994, unmanned driving cars called VaMP and VITA-2 joined the normal traffic stream on highways and the max speed has reached to 130 km/h [13].

Since 2006, Europe began to hold European Land-Robot Trials (ELROB) to test the properties of land robots including unmanned driving cars under real situations. It has held three tests of military scenes and two ones of civil scenes. The military themes included reconnaissance and surveillance, autonomous navigation, fleet transport and so on while civil scenes included safety, fire protection, and disaster control and so on. In the later tests, the autonomous cars and its task completion advanced year after year [8]. ELROB has played an active part in promoting the research of unmanned driving technologies in Europe [9].

In 2011, Berlin Free University researched the unmanned driving cars called Spirit of Berlin and Made in Germany. They finished tests of unmanned driving in urban areas and also other projects such as crowded traffic flow, traffic lights and travels around islands [10].

In 2014, BMW, Benz and Audi set forward Traffic Jam Assistant to control steering wheels, accelerators and brakes

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