To Explore the Development Status and Future Development Direction of Intelligent and Connected Vehicles

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Abstract: This article aims to explore the current status and future development direction of intelligent connected vehicles. The article discusses the development status of intelligent connected vehicles both domestically and internationally and extracts data closely related to the development of intelligent connected vehicles. The data is then analyzed and modeled. The results indicate that government policies and market size are two key factors. The model is used to predict and test its accuracy. The predicted results and the fitted model demonstrate outstanding performance. It is recommended to introduce more relevant policies in the future, explore more potential markets, and jointly promote the future development of intelligent connected vehicles.

Keywords: Intelligent Connected Vehicles, Development Status, Fitting Forecasts, Recommendations, Direction of Development.

1 Introduction

1.1 Summary of intelligent and connected vehicle technology

Intelligent connected vehicle (ICV) technology relies on the integration of multiple sensors, intelligent information acquisition modules, information processing modules, information transmission modules, and network communication technology. Together, these elements form a new technological paradigm that enables the seamless integration and operation of ICV systems[4]. This integration enables intelligent vehicle management and operation. The technical framework of this application includes V2X communication, TSP essentials, and on-board network architecture[12]. The overall communication network architecture of ICV is shown in Figure 1.

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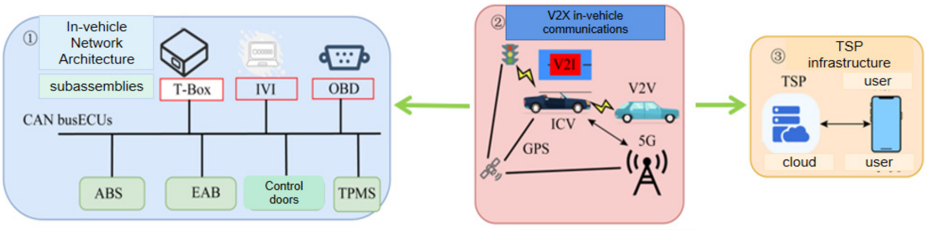

Figure 1. Overall communication network architecture of ICV

1.2 Status of Intelligent Networked Vehicles at Home and Abroad

1.2.1 Development status of intelligent and connected vehicle technology Abroad

The United States is at the forefront of the intelligent and connected automobile industry, and has implemented a structured three-stage plan to advance autonomous driving technology[1].

Japan and South Korea have made initial progress in autonomous driving through the development of the National Autonomous Driving Research and Development Plan (SIP)[3].

Intelligent voice interaction technology is already integrated into the in-vehicle assistive devices of smart connected cars for Arab drivers[13].

Swiss scholars have also introduced a secure formation control technique for intelligent connected vehicles in high-speed scenarios[14].

In addition, vehicle enterprises in Europe, America, and Japan have been progressively transitioning from assisted driving to connected driving[8].

Germany, the UK, France, and Canada actively promote intelligent connected vehicle technology through supportive government policies, investment, and comprehensive development plans.

1.2.2 Development status of Domestic intelligent and connected vehicle technology

During its initial development stages, China faced challenges related to the shortage of test sites for intelligent connected vehicles and the need for overall system improvement[10]. China is expanding autonomous vehicle testing sites nationwide, indicating growing emphasis on intelligent connected vehicle technology development and application[7].

China's autonomous driving technology is advancing from L1-L2 to L3-L4 systems, with some companies researching L5 systems, driven by evolving market trends and increased demand for advanced features in smart vehicles[6].

China's policies on intelligent connected vehicles prioritize improving quality of life and promoting advanced automotive technologies for safer, greener, and more coordinated transportation, reflecting the government's commitment to a civilized transportation ecosystem[5]. Chinese scholars propose that multi-vehicle collaborative driving, enabled by communication and coordination among vehicles, can reduce emissions by optimizing driving behaviors, aligning with China's commitment to sustainable and eco-friendly transportation solutions and improving fuel efficiency while reducing environmental impact[9]. China's reform commission has an innovative strategy for intelligent car technology, using domestic advantages in "bicycle intelligence" to foster indigenous innovation and create a distinct path in the global market[2]. From the perspective of the market of autonomous driving intelligent connected vehicles, it overall shows an upward trend. The main path of user satisfaction is usage attitude[11].

2 Method

2.1 Extracting feature Data and Modeling trend prediction

(1) Common characteristics of the development status of intelligent connected vehicles at home and abroad include government policies, technology research and development, and market size.

(2) By analyzing official data, the specific information about the number of international and domestic policies, technology research and development dimensions and market size of intelligent connected vehicles is obtained. The research and development focus includes vehicle sensing, communication, data processing and algorithms, human-machine interaction and security. The analysis primarily involves quantitative analysis, modeling, prediction, accuracy testing of policy numbers and market size. The related data are shown in Table 1.

Table 1 finds the official data sheet

a particular year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total number of international policies (copies)	1	1	1	3	7	9	17	24	28	30	33	35	
Total number of domestic policies (copies)	0	0	0	0	0	1	2	4	8	10	16	18	
Global market size ($ US billion)							7	8	9	11	13		
Domestic market size (RMB 100 million yuan)									400	600	700	900	1200

(3) The data were separately fitted for the above scenarios.

The S-curve trend model (Equation 1) is used to fit the cumulative introduction of international policies.

$$Y(t) = \frac{(10^3)}{(27.3191 + 3155.38(0.525136^t))} \tag{1}$$

The S-curve trend model fits the cumulative number of international policies (Y(t)) over time (t), where t is a year and $t \geq 2010$.

The S-curve trend model (Equation 2) is used to fit the cumulative introduction of domestic policies.

$$Y（t）= \frac{(10^2)}{(4.53488 + 223.007(0.451335^ t))} \tag{2}$$

The S-curve trend model fits the cumulative number of domestic policies (Y(t)) over time (t), where t is a year and includes t ≥ 2015.

The S-curve trend model (Equation 3) is used to fit the global market size of intelligent connected vehicles.

$$Y（t）= \frac{(10^2)}{(4.54545 + 19.7870(0.692308^ t))} \tag{3}$$

The S-curve trend model fits the global market size of intelligent connected vehicles (Y(t)) at a given year (t), where t is greater than 2016.

The secondary trend model (Equation 4) is used to fit the domestic market size of intelligent connected vehicles.

$$Y（t）= 340 + 61.4t + 21.4t^2 \tag{4}$$

The secondary trend model fits the domestic market size of intelligent connected vehicles (Y(t)) at a given year (t), including t ≥ 2018.

3 Experiment

3.1 Evaluation models and Predictive visualization

(1) The accuracy measure of the fitting results is presented in Table 2.

Table 2 List of accuracy parameters of fitting results

To fit the object	Fit accuracy metric		
	Mean percent error (MAPE)	Mean absolute deviation (MAD)	Mean deviation and the sum of squares
Total number of international policies (copies)	19.2162	0.8164	0.9824
Total number of domestic policies (copies)	5.01361	0.46785	0.4645
Global market size ($ US billion)	6.51942	0.47816	0.61343
Domestic market size (RMB 100 million yuan)	4.268	27.429	914.286

(2) From the calculated metrics, it can be seen that the model has a high prediction accuracy and the visualization of its prediction results is shown in Figures 2 to 5.

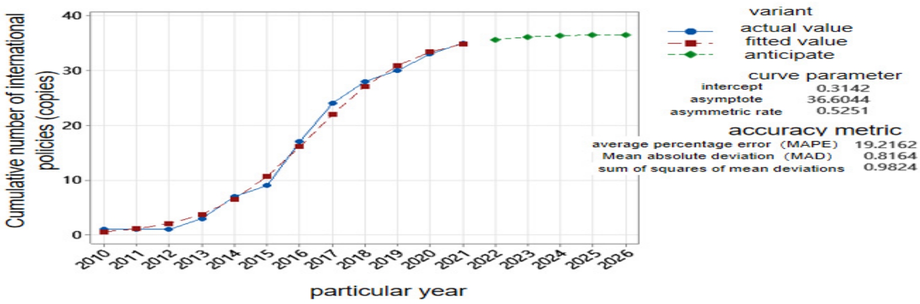

Figure 2 The cumulative trend chart of the number of international policies

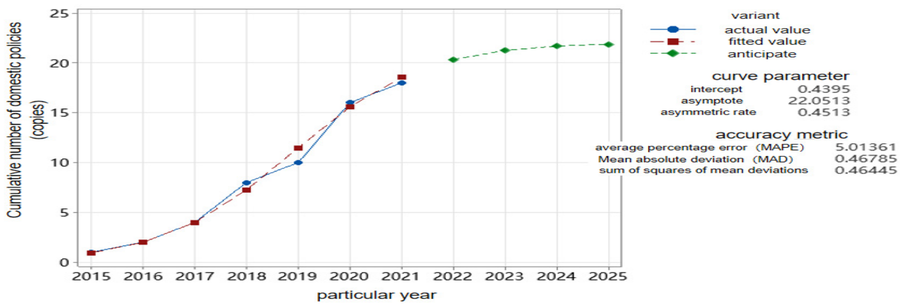

Figure 3 Cumulative trend chart of domestic policy quantity

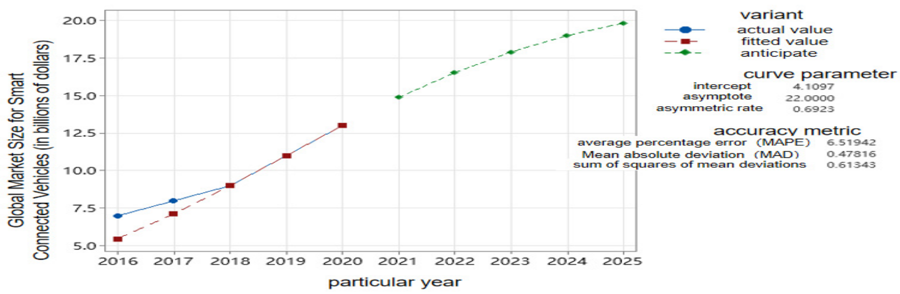

Figure 4 Trend chart of the global market size of intelligent and connected vehicles

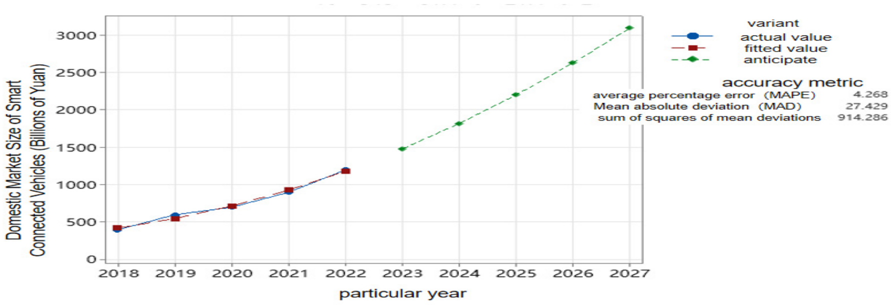

Figure 5 Trend chart of the domestic market size of intelligent and connected vehicles

4 Conclusion

In conclusion, intelligent connected vehicles have transformed into a practical technology that enables seamless communication between vehicles and integration with the internet and road infrastructure. This progress encompasses not only technological advancements but also policy formulation, implementation, market expansion, and investment.

The future of intelligent manufacturing in the automotive industry lies in enhanced technology, integrated transportation systems, the improvement of safety, and sustainable development.

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