International Core Journal of Engineering Volume 10 Issue 7, 2024
ISSN: 2414-1895 DOI: 10.6919/ICJE.202407_10(7).0013

Application Status and Development Trend Analysis of Machine Learning in Automotive Enterprise R&D

Xiaoxiao Yan, Mingwu Gao, Ziqian Wu

CATARC (Tianjin) Automotive Engineering Research Institute Co., Ltd, Tianjin 300300, China

Abstract

At present, the automobile industry is facing great market changes. This paper will study and analyze the main development routes of machine vision technology based on machine learning, self-driving technology, human-vchicle interaction technology, intelligent decision-making technology, marketing and after-sales service platform in Automotive Enterprise R & D, define the 2025,2030,2035 development goals for automotive enterprises, and propose machine learning technology routes, strategic support and support needs, provide effective guidance for automobile enterprises and upstream and downstream enterprises to carry out digital transformation.

Keywords

Machine Learning; Machine Vision Technology; Self-driving Technology; Human-vehicle Interaction Technology; Intelligent Decision-making Technology.

1. Introduction

At present, the automotive industry is facing huge market changes. Under the combined influence of multiple factors such as breakthroughs in the new generation of information and communication technology clusters, increasing personalized consumer needs, and unstable, uncertain, complex and ambiguous macro environments at home and abroad, the uncertainties faced by automobile companies have increased dramatically, posing major challenges to the traditional operation and management mode of automobile enterprises. This paper will study and analyze the main development routes of machine learning technology in the R&D of automobile enterprises, clarify the phased development goals for automobile enterprises in 2025, 2030, and 2035, and put forward the technical route, strategic support and guarantee needs of machine learning, so as to provide effective guidance for automobile enterprises and upstream and downstream enterprises to carry out digital transformation. This article will introduce the basic content of machine learning, the application background and development status of machine learning in automobile enterprises, and the key technologies, strategic support and guarantee needs, summary and prospect of machine learning in the R&D of automobile enterprises.

2. Machine Learning

Machine learning is an artificial intelligence science that studies how to improve the performance of specific algorithms in empirical learning. Machine learning is the study of computer algorithms that can be automatically improved through experience. "Machine learning is the use of data or past experience to optimize the performance criteria of a computer program" [1-3].

As a part of artificial intelligence, machine learning is currently the most rapidly developing branch of artificial intelligence research. To put it simply, machine learning is the process of achieving the self-improvement of a system through the performance of a computer program through accumulated experience [4], and each type of machine learning corresponds to a number of algorithms. Figure 1 shows the commonly used algorithms of machine learning and their main application scenarios.

ISSN: 2414-1895 DOI: 10.6919/ICJE.202407_10(7).0013

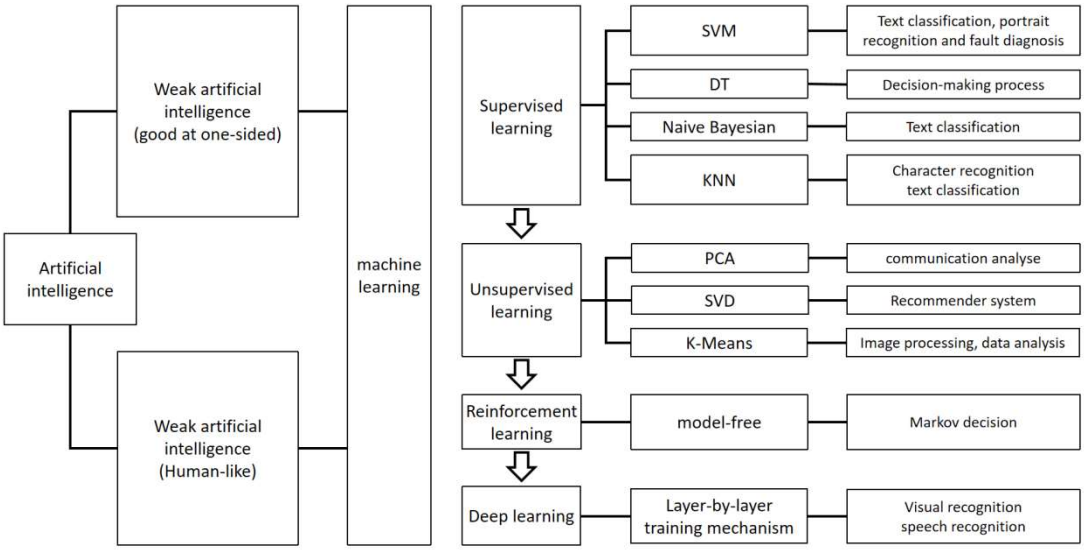

Figure 1. Diagram of the machine learning framework

3. Background and Current Status of Machine Learning in Automotive Companies

The application direction of machine learning in automotive enterprises includes autonomous driving R&D, production planning, intelligent manufacturing, marketing management, and after-sales service.

3.1 The Current Situation and Background of Machine Learning in the Research and Development of Autonomous Driving

Unmanned driving is the ultimate goal of intelligent vehicles and Internet of Vehicles. Developed countries such as Europe and the United States have carried out relevant work in the 60s of the 20th century. S. Tsukuba of the Tsukuba Engineering Research Institute in Japan developed the first unmanned vehicle based on machine vision in 1977. In 1983, the U.S. Department of Defense Advanced Research included "self-rescue" ground vehicles as part of a research program of the Strategic Computer Program. The following year, a prototype of a smart car was developed. In 1995, the Carnegie Mellon Institute and Assist-Ware built the NavLab-5 driverless car, in which experimenters operate the accelerator and brakes. Volkswagen of Germany has jointly developed a new "Shelley" vehicle with various universities, which uses precision GPS technology to accurately locate the vehicle, which has played a huge role in promoting the development of intelligent automotive technology [5-6]. BMW, Intel and Mobileye will collaborate with BMW in July 2017 to develop a new driverless car. Baidu will launch the Apollo software platform in 2017 to support the use of the software by partners in the automotive industry and autonomous driving.

At present, China's cars have been intelligent. On the other hand, the driving technology adopts a method based on machine learning and pattern recognition, and uses the collected data such as driving behavior, driving experience, and scenarios for in-depth research, so as to realize autonomous driving of the car [7-9].

3.2 Current Situation and Background of Machine Learning in Automobile Production Planning

After the 50s of the 20th century, semi-automated and automated assembly operations have appeared in the field of car manufacturing in China. In particular, the development of electronic computers and automatic control technology has enabled the entire production process to achieve a higher level of automation. In the 60s of the last century, large distillation towers, large rolling mills and other large machinery have been applied to the optimized design of electronic computers, and the direct digital

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control of DDC and SPC has been realized. In the 70s and 90s of the last century, with the emergence of microcomputers, the development of automated instruments and software and hardware made the automatic control of the entire production process reach a new height. After the 21st century, the concept of "people-oriented" and "energy conservation and environmental protection" has been rooted in people's hearts, and the mechanization of industrial production is developing in the direction of industrial integration.

3.3 The Current Situation and Background of Machine Learning in Intelligent Automotive Manufacturing

Companies in the automotive industry have been using robots on assembly lines to increase productivity since the 70s, but this is becoming more common. The 21st century is the era of Industry 4.0, with the Internet of Things, the servitization of manufacturing, "Industry 4.0" will play an important role in the field of intelligent manufacturing, the automotive industry is a leader in the manufacturing industry, such as Mercedes-Benz, BMW, Volkswagen and other enterprises, have been in the forefront of the field of Industry 4.0.

3.4 The Current Situation and Background of Machine Learning in Automotive Marketing Management and after-sales Service

In the Internet era, through intelligent marketing technology, suppliers can have a comprehensive understanding of potential consumers. From the aspects of brand, model, region, etc., the analysis is based on the characteristics of consumers' online and offline behaviors, and the prediction model of consumers' purchase intention is constructed by using machine learning technology, so that it can adapt to the sales situation of various models and the characteristics of various models.

At present, domestic automobile 4S stores generally have hardware quality but software backwardness. Compared with the sales of 4S brands in China, the brand car dealers in these European and American countries are more mature and advanced in terms of software. In the automotive industry, production, sales, and after-sales service should be a whole, but there is a certain disconnect between automobile production, sales, and after-sales service in China, which is an important factor leading to the unsatisfactory quality of automobile after-sales service. Dealers generally conduct business in the form of prepayment, while automakers mainly shift market risk to dealers. In such an environment, it is necessary to establish a systematic intelligent after-sales service system to improve the service quality of dealers and reduce operating costs.

4. Key Technology Applications of Machine Learning in the R&D of Automobile Companies

Machine learning is capable of operating in highly complex situations without explicit instructions. Machine learning is an inevitable trend in the automotive industry, which has led to the architecture of machine learning systems in the automotive industry, as shown in Figure 2 below.

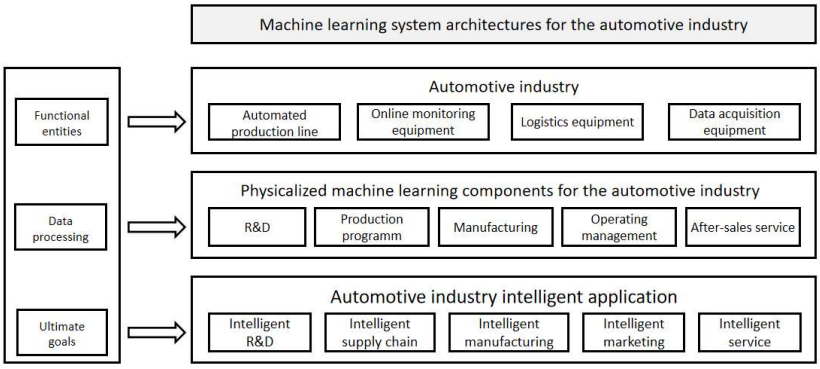

Figure 2. Architecture diagram of machine learning system in automotive industry

ISSN: 2414-1895 DOI: 10.6919/ICJE.202407_10(7).0013

4.1 Machine Vision Technology based on Machine Learning

Machine vision technology is an indispensable part of the implementation of machine learning in the field of automobile manufacturing. Its main applications in the intelligent manufacturing industry of automobile manufacturing are as follows:

A. Guidance and positioning. Generally, 3D vision is used to accurately locate and guide the robot arm to find the position of the material, grab the material and put it at the designated position for loading and unloading operation;

B. Visual inspection. This is the link that replaces the human eye the most, replacing the human eye for part defect inspection, such as scratches, bumps and other defects in the machining link, and defects such as multiple installations, missing installations, wrong installations and reverse installations in the assembly links;

C. High-precision detection. Measurement is the basis of industry, and high-precision parts of 0.01~0.02mm or even microns that cannot be recognized by the human eye must be recognized by machines;

D. Intelligent Identification. Processing, analyzing, and understanding of images, identifying target objects, and tracing and collecting data. Apply big data for rapid convergence and find key features in massive information;

E. Intelligent interconnection. The main application is the unmanned driving technology of automobiles, which interconnects data such as operators, process equipment, production materials, and production environment in intelligent manufacturing scenarios, and demonstrates the power of Industry 4.0 through deep learning, intelligent optimization, and intelligent prediction.

Visual inspection technology has been widely used in the automotive industry and basically runs through the entire automotive production process, and the main application scenarios include process inspection, dimensional inspection, virtual assembly, and error and leakage detection.

4.2 Autonomous Driving Technology based on Machine Learning

The key technologies and applications of machine learning in the autonomous driving technology developed by automobile companies are as follows: environmental perception technology, positioning, navigation and path planning technology, behavior prediction technology, and intelligent decision-making and motion control technology.

External and internal data collection and processing is the basis and prerequisite for autonomous driving. The navigation system of automobile positioning uses machine learning technology based on automatic positioning, digital map, and communication technology to realize the research on path guidance and wireless remote control of the car. In the vehicle positioning and navigation system, positioning is the premise and basis for realizing the navigation function. The prediction module in autonomous driving imitates the driver's prediction and judgment for different obstacles on the road, and different drivers have different judgments for the same obstacles. Intelligent decision-making technology is based on making decisions on the data obtained by the perception system, selecting appropriate working modes, and establishing corresponding control methods.

4.3 Human-vehicle Interaction Technology based on Machine Learning

Human-vehicle interaction technology is generally based on voice recognition, gesture control, biometrics and other technologies in machine learning. Speech recognition systems based on deep neural networks can further improve the accuracy of speech recognition in complex environments. By combining these technologies with the back-end cloud service platform, it is possible to create an on-board human-computer interaction system that can adapt to complex environments and perform a variety of tasks, providing drivers with a full range of information support.

4.4 Intelligent Decision-making Technology based on Machine Learning

In terms of smart production, machine learning technology can be widely used in smart decision-making, combined with the wide connection and low latency characteristics of 5G technology, it

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supports the transmission, storage and calculation of a large number of production data in intelligent factories, and is equipped with world-leading technologies such as industrial Internet, big data, edge computing and artificial intelligence on the basis of "public cloud + group cloud + private cloud", and builds four highly flexible adaptive production lines with AGV applications as the core, so that each production line can support the mixed production of a variety of customized models, and build an enterprise. The strongest brain". In terms of operation management of automobile enterprises, a digital platform for enterprise talent management is established through machine learning technology to realize data collection, processing and intelligent decision-making of employees in the organization.

4.5 Smart Marketing and after-sales Service Platform based on Machine Learning

The precision marketing platform is a marketing platform built by automobile companies based on machine learning technology, and online marketing uses offline dealer networks to integrate online resources to build their own e-commerce platforms. Using the official operation account equipped with third-party platforms, the company's own e-commerce portal and other channels, through the seamless online and offline mode, to provide customers with one-stop solutions.

The intelligent after-sales service platform developed based on machine learning technology, applies the Internet to connect the processes and data between stores and supply chains to provide users with services such as fault monitoring and early warning, maintenance plan management, service order management, maintenance care reminder, rescue guarantee, etc., and establishes a closed-loop service system of online option selection, offline service, and online evaluation.

5. Summary and outlook

In the automotive industry, machine learning is becoming more and more widely used. Through the synergy between the analysis of massive amounts of data and machine learning, the development of AI technology can be accelerated. The development of machine learning technology can uncover the potential correlations between different data sets and make accurate judgments about them, thereby improving people's experience and using big data to advance the automotive industry.

The industrial upgrading brought by machine learning to the automotive industry has begun, helping enterprises and even countries to find opportunities for improvement in the era of digital culture and intelligent economic systems, and the development goals of machine learning in the automotive industry in the next ten years are proposed, as shown in the following table.

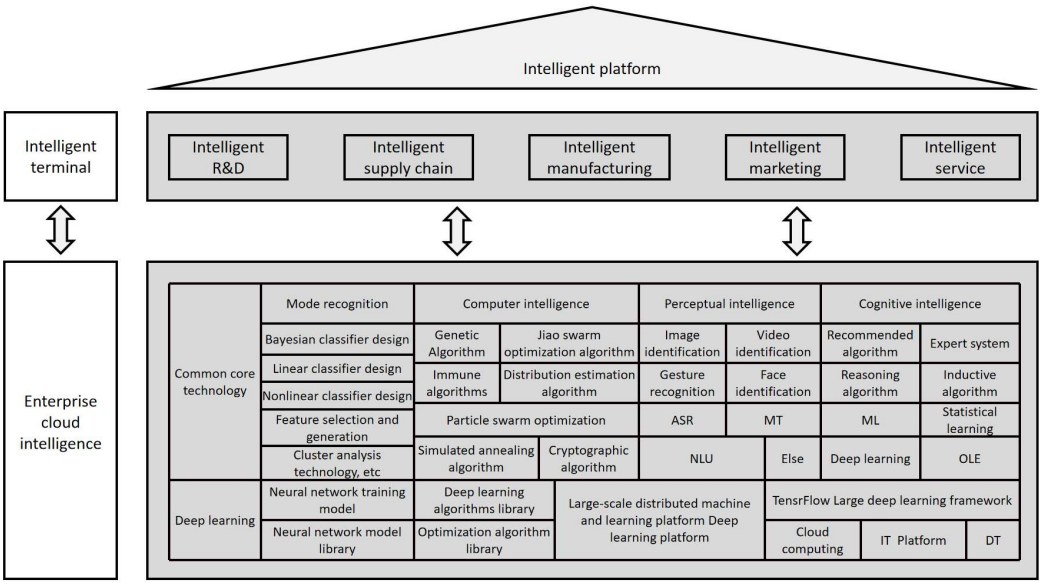

Figure 3. Application block diagram of machine learning platform in automotive industry

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Table 1. The overall goal of machine learning in the development of the automotive industry

2025	2030	2035+
The design and R&D personnel of automobile enterprises are proficient in machine learning algorithms, models and algorithm software, which are widely used in all aspects of automobile production, manufacturing and sales.	The design and R&D personnel of automobile enterprises use machine learning algorithms, models and algorithm software to create a relatively complete automobile industry chain.	With the development of large-scale modularization, digitalization and personalization of enterprises, the enterprise will eventually be built into an artificial intelligence platform with a large-scale distributed deep learning platform as the core. In this way, we can create a harmonious, green and environmentally friendly sharing; The interconnected, efficient, intelligent and safe smart society is an important guarantee for China to become an automobile power and an automobile society.
With the development of intelligent vehicle architecture, the centralization of domain controller DCUs with higher computing power, and the standardization of decentralized domain controller ECUs, automobile companies should increase cooperation with machine learning manufacturers to develop a large number of machine learning chips with key automotive technologies.	The intelligent vehicle architecture has developed into an architecture of "central integration + zone controller", cross-domain integration of domain controller DCUs with higher computing power, and deep learning chips and frameworks with key automotive technologies jointly developed by automobile companies and machine learning manufacturers, further improving the degree of automotive intelligence.	
The multi-layer machine learning platform model of automobile enterprises has been initially established, which is divided into three levels: basic services, intelligent analysis and decision-making, and cutting-edge innovation exploration, and supports the literal transformation of enterprise data at different levels.	With the development of digital transformation of automobiles, a multi-level machine learning platform with complete basic services, intelligent analysis and decision-making, and cutting-edge innovation exploration has been established.	

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