A Survey of the Development of Artificial Intelligence Technology

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***Abstract*—Artificial intelligence technology is currently a hot spot for research and application, and the new cross-technology formed by artificial intelligence and multiple technologies has been widely used in Internet, finance, security and other industries. This paper first introduces the development of artificial intelligence, and then analyzes the key technologies of artificial intelligence, including computer vision, machine learning, natural language processing, human-computer exchange, virtual reality, biometric recognition, etc. Finally, the development trend of artificial intelligence technology is described.**

Keywords—artificial intelligence, computer vision, machine learning, natural language processing, virtual reality

I. INTRODUCTION

The concept of artificial intelligence was born in 1956. In the development process of more than half a century, the development of artificial intelligence technology has experienced many highs and lows due to the influence of intelligent algorithm, computing speed, storage level and other factors. Since 2006, machine learning algorithm, represented by deep learning, has made great success in machine vision, speech recognition and other fields, making artificial intelligence widely concerned by academia and industry again. Artificial intelligence is an important branch derived from the field of computer science, and it is also an interdisciplinary subject which integrates a variety of disciplines. It is known as the three cutting-edge technologies in the 21st century with genetic engineering and nano science[1]. Artificial intelligence is currently in a situation of great concern. On the one hand, with the rapid development of science and technology, people's life needs are constantly changing. Computers should not only provide more intelligent services, but also provide more humanized services. On the other hand, the rapid development of science and technology provides a good foundation for artificial intelligence technology into people's production and life, and further promotes the application and promotion of artificial intelligence technology[2].

II. THE DEVELOPMENT OF ARTIFICIAL INTELLIGENCE

In August 1956, John McCarthy, Marvin Minsky (expert in artificial intelligence and cognition), Claude Shannon (founder of information theory), Allen Newell (computer scientist), Herbert Simon (Nobel Prize winner in Economics) and other scientists gathered at Dartmouth College to discuss an incredible topic: imitating human learning and other aspects of intelligence with machines. Although the meeting did not reach a consensus, it made a name for the content discussed at the meeting-artificial intelligence[3]. Therefore, 1956 is also known as the first year of artificial intelligence. Artificial intelligence technology has changed from the initial neural network and fuzzy logic to the present deep learning, image search. In this paper, the development of artificial intelligence for more than 60 years since 1956 is divided into the following five stages[4-6].

1) Starting Period

From 1956 to the early 1960s, the concept of artificial intelligence was first proposed. As the technology is in the enlightenment stage, and the computing conditions at that time are not mature enough to provide assistance for the development of artificial intelligence technology.

2) Rising Period

In the 1960s, artificial intelligence has made a number of remarkable research results, such as machine theorem proving, checkers program, setting off the first climax of the development of artificial intelligence. In 1969, The International Conference on Artificial Intelligence marked that artificial intelligence has been internationally recognized.

3) Low Development Period

From the 1970s to the 1980s, the breakthrough in the early stage of the development of artificial intelligence greatly raised people's expectations of artificial intelligence, and people began to try more challenging tasks. Due to the technical limitations at that time, artificial intelligence technology did not produce the expected breakthrough, which made the public and the government's attention to artificial intelligence drop sharply, making the development of artificial intelligence went to a low point. However, the subsequent expert system that emerged can simulate the knowledge and experience of human experts to solve problems in specific fields, and achieve a major breakthrough from theoretical research to practical application of artificial intelligence, promoting artificial intelligence into a new climax of application development. Subsequently, the application scale of artificial intelligence continues to expand, and the problems of expert system, such as narrow application field, lack of commonsense knowledge, difficulty in knowledge acquisition, single reasoning method, and difficulty in compatibility with existing databases, are gradually exposed.

4) Steady Development Period

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From the 1980s to the 1990s, the International Conference on Neural Networks was held in the United States, making neural networks widely recognized by people. Scientists began to conduct extensive research on artificial intelligence algorithms based on artificial neural networks, and various learning algorithms have begun to study. In addition, the development of network technology, especially Internet technology, has accelerated the innovative research of artificial intelligence, and promoted the artificial intelligence technology to become more practical.

5) Booming Period

Since the 21st century, with the development of big data, cloud computing, Internet and other information technologies, artificial intelligence technology has turned a period of rapid development. Deep learning algorithm based on neural network, genetic algorithm based on biological evolution and fuzzy logic and group algorithm have been practiced on a large scale. Artificial intelligence technology ushered in a new climax of explosive growth.

III. Analysis of Key Technologies of Artificial Intelligence

A. Computer Vision Technology

Computer vision technology is a kind of technology that studies how to make machines to see. It refers to the technology that uses computers to imitate the human vision system, so that computers have the ability to extract, process, understand and analyze images similar to human beings[7]. Computer vision technology is a visual information technology which is connected with computer system to analyze and process data information based on image and signal processing technology, probability analysis and statistics, network neural technology and information processing technology. In terms of technology operation, the camera is used to replace the human eye, and the computer acts as the human brain, so that it can recognize, judge and memorize the target under the support of technology, and can carry out some production operations instead of human beings[8]. The main functions of computer vision technology include: image acquisition, preprocessing, feature extraction, detection/segmentation, advanced processing. Computer vision can be divided into computational imaging, image understanding, three-dimensional vision, dynamic vision, video coding and decoding.

B. Machine Learning

Machine learning involves many fields such as statistics, system identification, approximation theory, neural networks, optimization theory, computer science, brain science, and so on[9]. It refers to that the computer acquires new knowledge or skills by analyzing and learning a large amount of existing data, and continuously improves its own performance, and thus have the ability to predict judgments and make the best decisions. Representative algorithms include deep learning, artificial neural network, decision tree, enhanced algorithm, etc[10]. Data-based machine learning is an important method in modern intelligent technology. It studies how to find rules from samples and uses these rules to predict future data. According to the learning mode, machine learning can be divided into supervised learning, unsupervised learning, semi-supervised learning and reinforcement learning. According to learning methods, machine learning can be divided into traditional machine learning and deep learning.

C. Natural Language Processing

Natural language processing is an important direction in the field of computer science and artificial intelligence. It is an interdisciplinary subject across linguistics, computer science, mathematics and other fields. It refers to the use of computers to process information such as form, sound, and meaning of natural language[11]. That is, the operation and processing of the input, output, recognition, analysis, understanding, and generation of characters, words, sentences, and chapters. Natural language processing connects mathematical modeling, computer technology, linguistics and other subjects together to make the language system of the information field more perfect, and it is a bridge between the virtual world and the real world through natural language communication.

The research of natural language processing can be divided into two parts: basic research and applied research. Basic research mainly involves linguistics, mathematics, computers and other fields; applied research mainly focuses on some fields of applied natural language processing. It consists of two processes, natural language understanding and natural language generation[12]. Natural language understanding is to let the computer turn the input language into symbols, and then process them according to the purpose; natural language generation is to convert the computer data into natural language to realize the information exchange between human and computer.

D. Human-computer Interaction

Human-computer interaction is a technology that studies people, computers and their mutual influence. It is an important peripheral technology in the field of artificial intelligence to realize the dialogue between human and computer in an effective way through computer input and output devices, which is closely related to cognitive science, ergonomics, psychology and other disciplines[13]. Human-computer interaction technology includes human input information to computer through input device and computer provides information to human through output device. The main way of human-computer interaction technology is touch interaction, which is widely used. From keyboard to mouse, to voice and touch, to multi-touch, human-computer interaction mode is changing with the expansion of its users. The breakthrough of somatosensory technology indicates that the main development direction in the future is to make the interaction more convenient. Motion-sensing technology is the core technology of almost all interactive motion-sensing feeling entertainment products, and also the core of the next generation of advanced human-computer interaction technology.

E. Virtual Reality

Virtual reality is a new technology in the field of computer, which is based on the combination of graphics technology, multimedia technology, sensor technology, human-computer interaction technology, network technology, stereoscopic display technology and simulation technology. Virtual reality generates a digital environment which is similar to the real environment in vision, hearing, touch and other aspects in a certain range. Users interact with the objects in the digital environment with the help of necessary equipment[14]. Virtual reality can be divided into five aspects according to different processing stages: acquisition and modeling technology, analysis and utilization technology, exchange and distribution technology, display and interaction technology,

and technical standards and evaluation system[15]. The key technologies to realize virtual reality include: dynamic environment modeling technology; real-time three-dimensional animation technology; Stereoscopic display and sensing technology; fast and high precision three-dimensional tracking technology; system integration technology.

F. Biometric Identification

Biometric identification technology is a technology that can identify and authenticate individuals by using their own physiological or behavioral characteristics. It is usually divided into two processes: registration and identification. In the registration process, sensors are used to collect the characterization information of individual biometrics, and feature extraction technology is used to extract feature data for training to obtain templates and store them[16]. Recognition is the process of identity identification. Feature extraction is similar to registration process. After feature extraction, feature information is used to match with stored templates to determine the identity of individuals.

From the perspective of application tasks, biometric recognition is generally divided into two tasks: identification and confirmation. Identification refers to the process of determining individual identity from template database; confirmation refers to comparing individual information with model information in template database to confirm identity[17]. Biometric recognition technology mainly includes face recognition, fingerprint recognition, iris recognition, hand shape recognition, palmprint recognition, palmprint recognition, voice recognition.

IV. Application of Artificial Intelligence Technology

Artificial intelligence technologies application are gradually increasing in various industries. In addition to the Internet, medical, education, finance, smart home and manufacturing are also more widely used and relatively mature.

A. Medical Field

The main reflections of artificial intelligence are intelligent devices, auxiliary diagnosis, medical records, surgical robots and image understanding in medical field. Artificial intelligence can assist in disease diagnosis through compare the description of symptoms of patients with disease database by take advantage of natural language processing technology[18]. According to relevant information, the recognition accuracy of the artificial intelligence system developed by Harvard Medical College to the cancer cells in the pictures of breast cancer cases has reached 92%.

B. Educational Field

Artificial intelligence is mainly used in school teaching and distance education in the field of education. The application of artificial intelligence education has enriched educational resources, made teaching methods more flexible, and optimized teaching links and processes[19]. Such as the application of intelligent teaching systems, intelligent tutor systems, intelligent adaptive learning systems and robots in education, fully considering the individual differences of learners, assisting teachers to better teach students according to their aptitude, and optimizing and innovating teaching methods; Achieving mixed personalized teaching and creating a new educational ecology. At the same time, in the teaching process, artificial intelligence provides technical support for smart education, such as intelligent correction, case-based reasoning and other emerging machine learning has injected fresh blood into education. Machine marking reduces the burden on teachers, and teachers can spare more time and energy to focus on student interaction, instructional design, professional development and education quality.

C. Financial Field

In the financial field, intelligent claims, intelligent investment consulting, anti-fraud, risk control, intelligent customer service, investment decision-making, precision marketing are the main application of artificial intelligence. The most widely used is investment consulting business, which is called "intelligent investment adviser" in the industry[20]. Wealthfront, Betterment, Personal Capital and other intelligent investment and consulting platforms are well-known all over the world. Intelligent investment adviser obtain personalized risk preferences of customers and their changing rules through big data. According to the risk preferences of customers, personalized investment plans are customized. Meanwhile, personalized asset allocation plans are tracked and adjusted in real time by using the Internet.

D. Smart Home Field

In the field of home, smart home appliances, smart control platforms, green home, home security, and home robots are the main application of artificial intelligence[21]. The intelligence of home products mainly lies in the comprehensive analysis and judgment of the surrounding environment to meet users' home experience. Through the interaction function of the sensing system, the home environment will be fully sensed, and the corresponding instructions will be calculated and executed.

E. Manufacturing Field

In the manufacturing field, there has three main application aspects of artificial intelligence: first, intelligent equipment, including specific industrial equipment such as intelligent recognition peripherals, human-computer interaction, and industrial intelligent machines. Then there is the smart factory, including smart automation design, smart production line, smart automation management, etc. Finally, intelligent services include specific service models such as personalized customization services, remote factory operation and maintenance, and equipment maintenance prediction.

The combination of artificial intelligence and manufacturing is an inevitable trend. Although current solutions cannot fully meet the requirements of the manufacturing industry, the future development of artificial intelligence technology will be more rapid[22]. The combination of artificial intelligence and traditional manufacturing has already demonstrated its value in a short time. Artificial intelligence will gradually subvert the products and architecture of traditional manufacturing. In the future, intelligence will become one of the standard basic functions of most products. Almost all traditional manufacturing industries will be changed due to the appearance of artificial intelligence.

V. Development Trend of Artificial Intelligence Technology

At present, artificial intelligence is playing an increasingly important role in the process of information collection, information analysis and decision-making, and its information processing capacity is far beyond the human brain. Undoubtedly, in the development of artificial intelligence,

highly intelligent is its main development trend. Specifically speaking, from the perspective of the future development of artificial intelligence technology, on the one hand, big data can bring richer materials for deep learning; on the other hand, cloud computing and GPU are important supports for the independent thinking and analysis of artificial intelligence.

In the future, the development of artificial intelligence technology will show the following trends:

- Artificial intelligence technology based on deep learning will show a faster development speed. It can absorb the current knowledge and experience, so as to make itself more perfect.
- Open source technology platform. The open source learning framework has a huge impact on the field of deep learning. It enables developers to directly use the deep learning tools that have been successfully developed, reducing secondary development and improving efficiency.
- Special intelligence towards general intelligence. The current development of artificial intelligence is mainly focused on special intelligence, which has limitations in the field. With the development of science and technology, various fields merge and influence each other, which requires general intelligence with strong adaptability. General intelligence can interconnect artificial intelligence with human characteristics to improve the ability to handle tasks.
- Intelligent perception towards intelligent cognition. The main development stages of artificial intelligence include: computational intelligence, perceptual intelligence and cognitive intelligence. The early artificial intelligence was computational intelligence, while the current artificial intelligence in the era of big data is perceptual intelligence. With the development of brain-like technology, artificial intelligence is bound to step forward to cognitive intelligence.

VI. Conclusion

In summary, artificial intelligence has been widely used in the production and life of modern society, which determines that the development of artificial intelligence technology can bring more changes to modern society. So far, the research on artificial intelligence is still in its infancy, and it still has a long way to go to reach its ultimate goal. Although artificial intelligence has caught up with human beings in many aspects, there is still a long way to go from real intelligence in essence, which is also the direction of our further expectation and efforts. We believe that with the development of artificial intelligence technology, its application scenarios will continue to enrich and drive the continuous development of its supporting technology. Human beings are gradually stepping into the "intelligent era". As a new technology in the Internet era, artificial intelligence will gradually penetrate into all walks of life.

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