Application and Development Trend of Intelligent Industrial Robot

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Abstract: With the development of industrial automation and digital technology, industrial robot has gradually become a widely used digital mechatronics equipment in the industrial field. Especially in unconventional and extreme manufacturing processes, industrial robots play an important role. In addition, in this information age, the emergence of industrial robots not only drives the improvement of social and economic levels, but also proves that technology has reached a new height. In order to better respond to the changing environment and application needs of the outside world, intelligence is one of the important research and development trends. Therefore, this paper mainly reviews the research status and development trend of intelligent industrial robots.

1. Introduction

With the development of science and technology, the industry has become the foundation of a country's development, and robot automation has become the main lifeline of industrial development [1-3]. And with the development and progress of the times, China's robot industry has made great breakthrough in technology, and effectively extended and developed towards the direction of independent research and development. Note that industrial robot is a robot system used in manufacturing production, and it is an automatic and programmable device with three or more motion axes [4]. At present, the development of industrial robots can be divided into three generations. The first generation is teaching and playback robot, the second generation is offline programming robot, and the third generation is the intelligent robot. The development of industrial robot automation, on the one hand, promotes the further extension of industrial robot technology, on the other hand, promotes the construction of industrial automation, and promotes the sustainable development of industrial robot. Industrial robots can effectively reduce labor force, solve all kinds of risk problems, reduce the impact of dangerous events on human beings, enhance the quality of production and management, improve decision-making, and adapt to different environmental needs.

In addition, as a system engineering developed with the help of modern high-tech, the main structure of industrial robot includes human-machine interface, motion controller and driver [5]. Meanwhile, it also includes the robot mechanical body. These components are closely connected and cooperate with each other through a variety of systems, finally forming a closed-loop system. Through human-machine coordination to achieve the operator's will, so that it plays its due function [6]. Due to the high degree of modularity of industrial robots, it can adapt to a variety of mechanical technology, and has a wide range of applications in the field of industrial technology and modern life.

2. Industrial Robot and Its Typical Applications

As mentioned above, industrial robot is oriented to the industrial field of multi-joint manipulator or multi-degree of freedom of the robot, and it is a machine device that performs work automatically and realizes various functions by its own power and control ability [7]. It can accept the command of human beings, and it can also run according to the preprogram. Modern industrial robots can also act according to the principles and programs formulated by artificial intelligence technology. Since the first industrial robot is created in the early 1960s, robot has shown its great vitality. In just over 50 years, robot technology has developed rapidly [8-10]. Among many manufacturing fields, the most widely used field of industrial robot is automobile and automobile

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parts manufacturing, and it is constantly expanding to other fields, e.g., the mechanical processing industry, the electronic and electrical industry, the rubber and plastic industry, the food industry, the wood, and furniture manufacturing industry. In industrial production, the welding robot, the grinding robot, the laser processing robot, the spraying robot, the handling robot, the vacuum robot, and other industrial robots have been widely used. Compared with traditional industrial equipment, industrial robots have many advantages, e.g., easy to use, high level of intelligence, high production efficiency and safety, easy to manage and significant economic benefits, which make them work in high-risk environment [10-12].

2.1 Pelleting Robots

In all kinds of factory palletizing, highly automated robots are widely used, manual palletizing work intensity, labor consumption, employees not only need to bear great pressure, but also the work efficiency is low. The palletizing robot can carry out efficient sorting and handling according to the characteristics of carrying objects, as well as the place where the objects are classified, on the basis of keeping the shape and the nature of the objects unchanged, so that the palletizing robot can complete the task of hundreds of blocks of stacking per hour. In short, the palletizing robot plays an important role in loading and unloading of the production line, container handling, etc.

2.2 Welding Robots

Welding robot mainly undertakes welding work, different industrial types have different industrial needs, so common welding robots include spot welding robot, arc welding robot, laser robot, etc. Automobile manufacturing industry is the most widely used welding robot industry, which has the advantages of manual welding in welding difficulty, welding quantity and welding quality.

2.3 Assembly Robots

In industrial production, the assembly of parts is a huge job, requiring a lot of labor. Due to the high error rate and low efficiency, manual assembly is gradually being replaced by industrial robots. The research and development of assembly robots combines a variety of technologies, including communication technology, automatic control, optical principles, microelectronics, etc. R&D personnel formulate corresponding procedures according to the assembly process and apply them to specific assembly work. The biggest feature of assembly robots is high assembly accuracy, flexibility and durability. Due to the complex assembly work, assembly robots are generally used for the installation of electronic parts and fine automotive parts.

2.4 Inspection Robots

Robots have additional functions on different dimensions. It can replace people on some special job position. Some jobs that have high risks, e.g., nuclear pollution area, poisoned, and high-risk unknown area, etc. Some places that human cannot reach, e.g., the detection of patient's diseased area, industrial defects, and the signs of life at the earthquake site.

2.5 Machining Robots

The machining robot is a combination of the robot technology and the machine tool technology. This kind of robot require small footprint and have high machining flexibility. This kind of robot has great potential in complex surface and can machine of large structural parts. Scholars in China and abroad have done a lot of tentative work in this area and gained some achievements. Currently this type of equipment has done some development on fundamental part and its application has certain limitations.

3. Development Status of Industrial Robot Industry in China

Industrial robots are widely used in China's manufacturing industry, it covers dozens of processes such as welding, spraying, assembly, handling, stacking, grinding, gluing, sorting,

packaging, testing, loading, and unloading, etc. [13-16]. There are many application scenarios in discrete manufacturing, process industries, warehousing and logistics and other industries.

In 2020, Covid-19 had caused a huge impact on the global economy. However, due to China react with Covid-19 in a short time, it leading to a blowout in many industries in the second half of the year, the demand for industrial robots has increased significantly. According to the statistics, January to November in 2020, the national industrial enterprises above designated size produced 206,851 industrial robots, an increase of 22.2% over the previous year; the national industrial robot manufacturers above designated size achieved operating income of 45.33 billion yuan, an increase of 3.4% over the previous year. According to the latest forecast, China's industrial robot sales will decline for two consecutive years in 2020, and from 2018 to 2019, it will again turn to positive growth. With the further expansion of the industrial robot application industry, the market share of self-owned brand robots continues to increase [17]. In China, a complete industrial robot industrial chain has been formed, with independent production and supporting capabilities for the entire industrial chain from upstream core components and midstream body manufacturing to downstream system integration and application.

However, note that the low localization rate of industrial robots in China has been a bottleneck restricting its development. Faced with the continuous development of foreign robotics technology and fierce competition in the international market, Chinese industrial robots are struggling to make progress [18]. Firstly, the current situation of domestic enterprises has obviously insufficient demand for robots. Secondly, domestic robots still have a certain gap compared with similar foreign products in terms of performance, price, serialization, and large-scale production. For this reason, higher requirements have been put forward for the independent development and technological progress of domestic industrial robots. Although in recent years, domestic enterprises have overcome some of the problems of the core components of industrial robots and have achieved certain technological breakthroughs. The application of domestic core components is continuously improving, and the recognition and market share of domestic independent industrial robots are also increasing [19]. But there is still much room for improvement in the future. In terms of application, following the automotive and 3C electronics industries, multi-functional industries such as sanitary ceramics, metal processing, and household appliances have begun to become the main growth points of China's industrial robot market.

In short, China is the fastest growing and largest industrial robot application market in the world, and the market space and development prospects are still broad. Although the installed capacity of robots in the Chinese market has gradually increased in recent years, the installed density of industrial robots still lags far behind developed countries such as Japan and Germany, and there is still much room for improvement in the future. At the same time, as the disease epidemic enters the stage of normalization of prevention and treatment, the demand for smart factory construction by manufacturing companies is stimulated, which will also drive the development of the entire industrial robot industry.

4. Development Trend of Intelligent Industrial Robot in China

As mentioned in the previous part of the essay, industrial robots is one of the most important kind of automatic equipment in the modern world. They combined machinery, electronics, control, computers, sensors and artificial intelligence. In 1962, the US has developed the first industrial robot in the world, the technology of the robots and its products have been developed rapidly and become as automation tools for flexible manufacturing systems, automated factories, and computer integrated manufacturing systems. The widespread use of industrial robots can not only improve product quality and output, but also ensure personal safety, improve the working environment, reduce labor intensity, increase labor productivity, save raw material consumption, and reduce production costs. Like computer and network technology, the widespread application of industrial robots is changing human production and lifestyles [20]. At present, industrial robots still have obvious shortcomings in terms of flexibility and intelligent decision-making capabilities. The main manifestation is that they have weak perception and can only complete various deterministic tasks

in a structured environment. Thus, there is a kind of robot that can realize the robot and the environment. Integration, integration of humans, integration of humans and robots, autonomous adaptation to complex dynamic environments and collaborative work “Integrated robots”. Traditional industrial robots have gradually moved towards intelligence through the collaborative application of sensors such as machine vision, force and touch, and collaborative robots have also begun to move towards “Human computer interaction.” It is conceivable that with the development of machine vision, intelligent perception, cloud computing and other technologies, as well as the combination with robotics, inclusive robots will become the future development direction of industrial robots and make them more intelligent and flexible.

The development of industrial robots is more systematic and has a wider range of applications. For example, welding robots and cleaning robots are gradually put into use, and the degree of engineering automation is significantly enhanced. With the continuous improvement of technical level, the cost of robot shows a downward trend, but the performance is continuously enhanced. E.g., for the manipulator in the industrial field, its main principle is to imitate the human hand and arm, realize the functions of flexible grasping and handling, and meet the goal of automatic operation. At present, the most widely used fields of manipulator are industrial manufacturing, packaging, etc. The manipulator can complete the operation accurately and efficiently in a given time, which has also become the main direction of the development of industrial robots. At present, with the rapid development of information technology, especially the continuous expansion of the influence of artificial intelligence technology, coupled with the support of Internet technology, the development of industrial robots presents more systematic characteristics and strengthens the improvement of control system functions. Diagnosis system and maintenance system. At the same time, relying on simulation program design can effectively improve the level of intelligence and automation, continuously improve the overall performance, and show greater reliability in the application.

Based on the constantly upgraded and updated computer information technology, the control system of industrial robot is more perfect and the realization of unification and standardization is accelerated. In the interior of the robot, the core composition is the control system, which is an important guarantee to give full play to its functions, and strengthen the support for memory, teaching, communication connection and coordinate setting functions [21]. At present, computer technology is constantly upgraded, which provides a strong driving force for the optimization and improvement of industrial robot control system, and the overall control level is significantly improved. Specifically, in terms of controller, it has developed from special closed type to open type. In other words, the improvement of computer level makes the control system of industrial robot break through the constraints of special supply, show the trend of unification and standardization, and have obvious network characteristics. Based on this, the operation of the industrial robot is more convenient. It can have simple operation knowledge. There is no need to invest human and material resources for training. The module function of the robot can be adjusted in a very short time, which fundamentally makes the use of the robot more convenient and faster, and the maintenance and management work is easy to carry out.

The integrated sensor fusion technology is becoming more mature and perfect, realizing the perception of human thinking and nerves, and inducing the development direction of the future development trend of industrial robots in the era of biological information. The promotion of human learning requires a higher level of imitation, which not only imitates human actions and behaviors, but also requires human thinking and nerves. Based on this, sensors have become an important part of intelligent industrial robots, especially the emergence of remote robots at another distance. The emergence of force and sensors represent the development speed of industrial robot vision. Another type of remote robot represents a new level of comprehensive sensor research and development technology. This kind of technology will appear in the future development of robots. The promotion and application of a more complete range of applications are appearing in constant maturity and maturity.

In short, the industry and application scenarios of industrial robots are constantly being explored.

Industrial robot technology has served the automotive industry for a long time. The industry is the current application of industrial robots. However, driven by the demand for intelligent manufacturing of the general industry and the overall popularity of the automotive industry, the application of industrial robots is also expanding to the general industry. Development, application scenarios are constantly updated. In application, it has been rapidly processed from the automotive metal industry to 3C electronics, plastics, chemicals, rubber, plastics, and food processing industries; in specific application scenarios, the applications of industrial robots include welding, automobiles, polishing, coating, and glue coating. Loading and unloading, deburring, handling, palletizing, accessories, sorting, packaging, testing, etc.

5. Conclusions

Industrial robots are the product of multi-disciplinary integration and development, and are of great significance to the development of industrial industry. Therefore, with the support of artificial intelligence technology, accurately grasp the development trend of industrial robots, promote the continuous reduction of industrial robot manufacturing costs and the gradual improvement of work performance. At the same time, pay attention to the research and application of bionics in the field of industrial robots, and strengthen the continuous upgrading and transformation of the control system. In addition, the huge market demand and complex competitive environment have brought unprecedented opportunities and challenges to China's robotics industry. To make “Made in China” robots go faster and farther, breakthroughs in core components are the key. Companies with independent core components will have great advantages in product development, service timeliness and cost, and accessories prices. Under the background of policy support and strong market demand, China's robotics industry will have a good future prospect.

References

[1] Wallén, J. (2008). The history of the industrial robot. Linköping University Electronic Press.

[2] Wang, T., & Tao, Y. (2014). Research status and industrialization development strategy of Chinese industrial robot. Journal of mechanical engineering, 50(9), 1-13.

[3] Appleton, E., & Williams, D. J. (2012). Industrial robot applications. Springer Science & Business Media.

[4] Wang, T. M., Tao, Y., & Liu, H. (2018). Current researches and future development trend of intelligent robot: A review. International Journal of Automation and Computing, 15(5), 525-546.

[5] Chen, Y., & Dong, F. (2013). Robot machining: recent development and future research issues. The International Journal of Advanced Manufacturing Technology, 66(9-12), 1489-1497.

[6] Iglesias, I., Sebastián, M. A., & Ares, J. E. (2015). Overview of the state of robotic machining: Current situation and future potential. Procedia engineering, 132, 911-917.

[7] Zheng, L., Liu, S., & Wang, S. (2016). Current situation and future of Chinese industrial robot development. International Journal of Mechanical Engineering and Robotics Research, 5(4), 295-300.

[8] Yan, D. (2018, September). Research and application status of industrial robot control system. In 2018 3rd International Conference on Mechanical, Control and Computer Engineering (ICMCCE) (pp. 16-20). IEEE.

[9] Karabegovic, E., Karabegovic, I., & Hadzalic, E. (2012). Industrial Robot Application Trend in World’s Metal Industry. Engineering Economics, 23(4), 368-378.

[10] Karabegović, I., Karabegović, E., & Husak, E. (2011). Comparative analysis of the industrial robot application in Europe and Asia. EUROPE, 35(22.600), 34-200.

[11] Lixia, P. (2010). Development and Applications of Industrial Robot. Shanxi Science and Technology, 03.

[12] Zhao, Y. (2021, June). Current Status and Industrialization Development of Industrial Robot Technology. In International Conference on Applications and Techniques in Cyber Security and Intelligence (pp. 804-808). Springer, Cham.

[13] Kopacek, P. (2013). Development trends in robotics. e & i Elektrotechnik und Informationstechnik, 130(2), 42-47.

[14] Wu, Q., Liu, Y., & Wu, C. (2018). An overview of current situations of robot industry development. In ITM Web of Conferences (Vol. 17, p. 03019). EDP Sciences.

[15] Guo, X., & Lu, H. (2010, May). Recent development of forest industrial robot in China. In 2010 International Conference on Intelligent Computation Technology and Automation (Vol. 2, pp. 984-987). IEEE.

[16] Zhou, X. Development Status and Trend of Industrial Robot and Intelligent Manufacturing. International Journal of Social Sciences in Universities, 289.

[17] Wen, B., Tao, B., & Li, G. (2019, August). Research Status and Tendency of Intelligent Industrial Robot. In Journal of Physics: Conference Series (Vol. 1302, No. 3, p. 032050). IOP Publishing.

[18] Hao, X., Bian, Y., Bai, L., Li, L., & Sun, C. (2019, March). The Research and Application of Industrial Robot in Steel Deep Processing Field. In IOP Conference Series: Materials Science and Engineering (Vol. 484, No. 1, p. 012027). IOP Publishing.

[19] Okuda, H., Haraguchi, R., Domae, Y., & Shiratsuchi, K. (2016, June). Novel intelligent technologies for industrial robot in manufacturing-architectures and applications. In Proceedings of ISR 2016: 47st International Symposium on Robotics (pp. 1-6). VDE.

[20] Zhang, T., Li, Q., Zhang, C. S., Liang, H. W., Li, P., Wang, T. M., ... & Wu, C. (2017). Current trends in the development of intelligent unmanned autonomous systems. Frontiers of information technology & electronic engineering, 18(1), 68-85.

[21] Mizukawa, M. (2005, June). Robot technology (RT) trend and standardization. In IEEE Workshop on Advanced Robotics and its Social Impacts, 2005. (pp. 249-253). IEEE.