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Key Technologies of Warehousing Robot for Intelligent logistics

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***Abstract*—Fully automatic warehousing system is one of the basic trend of future intelligent logistics development. Intelligent warehousing robot is an important carrier connecting data, information and warehouse. By machine vision, machine learning and related photoelectric technology intelligent warehousing robot complete cargo handling, sorting, distribution, storage, inventory, and improve the efficiency of goods out of warehouse. Relying on the big data of logistics industry, integrating the advance technology of artificial intelligence, so as to improve the efficiency of end-to-end supply chain and achieve intelligent logistics.**

Keywords—Intelligent Logistics; Warehousing Robot; Machine Learning; End to End

I. INTRODUCTION

In the past few decades, the logistics industry has experienced a triple jump from manual operation to mechanization, then to automation. With the development of information technology, the big data and machine learning have been introduced in the logistics equipment industry. Advances in technology have made people wonder whether an intelligent device can be developed to replace artificial, such as handling machinery, or even automated conveying and sorting equipment. With the unremitting efforts of many practitioners, the industrial robot used in the industrial field has become a helper in logistics industry. For example a new automation devices like KIVA robots have entered the warehousing industry [1]. With the rapid development of China's economy, the logistics industry is also developing rapidly, and the number of express parcels is also growing rapidly every year. At this time, manual handling, sorting, distribution, storage and inventory of goods can no longer satisfy the growing logistics industry. In addition, labor chaos, labor shortage, labor costs remain high. With the advance technology adopting, the total cost of logistics decreased from 17.8% to 14.6% of GDP, and the overall efficiency of social logistics was improved, but compared with the level of logistics efficiency in developed countries (less than 10% in the United States, Japan and Germany), there is still a large room for improvement [2].

On the other hand, due to various types of express goods, mixed and disorderly of specifications, it is difficult to achieve centralized and batch processing. The intelligent warehouse robot which be fused through a series of technologies reach the shelves of specific goods, and then lift the shelves to reach the destination from elsewhere. By adopting AI(artificial intelligence) technology the intelligent logistics and warehousing robot has higher working efficiency and accuracy rate than the artificial one. At present, all walks of life, including logistics, are developing towards the trend of automation and intelligence, which complies with the development trend of intelligent logistics. This study has some practical guiding significance for the construction of automated logistics system and intelligent logistics with intelligent warehousing robot. Now is a good time to introduce machine learning and deep learning into intelligent logistics. from the model, by collecting data and training, so as to provide an end-to-end efficient artificial intelligence solution for logistics system [3].

II. TECHNICAL COMPOSITION AND KEY TECHNOLOGIES OF INTELLIGENT WAREHOUSING

A. Application of Intelligent Warehousing Logistics Robot

Under the background of high information and automation, the logistics and warehousing has produced intelligent warehousing robot, which has been widely used in various logistics platforms. Amazon warehouse has disturbed more than 30,000 Kiva robots in its distribution centers, which are 40cm in height, up to 1.3m per second, 340kg of load, 2-4 times the efficiency of traditional logistics operations, and 99.99% accuracy. The operation process of Kiva is that the resource allocation algorithm run by the control system firstly, and instructions are sent to Kiva robot. Kiva finds the shelves along the planning path according to the instructions, and the shelves can sense and communicate with Kiva. When Kiva recognizes that the goods on the shelves need to be delivered, it jacks up the shelves and transports the shelves to the picking position. Kiva moves according to its visual system, which reads the grid marks on the ground, and plans the route and queue according to the algorithm [4].

In 2015, Geek+ officially launched the intelligent robot selection system in Tmall supermarket warehouse. In 2016, Geek+ joined Suning logistics research institute and S laboratory to help Suning build intelligent logistics ecology through the robot selection system. Geek+ robot use QR code visual navigation, multi-sensor fusion to avoid obstacles, and

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the shelves are lifted slowly by spiral driver, as can be seen from figure 1.

Fig. 1 Geek + Robot

Vision navigation + inertial navigation technology driven by two-wheel differential speed is adopted in Hikvision's Qianmo robot, whose positioning accuracy reaches millimeter level. Meanwhile, combined with the intelligent power management system, the "Qianmo" warehousing robot will independently walk to the charging pile for charging when the electric power is lower than a certain threshold. Hikvision's crisscrossing robot scheduling system (RCS) is responsible for task allocation, scheduling and operation and maintenance of all robots within the control scope [5] .

B. Technical Composition of Intelligent Warehousing Robot

Intelligent warehousing robot is mainly composed of positioning and navigation, artificial intelligence algorithm, robot management system and corresponding mechanical structure [6], as shown in figure 2.

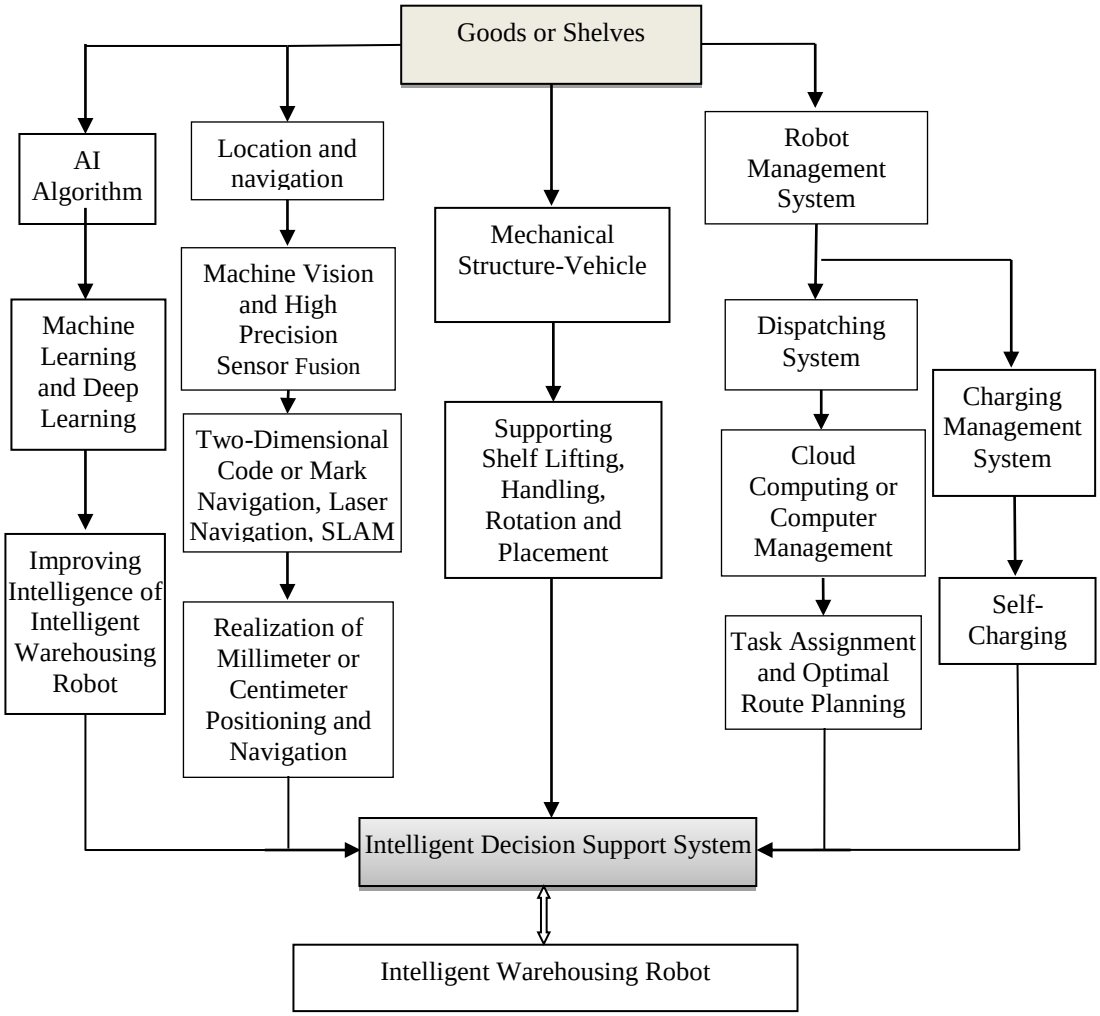

Fig. 2 Technical Composition of Warehousing Robot

1) Location and navigation. By using machine vision and high-precision sensor data fusion intelligent warehousing robots could position and navigate with sub-centimeter-level accurate, even millimeter-level accurate. In the system machine vision identify the path by the camera scanning the two-dimensional code and markers of the ground, and then feedback to the power transmission system for driving. On the basis of visual navigation, multi-sensor information is fused for navigation, which can identify obstacles of unknown circumstances and avoid obstacles, so as to accurately locate

and automatically identify paths with high reliability [7]. Besides two-dimensional codes or specific markers for positioning and navigation, laser guidance and SLAM navigation can also be adopted in the system.

2) Mechanical structure -- vehicle diversification. The mechanical structure of intelligent warehousing robot requires that goods or shelves can be lifted, handled, rotated and placed independently. A typically application, spiral lifting structure is adopted, shelves can be lifted, goods can be placed by tilting a certain angle, and rotating mechanical structure can adjust the angle and direction, etc. Because the mechanical structure has to carry much heavier goods than itself, the strength of material used in the mechanical structure are required to be higher, and the structural design too.

3) Robot management system. The mainly responsibility management system of the intelligent warehouse robot is responsible for the task allocation, scheduling and operation maintenance of all robots within the control scope with the robot scheduling system(RCS). By establishing the world model of mobile robot, converting the warehouse map into the model data that the robot can recognize, adopting various advanced algorithms, RCS realizes the optimal such as task allocation and optimal path planning. In addition, it also could arrange the intelligent warehousing robot to carry out self-charging, path secondary-planning and so on, so that the system can give full play to its best work efficiency. RCS can monitor the running state of the robot, if the robot fails, the system will automatically generate warning information and corresponding processing opinions [8], which will be sent to the operation and maintenance personnel, so as to achieve intelligent operation, maintenance and real-time feedback [9].

4) AI algorithms. AI algorithm supporting machine learning, in particular deep learning with multi-layer perceptron that is multiple hidden layers structure, which combines low-level features to form more abstract high-level attribute categories or features to discover distributed feature representations of data. With big data it can continuously learn through the learning model established by algorithm, such as convolutional neural networks, deep belief nets and so on, so that the warehouse robot can adapt to the complicated environment to be applied more quickly, so as to reduce the staff's workload of training intelligent decision support system with big data [10].

C Intelligent Logistics System Based on End-to-End

In view of the diversity demand of logistics system's last-kilometer-delivery, intelligent logistics dynamically monitors, manages and optimizes the entire logistics process, and constructs an end-to-end digital supply chain. The focuses of intelligent logistics is providing standardized, integrated and efficient logistics resources integration services for small and medium-sized logistics enterprises, which include express tower, unmanned vehicle, unmanned aerial vehicle integrated terminal unmanned distribution scheme, brush-face pick-up cabinet and novice box express artifacts, so as to provide efficient and high-quality logistics services for shippers (enterprises, institutions, organizations and individuals) and recipients. subverting and rebuilding the entire logistics industry business value chain with internet spirit (equality, openness, collaboration, sharing), so that a complete end-to-end artificial intelligence solutions is formed, so as to improve the survival and growth environment of small and medium-sized logistics enterprises, and build a smart logistics system [11].

III. EXPLORATION AND PROSPECT OF SEVERAL KEY TECHNOLOGIES OF INTELLIGENT WAREHOUSING ROBOT

Intelligent warehousing robots are widely used in logistics platforms. With the rapid development of artificial intelligence technology, natural language processing, machine vision, machine learning and other technologies are becoming more and more mature, and intelligent warehousing robots would gradually affect all aspects of our lives.

1) Warehousing robots are becoming more flexible. With the continuous development and progress of science and technology, warehousing robots are becoming more and more intelligent, in practice warehousing robots would encounter many obstacles and infinite possibilities situations occurring in the process from point A to point B. This requires warehousing robots to accurately handle all kinds of situations, which is the "flexibility" of warehousing robots. Combining with the dispatching system of the Robot Management Center, we try to reduce the dependence on hardware to perceive and deal with all kinds of emergencies, and turn to AI algorithm to "think independently" to solve such emergencies, that is, the warehousing robot is given a "brain" to make them can think independently.

2) Warehousing robot-human interaction is decreasing, and warehousing robot's awareness of the environment is strengthening. At present, warehousing robots mainly rely on machine vision and multi-sensor to perceive the external environment. With the development of vision technology, machine vision can reconstruct 3D images through two-dimensional images, so as to recognize the external environment more effectively, which would improve the maneuverability of the robot. At the same time, warehousing robots may need to handle goods from different floors, which may require the robots could "riding" the elevator, that is, the robot "communicate" with the elevator by transmission of wireless signals, and perceive the external environment, so as to robot could handle goods to the designated floors.

3) Combining Internet of Things and artificial intelligence to achieve high performance storage robots. The three basic abilities of modern logistics warehousing robots are environment perception, decision making and decision execution. The Internet of Things can send big data back to robots, and machine learning with deep learning as the core can make intelligent decisions quickly and accurately based on big data, so robots could implement these decisions. Future high-performance warehousing robot equipment may not only be hardware assembly, but also a combination of Internet of Things, artificial intelligence and other technologies, which allow data to flow freely between carriers, let algorithms combine with system hardware and come to maximize effectiveness [12-13].

4) Diversification of warehousing robots. In the whole logistics system, handling goods from warehouse is only a small part of it. In addition, the selection, sorting and loading of goods need the participation of people or robots. However, different links have different functional requirements for warehousing robots, so the diversification of warehousing robots will also be a major development trend. Diversification also reduces the difficulty and cycle of robot development, and reduces the risk of failure of robot development.

IV. CONCLUSION

Warehousing is one of the links of logistics operation. Intelligent warehousing robots play an important role in the development of intelligent logistics. Therefore, it is necessary to constantly break through new technologies or engage in cross disciplines, and adopt the latest research results, such as machine vision and artificial intelligence, to improve the application of warehousing robots, leading the technological change and development of the whole logistics system. The further research of the subject is to deal with extensive market research, take deep learning as the engine, carry out theoretical research and technological development, to achieve the pioneering application of deep learning in intelligent logistics.

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