



Figure 8 Various performance levels of domestic and foreign industrial robots

4.2 Analysis of the current situation and problems in industrial robot trajectory planning

4.2.1 Analysis of problems in trajectory planning of industrial robots

Route planning is mainly for specific tasks. When there are many different tasks in a factory, a lot of manual route planning is required. Due to partial tolerance, the same task often leads to direction changes, which seriously affects the efficiency of SMEs in using products flexibly. Adaptive intelligent path planning is one of the current path planning problems[14].

Previous research on industrial robot path design based on trajectory planning algorithms and kinematics have focused on the construction of interpolation curves and the application of non-interpolation algorithms. The more interpolated curves (classical and cubic curves), the more difficult it is to find the robot's path during motion to meet the robot's performance requirements, but this is complicated and reduces efficiency. Many scientists have studied higher-order curves. Although the correct flight paths have been obtained, further analysis and research is needed to determine which curve is best suited for different flight paths. Most design paths focus only on local objectives and constraints, such as time, energy, impact, etc., without considering other factors, such as load, deformation, etc. Using the weighted coefficient method to optimize multi-objective metrics based on one objective often leads to the weakening of some objectives and shortening of the actual execution process. For the improved genetic algorithm improves the global search capability and speed, however it cannot meet the requirements of global convergence, accuracy and real-time. These problems affect the efficiency and effectiveness of industrial robots in practical applications.

4.2.2 Prospects of machine path planning algorithms for industrial robots

Hybrid optimal orbits considering time, energy and impact is a subject of research and application in the existing orbit design literature[18]. Most approaches create simplified optimization models of track design based on key factors to find the correct optimal solution. However, practical factors such as robot motor performance (engine speed, torque, load, etc.) should not be ignored in the actual route planning process. Operating conditions (to extend the robot's life in high temperature, low temperature, underwater, etc., often affect the performance of motors, reducers, etc.). To ensure high reliability of the planned flight path, detailed and comprehensive planning must be carried out based on the different tasks, operating conditions and needs of the target audience of the industrial robot. For example, when optimizing route planning when the machine is running at high speeds, it is necessary to keep acceleration strictly at a relatively low level to reduce the maximum load on the engine to reduce the effects of vibration. Under the given actual operating conditions, multi-objective optimized flight path design can ensure the quality of robot work and improve the service life of industrial robots.

Intelligent observation-based autonomous real-time trajectory planning algorithm and kinematics-based path is planning for industrial robots. Flexible production is the trend for SMEs. To perform various tasks (e.g., painting robots and painting different products), tracks must be handled manually several times, which seriously affects work efficiency. On the other hand, even in the same task, industrial robot automation usually has gaps between different workpieces and handles, so the predicted trajectory is slightly different from the actual required trajectory. As machining accumulates, some machining defects can lead to product quality degradation. To adapt to different tasks and different working environments of the same task, autonomous real-time path planning is needed. In recent years, it has been a good method for task detection and path planning due to the rapid development of intelligent detection methods such as image processing and laser. The real-time path planning task of the robot is completed with the help of intelligent detection technology, and the path of the robot is formed according to the established algorithm to realize the real-time autonomous path planning of the robot. The flexibility and anti-interference capability of industrial robots will be improved.

For industrial robots, commuting is only possible as part of a specific plan. A major introduction is usually required before formal work begins. The feasibility of the route is ensured by pre-processing and adjustments are made based on the results of the trials to ensure the reliability of the route. This process not only leads to unemployment but also reduces the efficiency of network design. Although some major robot manufacturers have developed robot modelling software, such as ABB's Robo Studio, it is currently unsuitable for complex trajectory design and relatively weak in intuitive trajectory design. Virtual reality technology provides good technical support for user-friendly interaction and is used in product design,

technical training, and entertainment games. A new path-planning model is proposed. Using virtual reality, users can easily build an industrial robot scheduling simulation platform, perform flight path design in a virtual environment, monitor flight path results and adjust parameters in real-time. Even a virtual reality route planning simulation system can be directly connected to a factory robot for remote control of the robot. This has harmed the trajectory design of industrial robots and has contributed significantly to their development. The program is based on the study of aircraft paths. In recent years, machine learning has been widely used in many fields with the development of artificial intelligence technologies such as machine learning. The algorithm achieves the prediction of unknown data and avoids subjective interference by automatically analyzing samples. Although a lot of work has been done in the construction of curve functions and path-planning algorithms, most of the work has been done by different researchers according to different needs. Optimal route planning has not been analyzed, nor has a complete train planning system been created. On the one hand, a machine learning program can independently learn and support methods for constructing optimal curves, and on the other hand, it can avoid adjusting parameters for human intervention during the solution process. The machine research-based design aims to ensure the generality of the design. Research on route guidance and machine learning has only just begun. The introduction of artificial intelligence techniques such as machine learning has greatly improved the intelligence of route planning. Despite the many successes of industrial robot design methods based on trajectory planning algorithms and kinematics, challenges remain. Since interpolation functions are different from intelligent algorithms, there is no universal path system to meet all job requirements, but they can be selected and designed based on task requirements and the merits of various additive functions and intelligent algorithms. There are still many aspects to be optimized in terms of practicality, real-time, visibility, comfort and objectivity. This paper presents research on intelligent observation, virtual reality flight trajectory and autonomous real-time flight trajectory design based on flight trajectory machines, which have made important contributions to improving flight trajectory design. The wide application of industrial robots provides a good development opportunity and a broad market demand for industrial robot design.

5. Conclusion

The development level of industrial robots based on trajectory planning algorithms and kinematics is getting higher and higher, but the involvement of high-level industrial robots and the research of trajectory planning algorithms in China is limited. With the development of Chinese industry, the manufacturing industry is changing from traditional manufacturing to intelligent manufacturing. Industrial robots have become an

important tool for "smart manufacturing" and an important strategic emerging industry to improve the adaptability and competitiveness of industrial markets. Innovation is the first driving force of industrial development. The innovation potential of the industrial robotics industry can reflect the competitiveness and sustainability of the industry. Innovation mainly includes knowledge innovation and technological innovation. In the current study, information innovation is an attribute of thesis data and technological innovation is based on patent data. Industrial robots have a high level of capability and high-density technology. Therefore, knowledge and technological innovation are very active in this field. The development of the manufacturing industry in China is facing the problem of labour shortage. An effective way to solve this problem is to innovate, renew and modernize the manufacturing industry. Since the reform and opening up, China's manufacturing industry has made significant progress in industrial production in terms of machinery, standardization, automation and information technology, but at the cost of cheap labour, a huge consumer market and national policy orientation. At the same time, compared with Western industrialized countries such as Japan, Germany and the United States, China's manufacturing industry as a whole is large but not strong, which is mainly reflected in the fact that the development of nuclear technology has not yet begun and manufacturing enterprises do not have the ability of independent innovation. Therefore, this paper delves into the mechanical design method and joint simulation analysis of industrial robots based on trajectory planning algorithms and kinematics.

6. Acknowledgements

Tianshi College -"Electronic technology practice" quality course construction-JP20150005

References

- [1] Ahanda Joseph Jean-Baptiste Mvogo,Aba Charles Medzo,Melingui Achile,Zobo Bernard Essimbi,Merzouki Rochdi. Task-space control for industrial robot manipulators with unknown inner loop control architecture. *Journal of the Franklin Institute*,2022,359(12).
- [2] Liu Ying, Kukkar Ashima,Shah Mohd Asif. Study of industrial interactive design system based on virtual reality teaching technology in industrial robot. *Paladyn, Journal of Behavioral Robotics*,2022,13(1).
- [3] Le PhuNguyen,Kang HeeJun. A New Manipulator Calibration Method for the Identification of Kinematic and Compliance Errors Using Optimal Pose Selection. *Applied Sciences*,2022,12(11).
- [4] Liu Huan,Lei Yaguo,Yang Xiao,Song Wenlei,Cao Junyi. Deflection estimation of industrial robots with flexible joints. *Fundamental Research*,2022,2(3).
- [5] Kim MinGyu,Kim Juhyun,Chung Seong Youb,Jin Maolin,Hwang Myun Joong. Robot-Based Automation for Upper and Sole Manufacturing in Shoe Production. *Machines*,2022,10(4).
- [6] Izadbakhsh Alireza,Kalat Ali Akbarzadeh,Nikdel Nazila. FAT-based robust adaptive controller design for electrically direct-driven robots using Phillips q-Bernstein operators. *Robotica*,2022,40(10).
- [7] Solanes J. Ernesto,Muñoz Benavent Pau,Armesto Leopoldo,Gracia Luis,Tornero Josep. Generalization of

- reference filtering control strategy for 2D/3D visual feedback control of industrial robot manipulators. *International Journal of Computer Integrated Manufacturing*,2022,35(3).
- [8] Moraitis Michail,Vaiopoulos Konstantinos,Balafoutis Athanasios T.. Design and Implementation of an Urban Farming Robot. *Micromachines*,2022,13(2).
- [9] Ditzler Lenora,Driessen Clemens. Automating Agroecology: How to Design a Farming Robot Without a Monocultural Mindset?. *Journal of Agricultural and Environmental Ethics*,2022,35(1).
- [10] Skrzek Murillo,da Silva Leandro L.,Szejka Anderson L.. Towards a smart reconfiguration process for complex product manufacturing based on industrial robot cells. *IFAC PapersOnLine*,2022,55(2).
- [11] Borowski Karol,Wojtulewicz Andrzej. Implementation of Robotic Kinematics Algorithm for Industrial Robot Model Using Microcontrollers. *IFAC PapersOnLine*,2022,55(4).
- [12] Gu Su,Hu Kang,Liu Lanlan,Li Zhihui,Chen Zhiio,Qiao Mingming,Jiang Wei. Design and Application of Single-Arm Live Working Robot System on Transmission Line. *Journal of Physics: Conference Series*,2022,2166(1).
- [13] Zou Dehua,Fan Shaosheng,Peng Shasha,Liu Lanlan,Jiang Zhipeng,Jiang Wei. Design and Research on the Automatic Online and Offline System of Live Working Robot on Transmission Lines. *Journal of Physics: Conference Series*,2022,2166(1).
- [14] Mingkang. An Investigation on the Grasping Position Optimization-Based Control for Industrial Soft Robot Manipulator. *Machines*,2021,9(12).
- [15] Rathore Rahul,Kahn L.E.,Lum P.S.,Rymer W.Z.,Reinkensmeyer D.J.,Moran M.E.,Kopacek P.,Reinkensmeyer D.J.,Emken J.L.,Cramer S.C.,G.K.. The application of the robot for the coffee manufacturer. *Asian Journal of Research in Social Sciences and Humanities*,2021,11(12).
- [16] Jin Yucheng,Liu Jizhan,Wang Xiuhong,Li Pingping,Wang Jizhang. Technology Recommendations for an Innovative Agricultural Robot Design Based on Technology Knowledge Graphs. *Processes*,2021,9(11).
- [17] Hassan M A S M,Shahriman A B,Razlan Z M,Kamarrudin N S,Hashim M S M,Khairunizam W K N,Harun A,Ibrahim I,Faizi M K,Fadzilla M A,Rahman M F A,Hamid N M F N A,Manaf A A,Rani M F H. Investigating and improving Boeing aircraft composite panel industrial painting issues by designing smart robotic precision painting system. *Journal of Physics: Conference Series*,2021,2051(1).
- [18] Rocha Filipe,Garcia Gabriel,Pereira Raphael F. S.,Faria Henrique D.,Silva Thales H.,Andrade Ricardo H. R.,Barbosa Evelyn S.,Almeida André,Cruz Emanuel,Andrade Wagner,Serrantola Wenderson G.,Moura Luiz,Azpúrua Héctor,Franca André,Pessin Gustavo,Freitas Gustavo M.,Costa Ramon R.,Lizarralde Fernando. ROSI: A Robotic System for Harsh Outdoor Industrial Inspection - System Design and Applications. *Journal of Intelligent and Robotic Systems*,2021,103(2).
- [19] Guerra Zubiaga David A.,Luong Kimberly Y.. Energy consumption parameter analysis of industrial robots using design of experiment methodology. *International Journal of Sustainable Engineering*,2021,14(5).
- [20] Zhang Bei. Design of VR application in detection line based on industrial robot for optical routers. *Journal of Physics: Conference Series*,2021,2024(1).