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Study on Optimization of Grasping and Releasing Strategy of Delta Robot Based on Midline Selection Algorithm

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ABSTRACT

Aiming at the common grasping and releasing efficiency problems of delta robots in practical production, this paper optimizes the algorithm according to the characteristics of the end effector of parallel robots, and puts forward an innovative optimization strategy. Processing the target workpiece obtained from the camera using Visual Studio to obtain the coordinates of the workpiece center position in the pixel coordinate system and proposing an optimization algorithm for selecting the centerline based on the maximum interval algorithm. Obtaining the centerline position through optimization algorithms, the robot's pick-and-place path is planned accordingly, and the centerline selection algorithm is validated using MATLAB. The results showed that compared to traditional single-handed grabbing and dual-handed grabbing, the optimized grasping and releasing method based on this algorithm can increase efficiency to 80 per minute, greatly improving the efficiency of the robot's grasping and releasing, proving the algorithm's high practicality and speed.

KEYWORDS

Maximization Algorithm, Machine Vision

INTRODUCTION

Parallel robots are closely related to our production and life, and are widely used in industrial production (Hägele et al., 2016). It is widely used in food, medicine, electronics, and other light industries and has unparalleled advantages in material handling, packaging, and sorting. Parallel robots really attracted widespread attention in the 1990s, and they have the advantages of high rigidity, high speed, high precision, strong bearing capacity, and high repeatability precision. Together with serial robots, it constitutes an important part of industrial robots (Licardo et al., 2024). Therefore, it is widely used in packaging, sorting, and precision assembly processes (Pham & Ahn, 2021). In the last two years, with the increasing application of parallel robots in the market, it has become a new force for the growth of industrial robots.

In 1931, Gwinnett put forward an entertainment device based on spherical parallel mechanism in his patent (Singh et al., 2022). In 1940, Pollard put forward a space industry parallel mechanism in his patent, which was used for painting automobiles (Keisner et al., 2016). In 1965, Stewart

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first studied this mechanism invented by Gough in the sense of mechanism and extended it to the motion generating device of a flight simulator. This mechanism is also the most widely used parallel mechanism at present, and it is called Gough-Stewart mechanism or Stewart mechanism (Wei et al., 2022). In 1978, Mccallino and others designed a parallel robot for the first time to complete the calibration task in a precision device under the control of a small computer, which really kicked off the research on parallel robots (Silva et al., 2022). Since the late 1980s and 1990s, parallel robot talents have attracted extensive attention.

In China, Professor Huang Zhen of Yanshan University developed the first 6-DOF(Six Degrees of Freedom) parallel robot prototype in China in 1991 (Huang et al., 2012). In 1997, Versatile And Multi-Tasking Industrial Ystem, a large-scale parallel prototype of boring machine, was jointly developed by Tsinghua University and Tianjin University (Guan et al., 2003). In 1999, Tianjin University and Tianjin No.1 Machine Tool General Factory jointly developed a commercial prototype of a three-coordinate parallel machine tool, Linear Integrated Actuated Parallel Operating Device, and Harbin Institute of Technology also developed a prototype of a six-degree-of-freedom parallel machine tool (Ni et al., 2022). The research on parallel robots in China started late, and there is still a gap in technology compared with foreign countries. However, after the development in recent years, the application level of domestic parallel robots is increasing, and it is gradually recognized and used by enterprises.

In the parallel robot mechanism system, there are many kinds of mechanisms, which can be divided into 2-DOF parallel mechanism, 3-DOF parallel mechanism, 4-DOF parallel mechanism, 5-DOF parallel mechanism and 6-DOF parallel mechanism according to the degree of freedom (Chu et al., 2022). The delta robot is a spatial 3-DOF parallel mechanism. The delta robot is a high-speed, light-load parallel robot. Generally, the target object is captured by teaching programming or vision system, and the spatial position of the gripper center is determined by three parallel servo axes, so as to realize the transportation and processing of the target object (Hmadi, 2021; Portillo-Vélez et al., 2022). The delta robot is a typical spatial three-degree-of-freedom parallel mechanism. Its overall structure is precise and compact, and its driving parts are uniformly distributed on a fixed platform (Kim et al., 2022). It has the following characteristics: strong bearing capacity, high rigidity, low dead weight-load ratio and good dynamic performance, parallel three-degree-of-freedom mechanical arm structure, high repetitive positioning accuracy, and the ability to pick up items at ultra-high speed and shoot more times per second (Romanishin, 2024).

The delta robot is widely used in the market because of its light weight, small size, fast movement, accurate positioning, low cost, and high efficiency. Delta robots are mainly used in the processing and assembly of food, medicine, and electronic products (Vasques & Figueiredo, 2021). The existing control algorithms are more based on kinematics control, in order to ensure that the robot has good dynamic quality when running at high altitude. The grasping efficiency of the optimized control method has been improved, but the real-time performance and efficiency still need to be further improved.

Based on the inherent characteristics of parallel robots, optimizing the grasping and releasing paths and reducing unnecessary working time will greatly improve industrial production efficiency. Machine vision can rapidly acquire a large amount of information and automatically process it. Using machine vision methods for detection can greatly improve production efficiency and automation level. By establishing external communication between the camera industrial PC and the robot controller, the robot can track and grasp/release the target workpiece by processing the real-time position sent by the camera. The camera's photo shooting frequency, the processing time of the industrial control computer software, the external environment, and the grasping and releasing paths of the robot will all affect the production efficiency of the sorting system, which requires further optimization (Liu, 2022).

This article focuses on the delta robot, proposing an optimization method for grasping and releasing based on its end effector characteristics. The method aims to increase the number of items grasped and released in a single operation. By using the real-time position of workpieces captured by a camera, a clustering algorithm based on interval maximization is employed to select the optimal