Automatic Grinding Difficulties Analysis and Solutions for Dynamic Arm Plate (Movable Arm Plate, Boom Plate)

Wenjun Li
Dalian YuYang Industrial Intelligence Co, Ltd., No.3 Yinggang Road, Shagangzi Village Street, Ganjingzi District, Dalian, Liaoning Province, China
*Corresponding address: e-mail: lidantong@kinhanyan.com

Abstract: As the castings with multiple varieties and specifications, as well as the inconsistencies, it is difficult for the dynamic arm plate to achieve automatic grinding. There are over a hundred different types of castings, and each type of casting undergoes flame and plasma cutting to produce different sizes of deformation, resulting in significant changes in appearance. The traditional automatic fettling method requires continuous programming adjustment and different fixture designs according to the different models of products and the same model of products with different shape variables, which is an extremely huge workload, nearly impossible to complete. Therefore, the traditional automatic grinding method cannot achieve continuous production of dynamic arm plate.

Keywords: dynamic arm plate (movable arm plate, boom plate); automatic grinding; AI learning; mathematical model; castings with multiple varieties and specifications; large deviation of dimensions

1 Automatic grinding difficulties analysis for dynamic arm plate

Engineering machinery castings, especially dynamic arm plates, are characterized by strong rigidity and high hardness. After mixed-line production, there are more than a hundred models, each of which is subject to different dimensional deformations after thermal cutting by flame, plasma and so on.

For example, the deformation generated by overheating processing is not only a variation of 2-4 mm in the product size itself, but also the thermal warping deformation caused by heat in different parts of the steel plate. This thermal deformation is irregular and most of the deformation is between 5-15 mm, with some even reaching 20 mm, and the shape of the casting is extremely variable.

In this situation, how to realize automatic grinding of dynamic arm plate has been a challenge for the whole industry, including common issues of tooling and fixture, massive manual programming problem, high precision issues of chamfering and grinding, and so on.

2 Automatic grinding solutions for dynamic arm plate

2.1 AI automatic recognition of workpiece size

There are significant differences in the size of each model of the dynamic arm plate, especially in length. After thermal cutting, the workpiece of each model will generate significant deformation, which puts forward higher difficulties for the design of fixtures and the positioning and gripping of loading. The working principle of tooling and fixtures is to find a suitable position firstly to push the workpiece to ensure its orientation and position dimensions, and the second step is to select a suitable position to tighten the workpiece so that it will not move during the grinding process.

Due to the wide variety of workpieces, the above two points need to be completed through AI intelligent recognition. The positioning mechanism and fastening mechanism used for large and small workpieces are different, therefore, during the loading process, the 3D vision system scans and identifies the specific model of the workpiece, and the AI mathematical model will call out the matching tooling mechanism to complete the positioning and fastening of the workpiece through self-learning and calculation. This requires the design of tooling to meet all workpiece types, but also to solve the interference and influence of different size workpieces on the same fixture.

2.2 3D scanning to avoid manual programming

In the process of workpiece size detection, there is a significant difference between the actual workpiece shape position and the theoretical size, which is one of the important issues affecting the grinding quality. The traditional automatic fettling method requires continuous shutdown programming and adjustment based on different models of products and different deformation variables of the same model of product, which is a huge workload that is almost impossible to complete, so the traditional automatic grinding method cannot realize continuous production of dynamic arm plate.

3D scanning automatic grinding technology breaks through traditional visual technology, each contour including 3200 data points will be scanned through 3D laser, which can quickly and accurately have production point cloud data for the scanned object. The data will be converted into robot coordinates, which are then converted into grinding trajectories, that is, automatic production grinding program.

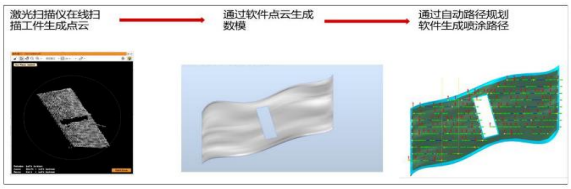

Fig. 1

By collecting drawing data to understand the shape, size, grinding position, and process of the dynamic arm plate, and design the underlying software that meets the processing technology. The scanning parameters are set through a customized software system and based on the actual situation of the workpiece, and input the required types and quantities of toolings into the software in advance for use in subsequent program generation. The visual system (customized software) will generate mathematical models through software to automatically calculate the trajectory points of the robot, convert them into recognizable data, and send to the robot.

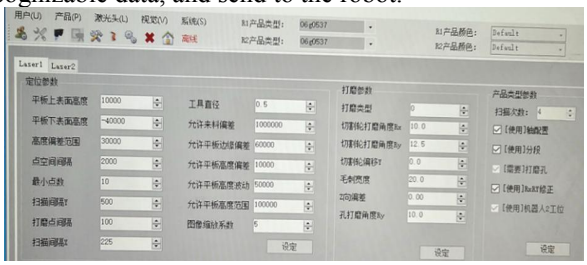

Fig. 2

When a new workpiece enters the grinding area, the system gives a command to the robot to start executing the scanning command. Scanning can finally give two modules, one is the robot point position, the other is the path module, through the visual module, the two modules will be transformed into the final grinding trajectory. The trajectory is given by the software, and the automatic grinding function is realized after simple input of processing parameters. Not only can the trajectory be automatically produced, but robot can also achieve automatic tool changing to meet the requirements of processing technology. After completing the above, the automatic grinding program can be produced such as similar parts are only slightly different in size, the above parameters can be directly copied.

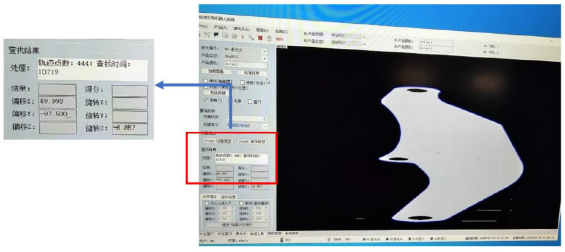

Fig. 3

2.3 Real time force control system ensures the accuracy of chamfering and grinding

During the whole grinding process, strict grinding accuracy control to the dynamic arm plate is required, especially the chamfering of the workpiece. The traditional grinding method adopts airbag and spring type, both of which are not precise enough in controlling the grinding force. When the spindle changes orientation, it is greatly affected by gravity, for example, the spring type of grinding, which is unable to make corresponding adjustments to the force according to different grinding positions and the amount of grinding, and thus fail to satisfy the requirement of high-precision fettling of chamfering.

For the dynamic arm plate grinding, it adopts 3D scanning, and add real-time force control system at the same time, to achieve flexible grinding by detecting and controlling the grinding force. The real-time force control system can control the different grinding forces required by the spindle in all directions and angles to ensure a constant output effect. No matter what tools the robot uses or what position angle the spindle is placed at, the system can accurately calculate the designed grinding force through real-time force control and maintain it in this state to meet grinding quality requirements.

3 Conclusion

From the above, it can be seen that the successful application of the dynamic arm plate grinding technology has overcome many difficulties encountered in the actual production of engineering machinery castings in the field of post-casting fettling, such as a variety of types, models, and large deviations in the external dimensions. It has filled the gap in the AI self-learning system for building mathematical models in the subdivision field of post casting fettling, and achieved full automatic programming of 3D scanning for casting grinding technology. With the continuous development of science and technology, the research on the grinding of such castings will certainly have new breakthroughs. The continuous improvement of grinding technology will also enhance our manufacturing production level.