Proceedings of the 72nd World Foundry Congress
21-25th May 2016, Nagoya, Japan

Robotic Applications of Foundry Industry in China

Yang Yang[1,2], Yongquan Zheng[1,2], Yan Xu[1,2], Mo Yang[1], Boyang Lu[1], Fenfen Liu[1]
[1] Chaint Robotics Co., Ltd. China, 410717
[2] Hunan Province Industry Robots Demonstration Base, China, 410717

Abstract: For decreasing the labor intensity and producing higher quality products ultimately, a proposal has been raised for an industrial robotic casting solutions. The industrial robotic casting production process plans to include molding, post processing and cold-working. With the help of robots, firstly the molding stage implements intelligent sand core processing. Then, the post processing stage implements intelligent rough casting finishing. Finally, the cold working stage realizes intelligent casting deburring, chamfering, cleaning and blowing by robots. The rich experience and successful applications have testified a promising future for foundry industry with a full combination of robotic, automation and information technology.

Keywords: *Industrial robots, Foundry, Intelligent equipment*

1. Introduction

Foundry industry, the cornerstone of automobile, oil, steel, electric, vessel and textile etc., is of critical importance. Since year 2000, the casting production in China has become the first place in the world [1]. Nevertheless, the domestic foundry industry still experiences the low level of relative technology and product quality which have been improved in developed countries to some extent [2]. Furthermore, the demographic dividend is near to being cashed out, which increases the labor risk in foundry corporations. Consequently, the traditional method "poor efficiency and dirty work environment" seems to be unable to meet the recent requirements. It is urgent indeed to construct a modern casting production line with high efficiency and environment friendly [3,4]. This paper will focus on the research about how to implement robotic technologies into full processes of casting production.

2. Robots utilized in casting production processes

The whole casting production process can be re-planned into molding, post processing and cold working stages. The rich robots application experience as the following description fully indicates the success on solving the aforementioned problems.

2.1 Molding stage

In the molding stage, the sand core intelligent processing (including sand core transport, setting, assembling, dip-coating, deburring and mold separation) can be implemented with the help of industrial robots. The key technologies include the following points:

1) Dynamic Finite Element Analysis. The optimized clamping position and force could be calculated and it fulfils some goals like more accurate clamping, sand core protection and higher precision of core-assembly.
2) 3D laser vision technology. Non-contact sand core recognition, measurement and positioning can be achieved, which increases the system flexibility and ultimately reduces the relative cost as well. Meanwhile, it also effectively combat the precision problem caused by mechanical wear.
3) High flexible clamp helps fulfil the requirement of multi-type production.

Figure 1 shows the sandcore dip-coating in rail industry (left) and the sandcore transportation in automobile industry (right) with the help of industrial robots.

Fig. 1 Robots used in rail and automobile industry

2.2 Post processing stage

The intelligent rough casting finishing (including casting finishing, polishing, transport and stacking) is implemented in post processing stage. The key technologies contain:

1) Error Detection and Robot Path Correcting

System (EDRC), which will help implement automatic finishing under casting and clamping deviation.

2) Feedback and alarming system, which will help robots implement automatic and safety work with uncertain and different casting characteristics, in order to prevent some serious accidents and protect devices.
3) Offline programming technology based on expertise experience database. This technic guarantees the fitting precision and decreases labor hours [5]. Meanwhile, the advance simulation and optimization avoid some serious risks, the engineering change can be designed off line, which reduces rework hours and decreases negative effects.

The post processing technologies have been utilized successfully in automobile, rail and aerospace area. For instance, one automobile plant had a 1.5 times increase in the production ability and the number of workers decreased from 62 to 20.

Fig. 2 Robots used for the post processing

Figure 2 represents the overall layout of the intelligent rough cylinder finishing unit (left) and specialized robots arranged inside this unit (right), these robots will carry proper tools to implement rough casting finishing.

Especially, these research results had been awarded in 2014"IERA AWARD" and collected as a part of "2014 Chinese High-tech results" in 2014 by the Chinese Academy of Engineering.

2.3 Cold-working stage

In cold-working stage, it is mainly to complete some intelligent procedures including the casting deburring, chamfering, cleaning, blowing and so on, which realizes the intelligent seamless interfaces. The key technologies include:

1) The robotic casting deburring and chamfering. The high flexibility of robot can adapt to complex multi-type casting, break the bottleneck while the traditional pattern is difficult to achieve.
2) The robotic casting cleaning and blowing effectively combat some key problems, e.g. Cleaning indicators are extremely difficult to reach the standard where usually occurs in the internal cavity of the workpiece, voids, corners and so on. Compared to traditional washing machine, the flexibility and efficiency of the system has been increased.

Figure 3 shows the industrial robots implemented for the cold-working stage like crankshaft deburring, chamfering (left) and ship motor cylinder washing (right).

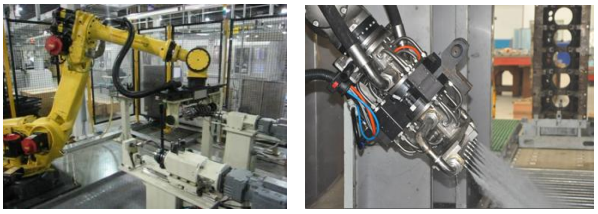

Fig. 3 Robots used for the cold-working stage

3. Conclusion

In traditional casting processing model, there are many problems like safety, health, harmful dust and low work accuracy. In order to guarantee the high product quality, the industrial robot is the best choice due to flexible procedures for multi-type castings, and meanwhile the industrial robot can perform jobs that might be hazardous to implement or be difficult to keep high accuracy. Recently, robotic and automation become a definite trend especially in automotive industry. In addition, the industrial robot can be much smarter by combining with internet of things, big data, cloud computing and mobile internet etc., which could promote the development of smart foundry industry in terms of intelligent casting and green foundry eventually.

References

[1] W. P. Chen, J. Luo, Y. Y. Li: *Net Shape Casting Technology and The Energy Conservation and Emissions Reduction*, (Week Proceedings of 2009 China casting activities, 2009).

[2] H. Liu, P. Xu: *Robots applied in casting production*,(24th Annual casting congress of Chongqing, China, Feb. 2014).

[3] X. L. Liu:*The Modern Casting Cleaning Method*, (Foundry Equipment and Technology,2011)pp. 6-7.

[4] X. X. Zhang:*Industrial robots application in foundry industry* ,(Machinist Metal Forming,2014)pp. 18-21.

[5] R. Zheng: *Robot Offline Programming System Design and Research*,(World Manufacturing Engineering & Market,2010)pp. 90-92.