Welding scheme design of wheat harvester chassis frame based on welding robot

Shuqiang Xu[1], Shukun Cao[1*], Kuizeng Gao[2] and Wenlong Cao[2]

[1]School of mechanical engineering, University of Jinan, Jinan, Shandong, 250022, China

[2]Shandong juming machinery co. LTD, Zibo, Shandong, 256400, China

[*]Corresponding author's e-mail: caoshukun@126. com

Abstract. In recent years, the welding technology is more and more widely used in agricultural machinery. The traditional manual welding can not meet the market competition. The chassis frame of wheat harvester is a large-scale structure composed of many kinds of welding parts. At present, the agricultural machinery production enterprises adopt the way of manual welding. Aiming at the problems of manual welding quality of the wheat harvester chassis frame is difficult to guarantee, low production efficiency and high labor intensity, this paper designs an automatic welding scheme for the wheat harvester chassis frame.

1. Introduction

With the rapid development and maturity of harvesting machinery in China, customers have higher and higher requirements on the appearance and internal quality of products. Harvester chassis frame is the most important part affecting the safety performance of harvester. If the chassis frame has quality problems, it will cause significant loss to the safety of life and property of users [1].

In the past, the traditional harvester chassis frame was welded manually during production and processing. There are five disadvantages in manual welding: ① welding voltage, current, welding speed, wire extension length and other parameters are variable, so it is difficult to achieve consistency in safety performance of all parts of chassis frame. ② the operating environment of the welding workers is relatively poor, and there are hazards such as welding arc, welding dust, manganese poisoning and metal splashing. ③ the productivity is low, operators are easy to fatigue, and it is difficult to maintain the stability and consistency of welding work for a long time. ④ the manufacturing cycle of the product is uncontrollable, which is greatly affected by the operator's mood and physical condition. ⑤ welding quality is highly dependent on the skill, technology and experience of operators[2].

Robot welding instead of manual welding is the development trend of harvester chassis frame production and processing. Based on the current welding technology of wheat harvester chassis frame, this paper designs the welding scheme of wheat harvester chassis frame based on welding robot workstation.

2. Chassis frame welding scheme design

At present, the welding scheme of chassis frame is manual assembly before manual welding. The assembly is to erect the header support and rear axle pipe beam on two small tooling, and finally assemble the chassis frame on a large tooling; the welding is to erect the chassis frame on the side, weld the front part first, then the middle part, then the back part, and finally the other side of the part. The chassis frame structure is shown in Figure 1.

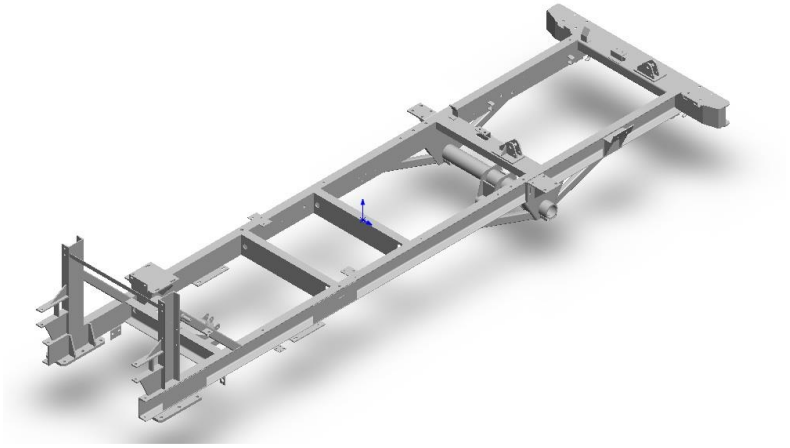


Figure 1. Structure of wheat harvester chassis frame

2.1. Welding process analysis of chassis frame

(1) Description of welding workpiece

The welding object is the chassis frame of wheat harvester, its overall dimension is 5035mm×1580mm×1190mm, the main material is Q235A, and the gross weight of workpiece is 471kg.

(2) Welding process

Before robot welding, the workpiece shall be manually assembled, fixed and welded, and the spot welding position shall be manually polished, and then the workpiece shall be manually clamped on the positioner of robot workstation. After the worker presses the appointment button of workstation robot, the robot holds the welding gun to the weld seam and starts welding; with the cooperation of the contact sensor system, the starting point of the weld is determined first, and the robot calculates the trajectory deviation and then starts welding to ensure the best welding quality. After welding, the workers unload the workpiece; then install the workpiece on the tooling to position and clamp; press the appointment button; the workstation enters the cycle work.

MAG single layer single pass welding is adopted, the shielding gas is argon rich mixed gas (80% Ar + 20% CO2), the welding wire is 1. 2mm solid core welding wire (barreled), the power supply voltage is 380V/220V±10%50Hz, the compressed air source is 0. 5~0. 7mpa, and the service temperature is 5℃-45℃.

2.2. Construction and application of welding robot workstation

In view of the existing problems of manual welding, this paper designs and applies a set of chassis frame welding robot workstation. The overall design principle is to ensure the welding quality of chassis frame, strive to make the chassis frame similar to each other in safety performance; reduce labor intensity of workers; improve production efficiency and ensure production cycle. The layout of welding robot workstation is shown in Figure 2.

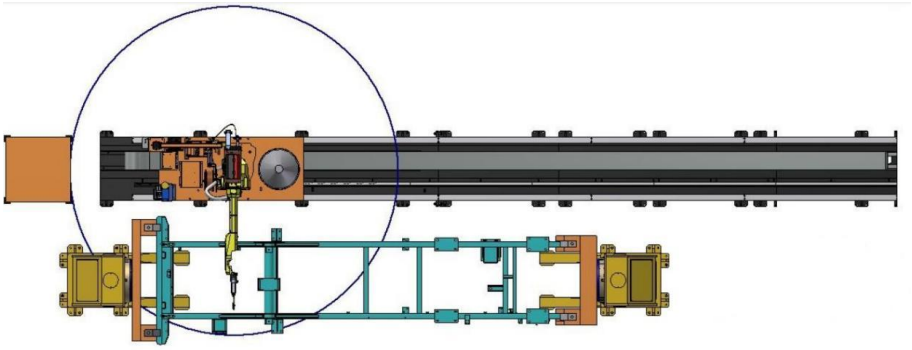


Figure 2. Chassis frame welding robot workstation

The welding robot workstation consists of a FANUC industrial robot system M-10iA 8L, a meggitt artsen PM500 II pulse welding power supply, a heavy load external axis welding positioner, a light load external axis welding positioner, a TBI water-cooled welding gun, a robot external axis walking mechanism, a TBI automatic gun cleaner and a PLC control system.

2.2.1. Design of robot walking mechanism

The external axis of the robot drives the walking, which can be programmed freely, and can be combined with the robot system for trajectory interpolation; the servo motor of the walking mechanism uses the FANUC brand, which can coordinate communication with the robot, and the walking speed and acceleration can be adjusted to ensure that the mechanism is stable and does not shake when walking; the reducer of the walking mechanism uses the imported brand to ensure the walking accuracy; the effective travel meets the workpiece welding According to the requirements, the fixed dust cover is used for the track, which has low failure rate and is not easy to be damaged; the robot body walking track has the maintenance free function, and each lubrication point of the track belongs to the centralized lubrication mode, and the robot walking mechanism is shown in Figure 3.

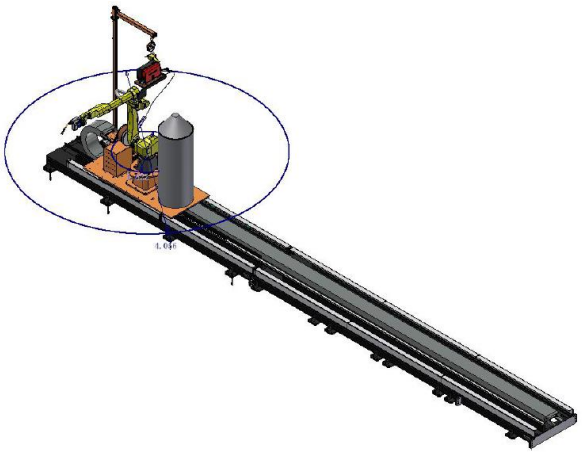


Figure 3. Walking mechanism of chassis frame welding robot

Technical parameters of the walking mechanism:①X-axis travel: 7000mm; ②rated travel speed of X axis: 623mm / S;③X-axis rated output torque: 134. 4n·m;④repeated positioning accuracy:±0. 1mm.

2.2.2. Design scheme of external shaft positioner

The positioner is driven and rotated by the external axis motor of FANUC, which is freely programmable and can be combined with the robot system for trajectory interpolation; after the positioner is installed with the largest workpiece, it is turned to the largest eccentricity, and the largest eccentricity is redundant enough to avoid the phenomenon of self turning after locking, abnormal

noise and vibration during turning, and the safety factor is greater than 1. 5 times; the rated load of each axis of the positioner is linked During full speed operation, there is no stagnation, vibration, wriggling and channeling, no abnormal sound and no abnormal heat. The positioner is shown in Figure 4 [3].

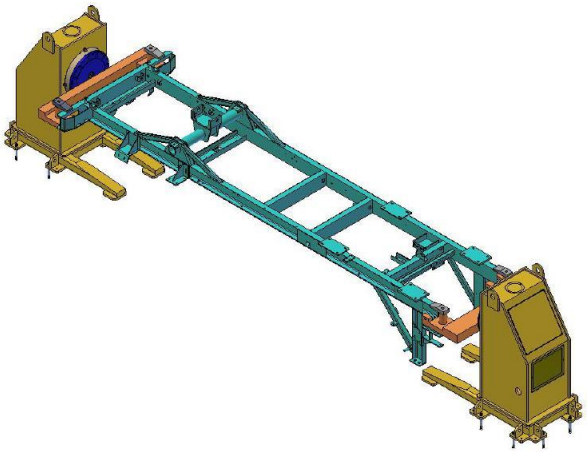


Figure 4. Positioner

Technical parameters of the positioner:①rotation angle: -180 °~180 °;②rotation speed: 2rpm;③ maximum eccentricity: 200mm;④rated load: 1000kg;⑤maximum eccentricity: 200mm.

2.2.3. Fixture design

The welding fixture is a manual fixture, which is fast and reliable in positioning and clamping. When the positioner is rotating, ensure that the workpiece does not loose or slide. The loading and unloading time of the workpiece is ≤ 25 min. Under the premise of ensuring the strength, it is designed as a fast loading and unloading mode, and the shielding of welding position is reduced. The design of welding fixture should be modularized and standardized as much as possible. The integrated base should be used to ensure the relative position stability of each unit. Considering the expansion ability of the workstation, bolts are used to fasten between the fixture and the flange of the robot positioner, between the mounting base and the base plate, and positioning pins are used for positioning, so as to ensure the accurate positioning of the whole system in the process of fixture replacement. The fixture adopts the frame engine base as the positioning point and the longitudinal beam as the pressing point. Increase the support hold down point at a proper position to control the welding deformation of the frame.

2.2.4. Main functions

(1) Intelligent positioning function: the real weld position can be determined by touching the workpiece with nozzle or welding wire, and the positioning accuracy is ± 0. 25 mm [4];

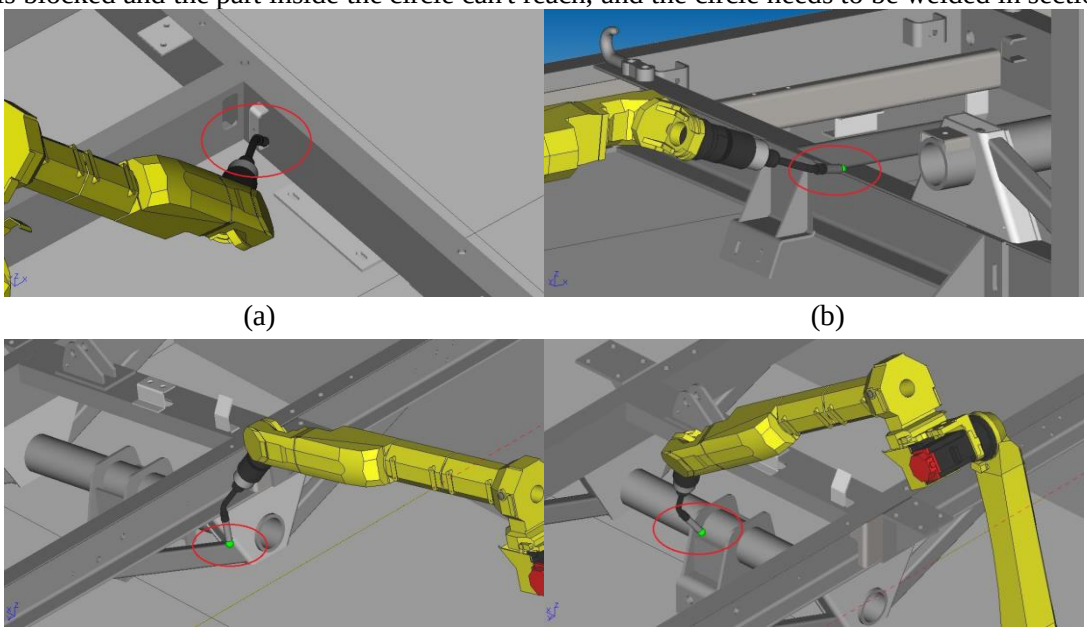
(2) Function of silicon oil spray for cleaning gun, cutting wire and spraying: the silicon oil spray device is designed in the same position, and the robot can complete the process of silicon oil spray and cleaning gun with only one action. The silicon oil device adopts double nozzle cross spray, so that the silicon oil can better reach the inner surface of the welding gun nozzle, and ensure that the welding slag and nozzle will not cause life and death adhesion;

(3) Automatic recovery function of temporary stop point and power-off: in case of arc abnormality, power-off and temporary stop during welding, after removing the error factors or temporary stop reasons, call the command when starting again, and automatically recover from any position to the arc cut-off position. At the same time, it can also set the offset for the arc cut-off position (welding line based on the arc cut-off position Direction translation), you can specify the overlap of the weld and the rest of the weld [5];

2.2.5. Weldability

After calculation, the total weld length of harvester chassis frame is 40125 mm, the applicable weld length of robot is 34129 mm, the amount of molten metal welded by robot is 9. 56 kg, the welding time is 120 min, and the welding rate of robot workstation (accounting for the total weld length) is 85. 1%. Manual repair welding shall be adopted for welds that cannot be welded by robot.

The parts that the robot can't reach are shown in Fig. 5, mainly including the following situations: the inner weld in Fig. 5(a), the welding gun can't reach in; the weld angle in Fig. 5(b) is too small, the welding gun can't reach down; the weld in Fig. 5(c) is blocked and can't reach; the welding gun in Fig. 5(d) is blocked and the part inside the circle can't reach, and the circle needs to be welded in sections.



(a) (b)

(c) (d)

Figure 5. Several kinds of parts no welding

2.3. Economy

In the process of building robot welding workstation, there are some problems, such as high welding rate and large increase of searching time. The highest weldability of the robot workstation to the chassis frame is 93%, but the positioning time of some short welds and some parts (such as rib plate) with low position accuracy requirements is much longer than the welding time, which greatly increases the production cycle of the chassis frame.

In order to shorten the production cycle, the weldability of chassis frame is reduced to 85. 1% by robot workstation, and manual repair welding is used for some short welds and parts with low position accuracy requirements. In order to further reduce the locating time, improve the blanking accuracy, achieve the same positioning mode of assembly fixture and welding fixture, reduce the number of welds to be located, and improve the economy of robot workstation.

3. Conclusion

The welding scheme of wheat harvester chassis frame designed in this paper can guarantee the welding quality, reduce the labor intensity and improve the working conditions of workers, improve the productivity, guarantee the production cycle and accelerate the development cycle of new products by using the welding robot workstation. The digital manufacturing and automatic production line of harvester chassis frame is the integration of welding technology, information technology, intelligent control technology and robot technology. Its many advantages will promote its application in the

harvester industry. Intelligent and digital welding technology will further promote the rapid development of manufacturing technology.

References

[1] Wang Yuejuan, Lin Yihui, Xu Junsheng. Research and development of robot welding workstation [J]. Tractor and agricultural transport vehicle, 2019, 46 (01): 41-44.
[2] Wang Decheng, Gao Lin, Zhang Daqun, Li dengkun. Design of robot welding workstation for wheat harvester chassis frame [J]. Agricultural engineering, 2015, 5 (03): 77-79.
[3] Xu Wenqing. Design of positioner in robot welding system [J]. Welding technology, 2004, 33 (3): 44-45.
[4] Lu Xueqin, Zhang Ke, Wu Yixiong. Weld tracking control based on the dynamics of mobile welding robot [J]. Journal of welding, 2013, 34 (10): 13-16.
[5] Deng Haipeng. Integration and application of intelligent manufacturing and robot welding technology [J]. Electromechanical information, 2018 (18): 105-106.