IOP Conf. Series: Materials Science and Engineering **394** (2018) 042070 doi:10.1088/1757-899X/394/4/042070

The Intelligent Flexible Welding System for Robot Based on Double Station

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Abstract. In order to improve the production efficiency and reduce the cost of enterprise and promote the enterprise safety production. This paper presents an intelligent robot welding system which based on double station. It solves welding matched problems of different water main and different distributed water pipe for enterprise. Due to adopt the technology which simultaneous welding on both sides of the main pipe with double station. The influence of heat expansion on welding deformity of the main pipe is greatly reduced during the welding process. The motion control of whole set of intelligent welding control system consists of three parts. The motion control system for charging of the branch pipe and the control system of main water pipe and the robot welding control system. All motion control is unified centralized and synchronous control management in the central control room by PLC.

Keywords: Robot; Welding Technique; Cartesian manipulator.

1. Background

Robot technology is a typical representative of advanced manufacturing technology and the main technical means. It plays an important role in promoting technical level of the enterprise and the stabilizing quality of products and improving the production efficiency and realizing the civilized production [1].

Manual welding still occupies the leading position of welding operation in our country. The welder often suffers from changes in psychological and physiological conditions and the disturbance of the surrounding environment during artificial welding. The worker is tired easily under bad welding conditions. It is difficult to maintain stability and consistency of the welding work for a long time. The working state of welding robot is platform. It won't feel tired [2]. The research and application of industrial welding robot at home and abroad. The research and application of welding robot has also been started in China [3]. On the basis of the introduction of foreign technology. We began to study the welding robot at the end of the 1970s. The first HY-1 welding robot is developed by Harbin Institute of Technology in 1985 in China. The HY-1 spot welding robot pass the acceptance tests by National 863 Plan Intelligent Robot subject experts in July 15 1999.It was jointly developed by the "FAW" group and the Harbin Institute of Technology and the Shenyang Institute of Automation [4-5].

Based on previous studies, the technology of welding robot replaces the work of traditional workers has already mature. In the light of the diversity problem of pipe welding. A flexible and intelligent multi position welding system is proposed in this paper.

2. Classification of welding robot

The welding robot is divided into two categories at present. Arc welding robot and spot welding robot [6]. The characteristics of spot welding robot. The spot welding requirements for the robots used are not very high. Because spot welding only needs point control. As for the mobile trajectory of holder between points is not strict. This is the first reason that robots can only be used for spot welding. The robot of spot welding should not only have enough load capacity, but also the speed of shifting between points and points is fast. The robot moves smoothly. Accurate positioning of the robot. This is the only way to reduce the time of shift. Improving the working efficiency of manipulator. How much load capacity is required for a spot welding robot. It depends on the form of the holder. The present is the most used Integral holder. The characteristics of arc welding robot. The arc welding process is much more complicated than the process of spot welding. Many parameters need to be controlled accurately. It including path of particle and welding gun posture and welding parameters. Therefore, the arc welding robot must have some functions suitable for arc welding in addition to the general function described above.

3. Structure of welding system based on double station

As shown in Figure 1, a schematic diagram of flexible welding system based on a double station. The system includes the following parts and main movement slide platform and cartesian coordinate manipulator and charging platform and welding machine and welding robot and control panel and welding shading board and external fence. The following is described according to the functional design in detail.

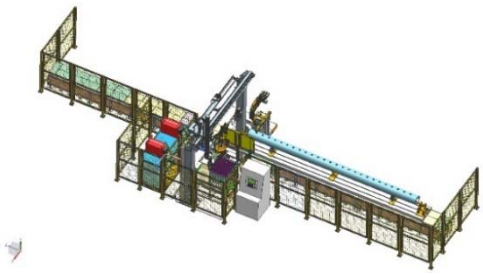

Figure 1. A schematic diagram of flexible welding system based on a double station

The main motion slide platform is used to carry the straight-line motion of main water pipe. The length of the main pipe is usually 1.5 meters to 2.5 meters. The longest is no more than 3 meters. The maximum weight is not more than 1.5 tons. The workers first hoisted main pipe through the sky car to the main sports slide. Ensure that the hole direction of the main movement slide is upward and the first hole can be inserted by the Positioning pin the two ends of the main pipe are fixed with the compression module Jacking oil cylinder in the middle of main pipe. To prevent mechanical deformation from welding. At this time the main pipe is finished. The slide platform of the main pipe is driven by the gear rack through the servo motor. The servo motor is directly controlled by the PLC central controller. As shown in Figure 2, Schematic diagram of the main sliding platform.

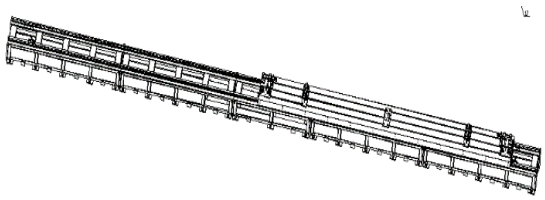

Figure 2. Schematic diagram of the main sliding platform

A Cartesian coordinate manipulator with three degree-of- freedoms is designed. It main function is to complete the role of charging and feeding. The motion control of cartesian coordinate manipulator consists of three parts. The up and down motion in the direction of Z axis. The horizontal motion in the direction of Y axis. The rotation motion of R axis. The maximum speed of the Z axis can reach 10m/min. The maximum range of 1.2 meters. The maximum speed of the Y axis can reach 10m/min. The maximum range of Y axis is 3 meters. The R axis can rotate positive and negative 180 degrees. As shown in Figure 3 The diagram of rectangular coordinate manipulator

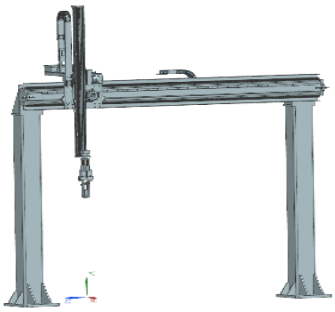

Figure 3. The diagram of rectangular coordinate manipulator

The charging platform mainly completes the charging work of split pipe. The charging platform is driven by a 1.5Kw servo motor through the gear and rack connection. A total of two types water pipes can be installed on the charging platform. Each water split pipe has 36. There are 72 water pipes. It can meet the demand of a main pipe is welded completely. As shown in Figure 4, the diagram of charging platform.

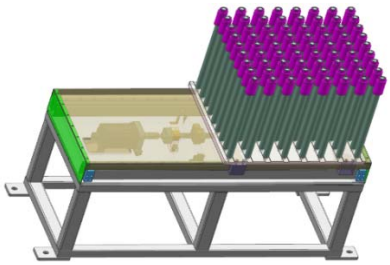

Figure 4. The diagram of charging platform

The welding machine using the MIG welding machine of Fronius TransSy nergic 4000.It use the welding torch of Robo 7G of TBi. The welding torch is fixed on the sixth axis of KUKA robot. The robot is placed on both sides of the main slide. It welding the split pipe at the same time. In order to reduce the thermal stress and deformation of welding. We use hopping welding in welding.

The control panel is a display interface in the process of human-computer interaction. We can set welding parameters. Look at the welding process and alarm information. The operator can set the length and diameter of main pipe by the control panel. It can also set the length and diameter of split pipe.

The welded shading board is used to protect the eyes of workers on the spot. The welding shading board is raised when the welding begins. A transparent protection between the operator and the welding position. It can reduce the effect of strong light for spot workers' eyesight. The shading board is down to main slide when the welding is completed. It does not affect the unloading of the main pipe.

The external enclosure is used to protect the working area to prevent accidental accidents caused by people entering the welding process.

4. Study on control method of flexible welding

This set of devices is designed by mechatronics techniques. The master control is controlled by PLC. The master control not only controls the robot but also controls input-output of the module. The main control section generates the work program according to the information which is provided by the Workflow. Transfer this information to the servo driver. The servo drive will deal with the master command. It produces servo drive current. The Plc control main slide platform and the charging platform and the Cartesian-coordinate manipulator and the Robot. And receive the corresponding feedback instructions. The servo drive system has various kinds of protection. Such as overload and overflow and lack of phase and super difference and so on. The performance are safe and reliable. The trajectory of robot is very accurate. The repeat positioning accuracy is less than 0.5mm. The welding robot can control welding program package to finish welding control through the off-line digital programming or teaching protocol. As shown in Figure 5, The Schematic diagram of flexible welding control system.

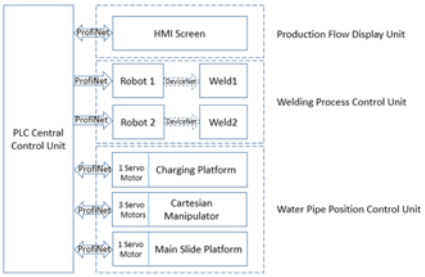

Figure 5. The Schematic diagram of flexible welding control system

The control system uses multi thread synchronization control mechanism. The Cartesian coordinate manipulator completes the reclaiming work when the robot is in the process of welding at the same time. It improves the work efficiency greatly.

The whole control part of flexible welding system consists of two parts. Robot welding process control and pipe position control. The position control of the water pipe includes the position control of main pipe and the position control of split pipe. The robot welding process control is mainly completed by robot control. The arc welding package is integrated inside controller of robot.

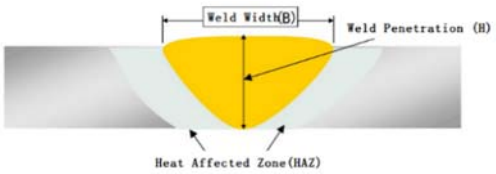

Figure 6. The weld shape coefficient

The welding wire is used in diameter 1.2mm. As shown in Figure 6, The weld shape coefficient. The width of weld is 50mm.The weld penetration 25mm. According to the formula $\Psi = B/h = 50/25=2.5$. It is ideal. We use multi-layer and multipass welding. The front weld seam is the preheat of next weld seam. The rear weld seam is the annealing of front weld seam. It prevents hardened tissue. The current

of bottom layer is about 100 ~ 120A. It guaranteed the shaping of welding line. It will not cause the water pipe to be knocked out because the current is too large. The welding current range of filling layer is between 150 and 250A. This ensures both the welding efficiency and the good fusion between the welds. The cover layer usually reduces the welding current. The welding current is 150 ~ 160A. This ensures the appearance of the surface. Control the walking speed of welding. Move fast when the current is large. It can be swung properly to form a fish scale when the current is small. Make the welded finished product more beautiful. The same welding process is adopted for both sides of the robot. Symmetrical welding. The welding parameters are different between different main pipes and split pipe.

The position control of water pipe includes the position control of main pipe and the position control of the split pipe. The position control of main water pipe is done by the way of manual and mechanical methods. The first hole of main pipe is fully anastomosing to the positioning pin. Evacuation of personnel in the working area. The shading board rises. The staff press the start button. The whole set of equipment started to run. The R axis of the Cartesian manipulator takes first water pipe from the charging platform firstly. The Z axis of manipulator upward movement. The Y axis of manipulator right movement. The Z axis of manipulator downward movement. Put the split pipe insert main pipe firstly. Spot welding fixed split water pipe into main pipe on both sides of the slide. The robot on both sides of sliding platform began to weld split pipe into main pipe firstly. The Z axis of manipulator upward movement. The manipulator returns to charging platform and takes the second split water pipe. The robot began to weld the second weld seam between main pipes and split water pipes at the same time. Whether to weld the third weld seam according to the actual situation of field. And so on, until all openings on the main pipe are welded. To reduce the effect of thermal stress on the deformation of main pipe in the process of actual welding. Use of welding sequence, the first hole, the fifth holes, the tenth holes. It is not the continuous welding of the hole of main pipe.

5. Conclusion

The intelligent flexible welding system based on double station replaces traditional artificial welding. Kinds of main pipes and kinds of split water pipes can be flexibly welded together. Improving the efficiency of enterprise production. Reducing enterprise user cost. Promoting safety and accident free production of enterprises. A variety of tasks can be finished when the robot complete welding. Such as, material packing and cargo handling. It lay a foundation for welding system which expansion other applications.

Acknowledgements

In this paper. The research was sponsored by the Comprehensive Standardization Project of Intelligent Manufacturing in 2017 (Predictive Maintenance of Intelligent Equipment for the Standard and Verification Platform Construction).

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