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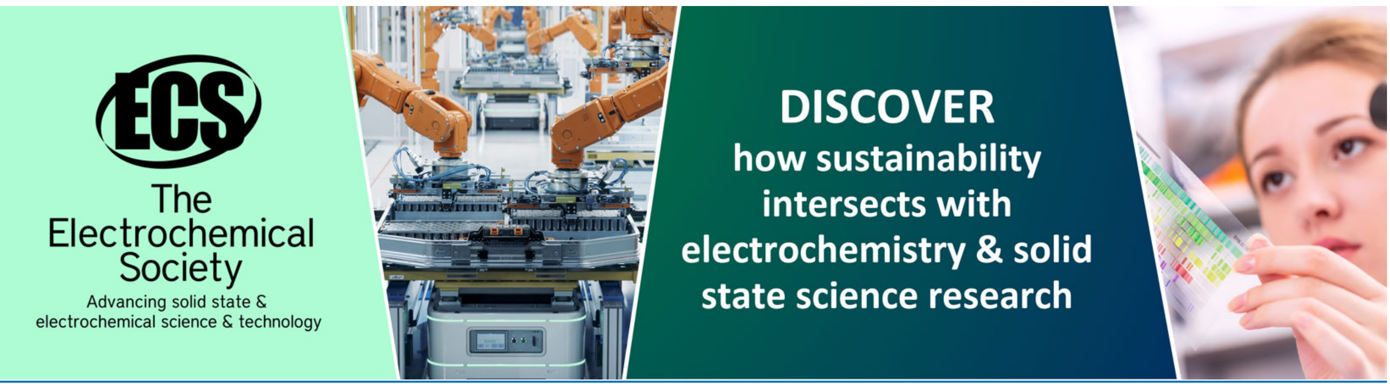

A Study on 3 D Printing Automatic Control System Based on Major Metal Components

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Abstract. 3D printing has been developing for nearly 40 years since the 1980s. This technology from the present point of view is an important complement to the traditional mechanical manufacturing way. At present, it is widely used in education, medical treatment, military industry, automobile, traditional manufacturing, construction, film and television and other fields. Generally, it mainly produces models for demonstration as well as some test parts and functional parts used in the early stage of development. 3D printing belongs to additive manufacturing technology. Compared with traditional processing technology, 3D printing has the advantage of saving time, labor and labor. Therefore, it is of great benefit to establish a 3D printing automatic control system for maj-or metal components. Based on this, this paper explores the 3D printing automatic control system of major metal components.

Keywords: Major Metal Components, 3 D Printing, Automatic Control System

1. Introduction

3D printing, formerly known as rapid prototyping, has been used in industrial design and production processes since the 1980s. Now the general 3D printing technology, basically had been developed at that time. However, 3D printing was a late name. It wasn't until 1995 that two MIT graduates, JimBredt and Timanderson, first proposed the concept of "3D printing". The reason they named the technology "3D printing" is that its prototype is designed to produce products like a printed document, and that it is hoped that the technology will eventually be used in many homes like a printer. In our industrial field, metal 3D printing can be said to be an important direction of the development of advanced manufacturing, and is also a very potential technology of 3D printing technology system. Therefore, it can be seen that the research of 3D printing automatic control system based on major metal components is a meaningful proposition.

2. 3D printing process

The working principle of different 3D printing equipment is different. From the different heat source 3D printing equipment can be divided into laser sintered rapid prototyping machine, electron beam melting rapid prototyping machine, melt extrusion 3D printer and laser curing rapid prototyping machine. 3D printing equipment in this paper mainly uses the principle of arc heating to realize the primary forming of large metal workpiece, and realizes the rapid forming of metal by automatic control and layer by layer superposition.

The principle of this paper is to connect the positive and negative electrode of the power supply to the electric melting head and the metal base material, to send the metal raw material wire to the metal base material surface under the action of the conveying mechanism and the electric melting head, to produce the arc under the protection of the granular auxiliary material, to melt some granular auxiliary materials into the molten slag pool, to flow the current through the raw material wire and the molten auxiliary material slag pool to form the same resistance heat and electroslag heat, to melt the metal wire under the action of three composite high energy heat sources (arc heat, resistance heat, electric slag heat), to form a local melting pool on the metal base material surface, and to continuously transport the raw material wire and auxiliary material, By using PLC programming to control the relative movement of the electric melting head and the metal base metal, the molten wire can be cooled quickly and accumulated layer by layer on the metal base metal, and finally the metal workpiece is formed.

Article 3 D the mechanical structure of printing equipment is divided into five parts: wire feeding mechanism, power fusion system, bedside transmission mechanism, negative pressure recovery system and beam moving mechanism. These five parts cooperate with each other in the following ways. First, the wire is driven by the wire feeding motor in the wire feeding mechanism. After the wire is connected to the power supply, the head box drives the base metal rotation and the beam moving mechanism drives the printing gun head to move up and down in a certain working range. In the process of printing, the wire material melts continuously under the action of arc heat and adheres to the metal base material driven by the headbox. In order to ensure the balance and stability of the printing process and the technological level of the workpiece, The wire feeding speed should be accurately controlled to match the melting speed of the wire. At the same time, in order to reduce the waste of auxiliary materials, a negative pressure recovery system is designed to realize the recycling of auxiliary materials. Figure 1 is a physical diagram of the workpiece in print.

Figure 1. 3D printing process

3. Hardware design of control system

The hardware system of 3D printing equipment mainly consists of PLC controller, welding power DC servo motor, headbox drive servo motor, upper computer and so on. According to the performance and field requirements of the welding power supply, Welding power supply system adopts VIZ--1500 welding power produced by Chengdu Zhenzhong Company. This paper focuses on the control system, Through precise control of mechanical transmission and power fusion, Using arc voltage to feed back wire speed, Control wire feeding and metal melting speed matching, Keep the print steady, Aiming at improving the control precision of 3D printing equipment and improving the process quality of printing workpiece.3D printing equipment in this paper includes five subsystems: transmission support system, welding system, gun frame tracking system, automatic beam shift system and temperature control system. Select Siemens CPU224XP transistor output PLC, according to field control 14 Input/10 output, Maximum pulse output frequency 20 kHz, 5 VD. pulse output voltage By programming PLC subsystems, the control system designed in this paper realizes the control of the underlying devices such as sensors and actuators, In order to accurately adjust the beam moving mechanism to improve the accuracy of the control system, Select the PLC high speed pulse output mode (PTO) to control the period number and number of pulses, The PLC high speed counter HSC instruction can count and locate the high frequency pulse signal. In order to grasp and assign the data of the subsystem in real time, main station selects siemens 300 series PLC to realize data transmission and communication. The PC machine uses MCGS embedded version 7.2 software to design the operating interface of the MCGS touch screen, monitors the process parameters of the whole printing process and the running state of the subsystem in real time, transmits and saves the data generated by the printing process in real time in the server.

The S7 200 controller is connected CPU the expansion module in the schematic diagram of 3 D printing control system (figure 2). The analog quantity of welding current and arc voltage is collected and transported to S7 200 for mode / number conversion. Then the digital quantity is converted into analog output to the DC governor of the wire feeding system to control the speed of wire feeding during printing. PLC pulse output instruction and high speed counter HSC instruction are used to adjust the beam moving mechanism accurately.

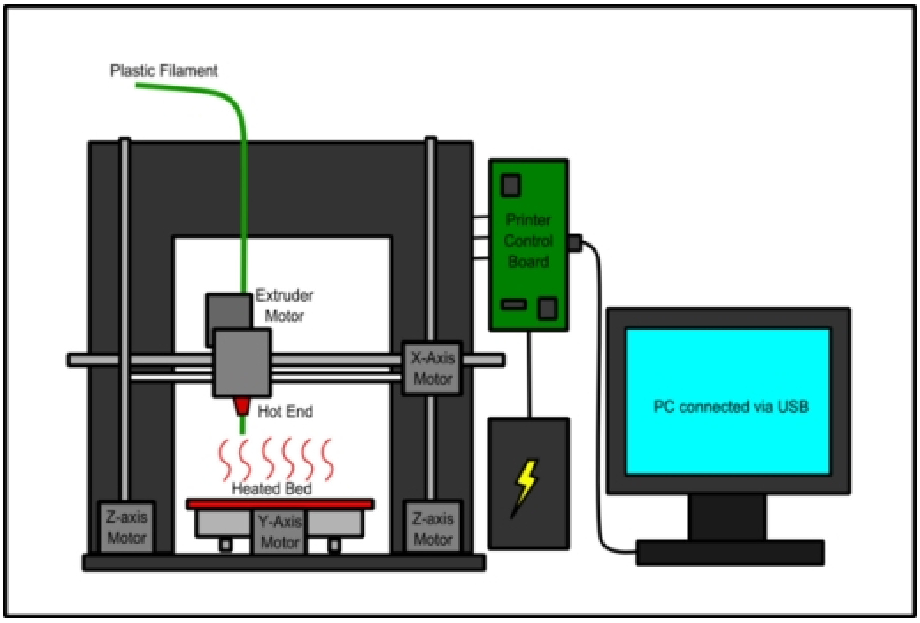

Figure 2. 3D Schematic diagram of the printing control system

The gun control system is the main structure in the printing process, includes a gun rack unit, a programmable logic controller (PLC), and a host computer, In order to monitor the process quality of the workpiece in real time, Prevent wire adhesion and structural inhomogeneity, Add a laser range sensor to the system, Used to monitor the distance between the conductive nozzle and the workpiece surface, That is, according to the field situation later increased laser tracking system. The system is designed to satisfy the relative stability of the process parameter "dry elongation" in the whole process of increasing the workpiece, Read the feed speed, arc voltage and distance between the conductive nozzle and the workpiece surface through the <unk3> PLC of the main station, The distance between the conductive nozzle and the surface of the workpiece is approximately constant, The error range is controlled mm,±2 The closed loop control of dry elongation is realized by programming the 200 series PLC and MCGS the parameters given by the touch screen according to the distance feedback signal, Real-time control of the gun frame in the process of material increase. The system ensures the relative stability of dry elongation and the thickness of protective excipients, Further enhancing the stability of metal cladding, Reduce deformation.

4. Software design of control system

This article 3 D the printing equipment designs the control scheme for five systems according to the process requirements. Through the programming of subsystem and main station PLC and the design of printing interface of MCGS touch screen by using MCGS configuration software, the software and hardware foundation of nearby / remote real-time monitoring and management is established. At the same time, in order to facilitate management, the functions of database interaction and the detection and control of process parameters of printing process are added. The printing process is divided into four processes: setting the printing parameters, starting the arc, printing and ending the arc extinguishing printing, while the printing process is the focus of the printing adjustment of the whole control system. According to the MZ of Chengdu Zhenzhong Company, the working mode is divided into two modes: constant current and constant voltage. In this paper, constant current mode is selected and arc voltage feedback is used to realize variable speed wire transmission. The PID closed loop control arc voltage is selected to meet the requirements of the material increasing process. At the same time, the PLC programming and the DC governor are used to adjust the speed of the wire feeding accurately to ensure that the arc voltage is within the set range.

4.1. Print parameter setting

Through the MCGS touch screen, the relevant printing data is input into the printing interface, such as printing current, printing voltage, selection of fast / slow wire, printing length, number of layers, etc., to determine that the assigned data will be transmitted to the corresponding storage area of the PLC through the MODBUS communication protocol

4.2. Striking the arc

To adjust the wire extension length and the corresponding position of the printing gun head first, click start to complete the system initialization and assignment work, and then start the welding power supply, The wire contacts the base metal surface to form a short circuit after the instantaneous potential difference between the wire and the workpiece ignites the arc Ir, and the short circuit current is measured by the current sensor and compared with the set arc current threshold It; If the Ir>It, is considered to be successful, the digital quantity is converted into analog output to the DC governor by PLC programming, and the feeding speed is adjusted according to the corresponding voltage value to maintain the continuity of printing.

4.3. Put a seal on

After entering the automatic printing stage, the system automatically calls the printing subroutine, according to the arc voltage directly proportional to the arc length under certain conditions, the printing voltage is detected by the voltage sensor in real time. In this process, it is necessary to accurately balance the change of speed, not to make the beat amplitude of printing speed too large, to maintain the stability of wire feeding speed as soon as possible, otherwise it will affect the performance and technology of printing workpiece. Under the above control idea, the PID controller continuously adjusts the wire feeding speed to make the voltage stable in the printing process, PLC carries on the digital-analog conversion output to the wire feeding DC governor according to the operation result of the PID control subroutine, accurately controls the wire feeding speed. At the same time, the transmission support system rotates the melted wire on the base metal surface by rotating the metal base metal at a certain speed, and obtains the workpiece of the required process through the temperature control system to reduce the deformation. Finally print forming.

4.4. Arc extinguishing，end of print

When the beam moves the trigger stroke switch and completes the set number of printing layers, the PLC input module receives the electrical signal that causes the wire feeding motor and the beam moving motor to stop working. It also causes the wire feeder motor to reverse back Is and stop working to prevent adhesion between wire and printing workpiece. When an emergency during printing needs to stop printing immediately, just press the stop button.

5. Closed loop control of 3D printing voltage

PID control is a control algorithm to ensure the real-time correction of analog quantity and control the deviation between the set value and the actual value within the range of the set value control deviation. The actual voltage measured by the voltage sensor is sent to the analog digital module of the PLC, and the calculated results are converted by digital-analog calculation according to the deviation between the actual value and the set value. The analog quantity is output to the DC governor of the wire feeding, and the wire feeding speed is adjusted by adjusting the arc length to ensure that the printing voltage is within the allowable error range. This part is composed of S7 series of 200 PLC plus analog input / output expansion module, which completes automatic sampling and mode / number conversion, and stores it in the specified data register. After PLC operation, the output is sent to the wire feeder actuator for execution.

6. Experimental result

The printing operation interface is designed by MCGS touch screen and MCGS configuration software system according to the needs of the field. Through MODBUS protocol and PLC communication, the hardware lap diagram of the material increasing printing equipment is shown in figure 3.

Figure 3. Hardware Lapped Physical Map of 3D Material-increasing Printing Equipment

Figure 4 shows the wire adhesion during printing. This phenomenon often appears in the previous printing process, which is caused by the mismatch between the wire feeding speed and the welding speed. The control system designed in this paper has high accuracy and good speed matching. The concrete physical diagram after printing is shown in figure 5, which solves the problem of wire adhesion in the process of printing.

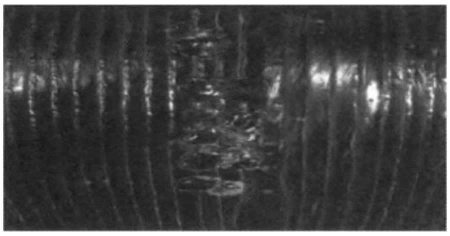

Figure 4. Physical drawing of the sticky work piece

Figure 5. Physical drawing of metal workpieces

7. Conclusion

In this paper, we designed an automatic control system for 3D printing of major metal components to conduct experiments. The experimental results tell us what functions and advantages this system has for the manufacturing and production of metal components. Therefore, 3D printing technology in this field also has a great development prospect and use value, which is worthy of our investment in more resources for in-depth exploration and final use.

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