International Core Journal of Engineering Volume 7 Issue 3, 2021
ISSN: 2414-1895 DOI: 10.6919/ICJE.202103_7(3).0006

Design of Laser Cleaning Mold Device and Its Control System

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Abstract

Based on the advantages of laser cleaning technology, a laser cleaning mold device and its control system are proposed to promote the application of laser cleaning molds in the actual production process. The device adopts two sets of control systems to control the laser output and the movement of the cleaning platform respectively, so as to achieve the purpose of effectively cleaning the mold with the laser.

Keywords

Laser Cleaning; Mold; Cleaning Device; Control System.

1. Introduction

The use of mold is carried out under certain pressure and high frequency, which will inevitably accumulate a large amount of contaminants on the mold surface. When the contaminants accumulated to a certain extent, it will affect the surface shape of the molded products, so that the products become defective or waste products. Therefore, the mold surface must be cleaned frequently. Mold cleaning is a key process in mold maintenance, which is also the bottleneck of mold maintenance [1].

After long-term exploration and practice, people have accumulated many methods of cleaning molds, which generally include traditional cleaning methods such as chemical cleaning, mechanical cleaning, and ultrasonic cleaning. In the face of increasingly sophisticated processing requirements, traditional cleaning technologies have more or less fallen into a certain bottleneck in principle [2]. Therefore, mold cleaning urgently needs a cleaning technology that is efficient, low-cost, and environmentally friendly.

Laser cleaning technology uses high-energy laser beams to irradiate the surface of the object, causing the surface attachments such as rust, paint or other coatings to vaporize or peel off instantaneously, thereby achieving the purpose of surface cleaning [3]. Compared with traditional cleaning methods such as mechanical cleaning, high-frequency ultrasonic cleaning, and chemical corrosion cleaning, laser cleaning has obvious advantages [4]. Laser cleaning has the characteristics of no contact, no grinding, no introduction of additional impurities and suitable for various unconventional materials. It can achieve low thermal effect or even no thermal effect, and is currently the fastest growing cleaning solution [5]. Therefore, this article designs a set of laser cleaning mold device based on pulsed laser, and proposes the corresponding control scheme, which provides a certain application reference for the automatic cleaning of mold.

2. Structure design of cleaning device

The mechanical part is mainly composed of device frame, cleaning platform, synchronous belt module, laser output device, laser generator, linear guide rail and connecting plate, sliding table module dual optical axis ball linear guide, sliding table module dual optical axis ball linear guide It is composed of connecting plate, L-shaped angle aluminum, fixed seat and other components, see Figure 1.

The working process is as follows: the laser generator is installed at the bottom of the device to generate the laser required for a specific cleaning object. The laser output device is installed in a fixed

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seat connected to the L-shaped angle aluminum, and the generated laser light is delivered to the laser output device through an optical fiber, and then output to the mold placed on the cleaning platform. The rotation of the stepping motor drives the synchronous belt module, and the movement of the cleaning platform is driven by the slider to realize the reciprocating back and forth in four directions. The angle aluminum is installed on the dual optical axis ball linear guide of the sliding table module, which can reciprocate up and down to adjust the light source focus of the laser output device at the height. The laser cleaning device has two cleaning methods, automatic and manual. The laser output device can be removed for hand-held cleaning, which can clean the partial structure of complex molds.

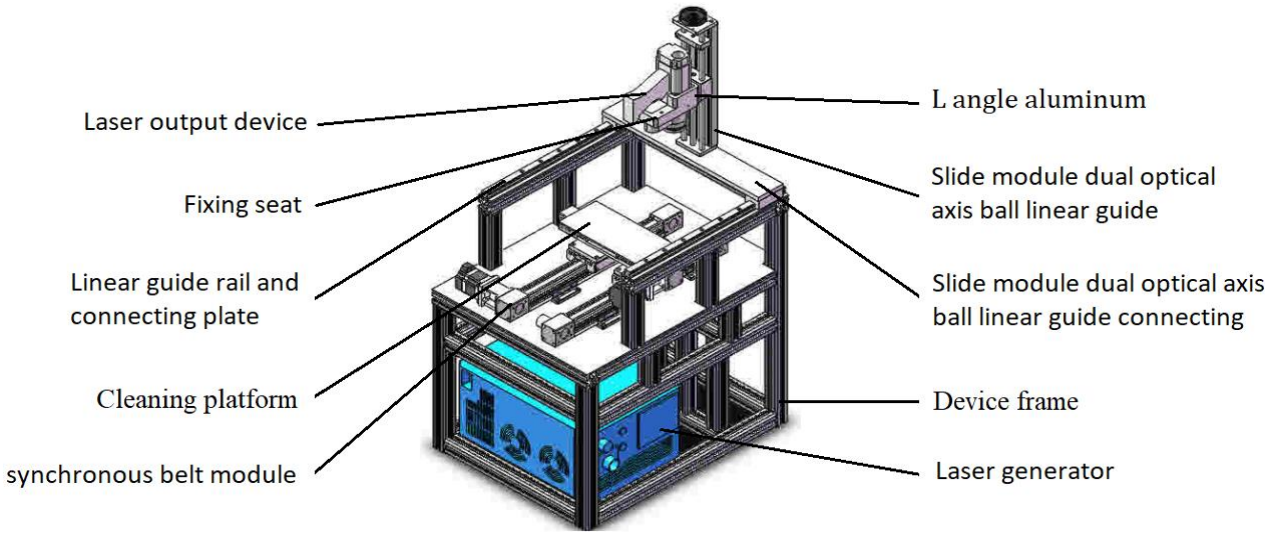

Figure 1: Laser cleaning mold device

3. Control system of cleaning device

The hardware equipment used in the control system of cleaning device includes upper computer, Ni pci-6503 board, PLC, switching power supply, synchronous belt slide module, proximity sensor, photoelectric sensor, TK8071ip-weinview and voltage regulating power supply.

3.1 Laser output control design

The system uses the NI Labview virtual instrument development platform, and uses the NI PCI-6503 board to send control signals and receive laser feedback information.The laser output parameters are set as follows: [6]

Laser power setting: Set the TTL signal of PIN1~8, and set the current of the pump laser diode through the combination of TTL signal. PIN1~8 can set the code in the range of 0~255, corresponding to the laser power output of 0%~100%.

Frequency setting: Set the frequency modulation signal through Pin-20. The system outputs a square wave TTL signal to the laser through the 6503 board.

Pulse width setting: The control system sends instructions to the laser through serial input pin-2, and at the same time sends a clock signal (10kHz) to pin 3. The instruction description will be transmitted in binary form, and the user can compile any pulse width.

Laser switch: The system will only receive the laser switch status when the MO switch is turned on after 12 seconds of power on.

Emergency stop signal: high level is normal, low level emergency stop is valid.

Laser feedback signal: Contains feedback information such as optical path temperature, current temperature, low-level circuit alarm, pulse-leakage alarm, and voltage error.

The control logic of the laser is shown in Figure 2.

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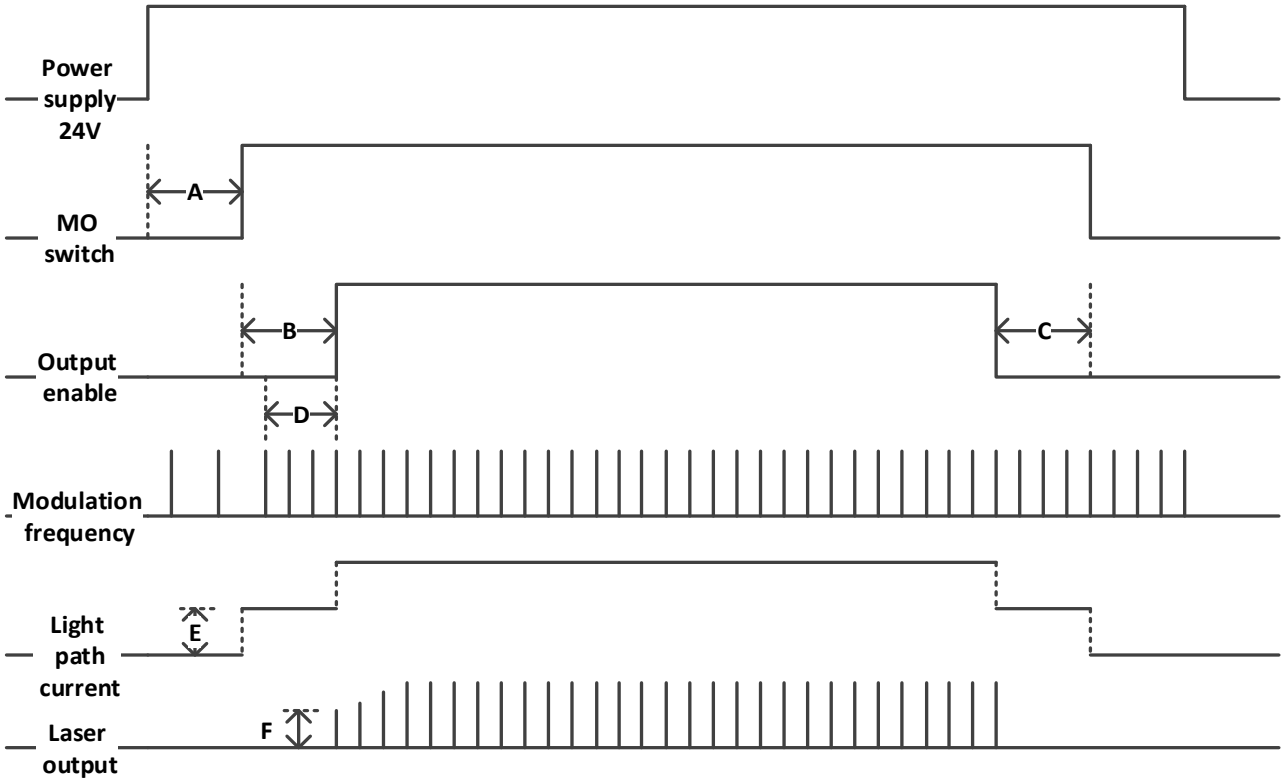

Figure 2: Control sequence diagram

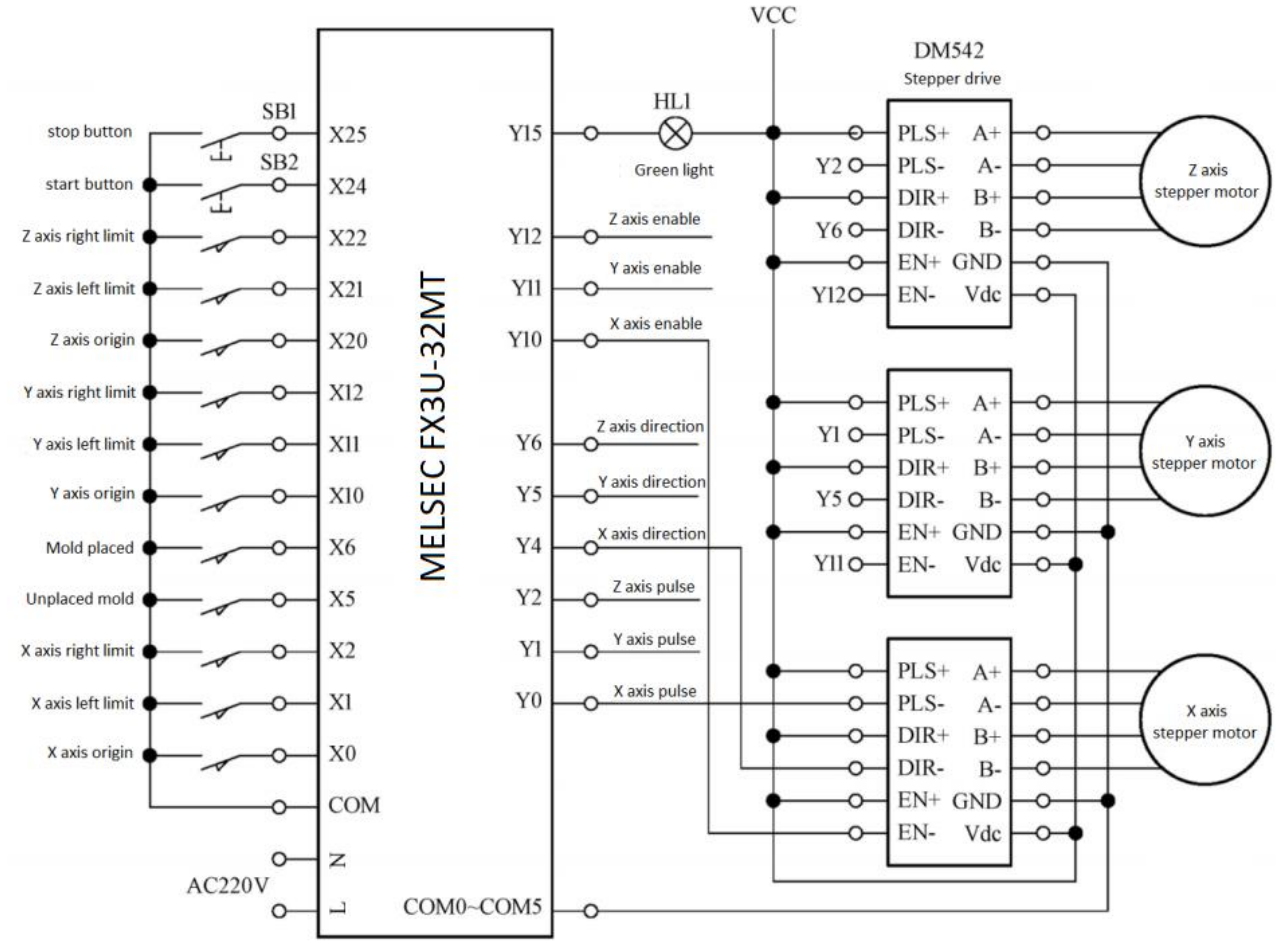

Figure 3: Control System Hardware Connection

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3.2 Control design of cleaning platform

Mitsubishi fx3u-32mt PLC is selected to control the movement of cleaning platform. MT belongs to transistor type and can realize three-axis positioning control. Y0 ~ Y2 is used as high-speed pulse output, Y4 ~ y6 as directional output and Y10 ~ Y12 as enabling output to control motor movement.

In order to realize the function of mold automatic cleaning, it is required that the cleaning platform placed on the synchronous belt slide module can accurately reach the designated position, and the laser output device can automatically adjust the cleaning focal length, so as to realize the effective cleaning of mold by laser. The system uses 57 stepper motor for precise positioning, and the angular displacement of the motor is controlled by the number of pulses generated by PLC, so as to control the space position of the cleaning platform and the laser output device; the speed of the motor is adjusted by the frequency of pulses generated by PLC, so as to control the moving speed of the cleaning platform and the laser output device. After shutdown, the winding resistance of the motor remains energized. At this time, the stepping motor has the ability of self-locking, which can prevent cleaning and sliding.

Each synchronous belt module is equipped with a proximity sensor, which serves as a stepper motor reference point signal and limit to ensure the movement positioning accuracy of the conveying mechanism. The photoelectric sensor is configured in the mold placement position to detect whether the mold is placed, and the stop and start buttons and indicator lights are configured. The main operation and parameter monitoring are realized by the TK8071ip-weinview.

The control system hardware connection flowchart is shown in Figure 3.

4. Conclusion

The laser cleaning device proposed in this paper has the characteristics of strong adaptability, which is controlled by the NI PCI-6503 board to control the laser generator and the PLC to control the cleaning platform to achieve precise movement. The touch screen controls the stroke and speed of the conveying mechanism and monitors the location of the cleaning platform and the laser output device. Status, the laser output parameters are controlled by the host computer, which has the advantages of convenient adjustment, intuitive monitoring, and simple operation. The mechanical structure and control system of the device can provide new ideas for the improvement of laser cleaning molds and have certain reference value.

Acknowledgements

2020 "Wenzhou Polytechnic New Technology Application Innovation and Entrepreneurship Project" "Green cleaning method for complex space in cabin based on laser technology" (No. WZYCY2006).

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