燃烧器喷涂专用九轴联动系统

东汽表面工程研究所
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PC-based control and drive technology in robotic surface treatment solution

Thermal spraying process leverages fast data communication and dynamic motion control

Thermal spraying is a coating process in which molten or heated material is sprayed onto a surface. Seeking to improve spraying quality, experts from Sichuan University, China created a 9-axis system in which a 3-axis rotary table works together optimally and simultaneously with a 6-axis robot. The system reaches its full potential by utilizing the performance benefits of open and fast control systems from Beckhoff.

Deyang Dongqi Surface Engineering Technology Co. Ltd., headquartered in the Chinese province of Sichuan, specializes in the creation of mechanical and electrical systems for machines used in surface treatment. In order to optimize the surface treatment process and the spraying quality in robot-based thermal spraying, the company turned to the School of Electrical Engineering and Information Technology (SEEI) located at Sichuan University.

Due to the relatively complex surfaces of the workpieces to be treated, and to make the thermal spraying process more flexible, the project developers suggested building a 3-axis rotary table as a clamping fixture in addition to the 6-axis robot already employed, providing the ability to optimally position the workpiece. The challenge of this 9-axis system is that the 3-axis rotary table developed independently by the SEEI, Sichuan University has an extended external axis which must move in perfect synchronization with the robot that guides the spray gun.

TwinCAT and EtherCAT solve time-critical motion control applications

In order to solve this task, numerous control platforms were evaluated by the experts of SEEI, Sichuan University: "Ultimately, we opted to use PC-based control technology, offering maximum flexibility and the best price-to-performance ratio. The wide range of available components and excellent collaboration between Beckhoff China and Sichuan University swung the search in favor of a PC Control solution. A further deciding factor was that TwinCAT software from Beckhoff represents an efficient and uniform automation platform."

In order to ensure operational reliability of the rotary table, the CNC system must control three servo drives simultaneously, while also reading the force sensors and angle encoders for five ropes. TwinCAT NC I automation software for interpolated path movements is ideally suited to these kinds of complex machine kinematics, with high requirements for real-time transformation in the

In order to improve the quality in thermal spraying, the developers at SEEI, Sichuan University utilized a 3-axis rotary table working simultaneously with the 6-axis robot.

CNC. The Beckhoff CP2216 built-in Panel PC with 15.6-inch multi-touch display supplies sufficient computing power for the control of the rotary table system and communication with the robot controller. In addition, EtherCAT provides very fast data communication, enabling extremely short process image update times – the CNC operates with processing times of 2 ms, the electronic cam plates with 1 ms, and the drive control cycles with 250 µs.

Significant time savings with TwinCAT

TwinCAT offers ready-to-use Motion Control function blocks, which shortens the development period, facilitates improved programming processes, and radically accelerates commissioning. This also significantly reduces the overall time invested in the engineering process. The research director of the project, Prof. Songyi Dian from SEEI, Sichuan University has said: "We see extraordinary time savings of up to 70 %."

Control of the 3-axis rotary table encompasses methods for the adjustment of the yaw, pitch, and roll angles. With the aid of electronic cam plates and the 3-axis interpolated Motion Control provided by TwinCAT NC I, as well as the modern PC- and EtherCAT-based control technology, the system ensures precise control of the five servomotors from the Beckhoff AM8000 series. Also from Beckhoff, the AX5000 Servo Drives used here fully leverage the performance of EtherCAT in the Drive Technology.
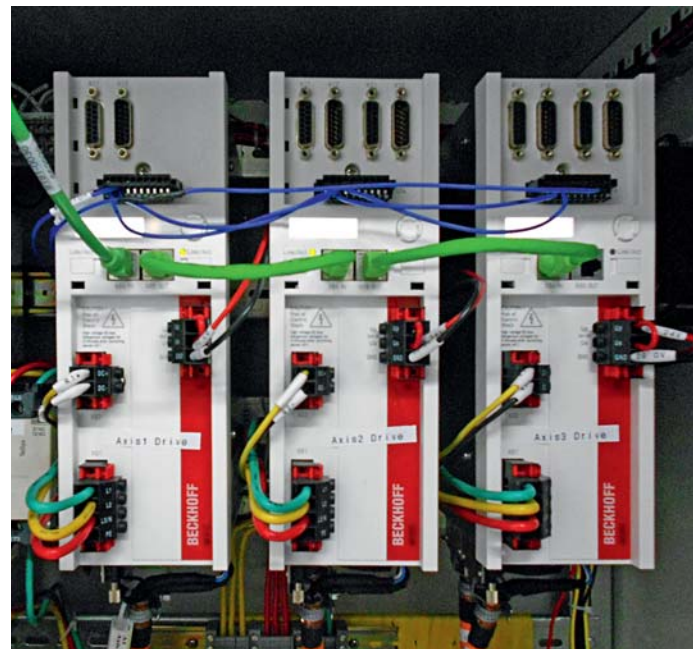
The AX5112 (12 A rated output current), AX5203 (2 x 3 A) and AX5206 (2 x 6 A) Servo Drives are used to carry out the three position changes of the rotary table. The pitch and roll movements each require two servomotors. This is where the AX52xx 2-channel Servo Drives come in to play, since they can drive two identical or different motors with a total current of up to 6 or 12 A respectively. Electronic gear units, implemented by means of software functions in TwinCAT, solve the problem of the double-motor drive load. This ensures that the accuracy of the drive synchronization meets the application requirements, streamlining the control system.

Open automation system as an added bonus

Following completion of the development, Prof. Songyi Dian and his group members from SEEI, Sichuan University see clear advantages in the use of Beckhoff control technology: "PC-based automation components ideally support the precise control of motion thanks to their high performance. TwinCAT and EtherCAT stand out as pillars of the automation solution, due to their unequalled openness. As a result, they are compatible with various fieldbus technologies and can communicate with any subsystem. Through the integration of the rotary table as an extended external axis, the quality of the thermal spraying has noticeably improved and the spraying process has been simplified significantly."

When connecting the AM8000 servomotors, only one cable needs to be laid, since the One Cable Technology (OCT) combines power and feedback systems.

The AX5112, AX5203 and AX5206 Servo Drives are responsible for the precise adjustment of yaw, pitch, and roll angles in the rotary table.

Further information:
www.scu.edu.cn
www.beckhoff.com.cn