

# The Application of Trio Controller in the Control System of Cutting Robot Design of Beef Cattle Feeding System Based on Motion Controller

De-Hui Zhang<sup>1,a</sup>, Da-Peng Liu<sup>2,b</sup>

<sup>1</sup>Inner Mongolia University for the Nationalities, College of Mechanical Engineering, TongLiao, 028000, China;

<sup>2</sup> NO.724 Research Institute under CSIC, Nanjing Jiangsu 210003, China;

<sup>a</sup>wuxiaoqiang6006@163.com, <sup>b</sup>liudapeng@163.com,

**Keywords:** Cutting robot, Trio motion controller, Openness, Control system

**Abstract.** With the development of industrialization, application of pipe is becoming more and more. The traditional pipe cutting method cannot meet the market demand. CNC cutting can make up for the deficiency of traditional manual cutting, a kind of cutting robot control system based on Trio motion controller is designed in this paper, the design of hardware and software is done. The system uses modular design, greatly improving the efficiency of software development, so that the system has good openness and portability. The use of double CPU mode can ensure the reliability and processing speed. This system can be used in cutting robot.

## Introduction

With the development of computer technology, the traditional manufacturing industry has undergone a revolutionary change. Numerical control technology is one of the key technologies in modern manufacturing system, it represents the direction of development of a country in manufacturing industry [1]. In the process of mechanical design and manufacturing, and many places will use pipes, such as in shipbuilding, the water pipes, gas pipes and cables are through the laying of pipelines [2]. In the pipe using process, there are many places need to punch hole, and the size and shape are different [3]. In order to further improve product quality, to welding and cutting has higher quality requirements, the traditional manual cutting cannot meet the technical requirements [4]. Therefore a multi degree of freedom robot need to be designed to instead of manual cutting and the application of NC technology in pipe hole, it can improve production quality, reduce labor intensity, and improve market competitiveness [5]. In this paper, a multi degree of freedom cutting robot is designed to cut the pipe, the control system adopts Trio motion controller to coordinate the robot control.

## Robot hardware design

**Overall design:** According to the specific application environment, cutting robot generally have the following requirements: driving device has high efficiency and quality is light; in the running process of the sensitive reaction, it requires smoothing action and no impact phenomenon; robot positioning accuracy requirement is high, the control must be flexible; robot needs reliability, high safety factor, and it is easy to operate. According to the above requirements, the robot takes a separate structure, as shown in Figure 1, the robot is divided into the mechanical parts and control system.

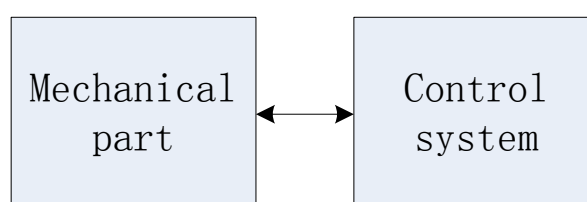


Figure1. Overall design

**Robot mechanical part design:** According to the survey, the mechanical structures of the existing cutting robot mainly are manipulator, cantilever and gantry etc. The structure of manipulator has a strong correlation between each motion, it may cause structural instability. The size of the cantilever is relatively small, cutting is not suitable for large pipes. In contrast, the gantry type structure has good rigidity, high stability, high speed in cutting and it also won't produce jitter phenomenon, which can ensure the cutting speed and cutting quality. As shown in Figure 2, the robot main body installed on the base of a four legged, when working, the robot stays above the processing position.

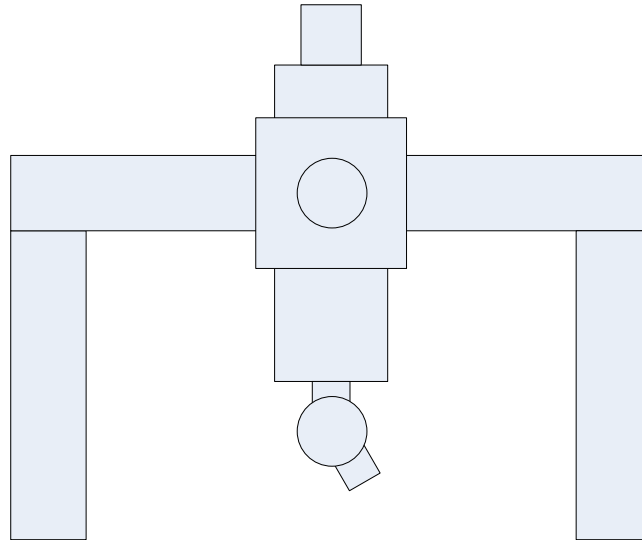


Figure2. The mechanical structure

**Robot control system design:** Typical control system has IPC + motion controller and IPC + special system, hardware of motion controller is simple than the special system, and it has high reliability. The construction of system motion controller has good openness and scalability. So we use motion controller to construct control system. As shown in Figure 3, the control system is mainly composed of Trio motion controller, servo drivers and other electronic components. The robot is driven by servo motor, servo system uses the Panasonic brand. The feedback speed and position information of the robot uses incremental encoder. One of the most important part is the Trio motion controller, which is the core of the system. TRIO digital motion controller is a kind of digital motion controller developed based on micro processing technology of high precision and high function by Trio motion technology Ltd. it can easily achieve a variety of forms of exercise, such as linear interpolation, circular interpolation, helix interpolation, electronic gearing and electronic cam. TRIO digital motion controller has good expansibility and provides a variety of functional modules, it can configure according to the application requirements of on-demand portfolio and it improves the system openness and portability.

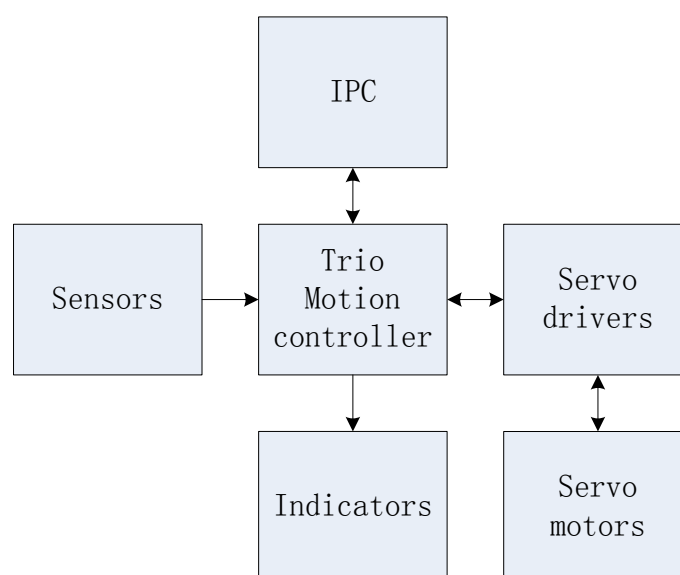


Figure3. The control system

## Software design

**Software overall design:** Robot system is mainly used to control the robot cutting, as shown in Figure 4, software takes modular design. The software includes the program explain module, control module and management module composition. The program module is used to explain the operator's instructions, which will be translated into system procedures to control cutting robot. The control module controls the robot movement according to the predetermined trajectory to ensure the smooth operation of the robot. The management module is used for parameter setting and display.

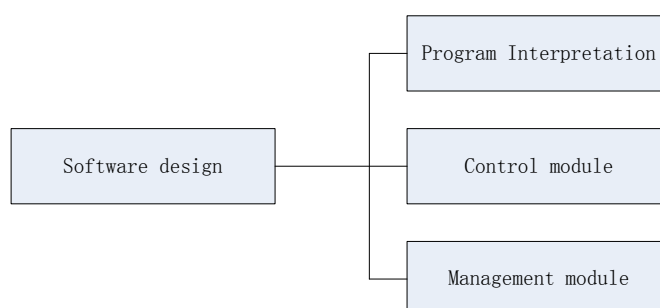


Figure4. The modular design of software

**System management software:** As shown in Figure 5, system management module mainly has the following functions: initialization, programming, parameter setting, parameter display, fault diagnosis. Initialization is used to initialize the state of the system, the I/O interface is on working state. The programming is mainly used for motion control program and logic program written through the keyboard, and the program is saved. Parameter setting and display module are for robot motion parameters and operating status display. The fault diagnosis module is used to record the running state of the robot, which is convenient for the machine maintenance and maintenance.

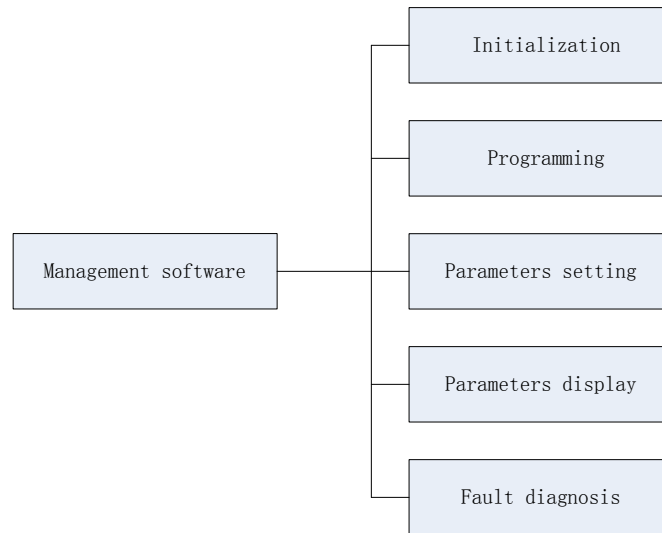


Figure5. The management software

**System control software:** As shown in Figure 6, the control software system first does zero returning operation robot each coordinate. After zero returning, do the robot action teaching through the teaching device. After teaching, system processes teaching program, after processing, finish cutting.

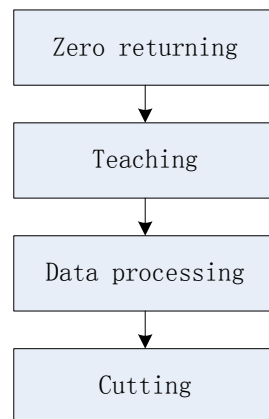


Figure6. Control software

**System interface design:** The system sends and receives signal through the I/O interface of controller, including position signal, signal indication. The design of I/O system is shown in table 1. Communication between the system and the PC uses Ethernet.

Table1. System I/O design

Input		Output	
IN0	Zero returning signal 1	OUT0	Indication signal 1
IN1	Zero returning signal 2	OUT1	Indication signal 2
IN2	Zero returning signal 3	OUT2	Indication signal 3
IN3	Zero returning signal 4	OUT3	Indication signal 4
IN4	Zero returning signal 5	OUT4	Indication signal 5
IN5	Position limiting signal 1	OUT5	Indication signal 6
IN6	Position limiting signal 2		
IN7	Position limiting signal 3		
IN8	Position limiting signal 4		
IN9	Position limiting signal 5		

## Summary

Cutting robot is designed taking the Trio motion controller as the core of hardware and software. This control system adopts the double CPU parallel mechanism, the reaction speed of the system and the reliability of the system is ensured. Modular design makes the system more open and transplantation, it can ensure the function of the system, and also can shorten the development cycle of the system. Between the modules are standard interface, which can be very convenient for the system with the hardware. The system has high openness, high stability, simple operation, it can be used in cutting robot.

## Acknowledgement

This research was financially supported by the National Science Foundation.

## References

- [1] Cai Guangqi Shi Jiashun, Shi Hong. Present situation and development of open CNC system [J]. Machinery manufacturing, 2005, 43 (6): 18-21.
- [2] Jun Li Zheng, Chen Qiang, Guo Sheng Zhou. Ship pipe tube accessories distribution management system modeling and its application [J]. Shipbuilding technology, 2014, (1): 51-56.
- [3] Xu Lihong. Metallographic sample cutting machine at home and abroad research [J]. Physical and chemical inspection: Physical Sciences, 2003, 39 (7): 357 - 360.
- [4] Hu Sheng Hai, Shi Jun Zhao. Large diameter open hole CNC flame cutting machine development [J]. Journal of Harbin Engineering University, 2003, 24 (3): 258-262.
- [5] Wang Cong. The present situation and development trend of multi wire cutting machine [J]. Electronic industry special equipment, 2008, 37 (11): 10-11.