

# Design of Bending Machine Based on Motion Controller

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**Abstract:** In the field of industrial automation, plate bending process has a wide application. Bending traditional method is not able to meet the needs of industry, NC technology make it possible to let bending machine automatically run. In this paper, a kind of automatic bending machine is designed based on motion controller, the working principle is analyzed, hardware and software are all designed. The bending machine has the advantages of simple operation, good reliability, portability, and it provides a new method for plate bending.

**Keywords** Bending machine; Control system; Motion controller

## INTRODUCTION

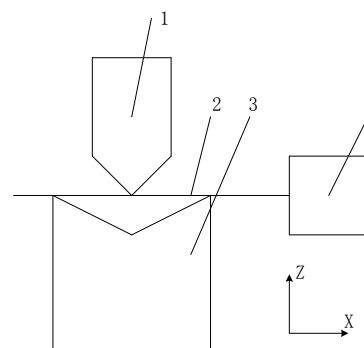
With the rapid development of industrial automation, more and more complex workpiece is used in all kind of field. Plate bending forming mould has good versatility, wide range of application, and it has wide application in many industries [Shang, 2010]. Plate bending parts are used in machinery, construction and other industries. The traditional manual bending machine needs to operate by man, labor intensity is large, in order to produce qualified bending pieces, it needs to take longer time to adjust [Xi, 2005]. In order to reduce the labor intensity, improve the production efficiency, improve the working environment, and improve the quality of the workpiece, the industry puts forward higher requirements for the automation degree of bending machine. The NC system provides a way for the improvement of automation degree of bending machine [Shu, *et. al.*, 2009]. CNC bending machine can automatically control the mechanical position according to the set point of view, the operation difficulty is reduced, and it can greatly shorten the adjustment time, improve the quality of the workpiece, and improve production efficiency. In this paper a kind of bending machine is introduced based on motion controller, motion controller has the advantages of quick response, high control precision, and good reliability [Zhigang, *et. al.*, 2005]. It has a certain practical significance of automated production of the bending of sheet metal.

## THE BENDING MACHINE WORKING PRINCIPLE AND HARDWARE DESIGN

### The bending machine working principle

Bending machine mainly bends for complex workpiece through the slider up and down movement. Bending machine working principle is shown in figure 1. Bending machine includes two degrees of

freedom of movement, respectively they are: the block along the horizontal direction movement, in this paper movement of the motion is defined as X direction; slide along the vertical direction of the up and down movement, in this paper movement of the motion is defined as Z direction. When working, the system control movement of X direction and Z direction, with the use of different mold, complex workpieces of different shapes bending can be realized. The specific working process is : the block drives the workpiece move forward, and stops at the designated location, the bending position of the workpiece is determined, after the workpiece position determined, the slider moves downward, and moves to the specified depth according to the bending angle for bending, after bending the slider moves upward back to the starting position, then the system repeats the above action, until the bending of the workpiece is qualified.



1.Upper die 2.Sheet 3.Lower die 4 Drive mechanism  
Figure 1.The bending machine working principle

### The bending machine hardware design

Bending machine control system must have the characteristics of fast response, high control precision, and good reliability. In recent years, the motion controller has been widely used in the field of industrial control, it has the advantages of high

control precision and good opening. In this paper, the motion controller is used as the core of system hardware. In addition to the system motion control part, there are driving part and the display part etc. Figure 2 is the system of bending machine. Motion controller is used to realize the logic control and motion control, servo drivers communicate with motion controller, motion controller sends out the control signal to the servo driver, servo drivers control servo motors to implement the corresponding motion. The system has some other detection devices, such as sensors; and there are some lights.

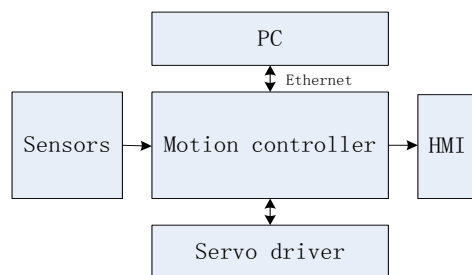


Figure 2. The system of bending machine

## SOFTWARE DESIGN

### The overall scheme of the software

In order to ensure the software real-time performance and scalability, modular design approach of software design is adopted. As shown in Figure 3, the software is divided into management module, motion module, parameter setting module and parameter display module. Management module is running on the upper computer, the motion controller only has operating environment, it does not have the development environment, so the development and management of the program must be done by computer. The motion module performs in the motion controller, motion controller is used for processing according to the prepared program. Parameter setting and display module are running on a touch screen. By this way, it can guarantee the system's response speed and control precision, ensure the quality and precision of workpiece machining.

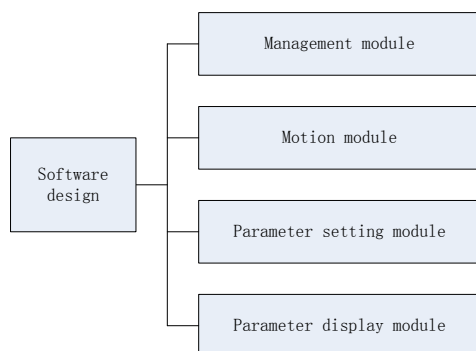


Figure3. The mode of control system

### The program flow design

In order to ensure the bending machine capable of stable operation, program flow must be strictly designed. First the system is initialized, system detects running state, if the system is operating normally, it continues to the next step. Bending machine can run manually, and it can also run automatically, operation mode must be selected before starting work, if adopting manual operation mode, manual operation can be done through the button on the touch screen. If taking automatic operation mode, first, parameter should be set, after all parameters set up, the bending machine can be set automatically according to the system for processing program.

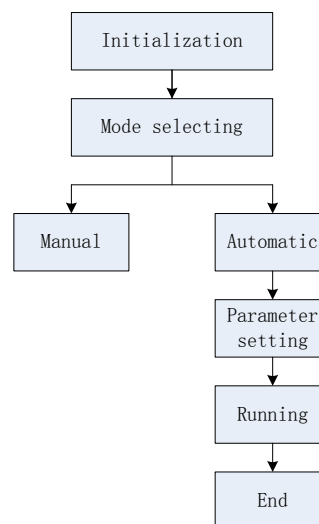


Figure4. Program flow design

### I/O design

Parameters of the system in the bending machine are received and sent through the I/O interface of the controller, including the position signal and the indication signal etc. System design of I/O is shown in table 1.

Table1.System I/O design

Input		Output	
IN0	Position signal 1	OUT0	Indicated light 1
IN1	Position signal 2	OUT1	Indicated light 2
IN2	Position signal 3	OUT2	Indicated light 3
IN3	Position signal 4	OUT3	Indicated light 4

## CONCLUSION

With the development of automatic control technique, the numerical control technology is widely used in various industries. CNC bending machine has become necessary for sheet metal bending, bending machine is the inevitable direction of development. A kind of bending machine is introduced based on motion controller in this paper, motion controller has the advantages of fast response, high control

precision, and good reliability. Bending machine designed in this paper can be set according to the procedure of sheet metal bending, it has automatic and manual two kinds of patterns, and it can meet the practical needs of industry.

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