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Research on Position Control Module of CNC System Based on Windows and RTX

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ABSTRACT: In order to make full use of Windows XP in the PC numerical control software in the process of multi-task function, this paper uses the Windows system kernel real-time expansion method to solve the shortcoming of Windows system real-time; according to the digital integral method, the interpolation increment is interpolated; finally we can make the linkage control of motor through the distribution of these pulse signals.
Keyword: Windows; CNC Digital integral method; Precision interpolation algorithm

I. INTRODUCTION

Open PC computer numerical control system[1] is generally composed by the industry control computer, the position control module and the I / O connection plate. The basic task of the position control module is to improve the feed speed and positioning accuracy under the premise of ensuring the stability of the system. [2] Its performance directly influences and determines the fastness, accuracy and stability of the CNC system. In this paper, the position control module outputs the "pulse + direction" control signal through the parallel port of the PC and sends stepping motor or special servo motor which can accept the pulse signal through the stepping driver. The pulse signal is generated by the high precision timer of Real-time extended RTX in PC host system. The interpolation increment of each axis is the digital quantity. In order to convert the digital quantity into the real-time overflow pulse signal, the method used in this paper is to do fine interpolation for the coordinate increment after interpolation with the digital integration method. The coordinates of the feed pulse is assigned to achieve the linkage of the stepper motor control. In the PC system, there are three parallel port operating modes: SPP, EPP and ECP. RTX environment can directly operate PC parallel port. PC parallel port in the RTX device environment works in ECP mode.[3]

Position control module

Position control module[4], mainly for pulse control of the stepper motor or servo motor, uses parallel interface as a signal interface conversion in the PC host system and stepping driver board. Pulse signal is generated by the PC host system RTX real-time expansion of high-precision clock. Position control in the fine interpolation uses digital integration method, and the entire position control algorithm flow is shown in Figure 1. Before sending the control signal for the parallel port, using the RTX port service, you need to set the parallel port to identify the device in the RTX environment.[5-7]

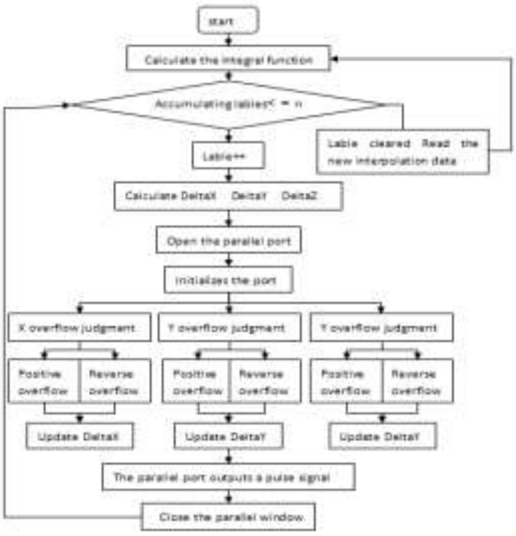

Fig.1 Flow chart of position control module

Digital integral principle

As shown in Figure 2.

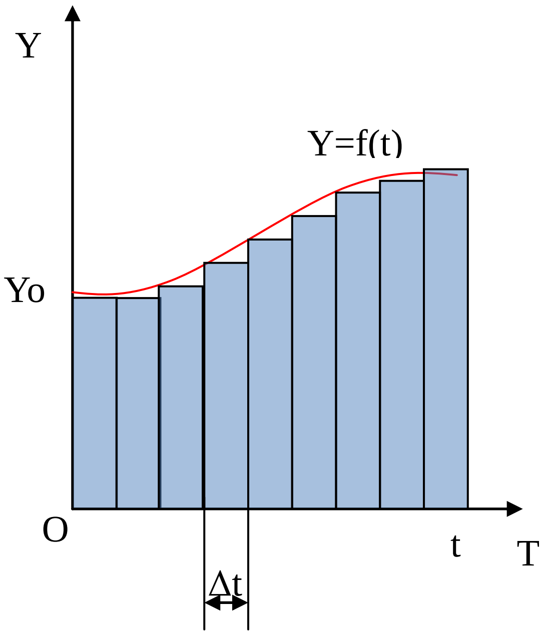

Fig.2 Digital integral principle

From time t = 0 to t, the area enclosed by the function curve can be expressed as:

$$S = \int_0^t f(t)dt \qquad (1)$$

If time t = 0 to t is divided into a time interval of a limited interval, when the time interval is sufficiently small, the formula can be expressed as:

$$S = \int_0^t f(t)dt = \sum_{i=0}^{n-1} Y_i \cdot \Delta t \qquad (2)$$

The integral operation can be approximated by a series of sums of small rectangles. If we take the minimum basic unit "1", then the above equation simplifies to:

$$S = \sum_{i=0}^{n-1} Yi \qquad (3)$$

In fact, this sum-up operation is integral operation and it can be achieved with digital integrator. As shown in Figure 3.

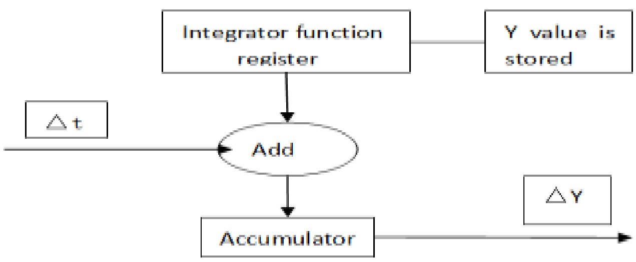

Fig.3 Digital integrator

The Principle of Fine Interpolation Algorithm

As shown in Figure 4, it is interpolated straight line segment. It's starting point is O and end point is P_e. According to the principle of data sampling, the process of interpolating line segment is that micro-line segment, started from the starting point to the end of the line segment, is used to approximate the interpolated line segment continuously.

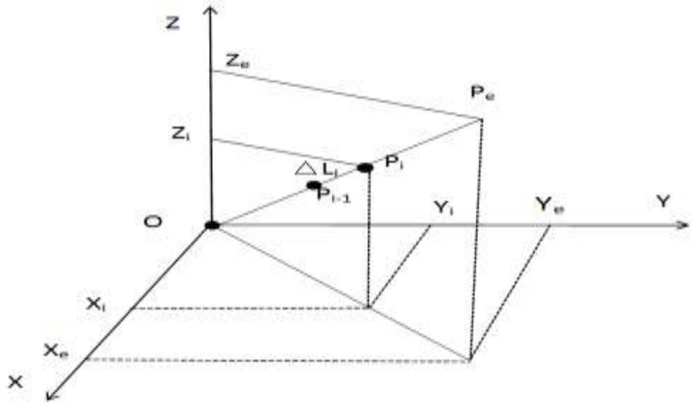

Fig.4 Schematic diagram of spatial linear interpolation

ΔL_i is the increment of the line segment that needs to be interpolated for each interpolation cycle,

$$\Delta L_i = \frac{T \cdot V_i}{1000} \tag{4}$$

In the formula, V_i is the line segment interpolation cycle speed. It can be calculated from the acceleration and deceleration in the calculation of the plan, unit: mm/s.

T is the Interpolation cycle, unit: ms.

The incremental value of the coordinate of the move point is $(\Delta x, \Delta y, \Delta z)$. It can be calculated as

$$\begin{cases} \Delta x = \Delta L_i \cdot N_x \\ \Delta y = \Delta L_i \cdot N_y \\ \Delta z = \Delta L_i \cdot N_z \end{cases} \tag{5}$$

In the formula, N_x, N_y, N_z are the unit vector's ($\overrightarrow{N}$) size of the component in the direction of each axis.

The movement distance of each axis in the interpolation cycle can be calculated as

$$L_x = \int_0^T V_x dt; \qquad L_y = \int_0^T V_y dt; \qquad L_z = \int_0^T V_z dt \tag{6}$$

In the formula, V_x, V_y, V_z is V_i 's size of the component in the direction of each axis.

According to the idea of digital integration, the coordinate increment of each axis in a cycle is divided by rational division in each position and then processed control cycle to determine when to send the pulse. The integral interval $[0, T]$ of an interpolation cycle can be subdivided into λt lengths of n segments. An approximation of Eq. (6) can be obtained by n accumulations,

$$L_x \approx \sum_1^n V_x \lambda t; \qquad L_y \approx \sum_1^n V_y \lambda t; \qquad L_z \approx \sum_1^n V_z \lambda t \tag{7}$$

Because $V_x = \frac{\Delta x}{T}$、$V_y = \frac{\Delta y}{T}$、$V_z = \frac{\Delta z}{T}$ are constants in the integration process and $\lambda t = \frac{T}{n}$, Eq. (7) can be changed to

$$L_x = \sum_1^n \frac{\Delta x}{n}、\qquad L_y = \sum_1^n \frac{\Delta y}{n}、\qquad L_z = \sum_1^n \frac{\Delta z}{n} \tag{8}$$

When the number of accumulations in an interpolation cycle is n, Eq. (8) can be changed to

$$L_x = \Delta x、\qquad L_y = \Delta y、\qquad L_z = \Delta z \tag{9}$$

Implementation of Digital - Pulse Conversion

The calculation of each axis integral function

$$I_x = \frac{\Delta x}{n\varepsilon}; \qquad I_y = \frac{\Delta y}{n\varepsilon}; \qquad I_z = \frac{\Delta z}{n\varepsilon} \tag{10}$$

In the formula, Δx、Δy、Δz can be obtained by Eq. (5) ;

n is the number of accumulations, constants ;

ε is the pulse equivalent, unit:mm/pulse.

In each interpolation cycle, the integral function I_x、I_y、I_z in the digital-to-pulse conversion is only required to be calculated once. The calculation can be carried out in the interpolation module, so that the processing capacity of the position control module can be reduced.

Each position control cycle can be accumulated

$$\begin{cases} DeltaX_i = DeltaX_{i-1} + I_x \\ DeltaY_i = DeltaY_{i-1} + I_y \\ DeltaZ_i = DeltaZ_{i-1} + I_z \end{cases} \qquad 1 \le i \le n \tag{11}$$

In each interpolation cycle, the instantaneous speed of the machine tool is represented by the magnitude of the Δx、Δy、Δz coordinate increment of each axis. In the position control processing module, the cumulative number of times n is a constant value. If more than one pulse is spilled during one interpolation cycle, then it is fast and vice versa.

II. CONCLUSION

Digital integral method is used to calculate the position of each tool control cycle along the axis of the displacement, which can be used to complete a variety of function processing operations. Digital integral method for each step of the instruction is simple and time-consuming, fast operation and more uniform pulse distribution, therefore it can achieve multi-axis linkage control. Through the Digital integral method, digital quantity will be converted to pulse signal, so that real-time extension software RTX can be applied to Windows system, making up for its shortcomings of lack of real-time.

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