geographical location and environment, and it is hoped that the study of green finance will contribute to the further development of the financial industry in the Free Trade Port.

REFERENCES

1. 陈体珠. 双碳"目标下完善绿色金融体系的政策建议—基于福建省绿色金融改革发展实践// 福建金融. – 2022. – №5. – p. 21-25.
2. 王荧,福建江夏学院课题组.福建省发展绿色金融的相关政策框架及战略研究// 发展研究. – 2018. – №3.
3. 纪晓东.«绿色债券支持项目目录 (2021年版)».实现绿债市场标准化 // 新理财(政府理财). – 2021. – №7.
4. 人民银行上海分行印发.上海银行业金融机构绿色金融评价实施细则 //上海节能. – 2022. – №1. – p.67.
5. 胡素琴. 高质量发展背景下绿色金融发展现状及政策建议—以长三角区域为例// 河北金融. – 2022. – №04. – p.34-36.

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ОПТИМИЗАЦИЯ ЧАСТОТНОЙ КРИВОЙ В ШАГОВЫХ ДВИГАТЕЛЯХ УПРАВЛЯЕМЫХ PLC

THE OPTIMIZATION ON THE FREQUENCY CURVE OF THE PLC CONTROL IN STEPPING MOTOR

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В данной статье рассмотрены варианты оптимизации управления работой шагового двигаиеля PLC путем разумного изменения различных параметров кривой частоты вращения шагового двигателя.

In this paper, based on the principle of driving a stepper motor work of the stepper motor drive of the PLC send pulse signals and direction, it can make the PLC control of stepping motor speed optimization by reasonable modifying the various parameters of the stepper motor frequency curve.

Ключевые слова: PLC, шаговый двигатель, частотная кривая, оптимизация
Keywords: PLC, Stepping motor, Frequency curve, Optimization.

1. Purpose of system design.

PLC programming is simple, powerful, widely used in digital control of automatic control systems, in the system through the PLC program to run to control the stepper motor. p LC by running the program, to the stepper motor driver output pulse signals and directional signals, control the stepper motor in accordance with the user's requirements [1]. Stepping motor is a kind of machine equipment that converts electric pulse into angular displacement, it rotates a fixed electric angle every time it receives a pulse signal, and it is possible to control the angular displacement by controlling the number of pulses, so as to make the stepping motor reach the accurate position [2]. Therefore, there must be a certain relationship between the speed of the stepper motor and the pulse frequency, and this relationship can be directly reflected by the frequency curve of the stepper motor.

In this thesis, the optimization method of the frequency curve is studied through the trolley feeding system. In the trolley feeding system, the number of pulses of the stepping motor is controlled by PLC, which ensures that the feeding trolley can accurately arrive at the picking position to pick up materials, and at the same time ensures that the rotation speed of the stepping motor is highly stable and the amount of jitter is small.

The shape of the frequency curve is determined by the number of pulses and frequency parameters. Frequency curve can be seen through the motor's operating conditions, in order to improve the efficiency of the entire control system, must be set up to send the driver the number of pulses of the signal and its frequency parameters, as shown in Figure 1 for the stepper motor three frequency curve.

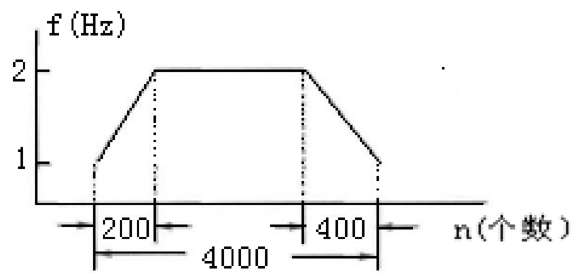

Figure 1 - Stepper motor frequency curve

Figure 1 fully embodies the stepper motor start acceleration, uniform speed operation, deceleration and stopping the movement process, but in the field of industrial control process, we must consider whether the machine is running smoothly, whether there is noise pollution, whether it will bring mechanical wear and tear and so on, so the actual operation of only these three curves is not enough, the specific situation will be more complex. According to the actual situation, we can use 7, 11 or even more segments to optimize the frequency curve of the stepping motor, so that the system runs smoother, to solve the machine's own reasons for jitter, noise, startup effort and other undesirable problems.

2. Optimization of the pick-up trolley in the pick-up system.

2.1. The working principle of the reclaiming trolley.

The pickup trolley system uses Siemens S7-200 series PLC to control the work of stepper motors, through the role of the device, with a material cup, the three parts of the raw material from three positions to send to another position, waiting for processing [3]. The system device mainly consists of two parts, one is responsible for the horizontal direction of travel of the pickup trolley, the other part is responsible for the vertical direction of travel of the robot. The manipulator is mounted on the trolley and controlled by a stepper motor in the vertical direction, while the trolley is controlled by a stepper motor in the horizontal direction. The trolley runs to the material cup, the manipulator lifts the material cup, the trolley drags the manipulator to continue traveling to the designated location of the raw material, take the first raw material, the second original kind, the third kind of raw material, and then pick up the material trolley and then send the material cup to the designated location, the raw material is waiting for processing.

2.2. Analysis of experimental data and optimization of frequency curve.

Here we mainly analyze the frequency curve of the stepper motor for horizontal direction walking control. Due to the different positions of the three kinds of raw materials, the pickup trolley in the process of picking up materials to walk a different distance, sometimes need to walk a short distance, sometimes need to walk a long distance. When the trolley short-distance walking speed should be slow, stable, start and stop to be accurate, to ensure the accuracy of the positioning of the material and the safety of the machine; when the trolley to long-distance walking should be fast, stable, accurate positioning, and at the same time to prevent the equipment shaking, reduce noise.

Therefore, using the three frequency curves in Figure 1 to control the accuracy and stability cannot meet the requirements. Stepping motor drive control of the trolley, through the S7-200 series PLC programming call subroutine to achieve, and the subroutine parameters needed in the PLC envelope table. The control parameters of the frequency curve include the number of segments of the curve, the initial period, the number of pulses, the period increment and so on, for the main program to call. When the trolley needs to walk a long distance, in order to make the trolley run more smoothly, according to the relationship between the operating frequency of the stepping motor and the step length, the stepping frequency curve in Figure 1 can be divided again and changed into a seven-segment frequency curve. As shown in Figure 2.

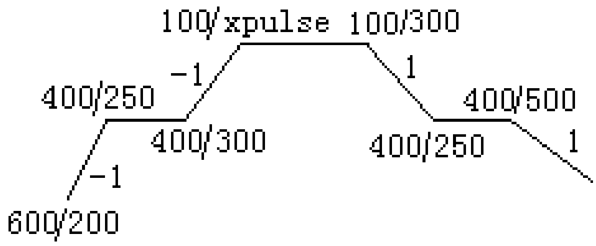

Figure 2 - Seven-segment frequency curve of stepper motor

Figure 2 shows the modification of the characteristic curve of the stepper motor to a seven-segment characteristic curve by modifying the envelope table data parameters in the PLC program, including the initial period, the number of pulses, and the period increment of each segment of the curve. The starting position of each curve segment is marked in the form of cycle value (us)/number of pulses (one). The data in the part of the curve whose slope is not zero represents the cycle increment of the curve, and the part of the curve whose slope is zero indicates that the stepping motor drives the trolley to move at a constant speed, and the number of pulses in this part represents the time of the trolley moving at a constant speed. Using Ta to represent the initial period of each curve section, Tb to represent the end period, X to represent the period increment, and P to represent the number of pulses, the period of each curve section and the quantitative relationship between the number of pulses and the period increment are as follows.

$$X = (Tb - Ta) / P \qquad (1)$$

According to Fig. 2, the end cycle value of each segment of the stepper motor cycle curve is equal to the initial cycle value of the next segment, so the initial cycle of the next segment of the curve is calculated by Eq. (1) as

$$Tb = XP + Ta \qquad (2)$$

In Fig. 2, if the initial period of the first curve is 700, the number of pulses is 300, and the period increment is - 1, the initial period of the second curve can be calculated by Eq.

$$(-1) \times 300 + 700 = 400$$

The initial period values of the third and fourth curves are calculated according to equations (1) and (2). Stepping motor startup acceleration time can not be too long, startup acceleration time is too long, resulting in insufficient starting torque to cause the trolley does not move up.

According to the formula (1) and formula (2) frequency curve segment formation principle, in the short distance traveling can be set according to the need for three or seven driving, when the long distance traveling can be reasonable settings for the number of pulses and the initial period, set to eleven a section, fifteen segments of the speed and other frequency curves, so that the system is smoother, the cart acceleration and deceleration is smoother, and the noise is lower.

3. Conclusion.

PLC has the advantages of simple structure, high stability, high cost-effective, widely used, widely used to drive motor equipment to control stepper motor work. Practice has proved that it is feasible to change the frequency curve of stepper motor to multi-stage by reasonably modifying the initial period and pulse parameters of the frequency curve. It can not only improve the speed of stepper motor driven equipment, but also reduce the noise and loss, so that the stepper motor works better, improves the operating efficiency of the equipment and reduces the maintenance cost. Therefore, it is beneficial to optimize the frequency curve of stepper motor, which is worth promoting and applying.

REFERENCES

1. 周建清. PLC在机床电气控制中的应用 // 电子元器件与信息技术. – 2020. – №11.
2. 郑荣. PLC技术在电气工程及其自动化控制中的应用实践 // 张菁华;焦言兵.光源与照明. – 2023. – №02.
3. 王彦博. PLC技术在电气工程及其自动化控制中的应用分析 // 电气技术与经济. – 2024. – №01.

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