

# Research and Design of Motor Control System Based on Labview PCI

**Gengcheng Chen, Yaping Lu**

Applied Technology College of Soochow University, Suzhou 215325, China

345815749@qq.com, luyaping1982@126.com

**Abstract.** Using virtual technology (labview) to study and design a kind of system software to detect and control DC motor. Functions include three parts: detection and analysis of motor speed frequency, forward and reverse rotation detection of motor and PID speed control. Using Alta PCI8932 signal acquisition card as a virtual software data input and output platform. Using labview software for interface and program design, mainly related to user interface design, data input and output design, speed detection design, motor forward and reverse rotation detection design and PID control design. Through the non-contact detection method, the motor speed detection and control can be realized.

## 1. Introduction

When the motor is more and more popular now, more and more motors are used in the field, The demand for the motor itself is rising rapidly, So convenient and efficient measurement of the motor is very important. Speed is an important feature of the motor, it is a main factor to measure if the motor or mechanical power device can run smoothly and stable operation, it is the important intelligent control of motor feedback variables. With the development of computer technology, the servo system software has a broad application prospects.

In recent years, with the development of new control theory, in particular, the rise and continuous maturity of intelligent control, coupled with the development of computer technology and microelectronics technologies, has enabled the integration of advanced control strategies based on intelligent control and traditional control strategies based on traditional control theory. Put higher requirements on servo control systems, including: Ability to start frequently, brake and fast forward and reverse switching; to achieve high performance torque, speed and position control; and has excellent stability and control accuracy, system response frequency and so on.

Virtual technology is regarded as one of the three core technologies in science and technology in the twenty-first Century. In the late 1980s, the United States developed a virtual instrument. The development of virtual instrument marks a new direction in the field of automatic test and electronic measuring instrument. It is widely used in aerospace, intelligent transportation, automotive, machining and other fields. The use of virtual technology can overcome the limitations of traditional instrument functions when they are manufactured and can not be changed. Many functions are directly set up by software. At present, computer and related technologies, for example, the development of data acquisition card, the measurement and control technology is pushed to a new development stage, and the test control system based on virtual instrument is started<sup>[1]</sup>.



## 2. System overall design

Using Labview as the design software of the system, the software is mainly characterized by powerful software instead of hardware, G programming language, which is beneficial to the analysis. And it has many functions, such as numerical analysis, signal processing and device driving. PCI8932 signal acquisition card is a kind of data acquisition card based on PCI bus, which can be directly inserted into any compatible computer PCI slot, and is widely used in various fields such as laboratories and product quality inspection centers. The card includes single-ended 16-channel and dual-ended 8-channel analog input channels, 2-channel analog output channels, 12-bit precision conversion resolution, and 16 digital input and digital output.. At the same time, the PCI device provides dedicated function interfaces, including device object operation functions, AD sampling operation functions, and DA sampling operation functions.

PCI8932 data acquisition card is used to collect signals from sensors. Carry out the front panel interface design and Block Diagram program programming. The front panel interface design is mainly for customers, the pulse waveform, motor speed, motor positive and negative state, PID parameter settings are presented to the user. The design of the Block Diagram mainly involves all aspects of the processing program. The main program design, forward and reverse program design, PID control program design are combined with each other.

A small magnet is mounted on the shaft of the motor, and two Holzer sensor elements A and B are located near the shaft. When a magnetic object approaches one of the Hall elements, The magnetic field inside the Hall sensor changes to generate a Hall electromotive force. And through the signal amplification module, the electromotive force of the periodic pulse is collected by the signal acquisition card displayed in the labview software. At the same time, the pulse waveform frequency is converted into the motor speed or motor speed reduction ratio through labview programming.

At the same time rely on the shaft side A, B two Hall elements, used to determine the motor steering (clockwise, counterclockwise), The steering is determined by the sequence of the small magnets passing through the AB elements. After the motor rotates, the two Hall elements produce two pulses, By comparing the sequence of the falling edges (or rising edges) of the two pulses in the same cycle, the direction of rotation of the motor is determined. Motor speed control is divided into manual control and automatic control, Use the ordinary knob to input 0-5V voltage on the driver for manual control, Use PID control algorithm and DA analog output to realize automatic control<sup>[2]</sup>. As shown in figure 1.

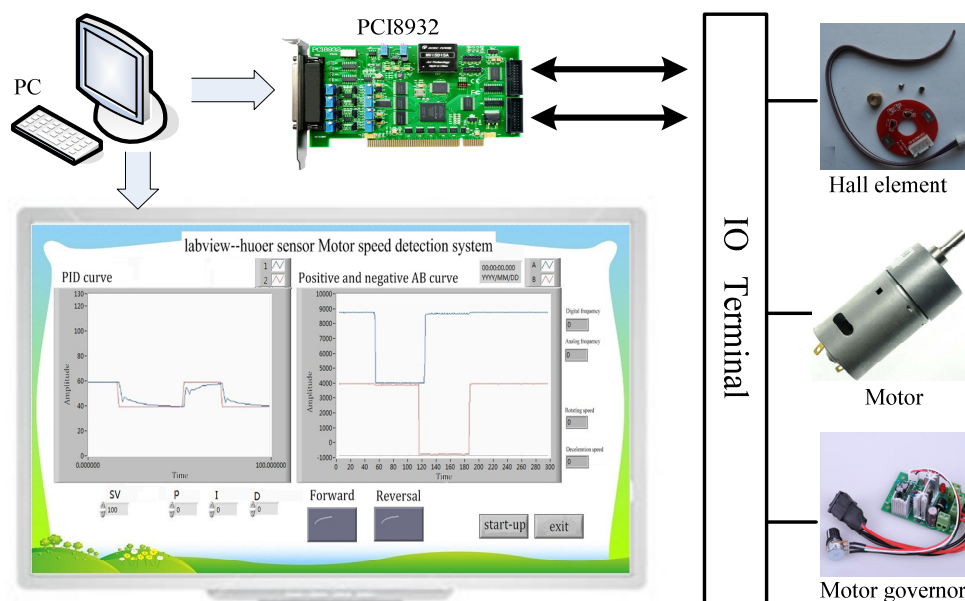


Fig. 1 System overall design process

### 3. Labview front panel design

As shown in figure 2, the front panel is a customer-oriented window, so the front panel interface design needs to be popular and convenient. The interface design needs to reflect the design style of the entire system. Front panel design Main content:

①Motor forward and reverse AB curve design: Using the waveform graph control to carry out post processing of the data that has been collected, Display the pulse waveform of AB Holzer sensors. The forward and reverse state of the motor is judged by comparing the waveforms. Since the control cannot display two or more waveforms in columns, it is necessary to make programming adjustments in Block Diagram to separate AB waveforms. And use the BOOL lamp control to reflect the current motor steering.

②Motor speed PID adjustment curve design: Using the waveform chart control as a record chart, the speed setting value (SV) and the rotational speed measurement (PV) data are displayed in real time in the coordinate axis, reflecting the real-time variables of the measured data. And use three input numeric controls as the values of the three parameters of the PID.

③Motor parameter data display design: The data display controls are used to complete the 4 data display of the digital frequency, the analog frequency, the motor speed and the deceleration specific speed, and the data control controls are used to complete the 4 data input of setting values (SV), P, I and D<sup>[3]</sup>.

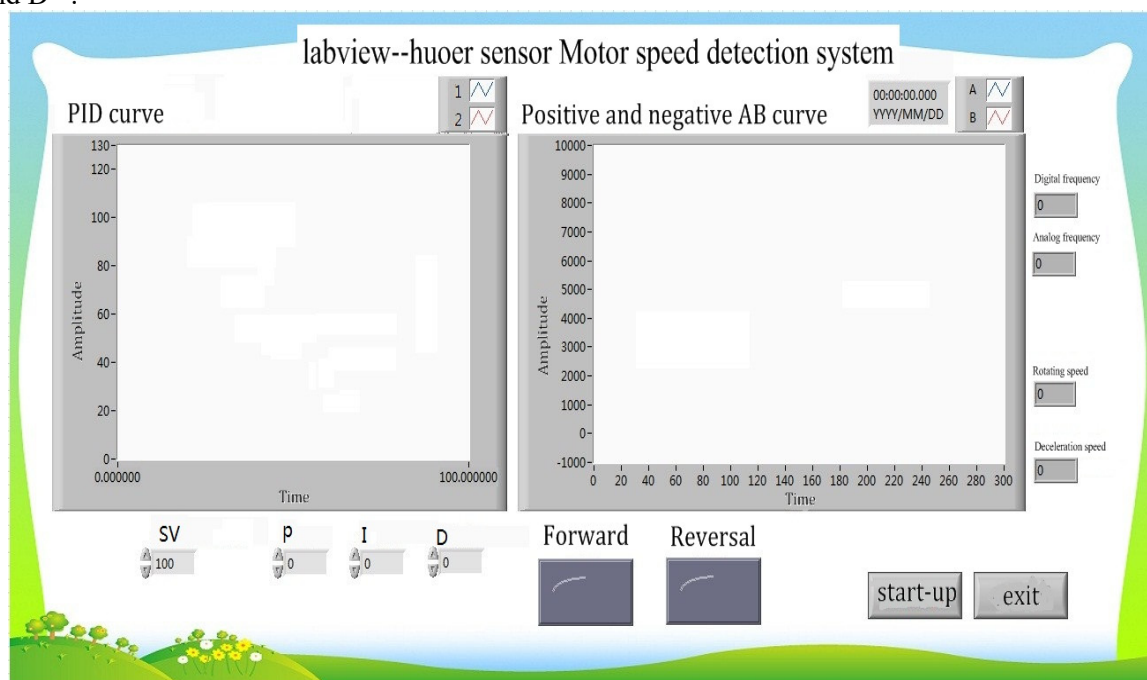


Fig. 2 User interface design

### 4. Speed measuring program design

The Holzer sensor outputs the signal at the pulse frequency, using the data acquisition function to output the collected signals in the form of an array(Array Array2). After the calibration conversion (2000/8192), Array (ADbuffer ADbuffer2) obtained the pulse signal data of the Holzer sensor. In the program design, the single-frequency signal VI module is used to extract the digital frequency of the output waveform. And the analog frequency is obtained by multiplying the sampling frequency (22252), thus obtaining its rotational speed, and finally showing its deceleration speed (the reduction ratio is 1:98). Speed formula  $n=60f/p$ , Unit R/min. At the same time, the detection data of the AB two Holzer sensor are displayed on the waveform graph through the Bundling function, Through the offset programming (-0, -10000), the two waveforms are separated and displayed. As shown in figure 3.

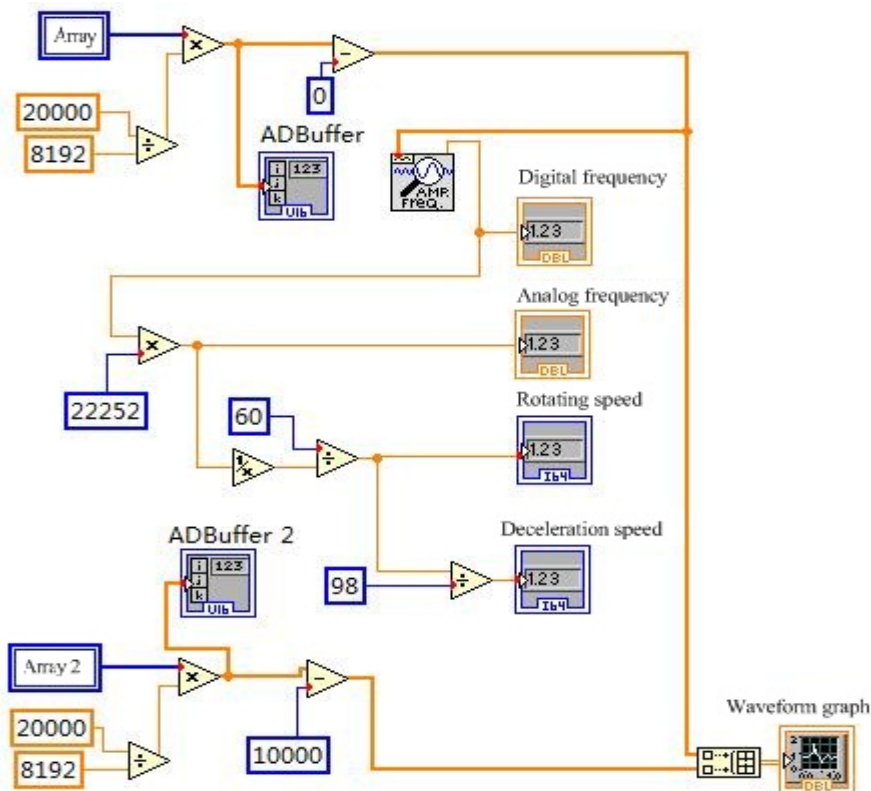


Fig. 3 Graphic program for speed detection

### 5. Forward and reverse detection program design

In the motor, clockwise rotation is positive, and counterclockwise rotation is reversed. Judging whether the motor is performing forward or reverse at this time, the array ADBuffer and ADBuffer2 can receive the data from the two Holzer AB respectively, And through the program analysis to achieve positive and negative detection. The design uses Boolean transformation (pointwise) module VI, Where 1 represents the conversion direction of the BOOL value (false-true), and when the ADBuffer value changes from 0 to 1, the trigger module output parameter is 1. CASE structure is used to determine the data state of ADBuffer2 at this time, when ADBuffer2 is 1, determine the motor is positive, and ADBuffer2 is 0, determine the motor is reversed, as shown in Fig 4, 5 and 6<sup>[4]</sup>.

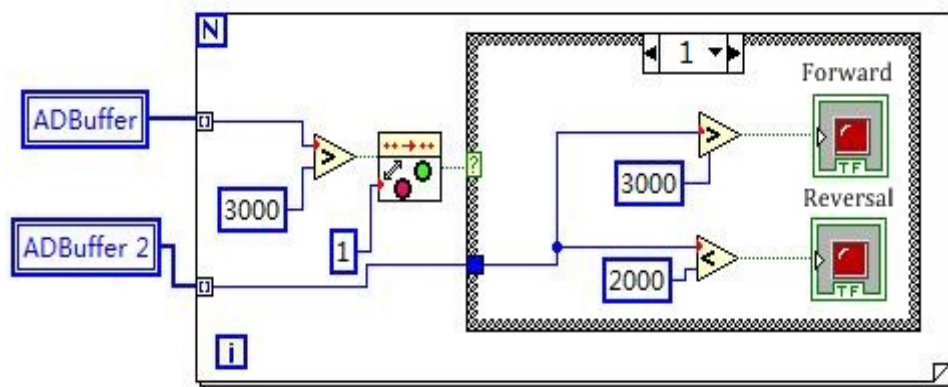


Fig. 4 Forward and reverse detection of graphical procedures

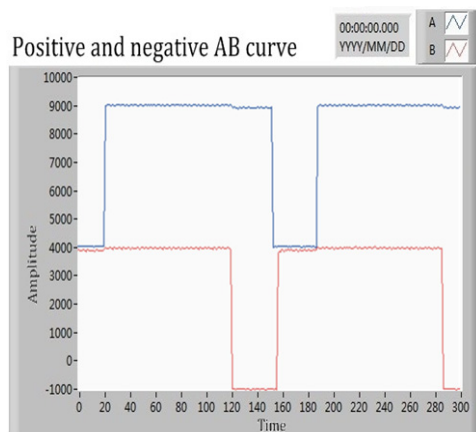


Fig. 5 The AB waveform curve during forward rotation

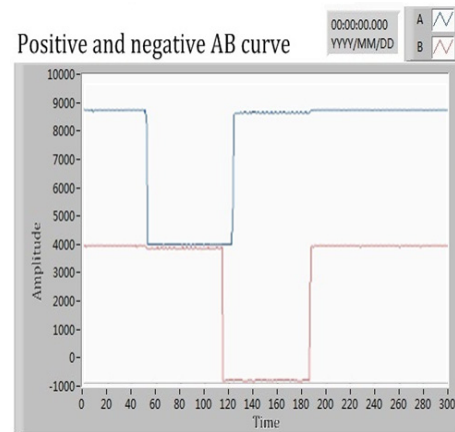


Fig. 6 AB waveform curve during reversal

## 6. PID control program design

Using the PID toolkit in Labview, graphical programming to connect related parameters, to achieve the motor control regulation. Using a numeric input control as a set value (SV), the real-time speed measurement (PV) as the controlled input. Proportion, Derivative, Integral are bundled to the incremental module in the PID module. The output range is limited between 0-4095 clusters because the output WriteDeviceDA is a data output module of the DA analog quantity, whose range is 0-5V, and the corresponding data is 0-4095, as shown in figure 7.

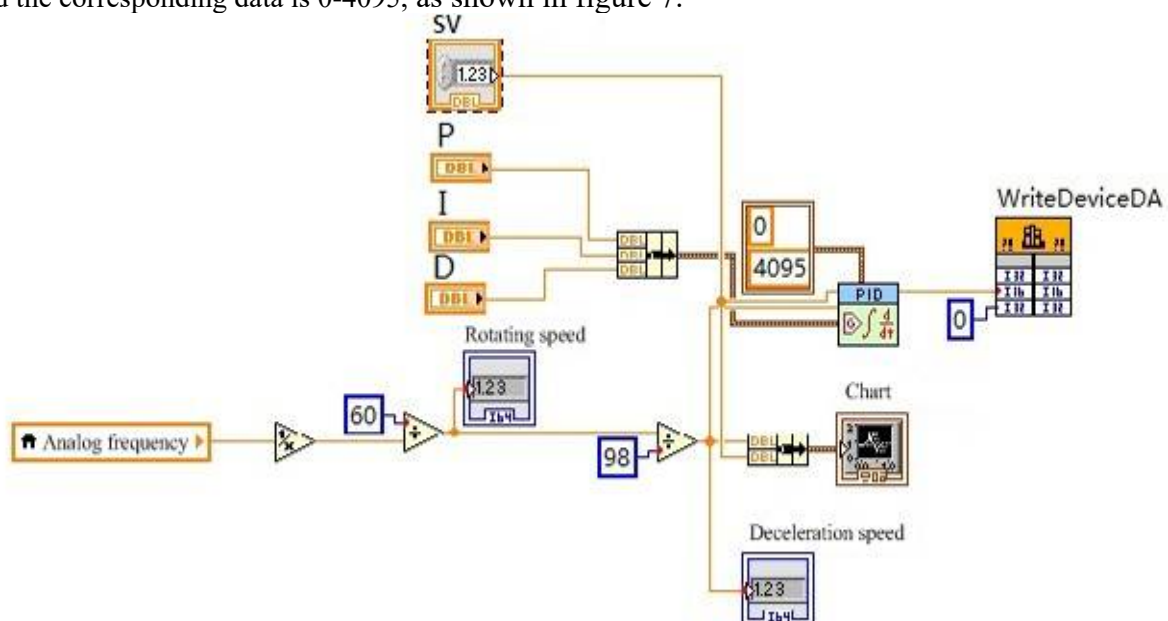


Fig. 7 PID Control graphical program

## 7. System debugging

Complete the front panel and block diagram of the design, debugging the system. As shown in figure 8. The beginning of the speed close to 60r / min, when the setting value (SV) is changed to 40 r / min, through the PID control, the speed is rapidly approaching to the set value as time increases. When the set value (SV) is changed to 60 r / min again, the speed was gradually increased to 60r / min. It can be seen from the figure that there will be a steady-state error at the beginning, and then the error will be reduced through the integral term<sup>[5]</sup>. As shown in figure 8.



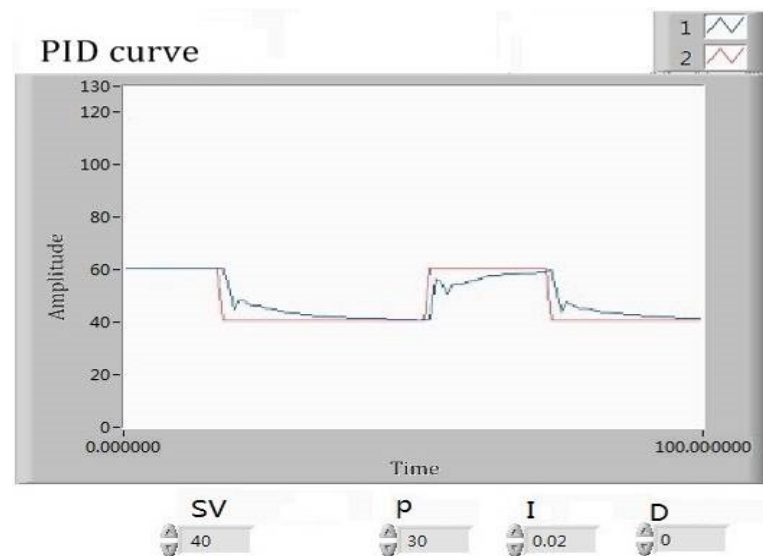


Fig. 8 PID Control waveform

## 8. Summary

The project will be the introduction of virtual technology to the servo motor control system design, Utilize Labview software to develop the system of motor speed detection, motor positive and negative rotation detection and motor speed control. It uses a small amount of hardware to complete the measurement and control of the entire motor speed, improve the accuracy and efficiency, and can achieve a better interface design. Using non-contact test method, it is very convenient to measure the motor speed. The use of virtual technology, using PC can be easier to analyze the motor speed, accurate and intuitive detection of the motor running status, easier to achieve PID control. And can be used for different types of servo motor drive requirements, and software online modification and upgrading is more convenient. At the same time, the program can innovate and improve some existing problems in traditional motor speed measurement and control.

## Acknowledgment

Yaping Lu is the corresponding author. Project Source: Jiangsu Province College Students Innovation and Entrepreneurship Training Program. No: 201713984001Y. And the paper was funded by the "Blue Project" of Jiangsu Universities in 2017. No. QLGC201701.

## References

- [1] Jianqiang Ding,Xiao Ren,Yaping Lu:Computer Control Technology and Application (Second Edition),qinghua university press 2017
- [2] Yaping Lu,Tianlin Song:algorithm and implementation of digital PID based on MCGS-DDC. Information technology and computer application engineering(ITCAE2013),CRC Press(2014), Pages 131~134
- [3] Yaping Lu,Tianlin Song:influence of silicon controlled rectifier voltage regulation device under DDC-temperature control. mechatronics and intelligent materials(MIM 2013), AMM Press.(2013),Pages 826~829
- [4] XiaoLu Tang,YaPing Lu:The design of regional environmental monitoring system based on labview,Environment,Energy and Applied Technology,Taiwan,2015,CRC Press Taylor&Francis Group publisher,Pages 83~86
- [5] Chen Da,YaPing Lu,Min Hu:The design of environmental monitoring system based on STC single chip microcomputer,Environment,Energy and Applied Technology,Taiwan,2015,CRC Press Taylor&Francis Group publisher,Pages 401~404