Design and Research of Video Photoelectric Spectrometer

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ABSTRACT

In this paper, the traditional spectrometer is refitted to solve the limitations of the eyepiece observation, the low adjustment efficiency and the inconvenience of mechanical counting in darkroom operation. Replace the eyepiece observation with the CCD imaging, use the optical disc as the mechanical count of the sensor-assisted angle plate, and use the embedded level to improve the regulation efficiency. The refitted spectrometer has the advantages of precise technique, convenient operation and high experimental efficiency. But it does not change the steps of simplifying the experiment, and also it has achieved good results in the experimental teaching.

KEYWORDS

Spectrophotometer. Video frequency. Automatization. Improvement

INTRODUCTION

The laboratory is an important base to train students’ comprehensive ability and the experimental teaching is an important approach to quality education for college students[1]. In order to meet the teaching reform of college physics experiment course and to improve teaching quality, We introduce modern
technology into high-tech elements today in the teaching, the application of CCD technology in the spectrometer experiment, the optical imaging signal in the photosensitive surface of CCD, by CCD camera to achieve the conversion of image signal is displayed on the monitor screen, while using digital logic circuit to realize digital measurement, design of video photoelectric spectrometer instrument. On the basis of ensuring the students' practical ability, it is easy to operate, intuitive and easy to measure accurately. After the instrument has been put into practice, good results have been achieved.

THE DESIGN OF VIDEO PHOTOELECTRIC SPECTROMETER

Video Design

The project uses CCD imaging technology; the optical image signal is magnified and imaged on the photosensitive surface by a microscope and then by the CCD camera to achieve the image signal photoelectric transition. Output video signal sent to the composite network and the measurement line pulse complex. The composite video pulse is sent to the monitor to display the image of the object to be displayed on the screen. To achieve automatic angle measurement, directly on the monitor image observation, expand the field of view, easy to adjust [2], in order to replace the microscope from the eyepiece to observe the image of the way.

The CCD sensor is divided into the formation and the matrix, the matrix response is fast, the precision is high, but the price is more expensive; the formation price is relatively cheap, and its response speed and accuracy can meet the requirements of general testing, and it is widely used. It has the function of photoelectric conversion, signal storage and transmission. It is more and more widely used in experimental teaching. [3]. Considering the cost of the system, the array CCD sensor is adopted. Each pixel of CCD array on a photosensitive element, when the light changes, the analog voltage output of each pixel will change by filtering, amplification, A/D conversion front-end signal processing, signal into DSP, after DSP treatment, such as gamma correction, color transformation, such as video format conversion, signal transmission to the video encoding chip processing, the formation of standard video formats such as CVBS, YCBCR, VGA, HDMI, sent to the display for display.
Angle Digital Design

The optical disc is used to realize the digital measurement of the angle, the optical code is mounted on the surface of the angle plate, and the optical disc is rotated by the rotation of the angle disc. The optical code pulse signal is transmitted to the composite line, the pulse signal into an angle digital signal displayed on the display, to achieve the angle of digital measurement of the angle to replace spiral micrometer method. Make the count more intuitive and convenient, at the same time does not affect the mechanical. When counting, press the “Start Count” key when the reflected cursor is aligned with the start counting position. When the reflected cursor is aligned with the end count position, the “stop count” key is pressed and the counter automatically calculates the angle difference between the two positions back and forth, that means the value of $|\theta_1 - \theta_1'|$ or $|\theta_2 - \theta_2'|$. 
Design of Level Adjustment Device

When the students in the experiment carried out rough adjustment, the visual inspection platform, the telescope and the collimator were horizontal. Without reference as a standard, the adjustment cannot reach the desired effect, increasing the difficulty of adjustment, and sometimes cannot even finish the experiment [4].

To solve this problem, this project uses embedded level instrument to solve the complexity of the adjustment of the stage and the microscope in the experiment.

A collimator is inserted on the surface of the collimator, the object platform and the telescope to reduce the complexity of adjusting the cross image of the reflecting cross image and the cross of the reticle, thereby improving the regulation efficiency.

![Horizontal regulation design drawing.](image)

**EXPERIMENTAL DATA AND ANALYSIS**

In this experiment, the vertex angle of prism was measured by autocollimation. The prism angle $\angle A$ of the prism with the improvement of the spectrometer to measured from beginning to end. From the contrast can be found, the modified angle value in the accuracy and accuracy meet the requirements, but the experimental efficiency has been greatly improved.

| times | $T_1$ | $T_2$ | $|\theta_1-\theta_1'|$ | $|\theta_2-\theta_2'|$ | $\angle A$ |
|-------|-------|-------|----------------------|----------------------|---------|
| 1     | 240°24′ | 0°22′ | 180°22′ | 119°58′ | 119°58′ | 60°2′ |
| 2     | 271°18′ | 31°20′ | 211°18′ | 120°2′ | 120°1′ | 59°58′30″ |
TABLE 2. IMPROVED EXPERIMENTAL DATA OF SPECTROMETER (50 MINS).

<table>
<thead>
<tr>
<th>times</th>
<th>$T_1$</th>
<th>$T_2$</th>
<th>$\angle A = 180^\circ - \theta'$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>119°59'30&quot;</td>
<td>60°30&quot;</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>120°14'5&quot;</td>
<td>59°58'15&quot;</td>
</tr>
</tbody>
</table>

CONCLUSIONS

After the improvement of experimental instruments, students can not only master the adjustment and use of spectrometer, but also have more regular, orderly and step-by-step experiments to complete the experiment without being blind. It not only makes the students obvious improvement in the experiment effect, but also greatly improves the experimental efficiency, and has achieved very good teaching effect.

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