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# *Research on Target Recognition Algorithm Based on Multi-Channel Polarization Image*

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***Abstract:*** In order to improve the target recognition ability of polarized images, a multi-channel based polarized spectral imaging system is designed. By analyzing the spectral characteristics of the target, the overall design scheme of the spectral target recognition system is proposed. On this basis, a spectral imaging system is built, a static Fourier transform interferometer is designed, and an optical receiving antenna is designed, so as to obtain the spectral distribution data of the target through the spectral target recognition system. Through the target comprehensive experiment, it can be seen that when the spectral target recognition imaging technology or the polarization target recognition imaging technology is used alone, the target recognition image is unclear or even unrecognizable when the background environment or target camouflage methods are different, and the image fusion technology is used. After changing various environmental conditions and target camouflage methods, the system can obtain better target recognition images.

## 1. Introduction

In the process of military application, it is very important to effectively identify the measured target under complex conditions [1]. An important research direction is derived: quickly and effectively identify such targets, which is also an important exploration content in battlefield surveillance, intelligence reconnaissance and target identification. Extracting the target image from the visible light image of the detection boundary is the main implementation method of target recognition technology in the traditional field. Acquire visible light images. At the same time, the discrimination skills of the system will be significantly affected when the target is camouflaged or obscured. Therefore, it is of practical significance to study the target recognition system that is not disturbed by the environment or is less disturbed by the environment. Spectral distribution characteristics and polarization characteristics of light are the two main characteristics of optical information. The method of establishing two-dimensional image data and the spectral image data cube of the spectral distribution data at the corresponding point position is a target recognition technology about spectral characteristics; The light source illumination needs to measure the area is the target recognition technology about the light polarization characteristics, because the measured target is often metal such as tanks, armored vehicles, etc., the polarization characteristics are more obvious in the metal, so the target can also be effectively identified in the polarization imaging system. The method of polarization imaging is highly targeted, but the occlusion and camouflage of the target will have a great impact on it, and there will be a significant depolarization effect.

The bidirectional reflectance measurement system based on polarized light was designed by NASA indoors and realized the measurement research of the target. The instrument for detecting polarization and directionality launched into space orbit is made in France. The instrument contains 8 channels, 3 of which are polarization channels. Clouds, atmospheric aerosols, and the surface state of land and oceans can be observed by technicians through the instrument. [2]. Polarization imaging was used by Demos et al. to study the human palmar epidermis. They irradiate the sample with the laser emitted by the dye laser, and the image is collected by the CCD camera. By changing the angle of polarization, the surface information and deep information of the sample can be obtained [3]. The British Defense Science and Technology Laboratory launched the MIN-DER project to conduct detection research using polarization imaging technology [4]. New York University's polarization target recognition of the B-52 aircraft can achieve long-distance detection. The Anhui Institute of Optics and Fine Mechanics of the Chinese Academy of Sciences has produced a corresponding principle prototype using a multi-band camera, and has obtained a large number of polarized image data using linear polarization remote sensing technology. The measured polarization imaging was obtained [5]. Using polarization de-noising technology to collect aircraft polarization images can effectively suppress noise. This technology was researched by Northwestern Polytechnical University [6]. The existing target recognition algorithm based on polarization technology is mainly realized by a single polarized light source, so this paper proposes a target recognition algorithm based on multi-channel polarized image.

## 2. Manuscript Preparation

The Fourier transform spectrum is a spectrum obtained by applying Fourier transform to the interferogram obtained by a two-beam interferometer. The interferometer can form two beams of coherent light, control the optical path difference, and allow the two beams to interfere, thus obtaining an interferogram. In order to obtain a spectrogram, it is necessary to apply Fourier transform to the interferogram. The Fourier transform spectrometer uses frequency demodulation, and different frequencies modulate light of different wavelengths, which is different from the dispersion spectrometer. The Fourier integral transform is used for demodulation, and finally different wavelengths can be obtained. spectral information.

Assume an ideal collimated monochromatic beam *a* with an amplitude *v*, the reflectivity of this beam is *r*, the transmittance is *t* on the beam splitter BS and is an ideal beam splitter, the beam splitter decomposes this beam The reflected and projected beams of different amplitudes are formed. The amplitudes of the reflected and transmitted beams are $r_a$ and $t_a$ respectively. The reflected and projected beams pass through the fixed mirror and the moving mirror and are then reflected, and finally return to the beam splitting plate, and pass through the plate again to become Two coherent beams, one beam returns to the light source, and the other beam propagates in the direction of 90 with the incident direction, and finally imaged on the imaging plane, there is

$$I(l,v)=2RTB_0(v)\left(1+\cos\varphi\right) \tag{1}$$

Among them, $R=r\cdot r^*$, is the light intensity reflectance, $B_o(v)=a\cdot a^*$b represents the beam intensity, $T=t\cdot t^*$ is the light intensity transmittance, $l$ is the optical path difference, $\varphi=2\pi\cdot v\cdot l$ is the phase difference of the reflected light.

Because the spectral shape is determined by the AC component, the DC component can be ignored, and finally we have

$$I(l,v) = B(v)\cos\left(2\pi vl\right) \tag{2}$$

Where B v =2RTBo v is the corrected light source intensity.
The light source is spread spectrum in the application, and its interference function is

$$I(l) = \int_0^\infty B(v)\cos\left(2\pi vl\right)dv \tag{3}$$

Finally, the spectral distribution curve has

$$\begin{cases} I(l)=\left\{B(v)\right\} \\ B(v) = F^{-1}\left\{I(l)\right\} \end{cases} \tag{4}$$

The optical path difference corresponding to the resolution of the Fourier spectrum, the spectral resolution of the maximum optical path difference is:

$$R_v = 2vl_{max} \tag{5}$$

## 3. System Design

The spectral acquisition system and the polarization data acquisition system constitute the polarization spectral imaging system. The spectral acquisition system has been achieved in the previous section using the design of the interferometric system. In this section, the polarized imaging system will be designed. The overall structure of the polarization imaging system is shown in Figure 1.

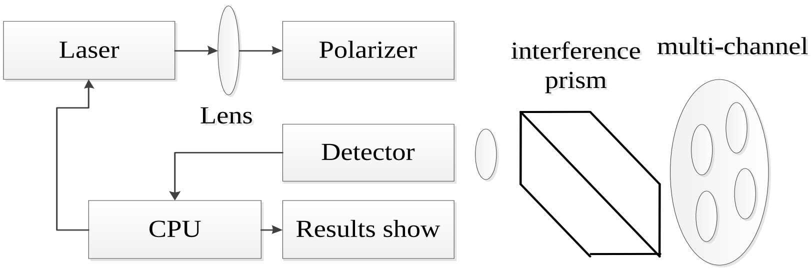



Figure 1: Multi-Channel Polarization Spectral Imaging System

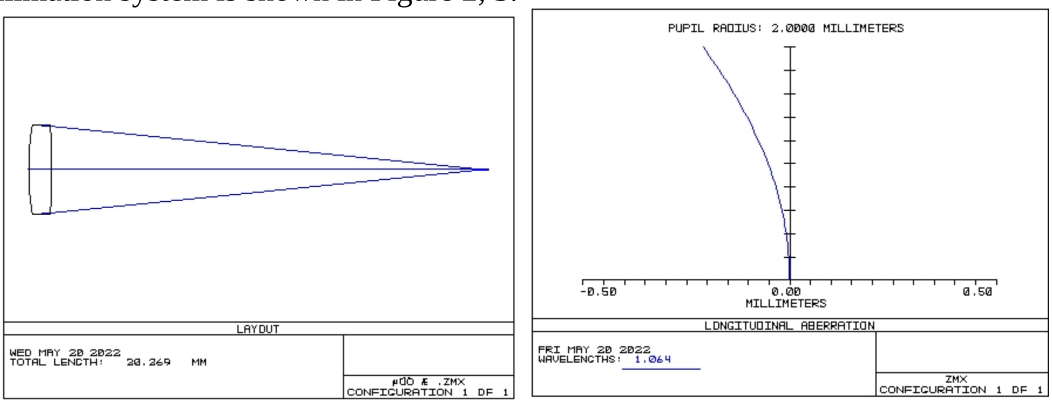
The laser entering the magneto-optical modulation crystal is emitted by the polarizer, and the target area is irradiated by the polarized light. After the echo light is shaped by the focusing and collimating system, it is incident on the CCD detector through the analyzer. Compared with visible light imaging, because of the use of a magneto-optical modulation system, only the light that conforms to the linear polarization characteristics in the echo optical signal can echo with the CCD detector, and the modulation characteristics of the local oscillator signal are the noise of the same polarization angle in the background. Astigmatism does not have. Therefore, a better image of the target can only be achieved if the surface material and topography are highly continuous, and the target signal can not be covered by background noise, because it has camouflage camouflage, which is caused by other backgrounds and irregular interferences. due to depolarization effects. The polarization dimension data information of the polarization spectrum image is composed of the polarization information collected by the polarization system and the two-dimensional image of the boundary to be measured. At the same time, the spectral imaging system adopts a static interference system (composed of an interference module, a detector, and a spectral database). Lie transform to achieve the extraction of spectral distribution. The spectral dimension information of the spectral image consists of this spectral distribution. In order to obtain the four-dimensional data volume of spectral polarization, the three information of two-dimensional space image information, spectral dimension information, and polarization dimension information need to be processed uniformly. Finally, the target is identified by combining the algorithm.

The structure of the system can also be combined as a whole, the polarized light receiving and the optical antenna are combined, and the polarized light of the echo is directly analyzed and coherently processed, and a single exposure can be formed to complete the synchronous collection of spatial two-dimensional images, spectral information and The result of polarization information, and the structure is more and more compact. However, such an architecture needs to demodulate the polarization information when the echo light is interferometrically processed, which increases the difficulty of the verification system design, and also reduces the target recognition ability of the system because the amount of demodulated data is reduced.

## 4. Simulation Analysis

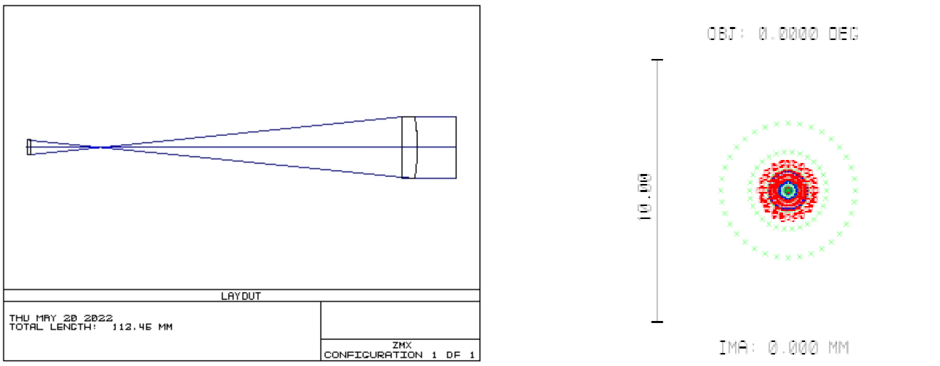
### 4.1. Optical Path Simulation

In the system, in order to improve the coherence efficiency, the interferometer ensures the parallelism of the incident light, and the aliasing order of the outgoing light is specified. The design of the collimation system is shown in Figure 2, 3.




(a) Optical path diagram (b) Spherical aberration diagram

Figure 2: Single lens simulation design




(a) Optical path diagram (b) Spherical aberration diagram

Figure 3: System optical path simulation design

## 4.2. Detector Selection

Since the laser selected in the experiment is visible light, the conventional CCD detector can meet the requirements in the system design, and then according to its central wavelength position of 550 nm, the conventional CCD detector with higher efficiency is selected in terms of relative quantum efficiency. Can. From the point of view of dark current and noise, its requirements in CCD detectors are relatively low. Since the system selects a static M-Z interferometer, the instrument has no slit design, so it has a larger luminous flux and a higher signal-to-noise ratio. , From the perspective of clock frequency, CCD detectors can meet the conversion rate required for real-time output of system target recognition. To ensure the acquisition speed of spectral data, the more convenient area array CCD detectors were not selected when choosing CCD detectors. .

The effective detection length of the linear array CCD detector exceeds the width of the effective area of the outgoing interference fringes. This is the size requirement of the CCD detector, that is, the vertical incidence width of the interferometer (a=30mm) above, which can maximize the more Interference fringes are obtained in large boundaries. From the inversion of its spectral distribution function, more high-order terms can be obtained in the spectral distribution function, thus improving the inversion accuracy.

## 5. Experiments

For the above-structured polarization detection system, the polarization data of the system should be detected initially, and the accuracy and stability of the system should be ensured when the polarization degree of the measured target echo data is checked. The semiconductor laser selected in the experiment is 550nm, and the outgoing light is passed through the polarizer, and these polarizers are required to have different degrees of polarization. Check the detection characteristics of the system, which are related to polarized light. On this basis, the incident light becomes the radiation light in the background range. In order to obtain the polarized image of the radiation light, the detector needs to be converted into an area array CCD detector.

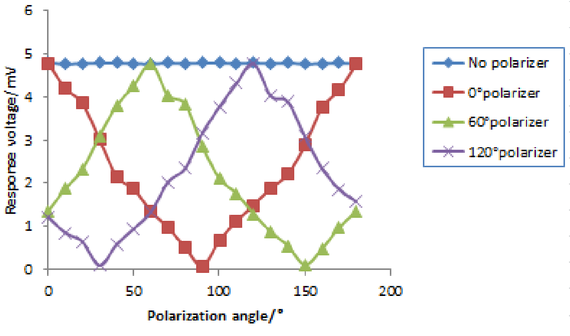



Figure 4: Test curves of different channels

The response voltage data table under different polarization angle conditions received by the photodetector is shown in Figure 4. In order to test the response voltage value of the system to the echo light under the condition of different polarization angles, the polarization angle of the analyzer with respect to the polarizer needs to be adjusted. When an empty lens is used, that is, no polarizer is installed, there is no polarization effect on the light, that is, when different polarization angles are detected, the detection effect is close to the same. Judging from the selection of 0 ° for the polarizer, that is to say, when the polarization and polarization angles are the same, the response voltage is almost the same value. The absolute difference between the following polarization and the polarizing angle gradually increases, and the response voltage value gradually decreases. When the polarization angle reaches 180°, the response voltage returns to the original voltage value. According to the test data, it can be known that for different targets, the polarizers adopted have different polarization angles, which can effectively divide the echo intensity characteristics of polarized light.

## 6. Conclusions

In this paper, a multi-channel based polarization spectroscopy imaging system is studied. By analyzing its basic working principle and simulating the influence of different polarization angles on the system, a response experiment is built. The test results show that the system can well separate and identify the multi-channel polarization spectrum, thus providing effective polarization spectrum information for target identification.

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