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Application of Polarized Light in UAV Navigation

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Abstract: This paper analyzes the advantages and disadvantages of UAV from the perspective of polarization. Inspired by the LCD and the improved gray-scale difference method of auto focus, it realizes the precise navigation and positioning of UAV and improves the image quality in three aspects: improving the color saturation, enhancing the focus function and enhancing the sensitivity of image transformation.

Keywords: UAV; Polarization; Accuracy

With the development of the times and Internet technology, intelligent navigation technology is the most important technology in the field of UAV. Through the real-time monitoring and precise calculation of the target position and current motion state, the calculation results are synchronously transmitted to the positioning driving system, and then the direction coordinate parameters and other indicators of the UAV are changed in real time according to the changes of the target, so as to guide the correct routes and accurately control the UAV to avoid obstacles.

1. General principles of UAV navigation

1.1 UAV navigation category

At present, UAV navigation system develops rapidly. Not only a single navigation mode, satellite navigation, inertial navigation, geomagnetic navigation, terrain aided navigation and other navigation instruments appear with the progress of science and technology and are applied to our daily life.

1.2 Composition and principle of UAV navigation

General civil UAV navigation usually uses satellite navigation. Taking the GPS positioning system of the United States as an example, it is composed of 24 satellites, which are distributed in six orbital planes. Four satellites are distributed in each orbital plane, achieving the effect that more than four satellites appear in our sky at any time and at any place (including the South Pole and the North pole). GPS navigation uses the principle of triangle positioning through the speed of signal transmission, time and the display data of the signal receiver to calculate the index data to achieve positioning. In addition to its continuity and accuracy, its biggest feature is real-time. However, civil GPS uses C / A code, which has low accuracy and weak transmitter, making it vulnerable to external interference.

2. Application of polarization in UAV navigation

2.1 Polarization and UAV application in military

In military, in order to detect the enemy's hidden equipments or dangerous layout, the requirements for image quality are very high. Ordinary UAV navigation

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sensors[1] can not accurately identify the contour, shape, material quality and other factors, which has a negative impact on the war. The United States has successfully developed an infrared focal plane array imager[2] with the ability of spectral coordination and polarization sensitivity. It can detect the target accurately in a disorderly and scattered environment with different wavelengths.

2.2 The application of polarization and UAV in life

In life, photography, express delivery[3] and traffic monitoring are the three giants of UAV navigation. The small UAVs has been widely used in photography industry, which pays more and more attention to the overall layout and exquisite editing for aerial photography, which requires a high quality of the picture. The express industry is starting to replace human couriers with drones to improve efficiency. With more and more complex road conditions and more and more vehicles, it is difficult to monitor the traffic conditions of the city as a whole with only fixed cameras[4] and traffic police enforcement. The aviation monitoring of UAV plays an important role in the traffic road monitoring.

3. Advantages and disadvantages of integration of polarization and UAV navigation

3.1 High definition of image quality

Because the polarizer filters out the light whose vibration direction is different from that of the polarizer, only the light whose vibration direction is the same as that of the polarizer is allowed to pass through. It greatly reduces the influence of the polarized light on the image quality, reduces the light spot and enhances the definition of the image outline. Its principle is that polarizer filters the light, and another polarizer filters the missing light again to improve the accuracy.

3.2 Relatively low color saturation

At present, due to the immature technology, UAV still has low color saturation. On the one hand, the color saturation has a very direct relationship with the light exposure on the surface of the object. In the dark environment, the color saturation is lower than that in the strong light. The outdoor lighting environment is very complex. The changing of cloudy and sunny days, the different terrains in different areas have an impact on it. The sun light intensity is weak in cloudy days, the color saturation is low, and the picture is unstable. On the other hand, it is because the display screen is not completely transparent and closed, the contrast is not ideal. For UAVs with high accuracy requirements, it not only affects the resolution of image quality, but also the judgment of information processing devices. Although the use of polarizers can reduce contrast and improve color saturation, more or less, it still can not reach the ideal state.

3.3 Weak color conversion sensitivity

In fact, the appearance of blocking frame and serial frame is due to the low response speed and the lack of steep electro-optic characteristics of the display. The response time of traditional display screen to light is slow. Generally speaking, the picture of the current frame has ended, but the light of the display screen to the previous frame has not yet finished, and the light of the next frame then hits the display screen, resulting in two pictures appearing on the same display screen. The phenomenon of frame blocking and series frames appears, and the sensitivity of picture conversion is low. Moreover, the light filtering effect of the light transmitting device is not good, which causes the redundant pixels to pass through the color filter screen, resulting in confusion in the picture.

3.4 Weak perception and obstacle avoidance ability of UAV

So far, the perception system of civil UAV is not perfect, and is greatly affected by the external environment. Although the emergence of inertial system navigation [5] has greatly improved the defect of UAV perception system, due to the high accuracy requirements of inertial navigation system for acceleration needle and gyroscope, the manufacturing process is complex, the cost is high, and it is easy to be worn. The error will accumulate over time, so it can not be widely used in the daily use of UAV. From another point of view, inertial navigation is easy to diverge. It needs to be corrected by other navigation systems, otherwise it will produce deviation. Once the perception system is not sensitive,

there will be corresponding deviation for information transmission.

4. The improvement and effect of UAV

4.1 Enhance color saturation

Because each pixel on the display screen is composed of three subpixels: red (R), green (G), and blue (B), when the backlight of the display passes through the color filter, it will produce color display with the RGB color resistance on the color filter. The higher the purity of the color resistance, the higher the color saturation, and the clearer the color contrast of the image. For the same type of color resistance, the thicker the thickness, the higher the color saturation. If we improve the type, purity and thickness of the color resistor in the UAV, its color saturation[6] will be improved, and we can make the obvious contrast to improve the image quality and enhance the detail differentiation of the captured image.

4.2 Enhanced focus

The function of UAV shooting not only needs to make the image quality clear, but also needs to automatically capture and enlarge the local suspicious object images. If the UAV is equipped with automatic focusing equipment, it is more advantageous for image capture. Focusing, in essence, is the principle of convex lens imaging. For an infinite scene, the imaging position is at the focus, while for a close-up object, the imaging position is in front of the focus. Auto focus is actually to adjust the image distance according to the distance data driving lens, so as to achieve the effect of auto focus. When focusing, the system needs to detect whether the image is clear at this time. Generally, the gray difference method[7], which uses the sum of the absolute values of the adjacent pixel differences of the image as the focus evaluation function is used.

$$F(x,y) = \sum_{x,y} \{|f(x,y) - f(x,y-1)| + |f(x,y) - f(x-1,y)|\} \quad (1)$$

It is the improved gray difference method [8]

$$F(x,y) = \sum_{x,y} \{(f(x,y) - f(x,y-1))^2 + (f(x,y) - f(x-1,y))^2\} \quad (2)$$

The evaluation of focusing effect is more accurate and more suitable for hardware.

4.3 Improve the sensitivity of picture conversion

Optical waveguide effect: the polarization direction of the polarized light of the incoming ray rotates synchronously along the molecular helix structure during transmission. Therefore, when the linearly polarized light incident perpendicular or parallel to the long axis of the molecule propagates in the liquid crystal box, the plane of polarization rotates synchronously along the molecular twist. It is still linearly polarized light after exiting the box, and its polarization direction is determined by the molecular twist angle[9].

Led by the optical properties of liquid crystal display: the optical anisotropy of liquid crystal into a single pump changes the polarization state or polarization direction of the incident light. When the incident light passes through the polarizer, it becomes a linearly polarized light. Under the action of the external electric field, it is deflected by 90 °; the polarizer and another polarizer are perpendicular to each other at the exit, and the polarized light rotating by 90 ° can pass through. At this time, the picture shows light transmission state. When the electric field is greater than a certain value, the long axis of the liquid crystal molecules are arranged along the electric field direction, so the incident linearly polarized light can not rotate 90 ° to through the polarizer, and the dark state appears at this time[10]. The principle is further improved. When the twist angle is increased to 180 ° ~ 270 °, the response speed of electro-optic characteristics is faster, so as to enhance the sensitivity of image conversion.

5. Summary

From the perspective of polarization, this paper describes the influence of clarity, color conversion sensitivity, color saturation, obstacle avoidance ability and information interpretation ability on the UAV's precise navigation. The inspiration comes from the LCD and the improved gray-scale difference method of auto focus in order to clarify the improved concept of achieving accurate navigation and positioning and

improve the quality of the image. This paper focuses on three aspects: improving color saturation, focusing function and improving image conversion sensitivity.

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