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Application of Multi-structure Light Measurement Technique

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Abstract: Structural light 3d measurement technology is a kind of 3d measurement technology with small volume, high precision and fast speed. It has a very wide range of application prospects, in China's aviation field, high-end car reverse imaging, sophisticated tooling, engineering construction and other important future development direction can be applied to this advanced measurement technology to achieve different difficult to achieve the goal, and this technology tends to mature. However, in the process of effective use of structural light measurement technology, it is necessary to pay attention to the practical, not the armchair strategist.

Keywords: 3D Measurement of Structural Light; The Mold; Image; Aviation

1. Various methods in measurement techniques

There are many ways to measure the surface of parts in optical measurement technology. The following are some common optical detection methods:

1.1 Mohr fringe method

Moire fringe[1] is the visual result of interference between two lines or two objects at a constant Angle and frequency. When the human eye cannot distinguish the two lines or two objects, it can only see the pattern of interference. The pattern in this optical phenomenon is moire fringe. It adopts two groups of grating, one main grating and one reference grating. The main grating of the contour surface is detected by the reference grating, and the contour surface shape of the object is calculated according to the fringe rule. With this method, the calculation is small, and it is easy to realize the rapid measurement. But moire striping is a potential problem for halftone screen printing. So-called halftone printing, is the continuous adjustment of the original through photography or other methods to decompose the different size of the dot to show the level of the method. Dark call printing large dot to show, light call printing small dot to show, the same color dot, especially multicolor printing or four-color printing color printing dot will intervene between the formation of moire stripe. Moire streaks between dots are a common problem in all levels of screen printing. Mesh and screen can also form another form of moire stripe, this moire stripe on the screen distribution can produce illegible and manuscript significantly different patterns.

1.2 Laser triangulation

Laser triangulation method[2] mainly USES a laser beam to irradiate the measured target at a certain incident Angle, and the laser reflects and scatters on the target surface. At another Angle, the lens is used to converge the reflected laser for imaging, and the spot imaging is performed on the CCD (charge-coupled Device, photosensitive coupling component) position sensor. When the measured object moves along the laser direction, the spot on the position sensor will move, and its displacement corresponds to the moving distance of the measured object. Therefore, the distance between the measured object and the baseline can be calculated by algorithm design from the spot displacement distance. Since the incident light and the reflected light form a triangle, the geometrical trigonometry theorem is

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used to calculate the spot displacement. Its principle is simple, high precision, because use good monochromaticity laser makes this approach rarely influenced by surface texture is relatively stable, so the laser triangulation method in precision demand is higher, the environment more complex industrial detection, application is very extensive, but in the experiment because of the single frame image information is very limited, laser triangulation need a one-dimensional mobile scanning, leading to low efficiency of the method.

1.3 Phase measurement and parameter calibration in three - dimensional structural light measurement

Phase measurement profilometry is based on the measurement principle of optical trigonometry to measure the three-dimensional shape of an object. The system is mainly composed of projection system, imaging system and computer. (1) The projection system projects a series of sine grating stripes onto the surface of the object being measured. The sine stripes are deformed due to the modulation of the height of the object surface. (2) The imaging system takes the deformed fringe image from another Angle (generally the included Angle of is 30°) and transmits it to the computer; (3) The computer processes the data of the captured image, calculates the truncated phase distribution of the object through the phase shift diagram, and then carries out the phase unrolling according to the phase unrolling algorithm. Finally, the 3d morphology of the object is reconstructed according to the phase information and the calibrated system structure parameters. Phase measurement and parameter calibration are two key techniques in 3d measurement of structural light. It can more accurately calculate and represent the image of the part surface, the use of a wide range, the accuracy is higher.

2. Selection and application of measurement technology

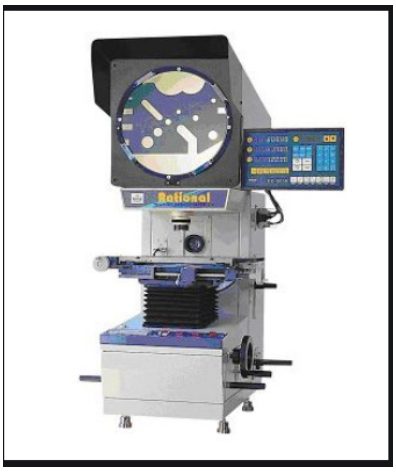
2.1 Phase measurement technology

Because the surface of the part we measured this time is not smooth and discontinuous, so we use the phase measurement technology and parameter calibration method in the structural light 3d measurement technology to measure the surface of the part. In the experiment, the algorithm can be divided into two categories: spatial phase unwrapping and time phase unwrapping. The phase extraction technique is very important in 3d measurement, which affects the accuracy of the whole measurement system. (1) Spatial phase unrolling: spatial phase unrolling[3] adopts a relative phase diagram, analyzes the phase value between adjacent elements in the space, and then recovers the continuous absolute phase distribution by adjusting the relative phase value according to the phase continuity. (2) Time phase unwrapping: the early phase unwrapping algorithms are limited to the two-dimensional space of wrapping phase, including path correlation and path independence. The phase value of each point in the path correlation unwrapping algorithm has a great dependence on other points in the field. Once the truncation point appears, the unwinding phase error will spread. The reliability of this algorithm is very poor. The path independent expansion algorithm overcomes the error diffusion, but the large amount of iterative calculation results in the measurement time consumption. In the late 20th century, the concept of time dimension was introduced to measure the phase, and the phase unrolling path was carried out along the time direction. The continuous phase value of each image point did not depend on the phase of any other image point, but only depended on its truncated phase in the time dimension. But in the structured light 3 d measurement technology, when using a spatial phase unwrapping, is measured in a lot cases is to require the surface of the parts is a continuous uninterrupted, wanting to measure discontinuity or spatial phase unwrapping is ups and downs of the object when there is a big difficulty, but in the industrial production parts, the discontinuous parts very much, so at present in the field of industrial measurement parts surface algorithm in most cases used algorithm is time. In this experiment, we chose the time expansion algorithm.

2.2 Parameter calibration

System parameter calibration is another key technique in 3d measurement of structural light. Traditional based on single camera - the projector of the structured light 3 d measurement system, in the process of measurement is composed of projection device to the selected image projected on the surface of the parts to be tested, at the same time to adapt to the cameras record the measured parts surface after calibration and deformation of raster image, then the deformation

of the raster image processing, again by a representative of the formula to calculate the height of the parts of the phase data, and then according to the phase have been calibration data and system structure parameters on the surface of object to be tested in 3 d point clouds reconstruction. This traditional method has too much constraint, inaccurate calibration accuracy, low operability and too many problems, which affect the measurement results in the actual operation process. In the recent research, a new method of parameter calibration has stood out -- using the projector as a reverse camera, which can transform the 3d measurement system of single-camera structured light into a binocular stereo vision system that can help with the measurement results. The key point of this method is that the projector needs the ability to "shoot" the image of the calibration plate, and then the accurate absolute phase value can be calculated to reconstruct the 3d data of the measured object surface according to the pre-calibrated system parameters. Figure 1 shows an optical projector, and figure 2 shows a model of the aircraft's tail made by 3d measurements and computer. So this experiment also shows that there are some disadvantages of this optical 3d measurement technology, that is, when the parts are too large, the process of implementing this experiment will be quite tedious and slow, but thanks to this complicated and slow process, the model obtained is indeed quite accurate.



3. Inflution factors of measurement

3.1 Environmental factors

Environmental factors are the most important factors affecting the precision of measuring parts. In the darkness of the environment, the structure light measurement after image texture clear and bright, but the brightness is a bit high brightness non-uniformity of environment, the environment light will largely influence on the structure light measurement, and measured the image will be similar to the background texture, wants with the experiment results in different ways. Sometimes the experimental data is completely unavailable. Therefore, when measuring the surface of parts with structural light, it is required to maintain uniform illumination brightness around the instrument in the measurement process.

3.2 Surface brightness of parts to be tested

When the structural light shines on the surface of the part to be tested, if the surface of the part to be tested is mirrored, the information received by the camera cannot fully show the three-dimensional characteristics of the surface of the part to be tested. Therefore, in our actual operation process, for parts with a particularly smooth surface and not easy to measure, a layer of chemical reflection is usually applied to the surface of the parts to avoid specular reflection, increase the scattering degree and improve the image quality.

4. Conclusion

This paper introduces three measurement methods of structural light, which are moire fringe method, laser triangulation method and phase measurement and parameter calibration. But only the phase measurement technique and parameter calibration method in the structural light 3d measurement technique are used to measure the model diagram of the part surface. The different phase choices make a great difference to the final result, so it is necessary to choose

the appropriate calculation method to measure before the experiment. Before starting the experiment, it is necessary to carefully consider whether different factors will affect the measurement results. During the experiment, it is necessary to avoid these factors as much as possible. Human error can also invalidate the measurement results.

References

1. Chandra Y, Saavedra FEI, Adhikari S. Buckling of 2D nano hetero-structures with moire patterns. Computational Materials Science 2020; 177. doi: org/10.1016/j.commatsci.2019.109507.
2. Anders A, Lennart V, Srdjan S, Lars O, Fredrik I, Mathias G. On the measuring of film thickness profiles and local heat transfer coefficients in falling films. Experimental Thermal and Fluid Science 2018; 99: 287-296. doi: org/10.1016/j.expthermflusci.2018.07.028.
3. Palmero MS, Díaz GI, McClintock PVE, Leonel ED. Diffusion phenomena in a mixed phase space. Chaos (Woodbury, N.Y.) 2020; 30(1). doi: org/10.1063/1.5100607.