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Development of a laser scanning system for non-transparent objects

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Introduction. Laser has the characteristics of good directional, high brightness, concentrated energy and stability, and is widely used in the field of precision measurement. In this paper, the method of surface shape measurement for non-transparent materials is investigated. By analyzing the principle of laser scanning measurement, an idea of a composite measurement method is proposed, and the possibility of realizing the measurement with this device is discussed.

Main part. Traditional laser triangulation is designed to measure depth or height on dull or rough surfaces. Laser triangulation sensors can be divided into two types: direct and oblique in terms of optical path design, which are suitable for the measurement of rough surfaces and smooth mirror surfaces, respectively [1]. However, for smooth surfaces specular reflections prevail, and diffuse reflections can be difficult to detect. This may cause errors in detecting of the laser line and building the profile of the scanned object [2]. We can modify the system settings to capture specular reflections, but at the cost of losing diffuse information. However, by designing a system capable to detect reflection both from smooth and rough surfaces, it is possible to reduce the re-adjustment of the system and reduce the measurement error.

We can split a light source into two beams through a spectroscope, deflect the laser beam through a reflector, and measure using different measurement methods [3]. However, this method requires the application of complex optical components and relatively precise optical path design. It also requires precise calibration of the performance of the beam splitting prism, so it is difficult to implement. In addition, the dichroic prism will also affect the intensity and wavelength of light, which may have a certain impact on the accuracy of the measurement. Therefore, we proposed the design of dual diffuse reflection and specular reflection modes for laser triangulation, and used the dual light source measurement method to avoid the uncertainty caused by the dichroic prism on the measurement results. Add polarizers to the optical path design as needed to eliminate stray light interference.

Conclusion.
By analyzing the characteristics of diffuse reflection and specular reflection of the light beam, the feasibility of the measurement device can be proved. It can avoid the trouble of repeated adjustments when measuring surfaces with different roughness. In the future, it may be possible to use this device to develop an algorithm that can combine the two measurements to varying degrees depending on the roughness of the measured surface, resulting in a more accurate measurement. This will help improve measurement accuracy between rough and smooth surfaces.

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