This concept can serve as a framework for developing a research project aimed to improve road safety by improving the behavior of road users.

The main result of the project will be an experimental system that encourages a car driver to drive more responsibly and safely.

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BINOCULAR DISTANCE MEASUREMENT PRINCIPLE

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Summary. *Common visual distance measurement is divided into monocular distance measurement and binocular distance measurement. Monocular distance measurement has low accuracy. Binocular distance measurement has the advantages of high efficiency and high accuracy and is an ideal choice for non-contact detection.*

With the continuous development of science and technology, visual sensor ranging technology has become an increasingly important field [1]. Due to the advantages of binocular ranging method, such as simplicity, low cost and high accuracy, it is widely used in the fields of drone visual positioning, robot automatic navigation, non-contact measurement and so on.

In figure 1, P is the target point, O_L and O_R are the optical centers of the left and right cameras. In the image coordinate system of the left and right cameras, the imaging points are P_L and P_R respectively, f is the focal length of the camera, and B is the baseline, which represents the distance between the centers of the left and right camera lenses. Z is the distance required for binocular ranging, that is, the depth information. Let disparity be the parallax, that is, $disparity = B - (X_L - X_R)$.

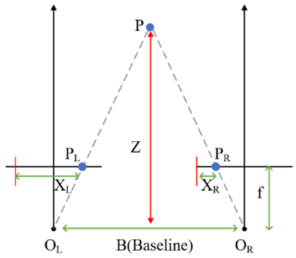

Figure 1 – Binocular camera model

According to the principle of similar triangles:

$$\frac{B-(X_L-X_R)}{B}=\frac{Z-f}{Z} \quad , \tag{1}$$

then:

$$Z=\frac{fB}{X_L-X_R} \quad . \tag{2}$$

Among them, the focal length f and the baseline B can be obtained through calibration, so as long as the value of $X_L - X_R$ (i.e., parallax) is obtained, the depth information can be obtained.

The actual operation of binocular ranging is divided into 4 steps: camera calibration, binocular correction, binocular matching, calculation of depth information [2].

Camera calibration: Due to the characteristics of the optical lens, the camera has radial distortion in the imaging. The calibration of a single camera is mainly to calculate the internal parameters of the camera. The calibration of binocular cameras not only needs to obtain the internal parameters of each camera, but also needs to measure the relative position between the two cameras through calibration (i.e. the rotation matrix R and translation vector t of the right camera relative to the left camera).

Binocular correction: Binocular correction is to eliminate distortion and align the left and right views respectively based on the monocular internal parameter data (focal length, imaging origin, distortion coefficient) and binocular relative position relationship (rotation matrix and translation vector) obtained after camera calibration, so that the imaging origin coordinates of the left and right views are consistent, the optical axes of the two cameras are parallel, the left and right imaging planes are coplanar, and the polar lines are aligned. In this way, any point on an image and its corresponding point on another image must have the same row number, and only one-dimensional search in the row is required to match the corresponding point.

Binocular matching: The function of binocular matching is to match the corresponding image points of the same scene on the left and right views. The purpose of this is to obtain a disparity map. Binocular matching is generally considered to be the most difficult and critical problem in stereo vision.

Calculation of depth information: After obtaining the disparity data, the depth information can be easily calculated using the formula in the above principle.

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