Correction of a Minor Error in the Implementation Software and the Original Paper of Tsai's Calibration Method

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Abstract. This note reports about a minor error in the original paper on Tsai's calibration method and in the corresponding implementation software available for free downloads on the Web. Tsai's camera calibration method allows a determination of eleven camera calibration parameters. There is an incorrectness in the formula for calculating the X-component of the translation vector T. This report corrects this minor problem.

1 Introduction

Camera calibration is an important task in computer vision, see [3]. Tsai's method is the most widely used calibration technique. It has been proposed by Roger Y. Tsai in [1] and [4]. There is a corresponding implementation software which can be downloaded from the website [2]. For both of the original paper and the implementation software, the formula of calculating the X-component of the translation vector T is erroneous. In this little note, we will discuss this minor error and how to correct it.

2 Error in the Original Paper

We address line 2 in the right column of page 333 in [1], i.e. the equation for calculating the X-component T_x of the translation vector. It is clear that the X component T_x of the translation vector should be calibrated after calibration of the horizontal scale factor S_x, because the fourth transformation parameter a_4 is defined as follows:

$$a_4 = \frac{T_x \cdot S_x}{T_y}, \tag{1}$$

and, obviously, the X-component T_x of the translation vector should be obtained by

$$T_x = \frac{a_4 \cdot T_y}{S_x} \tag{2}$$

rather than

$$T_x = a_4 \cdot T_y \ . \tag{3}$$

The original paper misses the horizontal scale factor S_x.

3 Error in the Implementation Software

The implementation software of Tsai's calibration method can be downloaded from the website [2]. It has been written by Reg Willson in 1995. This software is freeware and is widely used in the computer version field and the robotics field.

The minor incorrectness reported above is also existent in this software. In function *ncc_compute_Tx_and_Ty*() of file *cal_main.c*, the X-component T_x of translation vector should not be calculated here. It should be calculated after the calibration of the horizontal scale factor S_x and the formula of T_x should be Equ. 2 rather than Equ. 3

In order to correct this error, we remove the command of calculating T_x from the function

$$ncc\_compute\_Tx\_and\_Ty()$$

and put it into the function

$$ncc\_compute\_sx()$$

of file *cal_main.c*. We calculate T_x after calculation of S_x.

Sensors of CCD cameras are mostly square nowadays. Therefore, the horizontal scale factor S_x is nearly 1 for most of all cameras, and the reconstruction error caused by the reported implementation error is very minor consequently.

References

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