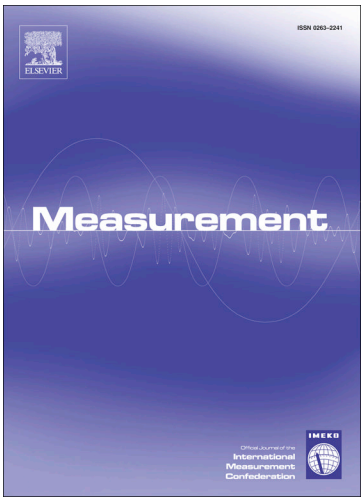

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A High Accuracy Method for Pose Estimation Based on Rotation Parameters

Kun Yan[a,b], Rujin Zhao[a,*] ,Hong Tian[a],Enhai Liu[a],and Zhuang Zhang[a,b]

[a]*Institute of Optics and Electronics of Chinese Academy of Sciences,Chengdu 610209, China*

[b]*University of Chinese Academy of Sciences, Beijing100149, China*

**zrj0515@163.com*

Abstract: In this paper, A high-precision pose estimation method based on rotation parameters is proposed. By introducing the parameterization of rotation matrix, we first formulate a nonlinear least-squares cost function whose optimality conditions constitute a system of three third-order polynomials. Then, based on Gröbner basis method, we solve the solution of polynomial equation directly,and then the attitude is calculated by back-substitution method. More importantly,one of the main advantages of our method is scalability, because the order of the polynomial equations we solve is independent of the number of points involved in the estimation.Finally,we compare the performance of our algorithm with the leading P*n*P method, both in simulations and experiments, and show that the proposed method achieves the accuracy of approaching the OP*n*P(optimal solution to the P*n*P problem).

Key words: Machine vision; Algorithms; Three-dimensional sensing;PnP.

1. Introduction

The problem of target pose estimation based on feature points is also called P*n*P (Perspective -*n*-Point)[1]. That is to say, if the internal parameters of the camera, the coordinates of the n feature points in the target coordinate system and the coordinates of the corresponding image points on the image plane are known, and then the position and orientation parameters of the target in the camera coordinate system can be obtained. Considering that the pose parameters of the target in the camera coordinate system and the attitude parameters of the camera in the target coordinate system (camera external parameters) is an inverse problem, the solution of the P*n*P problem can also be regarded as the calibration of the external parameters of the camera.

The application of pose estimation is quite wide, for example, in the field of space, the pose estimation procedure is used to help rendezvous and capture between the chase and the target spacecraft. Typical applications are illustrated in Figure 1. In addition, there is a general need to solve the P*n*P problem in the attitude estimation process.P*n*P is a very important problem in the field of computer vision, which is widely used in vision navigation, robot localization, photogrammetry and other fields[2-5]. At present, a large amount of research has been carried out on this issue by scholars, mainly focusing on the solution of P*n*P（$n\geq3$）problem with different feature points.It mainly consists of two kinds of special solution methods for specific number of feature points and a general solution to any number of feature points. For the specific number of feature points,the position and orientation solutions are obtained by solving the nonlinear geometric constraint equations.There are more studies on P3P[6,7], P4P[8-10]and P5P [11-13]. However, these methods are sensitive to noise and have limited precision.When n>5,the P*n*P problem always has unique solutions, but its analytic form is not available, so the general solution can only be used. In addition to n>5,many general methods can also be used to solve the P4P or P5P problem with unique solutions, and its range of application is more extensive than that of specific methods.