Precise Locating Algorithm by Modified Least Square Method for CES Switch Operating

Chen Zhen, Xu Jing, and Xu Wenhui
State Grid Huzhou Power Supply Company, Hangzhou, China
Email: swallow139@126.com

Guo Zihan and Qin Chuan
School of Mechanical Engineering, Shanghai Jiao Tong University, Shanghai, China
Email: naan_sunny@126.com

***Abstract*—Accurate positioning method of three dimensional pose of space circle is a typical problem of binocular vision. The correlation algorithm is particularly important for the positioning accuracy in the case of strong interference of edge feature information. According to the precise positioning requirements of the distribution cabinet handcart in the distribution room, this paper establishes the elliptic curve optimization method based on the European distance minimization feature. Based on the least square method, the information model of the outside edge of the switch is established by using the circular contour of the cylindrical groove, and the three-dimensional pose positioning method of the spatial circle is studied. Finally, the effectiveness of the algorithm is verified by a case study.**

***Index Terms*—binocular vision, precise positioning of space circle, least square method**

I. Introduction

With the rapid development of robot technology, robot based automation has become a major development trend in all walks of life. Distribution room is an important part of power supply system [1]. Its operation and maintenance has always depended on the traditional mode of manpower. Fig.1 a) and Fig. 1b) are 2 typical Circular Earthing Switches (CES Switch), In operation and maintenance, such switches need to be precisely positioned to switch the grounding state of distribution unit. Based on the binocular vision positioning and robot technology, this paper establishes the automatic on duty operation system for the traditional power distribution cabinet as shown in Fig. 1c). The CES switch is precisely positioned through the vision system, and the relevant and maintenance operations are completed by the robot operation tools [2].

As shown in Fig. 1a), the CES switch has a clear edge profile, and the general edge processing algorithms can handle it well. As for Fig. 1b) CES switch, the edge is not clear, especially in the case of shadow and other interferences. There are more interferences and noises, so it is necessary to study the related algorithms.

Manuscript received November 16, 2020; revised February 22, 2021.

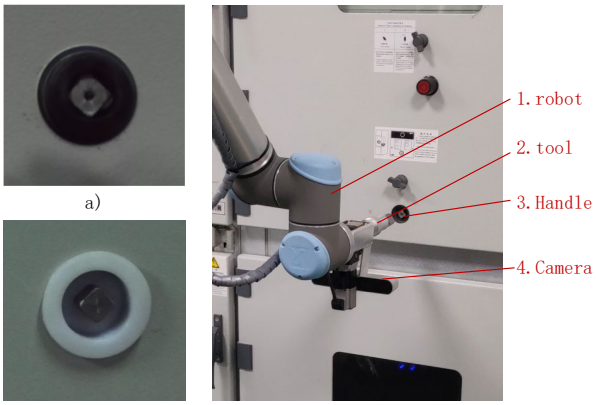

Figure 1. CES handle operating robot system.

II. Localization Algorithm of CES Switch

This paper adopts the method of binocular vision [3]. The overall flow of the precise positioning algorithm of CES switch is shown in Fig. 2. Firstly, the ellipse contour is extracted with binocular camera, and the contour points are fitted to ellipse. The pose of space circle is solved by two ellipse images [4]. Then calculate the rotation angle of the central square column by combining the side line of the square column, and the complete space attitude of the handcart is finally obtained.

For the precise positioning technology of space circle, Quan [5] proposes a method to solve the position and pose of circle in space by two conic parameters presented in different perspectives. In this method, the solution of space circular pose is transformed into algebraic solution of parameter equation. This process of algebraic solution relies strongly on the extraction of ellipse. The error of RANSAC algorithm used in the extraction process is further amplified when solve the set. Malassiotis proposed a positioning method based on three-dimensional hole model [6]. It is based on uniform sampling of 3D model. According to the projection matrix of camera and the projection of model pose in the left and right pictures, it calculates the sum of the distance between each contour point and the nearest projection point as the function to be optimized. And the gradient descent method is used to optimize the function

©2021 Int. J. Electron. Electr. Eng.
doi: 10.18178/ijeee.9.1.11-15