BULETINUL INSTITUTULUI POLITEHNIC DIN IAŞI
Publicat de
Universitatea Tehnică „Gheorghe Asachi” din Iaşi
Volumul 65 (69), Numărul 2, 2019
Secţia
CONSTRUCŢII DE MAŞINI

THE STUDY OF ALGORITHMS OF THE INDUSTRIAL VISION SYSTEM ALONG WITH THE DEVELOPMENT OF ALTERNATIVE ALGORITHMS

BY

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Received: May 17, 2019
Accepted for publication: June 19, 2019

Abstract. The article presents a comparison of image processing methods for an industrial 3D camera. In the first image analysis method, a point cloud was displayed using the application provided by the device manufacturer. In the second method, the values of the distances of particular points were converted to the form of the image in shades of grey. In the case of the method in which the image was obtained in shades of grey, two methods of image edge detection were used: the first one based on the determination of the function gradient (Canny method), the second developed on the basis of Tau Kendall's statistics. At the beginning, the principle of operation of the program provided by the camera manufacturer is presented. Then the algorithm of converting the point cloud to the image in shades of grey was discussed. Subsequently, the proposed methods of detecting the edge of the image using the Canny method and image ranking by Tau Kendall's statistics were used. Finally, the proposed ranking method was compared depending on the size of the sample and the work completed together with the wording of the final conclusions was summarised.

Keywords: vision systems; digital image processing; mathematical statistics; image rendering; numerical methods.

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1. Introduction

Vision systems are increasingly used in industry. They are used to detect objects that are unrecognizable by other devices, *e.g.* a laser distance sensor. Cameras are usually used in industrial robots as an element for unambiguously determining the location and orientation of an object. They are also used to determine the presence of objects or their quantity on production belts.

Usually, in industrial applications, 3D cameras are used that return a point cloud containing only information about the distance of the point from the obstacle without information about the colour value of the point in question expressed in the RGB components. Based on the data from the distance of all points, you can determine the image in shades of grey and use standard image processing methods.

The main problem in industrial applications are changing lighting conditions and air cleanliness. Usually, algorithms for detecting object edges that are sensitive to changing image contrast are used to determine the position and orientation of an object. The paper proposes a new method of image edge detection by using Tau Kendall image rankings. Rankings are used as elements of filters (Wanghua *et al.*, 2016) in the MOS (Mean Opinion Scores) method of analysis of medical images (Manousaki, 2006; Calautti, 2007).

2. Image Analysis Using Classical Methods and Ranking

In this article, the study was carried out on the IFM O3D301 industrial camera shown in Fig. 1.

Fig. 1 – IFM O3D301 camera.

Fig. 2 shows the object on which digital image processing algorithms will be executed. The sea shell was chosen because of its complex shape.

Fig. 2 − Research object.

The point cloud displayed using the ifmVissionAssistance program is shown in Fig. 3. The program allows detecting the presence and number of elements based on the patterns set in the application and then sends the data packet through the PROFINET industrial network.

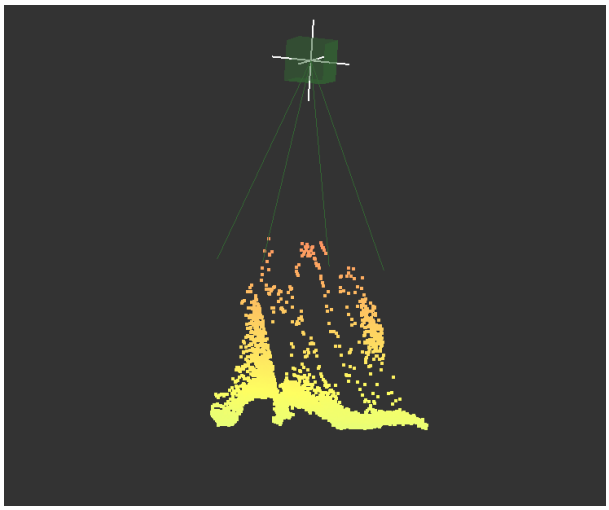

Fig. 3 – Point cloud from camera (ifmVissionAssistance).

For the use of Tau Kendall's statistics in digital image processing, the algorithm shown in Fig. 4 was used after transforming the data from the depth sensor to the image in shades of grey.

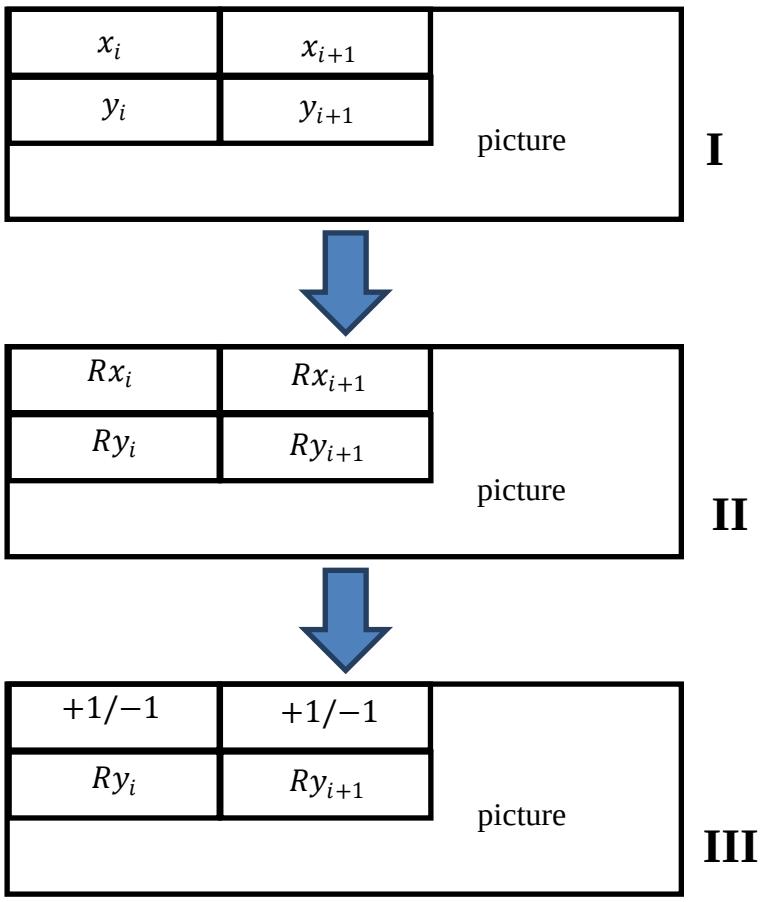

Fig. 4 − Schematic diagram of Tau Kendall.

In the first case, Fig. 4 shows the division of the image into two data vectors. Then the individual components of both vectors are ranked. The third case describes the sorting of one vector and then the ranking of the remaining vector according to this rank. Finally, the Kendall rank correlation coefficient is calculated from the dependence of (Habdi, 2007; McLeod, 2005; Walker, 2016):

$$r_s = \frac{\sum P_i}{\sum N_i} \tag{1}$$

where: $\sum P_i$ – the sum of the designated notes; $\sum N_i$ – the maximum amount of notes that can be obtained.

Figs. 5 – 7 compare the Canny method with the image ranking method.

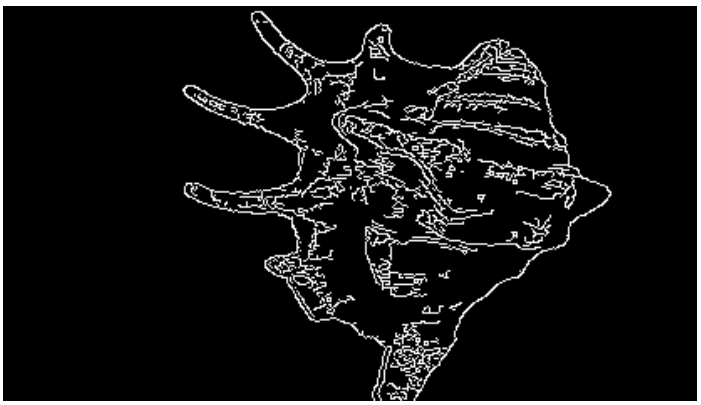

Fig. 5 – Canny algorithm.

Fig. 6 – Tau Kendall's rank correlation coefficient.

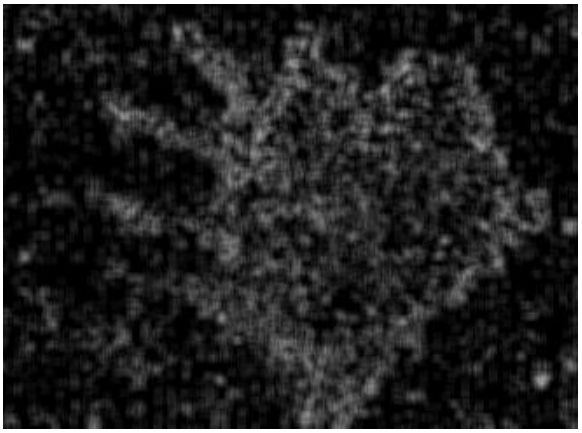

Fig. 7 – Median filter.

Fig. 5 shows the Canny edge detection algorithm (Canny, 1986) using the OpenCV library (OpenCV, 2019). Fig. 6 is the effect of calculating the Kendall rank correlation coefficient and Fig. 7 shows the use of the median filter.

The disadvantage of using image ranking is to get quite a lot of noise in the image. However, it is an advantage to obtain characteristic points describing the properties of the image in a given area.

3. Conclusions

This article presents three methods of object recognition by an industrial vision system. In the first case, the algorithms provided by the manufacturer were used, sending only information about the presence, location and orientation of the object through the industrial network. Two subsequent methods consisted in sending all values of points describing the distance from a given obstacle and then converting these values into an image in shades of grey. Analysing the image in shades of grey, the Canny method and the Kendall Tau correlation coefficient were used. The Canny method returns images with minimal noise compared to the image ranking method. However, the method using Tau Kendall returns characteristic points, which is less susceptible to changes in the image contrast.

In the next stages of work and the algorithm, a system for ranking in all directions of the image will be developed and the parameters of the median filter will be.

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STUDIUL ALGORITMILOR SISTEMULUI DE VIZUALIZARE INDUSTRIALĂ ȘI DEZVOLTAREA DE ALGORITMI ALTERNATIVI

(Rezumat)

Articolul prezintă o comparație a metodelor de procesare a imaginilor pentru o cameră 3D industrială. În prima metodă de analiză a imaginii, a fost afișat un nor de puncte folosind aplicația furnizată de producătorul dispozitivului. În a doua metodă, valorile distanțelor anumitor puncte au fost transformate în forma imaginii în nuanțe de gri. În cazul metodei în care imaginea a fost obținută în nuanțe de gri, s-au utilizat două metode de detectare a marginilor imaginii: prima s-a bazat pe determinarea gradientului funcției (metoda Canny), a doua s-a bazat pe statistica Tau Kendall. La început, s-a prezentat principiul funcționării programului furnizat de producătorul camerei. Apoi a fost discutat algoritmul de transformare a norului de puncte în imagine în nuanțe de gri. Ulterior, au fost utilizate metodele propuse de detectare a marginii imaginii folosind metoda Canny și statistica Tau Kendall și s-au formulat concluziile finale.