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Vision Based Machine for Pick-and-Place Operation

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ABSTRACT

Abstract—Pick and place machine is an important component of automatic assembly lines. This paper proposes a way for recognizing and localizing the objects which are moving on a conveyor belt. This Machine has an image processing system with 2D vision, a low cost 2D mono CCD camera to recognizing and localizing the objects by conduct image processing algorithms. Then a motion planning is generated to pick and place the different objects to different positions consequently. The experiment shows the proposed system has an excellent performance.

INTRODUCTION

Vision based robot is used in the industry improve the efficiency and also an essential part in production line [1][2]. It is also cheap and easy to implement, so it is a vital part of a robot.

There is a requirement of an automated system for sorting and locating the random placed objects. The problem of sense, rapidly and reliably, the location and class of a variety of non-overlapping objects by vision system has been a hot issue in industry robot society [3]. Especially for distinguish the objects. Most object recognition and location of moving conveyor belt objects proposed are only to segment them without deciding their classes. For a recognizing system, stable key point descriptors have led to a successful progress on object recognition. The key point descriptors are scale-invariant and insensitive to changes in illumination. But key point descriptors are only applied to those objects with a lot of features, which means that the objects with texture on the surface. So if got knowledge of the objects

size features in prior. What is need is only segment the object and compare with the database. In the program described below, we propose a method to recognizing the objects.

Figure 1. Experiment environment.

After an image is captured by the camera, a binary histogram based procedure will be conducted to determine whether object appears in view. If so, an ostu-based thresholding[4] process will thus be carried out to get a binary image. After that, Flood-fill is applied to segment the object. Then the size and shape is thus got. Lastly use Rotating calipers [5] algorithm to find centroid position and orientation of the objects.

MATERIALS AND METHODS

Hardware Configuration

The machine is made of a 4-DOF manipulator and a two-finger gripper, as shown in Fig. 1. A tablet PC is serving as the control unit. The PC is Windows8, 64bit and powered by Intel I5-4200u CPU, which can operate in real-time. A Basler industry camera with ring light is installed on top of conveyor belt and in front of robot operation area. The model of camera is Basler acA3000-30gm, which is equipped with Sony CCD sensor, and can deliver 30 frames per second at 1.3MP resolution. The manipulator is made by Alpha Robotics, which can moves at highest speed 2000mm/sec, and bear up to 160kg load.

Data Acquisition

Images are captured by a mono CCD camera at 750*966 resolutions as showed in Fig.2., To avoid specular reflections and shade, a ring light with an box is used to illuminate the detecting area. Each image capture will be processed by the computer.

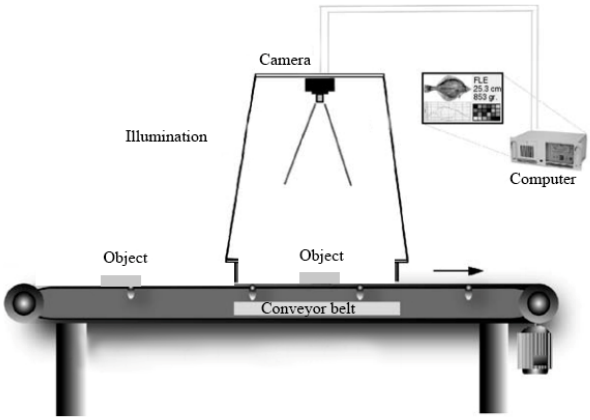


Figure 2. Data acquirement.

SYSTEM OPERATION

Object Detection

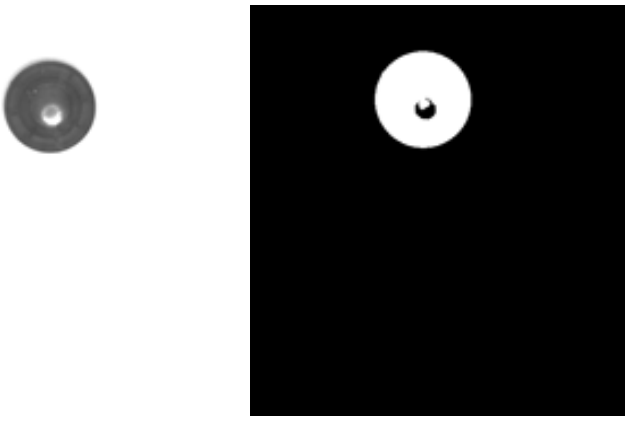
Object detection is based on a simple thresholding algorithm. During this process image is made binary. The thresholding algorithm is if the pixels value greater or equal the threshold T, set the pixels 0, otherwise set 1. The thresholding T is a static value which determined by the background. After getting binary image, a histogram is performed to set the maxim value. More than 80% of the pixels is 0, means no object is detected.

Background Removal

To remove the background, Ostu's thresholding algorithm is performed. It is an important procedure for further step segmentation. Ostu proposed a criterion for maximizing the between-class variance of pixel intensity to perform image thresholding. It is an automatically performed clustering-based image thresholding. Extract a target from its background on the basis of the distribution of gray levels or texture in image objects. The Ostu's thresholding algorithm is based on an idea:

Find the threshold that minimizes the weighted within-class variance which turns out to be same as maximizing the between-class variance.

The background removal is conducted as Fig. 3. below.



(a) (b)

Figure 3. Background removal. (a) Origin image; (b) Background removed image.

Segmentation

Flood-fill is used widely in the segmentation algorithms[6][7]. The purpose of flood-fill algorithm is to find the entire area of connected pixels with the same color. It is usually used in image editing software as the Bucket Tool. The flood-fill is used here to segment the object out. The algorithm is an iterative process in which each pixel iterative to find connected region. The flood-fill algorithm takes three parameters: a start node, a target color, and a replacement color. The algorithm looks for all nodes in the array that are connected to the start node by a path of the target color and changes them to the replacement color. There are many ways in which the flood-fill algorithm can be structured, but they all make use of a queue or stack data structure, explicitly or implicitly.

In the experiment, the start point lies in the background, so the algorithm will iterative to find all the connected background, thus we can get the contour of the object.

Matching

Based on the object contour, it is easily to get the object size and shape. The size here means the acreage, diameter of the min circumcircle. Match the size and object with the objects database, class will be easily determined.

Position and Orientation Estimation

Assume that the centroid is right the center of its minimum bounding rectangle(MBR), while the pose is estimated by find the centroid which represents its position coordinate, the 2D pose is the MBR longer side orientation. Based on the coordinate and orientation, the motion planning will choose a right way to grad and seize the object. We adopt Rotating calipers algorithm to get the MBR, The algorithm is to rotate the spring-loaded Vernier caliper around the outside of a convex polygon to get its MBR.

Motion Planning

Vision algorithm provides detailed information about the object. As the velocity of conveyor is fixed, the real-time position of object is obtained. Control the robot move to the specified position grab object and move it a particular position. [8]

EXPERIMENT RESULTS

In order to validate the vision algorithm and motion planning, an experiment is designed. Different kinds of object were placed consequently. The objects are recognized one by one. And different kinds of objects will be moved to different places.

In this experiment the camera continues capturing gray-level image of the moving objects. The captured images will be detected to find and recognize the objects and locate them. Then the robot manipulator will grab the object and place each to a specified area.

Fig.4. shows the experiment result; all kinds of objects were recognized.

(a) (b) (c) (d)

Figure 4. Experiment result. (a) Object 1; (b) Object 2; (c) Object 3; (d) Object 4.

CONCLUSION

A vision based method for automatic object spices detection and localizing by a computer vision system has been described. The proposed detection and localizing approach un-overlapping object for grapping has showed excellent performance. The experiment has proved the algorithm to be robust. The accuracy of recognizing and localizing is proved satisfactory. And also the time consumption is short which allows real-time processing.

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REFERENCES

1. Mattone R., Campagiorni G., Galati F. 2000. Sorting of items on a moving conveyor belt. Part 1: a technique for detecting and classifying objects [J]. Robotics and Computer-Integrated Manufacturing, 16(2): 73-80.
2. Manjunatha K.C., Mohana H.S., Vijaya P.A. 2000. Machine Vision Based Non-Magnetic Object Detection and Removal on Moving Conveyors in Steel Industry through Differential Techniques [J]. International Journal of Computer Vision and Image Processing (IJCVIP), 2(3): 59-70.
3. Baird M.L. 1977. Image Segmentation Technique for Locating Automotive Parts on Belt Conveyors [C]//IJCAI. 694-695.
4. Otsu, N. 1975. A threshold selection method from gray-level histograms. Automatica, 11(285-296), 23-27.
5. Toussaint, Godfried T.1983. "Solving geometric problems with the rotating calipers," Proc. IEEE Melecon, Vol. 83.
6. Nosal E.M. 2008. Flood-fill algorithms used for passive acoustic detection and tracking [C]//New Trends for Environmental Monitoring Using Passive Systems, 2008. IEEE, 1-5.
7. Arvo J., Hirvikorpi M., Tyystjärvi J. 2004. Approximate Soft Shadows win an Image - Space Flood - Fill Algorithm[C]//Computer Graphics Forum. Blackwell Publishing, Inc, 23(3): 271-279.
8. Hyun Woo Kim, Hu Chen, and Jang Myung Lee. 2014 "Path planning of 5-DOF manipulator," Advanced Intelligent Mechatronics (AIM), 877-881.