ภาคผนวก

งานวิจัยที่ได้รับการตีพิมพ์

An Alternative Platform of Screw Angle Detection in Automation Application

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Abstract

This paper presents the performance comparison between personal computer (PC) and embedded Linux platform (ELP) in an aspect of screw detection process. Although the PC has more resources and processing performance, the single board embedded Linux platform provides lower cost and requires less space. This paper also describes a screw detection experiment with industrial component part and compares performance, cost and processing time of both platforms by the same Hough transform algorithm.

Keywords: Embedded Linux Platform, Processing Time, Screw Detection.

1. Introduction

In the manufacturing, some applications are limited by area and cost such as automation for cleaning room. Therefore, some parts may be inconvenience to be clean or installed because of big size and variety of component parts. Moreover, the clean room type of industrial grade computer has high prize. Therefore, the single board computer with embedded Linux operating system or embedded Linux platform (ELP) is an alternative way to handle this problem.

Some researchers adapt this ELP to develop the low cost system. For example, Dudas proposed the cytology microscope with the Raspberry Pi [1]. Additionally, this ELP can be a remote controller for robotic manipulator in [2]. Furthermore, the stereo vision image processing algorithm for autonomous surface vehicle (ASV) was embedded in the ELP [3].

Although the ELP provides less processing performance and resources, it was used to process some complex works. Therefore, this paper presents the application of ELP for industrial work such as the screw detection for the robot end-effector angle calculation

2. Hough Transform Algorithm

Here, this research uses a robotic application that a robotic arm will pick the motor part from the tray. With the motor shape, we have to find the angle to catch it steadily. Consequently, we have to calculate the angle of end-effector. However, in this application we have to calculate screw angle of the part using Hough transform. Firstly, the ELP will collect image data from the web camera via USB port as in figure 1. Then the Canny edge detection algorithm will change the 1280x1024 pixels of .bmp image to be the dotted edge picture as in figure 2. Next, we can transform the edge picture to be the relationship between the angle of the checking line (θ) and the distance from origin (ρ). Lastly, we get the object angle by finding the angle of the checking line which provides the most relationship with the distance from origin in figure 3.

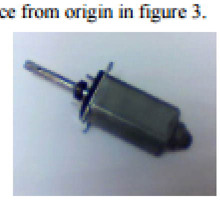

Figure 1. Image from Web Camera

Figure 2. Image after Canny Edge Detection

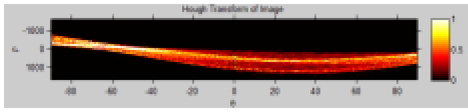

Figure 3. Hough Transform Results

3. Proposed System Modeling

For the system model, we have the USB 2.0 web camera connected with the controller which can be the industrial grade PC or the ELP. Both platforms can be used to control the 4 DoFs SCARA manipulator as in the figure 4.

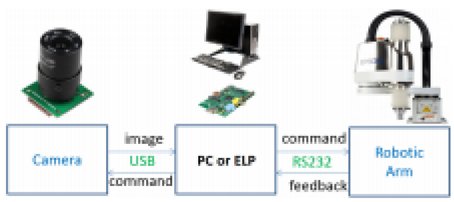

Figure 4. System Model

In this paper focus only on the screw angle of the object and we use this angle for setting the frame of end effector to catch the object steadily. The position of object is fixed.

4. Experiment and Results

In the experiment, we used the same algorithm and camera. Specifically, we applied OpenCV library and C++ code in both PC and ELP.

For PC, this research uses Dell Optiplex 980 consisted of CPU: Intel Core i5 2.8 GHz, OS: Windows 7 64 bit, RAM: 4 GB, Price: 666 USD, 155ms 1.1s

Additionally, this paper uses Raspberry Pi Model B for ELP with CPU: ARM1176JZ-F 700 MHz, OS: Raspbian (Linux based), RAM: 512 MB, Price: 66 USD.

The performance comparison is in table 1. Especially, the screw detection process in ELP and PC provide the same angle results. However, ELP requires more processing time than PC.

Table 1: Performance Comparison

Case	PC		ELP	
	Result (degrees)	Processing Time (seconds)	Result (degrees)	Processing Time (seconds)
	-64°	0.155 s	-64°	0.246 s
	-90°	0.131 s	-90°	0.239 s
	45°	0.123 s	45°	0.236 s
	-50°	0.112 s	-50°	0.221 s
	-90°	0.118 s	-90°	0.228 s
	1°	0.163 s	1°	0.259 s
	Average	0.133 s	**Average**	0.238 s

5. Conclusion

As in the results, we can conclude that the embedded Linux platform can reduce the cost and machine area in the automation system or manufacturing. Although, the ELP is petty slower than PC, It provides 10 times lower cost than PC. Moreover, ELP requires the lower energy and area for deployment. This ELP is a choice for low cost image processing development and experiment. In the near future we will improve the algorithm to reduce the processing time in the ELP and integrate the system with robot kinematic algorithm.

References

[1] Radu Dudas, BS, Christopher VandenBussche, MD, PhD, Alex Baras, MD, PhD, Syed Z. Ali, MD, FRCPath, FIAC, Matthew T. Olson, MD, "Inexpensive telecytology solutions that use the Raspberry Pi and the iPhone," Journal of the American Society of Cytopathology (2014) Volume 3, Page 49-55, 2014

[2] Ron Oommen Thomas and K. Rajasekaran, "Remote Monitoring and Control of Robotic Arm with Visual Feedback using Raspberry Pi," International Journal of Computer Applications (0975 – 8887), Volume 92 – No.9, April 2014

[3] Ricardo Neves and Anibal C. Matos, "Raspberry PI Based Stereo Vision for Small Size ASVs," MTS, 2013