Indonesian Journal of Electrical Engineering and Computer Science
Vol. 2, No. 2, May 2016, pp. 426 ~ 430
DOI: 10.11591/ijeecs.v2.i2.pp426-430

Weed Detection Using Fractal-Based Low Cost Commodity Hardware Raspberry Pi

Mohamad Iqbal Suriansyah*[1], Heru Sukoco[2], Mohamad Solahudin[3]
[1]Department of Computer Science Faculty of Natural Science and Mathematics, Pakuan University, Indonesia,
[2]Department of Computer Science Faculty of Natural Science and Mathematics, Bogor Agricultural University, Indonesia,
[3]Department of Mechanical and Biosystem Engineering, Faculty of Agricultural Engineering and Technology, Bogor Agricultural University, Indonesia,
addres, telp/fax of institution/affiliation
*Corresponding author, e-mail: mohamad.iqbal@unpak.ac.id[1], hsrkom@ipb.ac.id[2], msoul9@yahoo.com[3,]

Abstract

Conventional weed control system is usually used by spraying herbicides uniformly throughout the land. Excessive use of herbicides on an ongoing basis can produce chemical waste that is harmful to plants and soil. The application of precision agriculture farming in the detection process in order to control weeds using Computer Vision On Farm becomes interesting, but it still has some problems due to computer size and power consumption. Raspberry Pi is one of the minicomputer with low price and low power consumption. Having computing like a desktop computer with the open source Linux operating system can be used for image processing and weed fractal dimension processing using OpenCV library and C programming. This research results the best fractal computation time when performing the image with dimension size of 128 x 128 pixels. It is about 7 milliseconds. Furthermore, the average speed ratio between personal computer and Raspberry Pi is 0.04 times faster. The use of Raspberry Pi is cost and power consumption efficient compared to personal computer.

Keywords : *Weeds Detection, Computer Vision, Fractal, Raspberry Pi*

1. Introduction

Farm management systems based on information technology has been widely used to obtain optimum benefit, increase the efficiency of agricultural management [1], protecting the environment [2] and increasing agricultural productivity [3]. Farmers need information from a wide range of ICT tools to identify, analyze, and manage information in spatial and temporal diversity [4] as well as the specific characteristics of the land [5], so that the decision-making process to be more precise during soil preparation, seed selection, fertilizer regulation, management pesticides, watering schedules water and weed management [6].

The process of identification of weeds in the field is very important to determine the effective control of this due to lack of proper weed control will cause improper use of herbicides, inefficiencies cost, time and energy [7]. Conventional weed control system is usually done by spraying herbicides uniformly throughout the land [8], it results in excessive use of herbicides will potentially generate waste in the form of chemical residues, emissions to air and soil [9]. Dependence on chemicals also harm human health [10] and the environment [11].

The herbicides can be reduced by the application of precision farming application by spraying on right land by detecting weeds on land. Therefore, precision farming is needed to determine the level of weed vegetation in order to control the conditions and needs of the plant based on the specific characteristics of the land [12]. Precision farming is the application of information technology in agricultural management systems that allow rigorous treatment (precise treatment) agribusiness chain from upstream (on farm) to downstream (off farm) [13].

Computer vision as one of the precision farming applications is very promising [14] which can be used for the identification and classification of plants. OpenCV is a library Public License can be used to detect the image of weeds. Weed detection in realtime is still difficult to implement in the field due to need a large place and the use of large electric power. The need for specification of minicomputer and small power consumption has attracted the attention of

Received January 16, 2015; Revised April 12, 2016; Accepted April 26, 2016

some researchers to create a single board computer and a credit card sized using the open source Linux operating system which is called the Raspberry Pi [15]. The Raspberry Foundation launched the latest Raspberry Pi product in the form of Single Board Computer, a small-sized computer with low power consumption, 3.5 W (5 V and 0.75 A) [16]. The original Raspberry Pi is based on ARM1176JZF-S 700 MHz processor, VideoCore IV GPU, and was originally shipped with 256 megabytes of RAM, later upgraded (models B and B+) to 512 MB [17]. The development of a mini computer Raspberry Pi has opened up great opportunities in the computing system to be applied in a number of research areas [18] and can be one of the solutions to be implemented easily as functionally has the ability like a desktop computer.

2. Research Method

2.1. Image Acquisition

At this stage, weeds image is acquired using a digital camera. The data used in this study is a collection of images obtained weed plants from the laboratory of Mechanical Engineering and Biosystems IPB, Faculty of Agricultural Technology IPB.

In this study, the image of weeds which is used is a wide variety of dimensional image as can be seen in Table 1. The maximum size of 0.3 MB image is assumed as the conscientious size image to perform filtering process. Tests carried out mainly on land that has not been sprayed by herbicide before planting period (Pre Emerge), image data captured is planting period 1-4 weeks that is done because in that span it is the right time as a critical period of weed competition with the main crop.

Table 1. Image Dimension

Image	Dimension (Pixel)
1	128 x 128
2	256 x 256
3	380 x 380
4	480 x 480
5	512 x 512

2.2. Weeds Image Filtration

The image was taken and analyzed to determine the color of its constituent components. Based on the color components are then determined parameters filtration to separate the background image of the staple crops in binary (black and white). Data array of pixels that store binary values processed image using fractal dimension analysis, can be seen in figure 1. Assessment of the human eye is used as a benchmark to determine the accuracy of the performance system which is built.

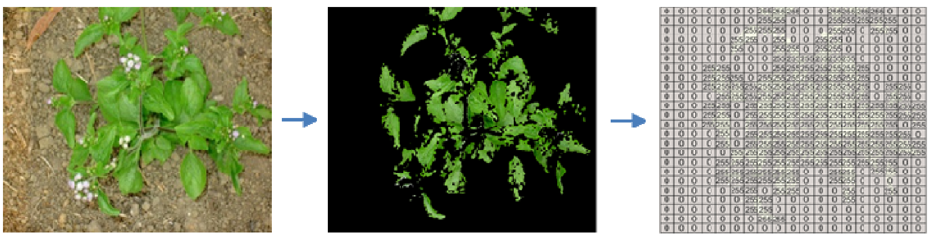

Figure 1. Image filtering process weeds into binary data

2.3. Fractal Dimension Analysis

Fractal dimension analysis is performed by fragmentation of the image that has been difilterisasi into a rectangular shape measuring s. Then calculate the number of squares N (s) that contains the white color (results filtration plant). This calculation is repeated with different values of s as much as 10 intervals. The next step is to plot the value of log N (s) to the value of log (1 / s) and determine the shape of the linear regression equation y = ax + b. Fractal dimension is a value on the linear regression equation.

3. Results and Analysis

3.1. Image Filtering

Computational image of preprocessing filter is obtained by comparing and testing as N = 10 trials for each image on the Raspberry Pi and PC, can be seen in Table 2 and Table 3.

Table 2. Image filtering on Raspberry Pi

Image Dimension (Pixel)	N Testing (Second)									
	1	2	3	4	5	6	7	8	9	10
128 x 128	0.1	0.1	0.13	0.11	0.11	0.11	0.12	0.12	0.1	0.11
256 x 256	0.48	0.49	0.45	0.45	0.43	0.44	0.48	0.45	0.47	0.44
380 x 380	0.89	1.09	1.04	0.93	1.18	1.12	1.04	0.98	0.92	0.89
480 x 480	1.47	1.79	1.53	1.63	1.78	1.52	1.89	1.56	1.41	1.47
512 x 512	1.72	1.98	1.8	2.21	1.65	1.8	1.69	1.81	1.78	1.8

Table 3. Image filtering on PC

Image Dimension (Pixel)	N Testing (Second)									
	1	2	3	4	5	6	7	8	9	10
128 x 128	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01
256 x 256	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.03	0.02	0.02
380 x 380	0.04	0.04	0.04	0.05	0.04	0.04	0.04	0.05	0.04	0.04
480 x 480	0.06	0.06	0.05	0.06	0.05	0.05	0.05	0.05	0.06	0.05
512 x 512	0.07	0.07	0.06	0.06	0.06	0.07	0.06	0.06	0.06	0.06

From the comparison of the preprocessing computation of image process with Raspberry Pi and the PC can be generated average value which can be seen in Table 4.

Table 4. The average time of image filtering on Raspberry Pi and PC

Image Dimension (Pixel)	Computation (Second)	
	Raspberry	PC
128 x 128	0.111	0.012
256 x 256	0.458	0.020
380 x 380	1.008	0.042
480 x 480	1.605	0.054
512 x 512	1.824	0.063

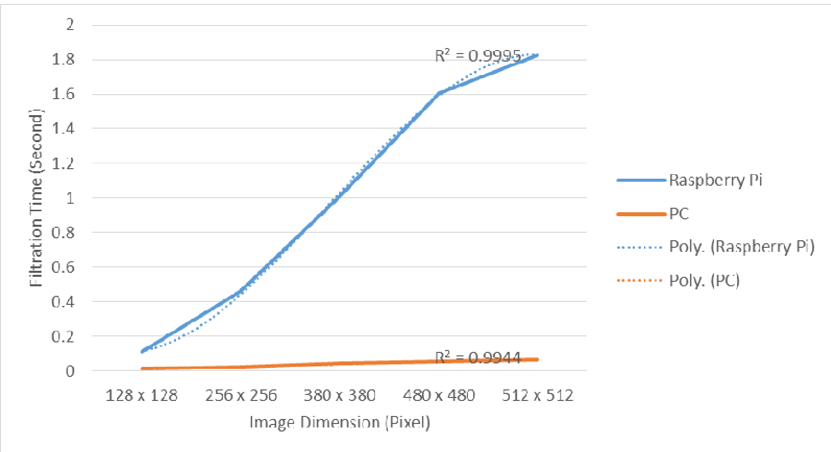

Figure 2. Comparison of image filtering on Raspberry Pi and PC

The results of the above experiments using Raspberry and PC show that the computational time of image preprocessing filter is worth polynomial that is close to 1 which means that the computing time proportional to the size of the image, the larger image is used more and more computing time required. In general, PC computation time is faster than Raspberry Pi.

3.2. Fractal Dimension Analysis

In the process of computing the fractal dimension analysis carried out by the processing results of image filtering weeds such as binary data in raspberry pi, can be seen in Table 5 by using fractal algorithms using C.

Table 5. Computational results using fractal on Raspberry Pi and PC

Image Dimension (Pixel)	Raspberry Computation (ms)	Raspberry Fractal	PC Computation (ms)	PC Fractal
128 x 128	7	0,9	0.1	0,9
256 x 256	12	1,1	0.5	1,1
380 x 380	37	1,3	2.1	1,3
480 x 480	74	1,7	4.2	1,7
512 x 512	93	1,8	5	1,8

The research results in Table 5 shows best fractal computation time in Raspbery Pi when performing the image with dimension size of 128 x 128 pixels. It is about 7 milliseconds.

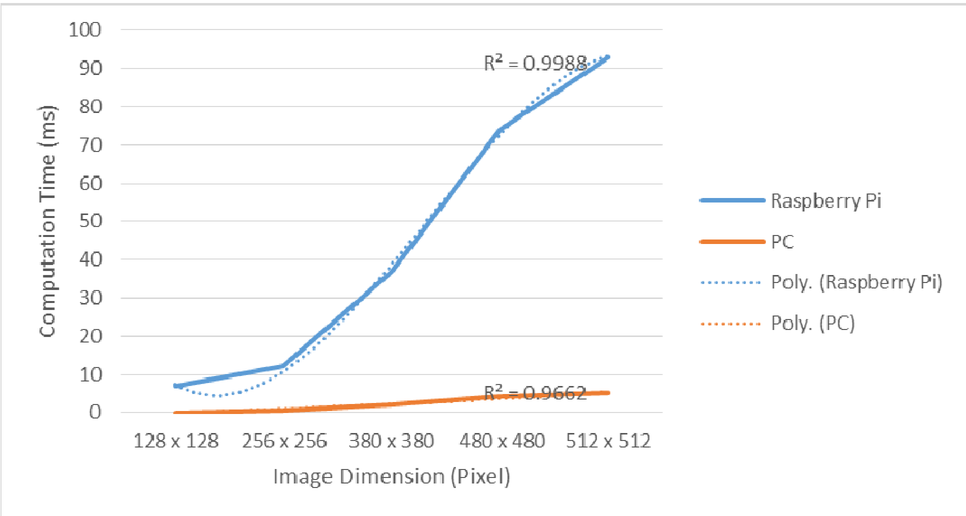

Figure 3. Comparison of computation time fractal image on Raspberry Pi and PC

The results of the above experiments show that the fractal computational time on a PC is faster than the Raspberry Pi. Furthermore, the average speed ratio between personal computer and Raspberry Pi is 0.04 times faster. The comparison of the specifications in Table 8 is 4 : 1 and the ratio of the power consumption of 34 : 1 is more efficient to use Raspberry Pi.

Table 6. General comparison between Raspberry Pi and PC

Specification	Raspberry Pi	PC	Comparison
Processor speed	700 MHz x 1 core	1,5 GHz x 2 core	4 : 1
RAM Size	512 MB	2 GB	4 : 1
Watts	3.5	65	16 : 1
Price	Rp 500.000	Rp 4.000.000	4 : 1
		The average ratio	4 : 1

4. Conclusion

The average ratio between the speed of the PC Raspberry Pi and fractal process is 0,04 times faster. The best filtering computation that can be done by Raspberry Pi is 512 x 512 Pixels. The use of Raspberry Pi is cost and power consumption efficient compared to personal computer.

References

[1] Blackmore S. Precision Farming: an overview. *Agricultural Engineer*. 1994; 49(3): 86-88.
[2] Kuhar JE. The Precision-Farming: Guide for Agriculturist. *Illinois: John Deer Publishing*. 1997.
[3] Shibusawa S, Anom IM, Sasao A, Sakai K, Hache C. Sampling strategiesin soil mapping with real-time soil spectrophotometer. Di dalam: Intelligent Control for Agricultural Application. *Proceeding of 2nd IFAC-CIGR* Workshop on, Bali Indonesia 22-24 August 2001. Bali: IFAC-CIGR. 2001: 40-43.
[4] Solahudin M. Pengembangan metode pengendalian gulma pada pertanian presisi berbasis multi agen komputasional. Disertasi Institut Pertanian Bogor. 2013.
[5] Mc Bratney, AB, Prongle, MJ. *Spatial Variability in Soil Implication for Precision Agriculture*. Proceeding Precision Agriculture, BIOS Scientific Publiser Ltd, Oxford. 1997.
[6] Fahad Shahbaz Khan, Saad Razzaq, Kashif Irfan, Fahad Maqbool, Ahmad Farid, Inam Illahi and Tauqeer ul amin. Dr. *Wheat: A Web-based Expert System for Diagnosis of Diseases and Pests in Pakistani Wheat*. Proceedings of the World Congress on Engineering WCE. 2008; 1.
[7] Solahudin, M Seminar, K Astika, W Buono A. *Weeds and Plants Recognition using Fuzzy Clustering and Fractal Dimension Methods for Automatic Weed Control*. International Conference, the Quality Information for Competitive Agricultural Based Production System and Commerce. 2010.
[8] Kargar BAH, Shirzadifar AM. *Automatic Weed Detection System and Smart Herbicide Sprayer Robot for Corn Fields.* Proceeding of the 2013 RSI/ISM International Conference on Robotics and Mechatronics, Tehran, Iran. 2013.
[9] Hong, Sung Minzan, Li Zhang, Qin. *Detection System of Smart Sprayers: Status, Challenges and Perspectives*. Int J Agric & Biol Eng. 2012; 5(3).
[10] Pimentel D, McLaughlin L, Zepp A, Lakitan B, Kraus T, Kleinman P, et al. *Environmental and economic effects of reducing pesticide use*. Bio Science. 1991; 41(6): 402-409.
[11] Leach AW, Mumford JD. *Pesticide environmental accounting: A method for assessing the external costs of individual pesticide applications.* Environmental Pollution. 2008; 151(1): 139-147.
[12] McBratney AB, Prongle MJ. *Spatial Variability in Soil Implication for Precision Agriculture*. Proceeding Precision Agriculture, BIOS Scientific Publiser Ltd, Oxford. 1997.
[13] Seminar KB. Paradigma Pendayagunaan Teknologi Informasi untuk Pertanian. Prosiding Seminar Nasional Seminar Informatika Pertanian Indonesia. 2011: 34-42.
[14] Steward, B and L Tian. *Real-time machine vision weed detection.* ASAE paper No. 983033 (UILU-ENG-98-7006). 1998.
[15] M Richadson, S Wallace. Getting Started with Raspberry Pi. US: O'Reilly. 2012.
[16] Rahman A, Mardhani R. High Performance Computing on Cluster and Multicore Architecture. *TELKOMNIKA Indonesian Journal of Electrical Engineering*. 2015; 13(4): 1408-1413.
[17] Albert Sagala, Deni Lumbantoruan, Epelin Manurung, Iroma Situmorang, Adi Gunawan. Secured Communication among HMI and Controller using RC-4 Algorithm and Raspberry Pi. *TELKOMNIKA Indonesian Journal of Electrical Engineering*. 2015; 15(3): 526-533.
[18] Ali, Murat et al. *Technical Development and Socioeconomic implications of the Raspberry Pi as a Learning Tool in Developing countries*. 5th Proceedings of the IEEE Computer Science and Electronic Engineering Comference (CEEC). 2013: 103-108.