Image Processing Technology for Edge Detection Based on Vision and Raspberry Pi

L Patria1,* and A Sambas2

1Department of Information, Universitas Terbuka, Indonesia.
2Department of Mechanical Engineering, Universitas Muhammadiyah Tasikmalaya, Indonesia

*Email: lintang@ecampus.ut.ac.id

Abstract Rice (Oryza sativa L) is the main food crop in Indonesia because most of Indonesia's population consumes rice as a staple food. In this paper, we present a system that functions to detect weeds in rice plants using imaging analysis with a camera device and a Raspberry Pi. The Raspberry Pi got a picture of the field from camera that connected through USB connection and send it to the IoT server. The method used in the analysis is to combine the vertical projection method and the linear scanning method. The results showed that our system was very effective in detecting edges in rice plants.

1. Introduction

There are some applications that use image processing in agriculture such as agricultural plant leaf disease detection [1], classification of agricultural products [2], weed detection [3], assessing sugar beet leaf nitrogen status [4], apple classification [5], plant detection of intact tomato fruits [6], non-destructive crop measurements [7], sorting systems in agricultural [8], estimating antioxidant activity and anthocyanin content of sweet cherry [9], extraction of hedgerows [10], quality and shelf-life prediction of cauliflower [11], recognition and classification of paddy leaf diseases [12].

Various important studies involve the edge detection. Vincent and Folorunso (2009) presented a descriptive algorithm for Sobel image edge detection [13], Revathi and Hemalatha (2012) conducted classification of cotton leaf spot diseases using image processing edge detection techniques [14]. Ezzaki et al (2018) presented a comparison of edge detectors performance through use in agricultural robotics [15]. The result shows that the good performance of Bouda’s and Kayyali’s detector. Qul’am et al (2019) created online image processing of a vision guide pick and place robot by using edge detection [16]. Danton et al (2020) developed a spraying robot for precision agriculture based on the edge approach [17].

In this work, we proposed a low-cost Raspberry Pi based image processing system for identifying edge from rice field. The Raspberry Pi got picture of the field from camera that connected through USB connection. The Raspberry Pi analyzes the picture using vertical projection and linear scanning method and send the result to IoT server. Finally, edge detection in rice plant can be analyzed comprehensively.
2. Architecture

The system consisted of Microcomputer (based on Raspberry Pi 4, 2 GB of RAM and 16 GB of memory card), camera, modem, and IoT server. The Raspberry Pi was a central system of all devices, that perform calculating, processing and converting. The Raspberry Pi processed image of field based on its rows in certain interval (one shoot for every day) with camera via USB 2.0 / 3.0 connector. The taken image was processed inside the Raspberry Pi using image processing algorithm without delayed after the camera shot a row of the field.

The processed image was sent to IoT server based on HTTP request through internet using the Modem (GSM Module). The IoT Server built from Virtual Private Server which could be adding an Operating System (OS) and several image processing resource independently (not a sharing hosting). The IoT Server saved the sent image inside server drive with unique name (based on time) and extension as an image file.

![Image processing scheme based Raspberry Pi](image1.jpg)

**Figure 1.** Image processing scheme based Raspberry Pi

![Camera for edge detection](image2.jpg)

**Figure 2.** Camera for edge detection
3. Methodology

3.1 Vertical projection method

The vertical projection of the image is a graph, which is the overall magnitude of the figure according to the y-axis. If we compute the vertical projection of the image after applying the vertical edge detection filter, the magnitude of a certain point represents the occurrence of the vertical edges at that time. Then, the vertical projection will be processed so that the image changes can then be used for vertical localization of the license plate. The vertical projection is detected by obtaining the pixel quantization value based on the image height (line). At this stage the image will be cut based on the graph of the vertical projection. The equation model used is as follows

\[ P_x(i) = \sum_{j=1}^{W} bw(i, j), \ldots i = 1, 2, \ldots H \]  
\[ P_y(j) = \sum_{i=1}^{H} bw(i, j), \ldots j = i, 2, \ldots W \]  

W denotes the width of images, H means the height of images, \( P_x(i) \) represents all the non-zero pixels of the i column in the horizontal projection direction; \( P_y(j) \) denotes all the non-zero pixels of the j row in the vertical projection direction.

3.2 Linear scanning algorithm

The vertical projection method generates the number of crop lines and the coverage of each crop line, with n denoted the number of the crop rows, \( P_{iTL} \) mean the left top boundary of i column of crop rows, \( P_{iTR} \) represented the right top boundary of i column of crop rows, \( P_{iBL} \) denoted the left bottom boundary of i column of crop rows, \( P_{iBR} \) designated the right bottom boundary of i column of crop rows [18]. In this method, we use ref from [18], Linear scanning algorithm flow chart is shown in Figure 3.

![Figure 3 Linear scanning crop line detection algorithm [18]](image)

\[ P_{x}(i) = \sum_{j=1}^{W} bw(i, j), \ldots i = 1, 2, \ldots H \]
\[ P_{y}(j) = \sum_{i=1}^{H} bw(i, j), \ldots j = i, 2, \ldots W \]
4. Result and Discussion

This research was conducted in Bojonggambir, Tasikmalaya. The first stage of this research was to create a manual outline for rice plants. The aim was to facilitate analysis of the rice plant row structure. The resulting pattern could be compared with the processed image. Manual outline creation can be seen in Figure 4.

By using the vertical projection method and the linear scanning method, we had processed the image on the rice plant to detect the edges of the plant. The goal was to see the regularity pattern of rice plants. If the pattern was found to be irregular, then there were other plants which called “weeds”.

The next step was to detect plants in green and convert them to black and white. If we applied this model to rice plants that grow regularly, the results obtained were edge detection that corresponded to the structure of rice plants (See Figure 5). But if we applied this model to rice plants that growth irregularly, the results showed irregular edge detection. With this method, we could conclude that plants that the irregular growth plants were weeds (See Figure 6).

Figure 4 Manual outline creation

Figure 5 Detect green plants and convert them to black and white on regular rice plants
5. Conclusions

This paper combined vertical projection method with linear scanning method to identify the center line of the crop rows, and divided the grid cells. Also, we proposed a low-cost Raspberry Pi based image processing system for identifying edge from rice field. The Raspberry Pi processed pictures of the field from USB connected camera. The results showed that our system was very effective in detecting edges in rice plants. The next research is to detect weeds using the convolutional neural network method.

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