# Development of real-time onion disease monitoring system using machine vision

Du-Han Kim[1], Kyeong-Hwan Lee[2], Chang-Hyun Choi[3], Tae-Hyun Choi[4], Yong-Joo Kim[1*]
*1 Dept. of Biosystems Machinery Engineering, Chung-Nam National University, Daejeon, 305-764, Korea*
*2 Dept. of Rural and Biosystems Engineering, Chonnam National University, Gwangju, 500-757, Korea*
*3 Dept. of Bio-Mechatronic Engineering, Sungkyunkwan University, Suwon, Gyeonggi, 440-746, Korea*
*4 Sensoreye R&D Solutions, Daejeon, 302-861, Korea*

## Abstract

**Background:** To provide optimum environmental condition agricultural crops, it is necessary to environmental monitoring of continuous crops. Especially, it needs to minimize that effect of crops to disease manifestation by real-time monitoring. Therefore, the purpose is development of machine vision system for disease monitoring of crops.

**Methods:** In this study, machine vision system consisted of infrared floodlight camera, servo motor and lifting device. The infrared floodlight camera contains intelligent video analytic function, automatic sound alarm, after recorded image function. In addition, this camera designed that enable to rotate 360 degrees for monitoring all around environment. Servo motor system is installed stand for position controller. Lifting device is available for moving the camera up and down.

**Results & discussion**: Image of crops was difference between disease crops and without disease crops. Therefore, it is possible to detection disease using a machine vision system. The results of this study showed that developed environment monitoring system using machine vision is feasible as real-time measurement by measurement condition such as day/night, and measuring point.

## Background

Onion is one of the most used seasoning vegetables in the world with increasing cultivation area both domestically and worldwide alike. As onion become known as a healthy food worldwide, the cultivation area of onion in Korea has increased by 10.4% in 2016 to 19,891 ha from 18,015 ha in 2015. During the same period, the production has increased by 18.7% from 1,093,000 ton to 1,298,000 ton. But, lately the damage to onion has increased on a gradual basis due to global warming and the drought stress from climate change. Downy mildew, the severest form of onion disease, is a soil infection caused by Peronospora destructor that causes a serious reduction in crop quantity by damaging mostly the leaves. Downy mildew occurs due to the lack of carbohydrates and potassium in the leaf of crop which causes prolonged dryness and browning in the leaf end and root that leads to reduced immunity and various damages. The downy mildew does not break out when the temperature of soil is 15℃ or below, but breaks out when the soil temperature is at 25 - 28℃. Rainy weather before harvest or wet packaging can be other causes of infection as well. In addition, onions are quickly infected in the repetitive reproduction from mid-April to early May. The disease breaks out in fall and spring, particularly in mid-April when the cold rain falls. The infected onion leaf shows early chlorosis and yellows down to its death. Therefore, with the recent expansion in the cultivation of the crop, it has become necessary to introduce advanced crop management technology for improved productivity and stability of production. To fulfil this need, more agricultural studies are now incorporating flying objects such as drones. However, despite its usefulness in periodic measurement, drone is not the most convenient tool for real-time and long-term measurement such as rapidly changing climate. For the prediction of the diseases and crop production, it is necessary to extract information such as the location and size of the crop through continuous cultivation monitoring. Accordingly, a real time imaging device is required for measuring the growth and diseases of the crop in connection with IT technology. The current research on onion cultivation using a real time imaging device is limited to those made by only a few researchers.

## Methods

The image acquisition system is made of the driving system that drives the motor and the image input system that takes the image of the plants. The driving motor system is made of the stepping motor and the motor control program that enables the camera to move either in an upward or downward direction. The driving PC was connected to the monitoring PC through the image input computer and RS 232 serial communication port. The motor driving program was designed in a way that the motor driving PC receives the signal from the image processing section and rotates the motor for control. The driving system was designed to rotate the motor in a proper time and angle for accurate measurement of plants. Fig. 1 shows the driving motor on the stand in a way the camera can move upward/downward as well as the camera installed on the driving motor.

The place of testing and packing for this study is the onion cultivation field located at Bio Energy Crop Center, National Institute of Crop Science, in Muan, Jeongnam, Republic of Korea. The reason of choosing onion is because it has both long and short sides of leaf and is susceptible to disease. The study targeted onion which was seeded in early November. Fig. 5 shows the onion that was measured.

**Figure 1. Onion test field for real-time disease monitoring**

The image acquisition system was installed 10m away from the onion field so that it can predict any damage or change in the onions. The measuring was conducted from Apr. 20, 2017 to May 1, 2017 from 07:00 am to 19:00 pm. 15 onions from different locations were measured in 30 minute intervals. To find out the disease-area-breakout rate of the onion using the image acquisition system, the measurement was conducted in an environment that is susceptible to Downy mildew during the entire test period. The measuring was conducted in mid-April which is the first infection cycle of downy mildew. 4 samples were randomly selected for the color images when the soil temperature was 25 ~ 28° for the image processing.

## Results

To identify Downy mildew infection through acquired images, the disease area was calculated by covering the green part of onion leaf in black excluding those parts affected by Downy mildew then acquiring image binarization. For data selection, 4 samples for which browning is visually identifiable in naked eyes were selected.

## Discussion

It was made possible with the use of image acquisition system device developed in this study to continuously predict the change of onion growth and disease outbreaks. It is decided that using the growth information that is continuously measured, as well as image processing, will effectively provide the optimum environment for each growth cycle. However, it shall be necessary to reinforce the image processing method as we experienced an error of surrounding element being included other than the onion leaf.

## Conclusion

This study is a basic study that predicts the timing of disease outbreak in onions by developing the image acquisition system and processing the obtained images. The developed image acquisition system measures the image of the onion field in a certain time interval. 4 randomly selected samples were analyzed using the image processing algorithm. The result of image processing showed that browning on the leaf of onion occurred. As with the detected discoloration in the leaf, the disease part area rate was calculated to be 5.34% for Sample 1, 6.94% for Sample 2, 3.38% for Sample 3 and 4.40% for Sample 4. However, it is decided that analysis on the accuracy shall be made in the future as not only the brown part of the leaf but the surrounding soil is also recognized.

Accordingly, it shall be possible to develop a crop image acquisition system that will detect any changes in crop state more rapidly by image processing the color, height, long side and short side of onion leaf as well as diseases. Also, for more practical and effective monitoring, it is decided that additional analysis on image processing is required to identify the reaction depending on growth conditions and climate.

## Acknowledgments

This study was supported by the Advanced Production Technology Development Project of the Korea Institute of Planning & Evaluation for Technology in Food, Agriculture, Forestry & Fisheries. (Project No.: 315012-3).

## References

Mo CY, Lee HJ, Ko SJ, Yang KY 2016. Control efficacy of several fungicides against downy mildew of onion at nursery seedling stage. Journal of The Korean Society of Plant Pathology 22(3): 208–212.

Chung SO, Kim YJ, Lee KH, Sung, NS, Lee CH, Noh HK 2015. Remote monitoring of light environment using web-camera for protected chrysanthemum production. CNU Journal of Agricultural Science
42(4): 447–453.

Yoon DH, Oh SY, Nam KW, Eom KC, Jung PK 2014. Changes of cultivation areas and major disease for spicy vegetables by the change of meteorological factors. Journal of Climate Change Research 5(1): 47–59.

Na IS, Kim SH, You SM, Lee KS 2008. Removal of the shadow of vehicle images using HSV color model. Journal of Korea Transportation Research Society 58(1): 1065–1070.

Lim EC, Kim JJ, Chang SS, Shim CB, Lee JH 2007. Implementation of a multimedia pest prediction management system for mobile users. Journal of The Korea Contents Society 5(1): 1–5.

Min BR, Kim W, Kim DW, Lee DW 2004. Determination of transferring period of several plants using image processing. Journal of Bio-Environment Control 13(3): 178–184.

Min BR, Kim W, Kim DW, Seo KW, Lee CW, Lee DW 2003. Analysis of the back propagation and associative memory for image system. Proceeding of Bio-Environment Control 12(1): 181–190.

Son JR, Kang CH, Han KS, Jung SR, Kwon KY 2001. Recognition of missing and bad seedlings via color image processing. Journal of The Korean Society for Agricultural Machinery 26(3): 253–262.

Kim GY, Ryu KH, Chun SP 1999. Identification of crop growth stage by image processing for greenhouse automation. Journal of The Korean Society for Agricultural Machinery 24(1): 25–30.

Kim GY, Ryu KH, Chae HY 1999. Analysis of water stress of greenhouse crops using infrared thermography. Journal of The Korean Society for Agricultural Machinery 24(5): 439–444.