Abstract of Thesis

Double Lighting Machine Vision System for Rice Quality Evaluation

by

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Automating quality assessment of rice grains, including physical, biochemical and physicochemical properties, while extremely important remains challenging. To date, most of the technologies developed in this area are for a specific parameter or use; what is needed are rapid, non-destructive, in-situ, multiple quality parameter assessment systems that can be applied to various production/process stages. In this research, a machine vision with a double lighting system has been developed for quality monitoring of rice grains. The effectiveness of this system was demonstrated at two different stages of rice production/processing: at harvesting and postharvest. At the harvesting stage, a double lighting machine vision system was developed for future monitoring of grain quality during combine harvesting; replacing visual (manual) inspection by the operator. The grain qualities that will be study in this stage are about purity and grain damage. To achieve this, a combination of backlighting (morphological features) and frontlighting (color features) were found to be useful in assessing grain quality. A machine vision system with double lighting and an image processing algorithm were developed to detect undesirable objects in the paddy as it is being harvested to provide information for adjustment of parameter settings by the operator and automate combine harvester procedures. The system consisted of a web camera, a double lighting system (frontlight and backlight), an image acquisition, and image analysis algorithm. To maintain a compact and robust system capable of being mounted and operated in the harsh environment of a grain tank, Ring white LED lights for frontlighting and Flat dome white LED lights for backlighting were found to give the most

uniform lighting distribution. Moreover, when using dot-patterned Flat dome white LED lights for backlighting, having them turned off provides a higher-contrast background for frontlight images. Both lighting systems were arranged in a coaxial axis, making the system simple, compact and easy to handle. Images captured by this system were used for detection of undesirable objects (long rachis branches, grass and leaves, straw and stalks) and damaged grain (brown rice and cracked rice). Evaluation of the results demonstrate the proposed detection algorithm had a detection correlation of determination, R^2 greater than 0.70 for detection of each of the undesirable objects. Future application of this system in the field could help the operator of the combine harvester to improve the efficiency and adjustment of automated harvesting procedures, as well as the quality of the harvested paddy. After harvesting, paddy will goes to postharvest stage which is drying, storage, milling and processing stage. Normally, the quality assessments were done during the processing and milling stage. For postharvest assessment, most of the technologies that have been developed to date predominantly focus on measuring only one quality characteristic at a time. What is needed are evaluation systems that simultaneously assess multiple quality parameters. In this research, a machine vision system with a double lighting was developed to evaluate a number of quality characteristics. The machine vision system developed has the capability to simultaneously assess morphological features, as wells fluorescence color related parameters of sake rice grain quality. The qualities that were looked into are about the chalkiness and freshness. In Japan, sake rice is one of the types of rice. The uniqueness of this type of rice is that the sake rice was grade based on the chalkiness. Therefore, for the second stage of this study, we used sake rice and measure the chalkiness and freshness. Freshness here is related to the ageing rice. This quality was choosing because during ageing of stored rice, a number of physiochemical and physiological changes occur and affect the quality of rice. Combined these image features were used to separate non-white core, white core, chalky and dead sake rice grains with different levels of freshness (2011 and 2016). Before developing the system, we identify the fluorescence characteristic: excitation (Ex) and emission (Em) wavelength for sake rice. From these results, we develop the image acquisition system. The double lighting system

that were used in this study consist of digital camera, object plate and two lighting system which are frontlight and backlight. For the frontlight, we used UV ring LED as frontlight and white LED as backlight. Frontlighting images give use fluorescence images. By using these images, we extract the color information that related to the fluorescence while from backlighting images the morphological features were extracted. From the EEM spectrum only one peak were found in all the type of rice which is at excitation 360 - 380 nm and emission at 46- 470 nm and the compound was suspected as Lipofuscin-like. High intensity of the peak was shown in the ageing rice compared to the new rice for all types of rice. The results from the image acquisition indicate the morphological features can be used to discriminate between the rice grain types with accuracy of 91%, while fluorescence color features can be used to detect the freshness with an accuracy of 82%. By combining both technologies into one, the system could separate rice grains into difference types and freshness levels with an accuracy of 88%. These results provide a path towards simultaneous multi-quality grading of sake rice. This system not only can be applied to the sake rice grading but also can be used for the ordinary/ table rice grading. The chalkiness also occurs to the normal rice because of the effect of high temperature during the filling in the growth stage. Besides that, nowadays, in the world, there are issues where regarding the adulteration of the rice for marketing at the high price. The illegal blend/ mixing rice that differ in quality and price. Therefore, this system has a potential to be used to solve the problems. In conclusion, these new double lighting machine vision systems have the potential for rapid, non-destructive, in-situ, multi-quality assessment of rice grain at different stages of processing from the field to milling.