Rice Research and Promotion Board

Project Title: Automated Non-Destructive Machine-Vision System for Inspection of Rough Rice

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Priority Area: POST-HARVEST

Status: Existing

2004 PROGRESS REPORT:

During the first 6 months of the project the following steps have been accomplished.

1. The light-proof chamber used for the previous studies has been reconstructed.
2. The glass turntable used to present the rough-rice kernels to the imaging system has been installed in the chamber.
3. Data have been collected manually that demonstrate that imaging both sides of the kernels results in an improved detection of damaged kernels.
4. Existing mechanisms for singulating kernels have been investigated prior to selecting the mechanism to be used.
5. The Visual Basic program written by previous investigators has been studied. It was not found to be user-friendly, and thus, seemed unsuitable for a prototype system to be used by the rice researchers in Stuttgart.
6. A user-friendly software package has been purchased. The package is capable of automating the capture and analysis of images, followed by signaling external hardware to sort the kernels into bins. This software is now in use and should enable the investigators to create a turn-key system for use by scientists at Stuttgart.

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Value to the Growers:

The improved assay system developed by this project will enhance the overall rice research program by providing to rice breeders a better high-speed non-destructive scientific tool to evaluate rough rice samples for resistant rice variety lines and to quickly assess a variety of shape and size properties. The imaging system uses a modified back-lighting technique combined with digital imaging techniques, to provide accurate quantitative data that will allow scientists to evaluate rough rice samples for susceptibility to discoloration caused by such problems as the rice stink bug (*Oebalus pugnax*) and the kernel smut fungus. The imaging system can also provide accurate measurement of kernel dimensions as well as variance analysis, which will accelerate progress in pathology, entomology, variety development, and genetic research programs. More efficient programs will result in a faster release of highly desirable rice cultivars.

Objectives:

To continue the development of the machine vision system to provide a quick, inexpensive, and nondestructive rough rice sample assay to detect, characterize, and separate rice grain damaged by insects, fungi, or other factors from healthy grains for entomology, pathology and breeding research programs. More specifically:

1. To design and build the materials handling system for presenting the rice kernels to the imaging system, in single file.
2. To develop the two-camera, two-ring-light configuration for imaging both sides of the kernels automatically.
3. To develop the mechanical system for automatic sorting of the rice samples based upon the type and extent of damage.
4. To develop and deliver a prototype for use in the laboratory at Stuttgart.

Justification:

Scientists have been developing resistant varieties for many years, but are limited by time-consuming manual examination of rough rice samples. An accurate, fast, and quantitative evaluation will provide for the early identification of the sources of resistance, which will enhance the selection process and accelerate the variety development process. Growers will benefit greatly through more disease and insect resistant varieties with enhanced crop quality, and lowered production costs. Finally, a rapid, non-destructive evaluation of shape and size will promote the development of improved varieties.

Through the initial efforts of Dr. Yang Tao, et al, a high-resolution vision system was developed as a very useful tool for identifying and quantifying peck in rough rice. The system used a novel back lighting technique, as shown in Fig. 1 & 2. Through tests and demonstrations, the system was shown to have the capability of identifying internal insect and disease damage and the severity of the damage. Further work was planned to develop automated separation of healthy and damaged kernels combined with the dimensional analysis and quantification of damage obtained by using non-destructive digital image analysis to eliminate the tedious screening of large rice samples and the time-consuming hand separation of good and bad kernels. Detailed information is available (Tao, et. al, 1997).

Previous Accomplishments:

Imaging System

An imaging system was set up to capture images of rough rice kernels as shown in Fig 1. The system required that single kernels of rough rice be positioned on a rotating glass plate so that they would pass over a small opening through which light from a fiber-optics ring could backlight each kernel. The fiber-optics ring and the small opening were sized so that the video camera used could not see the ring light. The kernels, however, were brightly lit, and the images captured could be used to distinguish undamaged kernels from damaged ones, as shown in Figure 2.

Fig. 1 Tao's vision system for evaluating internal damage in rough rice kernels

Fig. 2 Sample images under the special back lighting technique.

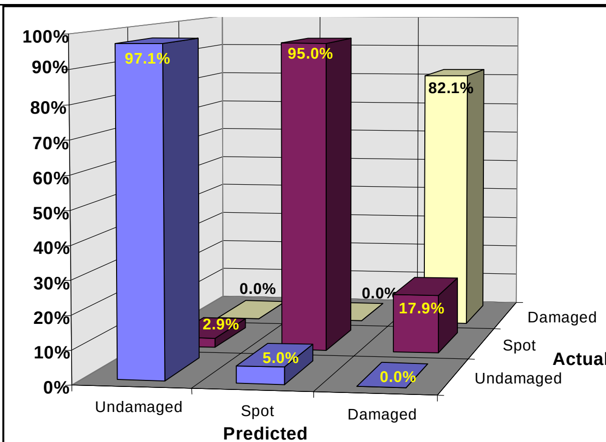

Fig. 3 Classification using APD Algorithm

Success of Imaging System

The imaging system and mathematical calculations made from the images were remarkably successful in identifying damaged and undamaged kernels, as shown in Figure 3. For example, when the computer program indicated that a kernel was undamaged, manual examination of the kernel was in agreement with that conclusion 97% of the time. There were some slight ambiguities in distinguishing between damaged and spot-damaged kernels, but it was felt that improvements in the mathematical formulas could reduce the ambiguities. In addition, preliminary results indicated that further improvements in distinguishing between damaged and undamaged kernels could be achieved by imaging both sides of each kernel.

Further Work

System Development

The purpose of this project is to complete the development of the system. The materials handling system for sample presentation, the dual-camera arrangement for imaging, the imaging software, and the mechanical system for sorting the kernels all require further work before a prototype system can be built for testing at the Rice Research and Extension Center in Stuttgart.

Equipment:

Currently, all the equipment and facilities used in the initial imaging investigations are available in the vision lab of the department of Biological & Agricultural Engineering at the University, where the initial prototype of the imaging system was constructed. Additional components will be necessary to complete the system for presenting the kernels to the imaging system in single file. In addition, a second camera and ring light will be needed to facilitate imaging both sides of each kernel.

Qualifications:

The research team has extensive knowledge and experience in both the machine vision and rice research areas.

Time table (within three years):

Tasks	Schedule
Mechanical system development	**Year 1**
Optical and lighting development	**Year 2**
Imaging software system improvements - pattern recognition, damage detection, and classification - three-dimensional grain size measurement and test - image analysis and user friendly interface development	**Year 3**
Electronic control system and Prototype Delivery to Stuttgart Lab - mechanical encoder interface & signal conditioning - separation mechanism driver and controller	**Year 3**