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RiSe-IViS: Rice Seed Inspection Vision System

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Abstract
Rice seed production in Malaysia is greatly dependent on the purity of the cultivated paddy seed produced through the government certified paddy seed program. Under the program, the seeds to be marketed by the seed processors must undergo quality control protocol where the seed lots are sampled from the seed farms and seed processing plants for purity analysis by the Seed Testing Laboratory of the Department of Agriculture (DoA), the enforcing agency. The current inspection conducted by the laboratory is based on manual process which is laborious, time consuming (max 40 min for newbie while skilled operator takes about 15-20 min.). The process is also very subjective and error prone as it is influenced by the skills and experience of laboratory workers especially those involving segregating vague and indistinct special morphological or even textural and color features. A prototype (Patent ID: PI2018500018) of a machine vision-based paddy seed inspection system (RiSe-IViS) was developed to explore the possibility of replacing the existing manual method in distinguishing the weedy rice and cultivated rice seeds under the SJPM standard protocol with a modern, effective and efficient technique. The RiSe-IViS prototype developed consists of two parts i) hardware configuration ii) software protocol development. A user friendly graphical user interface (GUI) was developed to assist user for image acquisition and analysis. Analysis protocol was first developed based on the morphological features of the paddy seed and was tested for MR297 against weedy rice. The classification accuracy was achieved up to 99%. Validation of the protocol is to be carried out with local seed plant in Kedah to enhance the system. The RiSe-IViS is expected to classify major rice seed varieties available in Malaysia against the weedy rice variants with superior accuracy.

Keywords: Machine vision, weedy rice, paddy seed, MR297, prototype, image processing, classification

Introduction

Weedy rice is a serious threat to the rice industry in Malaysia. The term weedy rice or locally known as *padi angin* refers to populations of the weedy types of rice that are identified through its characteristic of easy-shattering grains during harvest (Azmi et al., 1998). Weedy rice in Malaysia was reported to be an evolution from the cultivated rice due to dry seeding and volunteer seeding practiced by the farmers in the late 1984 - 1988 according to Abdullah et al. (1996). The morphological form of the Malaysian weedy rice seeds found in Peninsular as classified by Sudianto et al. (2016) are based on hull coloration and awn presence into eight morphotypes. Hull color were classified into strawhulled, intermediate strawhulled, brownhulled or blackhulled. The seeds either have awn or no awn. The pericarp could be either brown, red or white grain. Table 1 shows the eight morphotypes of weedy rice found in Peninsular Malaysia.

The long term paddy seed production program in Malaysia is addressed under the Enhancement of Paddy and Rice Industry of the National Agro Food Policy (Dasar AgroMakanan) – with strategy to enhance the productivity and quality of paddy and rice through the use of high quality produced paddy seed. The paddy seed producers are appointed by the government and supply certified seeds to the farmers.

Table 1: Morphotypes of weedy rice in Peninsular Malaysia

No.	Hull Color	Awn Presence
1.	Strawhull	Awn
		No awn
2.	Intermediate strawhull	Awn
		No awn
3.	Brownhull	Awn
		No awn
4.	Blackhull	Awn
		No awn

Source: Sudianto et al. (2016)

The paddy seed produced must achieve high quality standard in accordance to Standard Jabatan Pertanian Malaysia (SJPM 2011) through a Seed Testing Laboratory, a certification body under the Department of Agriculture (DOA). DOA, also an authorised new certified paddy seeds marketing, is continuously besieged with a problem in identifying and distinguishing weedy rice seed and existing and new true paddy seed variety every year. The current manual inspection under SJPM protocol involves the field inspection, seed plant

premises auditing, record and testing on the paddy seed samplings before certified seed can be released (Ismail & Said 2012). Seed testing requires laboratory workers to count and identify paddy seed samples and distinguish between the cultivated paddy seed and weedy rice/unwanted seed or off-type seed. The maximum allowable unwanted or dangerous weed seeds are 10 seeds/kg. If the producers did not comply with the standard, the seed lot will be rejected, thus give losses to the producers. Hence, the purpose of this invention is to explore possibilities in minimizing the workload of seed laboratories during quality inspection. The invention is expected to reduce the time taken and human error due to tiredness and eye sore of looking at small seeds.

Materials and methods

The development of RiSe- IviS was done in CEASTech Laboratory, Universiti Malaysia Perlis. The weedy rice seeds were collected around granary area near Pendang, Kedah. The cultivated rice seed were supplied from Rice Seed Bank of Rice Research Station, Malaysian Agricultural and ResearchInstitute (MARDI) Seberang Perai, Malaysia. Four rice seed varieties mainly the MR297, MR263, MR284 and MR219 were used to test the protoype accuracy in distinguishing the weedy rice and cultivate drice.

Figure 1 displays sample images of the cultivated rice seed and weedy rice variants. The shape of the rice seed varieties is almost similar to each other while weedy rice variants used in this project is slightly smaller than cultivated rice seed varieties and have an awn.

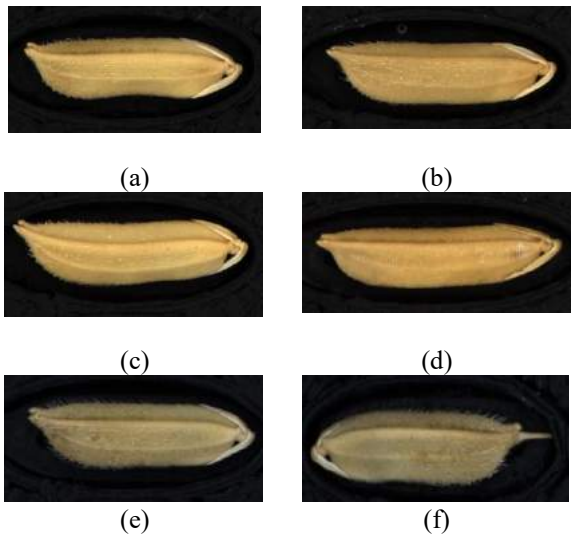
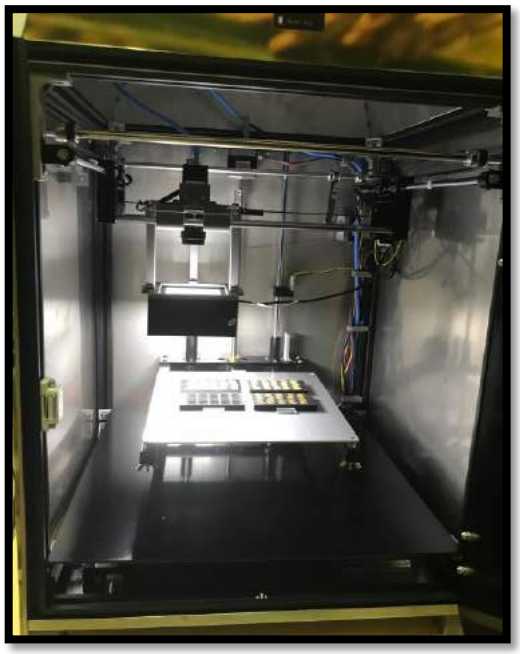


Figure 1: Rice seed variety and weedy rice variants (a) MR219 (b) MR284 (c) MR297 (d) MR263 (e) WRA (f) WRB

Hardware Configuration

RiSe-IVis is equipped with a CMOS 6MP 1/1.8" GigE area scan camera (MVCA060-10GC, HIK Vision) and 6MP 16mm focal length lens (MVL-HF2528M-6MP, HIK Vision). The camera has a resolution of 3072 x 2048 and sensor size of 2.4 μm x 2.4 μm per pixel. The prototype was arranged as in Figure 2. A low angled LED lighting (TMS Lite) was used to provide uniform illumination on the seed samples. The seed sample was kept at a distance of 14.1 cm from the lens and camera. The prototype allow the camera to move in X-Y-Z direction to cover seed images on the platform. The acquired images were saved and later analysed in LabVIEW programmed developed for classification of the seeds.

(a)



(b)

Figure 2: RiSe-IviS prototype machine vision (a) Overall view (b) Inside view

Software Development

Feature extraction was programmed in LabVIEW environment and IMAQ Particle Analysis VI was used. Image processing technique was employed to analyse the seed kernel images and extract morphological features of the individual seed. Image analyses were performed using discriminant functional analysis (DFA). Number of dominant morphological features to distinguish the weedy rice and cultivated paddy seed ranging from five to eight depending on the seed variety. Lower number of features reduced the time taken for analysis.

Results and discussion

The prototype works exceptionally well in identifying and distinguishing the weedy rice and cultivated rice seed in one seed plate. The accuracy of the machine is presented in Table 2.

Table 2: Classification accuracy of the RiSe - IViS

Seed Variety	MR297	MR263	MR284	MR219
Weedy Rice	99.1%	98.1%	93.7%	98.3%

Discriminatory ability of rice seeds depends on the variety as different seed have different inherent seed features. The most significant features selected in DFA were convex hull perimeter, minor axis length and area ratio. The developed system is fast, accurate and reliable. The maintenance for the hardware is minimal. The system's software need to be updated periodically and to be tested with new varieties of paddy seed.

Conclusion

RiSe-IVIs has met the requirement to distinguish between weedy rice and cultivated paddy seed. More paddy seed variety could be added in the software in future to cover wide range of seed variety produced by the seed producer.

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