

CLASSIFICATION OF PIPER NIGRUM SAMPLES USING MACHINE LEARNING TECHNIQUES: A COMPARISON

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ABSTRACT

Pepper is a key export of the state of Sarawak (Malaysian Borneo). At present, processed pepper berries are graded manually. This process is time consuming and error prone as it is very much dependent on the experience of the pepper grader. To overcome these weaknesses, we propose an automated Pepper Grading System which employs image processing and machine learning using image features and moisture content data of the pepper berries. In this paper, we present our findings of using twenty machine learning algorithms to classify the pepper berries into its respective grades based on image features, which is part of our research work towards an automated Pepper Grading System. We found that Rotation Forest was the best classifier.

KEYWORDS

Image processing and analysis, machine learning, classifiers, agricultural sciences

1 INTRODUCTION

Pepper or the scientific name *Piper Nigrum* is grown predominantly in the state of Sarawak, Malaysia. With the production of 98%, the pepper of Malaysian origin is traded in the world market as Sarawak Pepper. Malaysian Pepper Board (MPB), a statutory body established under the Malaysian Pepper Board Act 2006, oversees all pepper related activities in the country, including the grading of all pepper for export [1]. Buyers of processed Malaysian pepper are assured of receiving the quality of pepper that they agreed to purchase as per the grade certificates and colour labels issued by the

MPB. This serves as an assurance that Malaysian pepper exporters will deliver pepper that meets the specifications of that grade. The tropical climate of Sarawak is ideal for pepper cultivation. Harvesting stretches from April to September with the peak season in May and June. The Sarawak Pepper has been recognized internationally as a quality pepper with a unique flavour.

Sarawak Pepper has become the geographical indication (GI) for Sarawak and has registered its GI since 4th November 2003 as per stipulated in the certification of registration under the Geographical Indications Act 2000, Geographical Indications Regulations 2001. It has obtained a high reputation and among its major importing countries are Japan, South Korea, Taiwan, China, Singapore and European Union countries [2]. According to the Geographical Indications Act (2000), GI is defined as an indication which identifies any goods as originating in a country or territory, or a region or locality in that country or territory, where a given quality, reputation or other characteristic of the goods is essentially attributable to their geographical origin. Among the objective of GI registration for Sarawak Pepper is to protect its name, image and reputation such as the unique flavour profile, quality reputation, consumer loyalty and price premium.

Processed pepper berries are graded by size, colour, moisture content, and extraneous matter content. Six grades of white pepper berries and five grades of black pepper berries are used. Currently, the use of an automatic commercial colour sorter for the pepper berries is only for discriminating one grade, which is the best white pepper namely "creamy white". However, the sorting of pepper