

# Gaharu Sensor: Classification Using Case Based Reasoning (CBR)

Muhamad Faruqi Zahari<sup>1</sup>, Muhammad Sharfi Najib<sup>1</sup>, Wan Muhamad Azmi Mamat<sup>1</sup>, Kamarul Hawari Ghazali<sup>1</sup>, Fathimah Abdul Halim<sup>1</sup>, Saiful Nizam Tajuddin<sup>2</sup>, Erny Haslina Abd Latib<sup>2</sup>

Faculty of Electrical and Electronic Engineering, University Malaysia Pahang, Pekan, 26600, Pahang<sup>1</sup>

Faculty of Industrial Science and Technology, University Malaysia Pahang, Gambang, 26300, Pahang<sup>2</sup>

E-mail: sharfi@ump.edu.my<sup>1</sup>, ernyhaslina87@gmail.com<sup>2</sup>

**Abstract**—Gaharu or agarwood is a high value commodity in agricultural sector which is widely used in industry related to perfume product and aromatherapy product. The high grade gaharu determine its quality which influence the market price. Thus some trader manipulating the grading to raise higher price but the actual quality is lower. This paper proposed the intelligence classification technique using an Electronic Nose (E-nose) measurement. The sensor array in the E - nose are used for the inputs of the Case Based Reasoning (CBR) for intelligent classification. The experimental result shows that the technique accomplished to classify with high accuracy which is 86.7% nearly approach to 100% of accuracy.

**Index Terms**--Agarwood, E-nose, CBR, Intelligent Classification, Gaharu.

## I. INTRODUCTION

Agricultural defined as encompassing crop, forest product and the process of the state's agricultural production.

Therefore, agricultural can give economic impact to the state's because the agricultural industry purchases goods and services from other industries and hires local labor [1]. One of the high value commodities in agricultural industry is agarwood or gaharu. It mostly uses for traditional aromatic, incense smoke and perfume – burning chip wood and essential oil and in [2], [3]. In the eight century, gaharu also used as medical product that's been recorded in Sahih Muslim and Ayurvedic medical text the Susruta Samhita. In addition, over the past about 30 years, the demand for gaharu has been risen [4], [5].

There is no specific reference of grading standard to determine the gaharu quality as high grade, commercial grade, or low grade. The grading is decide by common perception and experience among region involved in agarwood industry. A study proposes the quality of gaharu referred to the resin content where the high grade consists of high resin [6]. The common accepting grading of gaharu oil is grade A+ was 100% of purity and grade A was 95 % to 99%, while the purity of grade B lower than purity of grade A [7]. The common characteristics that can be recognized for grade A was dark, dense, concentrated and heavy while other characteristic as in Table I [8], [9]. This characteristic can be manipulated by traders and they can change the characteristic of other grade or other wood in order to get the higher price to sell because the better the grade the price was higher [10]–[12].

In order to detect the quality of gaharu, there are several methods for detection such as Gas Chromatography- Mass Spectrometry (GC-MS), Solid Phase Micro-extraction (SPME) in the chemical field and electronic nose (E-nose) for gaharu quality detection in electronic field. GC-MS is an

instrument that can separate and analyzed samples based on chemical compound usually used for gaharu essential oil while SPME is a solvent-less extraction technique, based on adsorption which usually for analyze samples and for burning chip of gaharu [13]-[16]. An E-nose is able to detect odors for a variety of applications such as cherry essential oil, liquor, perfumes and others [17], [18].

Table I  
Grades and Prices of Gaharu at local levels, 1985-2007

Grade	Characteristics	Terengganu 1985 Price (RM/kg)	Terengganu 1999-2000 Price (RM/kg)	Hulu Perak 2002-2007 Price (RM/kg)	Central Pahang August 2007 Price (RM/kg)
A	Dark, dense, concentrated and heavy	1,000	3,200-4,000	3,000-7,000	10,000
B	Purple dark, less dense, small holes	250	1,800-2,500	1,500-4,000	5,000-7,000
C1	Yellow dark stripes	150	400-800	500-1,500	2,000
C2	Dark yellow	-	40-80	50-200	150
D	Gaharu remains	-	8-30	4-50	-

Fig.1: Grades and prices of gaharu at local levels, 1985-2007

There are several methods that can imply to classify the quality of gaharu essential oil such as an Artificial Neural Network (ANN), Principal Component Analysis (PCA), k-Nearest Neighbor (k-NN) and also Case Based Reasoning (CBR) [19]-[21]. CBR is mean by using stored case to solve the new case. There are several steps for classifying using CBR which is retrieve, reuse, revise and retain [22]. Retrieve is the most crucial step in CBR which is to recall a previous case that stored in CBR. Then, it will retrieve the best similar cases to compare with new case. The best of similarity cases will reuse in order to revise the case and retained it when it was solved [23].