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A Novelty Classification Model for Varied Agarwood Oil Quality Using The K-Nearest Neighbor Algorithm

Aqib Fawwaz Mohd Amidon[1], Siti Mariatul Hazwa Mohd Huzir[2], Zakiah Mohd Yusoff[3], Nurlaila Ismail[4], and Mohd Nasir Taib[5]

[1,4] School of Electrical Engineering, College of Engineering, Universiti Teknologi MARA (UiTM) Shah Alam, 40450 Shah Alam, Selangor, Malaysia, [2,3] School of Electrical Engineering, College of Engineering, Universiti Teknologi MARA (UiTM) Johor Branch, Campus of Pasir Gudang, 81750 Masai, Johor, Malaysia, [5]Malaysia Institute of Transport (MITRANS), Universiti Teknologi MARA (UiTM) Shah Alam, 40450 Shah Alam, Selangor, Malaysia

[1]aqibfawwaz.academic@gmail.com, [2]mariatulhazwa97@gmail.com, [3]zakiah9018@uitm.edu.my, [4]nurlaila0583@uitm.edu.my, [5]dr.nasir@uitm.edu.my

***Abstract*—Agarwood oil, in general, has become a highly advertised and in great demand commodity on the global market. The use of agarwood oil in the manufacturing of fragrances, medicine, and religious rites and festivities makes it even more important. Agarwood oil, on the other hand, never has a systematic grading system. As a result, each producing country must develop its own method for distinguishing between high-quality and low-quality agarwood oil. According to previous research, the current classification method relies solely on expert people in the search for agarwood in the forest. Their services are used to sniff and evaluate each agarwood to determine if it is of high quality or not. Unfortunately, this method has many shortcomings. Among other things, it will cause the health of those involved to be affected, require a long period of time to assess one by one, and certainly contribute to high operating costs. As a result, a new grading system based on artificial algorithms, namely K-Nearest Neighbor algorithms, was established. The value of the percentage of the quantity of significant chemical components contained in the agarwood oil samples is used to classify the agarwood oil samples using this method. Therefore, our algorithm has correctly assessed five distinct agarwood oil grades, according to the performance measure. Certainly, this research can contribute to future research, particularly in the field of data analysis involving agarwood oil grading development.**

Keywords— agarwood oil, no standard grading, K-Nearest Neighbor, classification model

I. INTRODUCTION

The kind of agarwood employed in this research is "Aquilaria Malaccensis" species. Thymelaeaceae is a family of plants that includes this species. Agarwood is known by a variety of names, including "aloeswood," "eaglewood," "agaru," "gaharu," and others [1]-[4]. This agarwood is used as a primary component in the creation of fragrances [4],[5]. Due to the nutrients found in it, it is also used as a medication for the treatment of certain disorders. It's also used in a lot of religious events and racing festivities. Agarwood is always in high demand on the worldwide market, which drives up its price, especially for high-quality agarwood [6].

Even so, the agarwood oil grading system still maintains the old way, which is to use human senses such as the eyes to see the level of color concentration of the oil and the nose to assess the level of odor produced by the oil [7]. For that, only experts are able to make this assessment. Of course, experts in each producer country are needed to run the grading process. This approach also has certain disadvantages, such as affecting the health of individuals engaged, taking a long time to finish each grading process,and needing a high level of operational expenditures.

Therefore, a simpler, faster, and more accurate agarwood oil classification model needs to be introduced. Thus, this study focuses on developing a classification model using artificial intelligence algorithm capabilities. The K-Nearest Neighbor (KNN) algorithm was used to make this study successful. Previous studies have found that the percentage of the abundance of significant chemical compounds can be used to make a grade of the dataset of agarwood oil [8].

II. MATERIALS

A. K-Nearest Neighbor Algorithm

In the field of statistics, the K-Nearest Neighbor (KNN) algorithm is a non-parametric supervisory learning method first developed by Evelyn Fix and Joseph Hodges in 1951 [9]-[12]. Subsequently, it was improved by Thomas Cover. This KNN algorithm is used for welding and regression [13]-[16]. In both cases, the input used must consist of the "k" example of the nearest exercise in the data set. The output will depend on whether the KNN is used for classification or regression.

B. Euclidean Distance Concepts

As its names suggest, the Euclidean distance formula calculates the distance between two locations (or the straight-line distance). Assume (x_1, y_1) and (x_2, y_2) are two points on a two-dimensional plane. The formula for calculating Euclidean distance as in (1).

$$d = \sqrt{(x_1 y_1)^2 (x_2 y_2)^2} \quad (1)$$

III. METHODS

In this study, a total of 660 samples of agarwood oil were used. The data was split into five different grades (A+, A, B, C, and D). Grade A+ has 240 data sets, grade A has 90 data sets, grade B has 30 data sets, grade C has 90 data sets, and grade D consists of 210 data sets. After going through the preprocessing data, there are eleven significant chemical compounds for this data set. The chemical compounds were 10-epi-γ-eudesmol, α-agarofuran, β-agarofuran, γ-eudesmol, dihydrocollumellarin, valerianol, ar-curcumene, β-dihydro agarofuran, α-guaiene, allo aromadendrene epoxide, and γ-cadinene.

A. KNN Classification Process Flow

All 660 datasets were taken and divided into two groups of datasets with a ratio of 80:20 as the training dataset and the testing dataset. This division is made using the "Holdout" function. After that, the training dataset was used to develop the KNN classification model. Following the successful construction of the KNN classification model, it was put to the test using dataset testing to check if it could grade correctly. Finally, a performance measure was undertaken based on the test to determine whether to accept or not the classification model. Performance measures carried out include the 5x5 confusion matrix table, accuracy, sensitivity, specificity, and precision.

IV. RESULTS AND FINDINGS

Fig. 1 shows a 5x5 confusion matrix table that is conducted when performing a performance measure on the model. This confusion matrix table has been record based on testing dataset that consist of 20 percent data samples used.

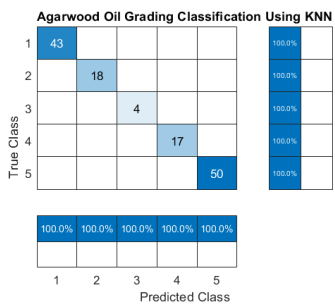

Fig. 1 5x5 confusion matrix table for five qualities of agarwood oil data (testing dataset).

Table 1 shows the results for the percentage of accuracy, sensitivity, specificity, and precision. All obtained 100%. This is because when ranking the confusion matrix assessment, there is not a single pound of sample data from the testing dataset that is misleading between prediction and actual classification. This excellent performance will definitely have a positive impact on calculating accuracy, sensitivity, specificity, and precision.

Table 1. Percentage of performance measure

Performance Measure	***Percentage (%)***
Accuracy	100
Sensitivity	100
Specificity	100
Precision	100

V. CONCLUSIONS

In conclusion, to make a classification of this agarwood oil sample, we need to understand the characteristics of the significant chemical compounds contained in it first. With that, the selection of the right artificial intelligence algorithm can be made. Each of these artificial intelligence algorithms has its own function. As an example, this KNN algorithm was created to create multiclass classification of data and data regression. Therefore, the KNN algorithm was chosen for this study. Next, the performance measurement process is important to implement. This is because an evaluation of the model needs to be conducted to determine whether it meets the specified specifications or not in making the classification. The KNN classification of this model has been proven to be able to classify high quality agarwood oil that has more than two quality differences easily, quickly, and accurately based on the performance measure result. The findings of this study will be useful in future research on the development of a classification model or system for the quality of agarwood oil.

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