PROCEEDINGS

The 20th International and National Conference on Applied Computer Technology and Information Systems (ACTIS) and The International and National Conference on Business Administration (NCOBA) 2023-2

Journal & Proceeding
ACTIS
Applied Computer Technology and Information System

AiAT
ARTIFICIAL INTELLIGENCE ASSOCIATION OF THAILAND

Online conference
25 August 2023

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สารจากคณบดีคณะเทคโนโลยีสารสนเทศและนวัตกรรมดิจิทัล มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าพระนครเหนือ

งานประชุมวิชาการระดับชาติและระดับนานาชาติด้านเทคโนโลยีคอมพิวเตอร์ประยุกต์และระบบสารสนเทศ ครั้งที่ 20 (ACTIS2023: The 20th International conference in Applied Computer Technology and Information System Acronym) และงานประชุมวิชาการระดับชาติและระดับนานาชาติ ด้านบริหารธุรกิจ ครั้งที่ 20 (NCOBA2023: The 20th National Conference on Business Administration) จัดขึ้นในวันที่ 25 สิงหาคม พ.ศ. 2566 โดยคณะเทคโนโลยีสารสนเทศและนวัตกรรมดิจิทัล มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าพระนครเหนือ คณะเทคโนโลยีดิจิทัล มหาวิทยาลัยราชพฤกษ์ สมาคมปัญญาประดิษฐ์ประเทศไทย และเครือข่ายความร่วมมือในการจัดงานประชุมวิชาการ จำนวน 11 สถาบันการศึกษา งานประชุมวิชาการนี้เป็นอีกหนึ่งเวทีในการแลกเปลี่ยนแนวความคิด องค์ความรู้ สร้างนวัตกรรมด้านเทคโนโลยีคอมพิวเตอร์ ระบบสารสนเทศประยุกต์เทคโนโลยีดิจิทัลและบริหารธุรกิจ มีวัตถุประสงค์เพื่อร่วมสร้างความเข้มแข็งทางวิชาการในการจัดบริการวิชาการ การทำวิจัย และการพัฒนาบุคลากร เพื่อการพัฒนาประเทศชาติอย่างยั่งยืน

งานประชุมวิชาการครั้งนี้ต้องขอขอบคุณทุกท่านที่ได้ส่งบทความเพื่อเข้าสู่กระบวนการการพิจารณาซึ่งเป็นบทความที่มีคุณภาพสูงทำให้งานประชุมวิชาการได้รักษาคุณภาพและมาตรฐานของงาน ขอขอบพระคุณคณะกรรมการพิจารณาบทความทุกท่านที่เสียสละเวลาอันมีค่าเพื่อให้ได้ผลงานวิจัยที่มีคุณภาพได้นำเสนอในงานประชุมวิชาการในครั้งนี้ด้วย

ขอขอบคุณเครือข่ายความร่วมมือทางเทคโนโลยีคอมพิวเตอร์ประยุกต์และระบบสารสนเทศในประเทศทั้ง 11 สถาบันการศึกษา ที่ให้การสนับสนุนเป็นอย่างดีทั้งด้านคณาจารย์ บุคลากรในการร่วมเป็นคณะกรรมการเครือข่าย คณะกรรมการดำเนินงาน และคณะกรรมการพิจารณาบทความ ได้แก่ มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าพระนครเหนือ มหาวิทยาลัยเทคโนโลยีราชมงคลสุวรรณภูมิ มหาวิทยาลัยเทคโนโลยีราชมงคลธัญบุรี มหาวิทยาลัยเทคโนโลยีราชมงคลกรุงเทพ มหาวิทยาลัยราชภัฏจันทรเกษม มหาวิทยาลัยสุโขทัยธรรมาธิราช มหาวิทยาลัยทักษิณ มหาวิทยาลัยราชพฤกษ์ มหาวิทยาลัยกรุงเทพสุวรรณภูมิ วิทยาลัยเซาธ์อีสท์บางกอก และมหาวิทยาลัยราชภัฏนครปฐม

ท้ายนี้หวังเป็นอย่างยิ่งว่างานประชุมวิชาการ ACTIS และ NCOBA จะเป็นเวทีในการนำเสนอผลงานวิจัยและนำไปสู่การพัฒนาตนเองเพื่อให้เป็นนักวิจัยที่ดีและมีคุณภาพสูงยิ่ง ๆ ขึ้นไป ACTIS และ NCOBA จะเป็นแพลตฟอร์มสำหรับการแลกเปลี่ยนความรู้ในด้านเทคโนโลยีคอมพิวเตอร์ระบบสารสนเทศประยุกต์ เทคโนโลยีดิจิทัล และบริหารธุรกิจ สร้างแรงบันดาลใจให้กับนักวิจัยเพื่อคิดค้นนวัตกรรมและพัฒนาองค์ความรู้ใหม่ ๆ เพื่อการพัฒนาชาติอย่างยั่งยืนตลอดไป

(ผู้ช่วยศาสตราจารย์ ดร.สุนันฑา สดสี)
คณบดีคณะเทคโนโลยีสารสนเทศและนวัตกรรมดิจิทัล
มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าพระนครเหนือ

Message from Dean, Faculty of Information Technology and Digital Innovation, KMUTNB

The 20th International Conference in Applied Computer Technology and Information System Acronym (ACTIS2023) and the 20th National Conference on Business Administration (NCOBA2023), held on 25 August, 2023. ACTIS & NCOBA are organized by Faculty of Information Technology and Digital Innovation, King Mongkut's University of Technology North Bangkok, Faculty of Digital Technology, Rajapruk University, Artificial Intelligence Association of Thailand, and eleven academic collaborations.

The conferences provide a unique platform both for exchanging innovative research in Applied Computer Technology, Information Systems, and Business Administration which aim to enhance collaboration network, researches, and improve the sustainability of our nation.These conferences made huge possible with innovative and progressive contributions from the research community. Herein, special thanks are due to all technical committee members for their diligent consideration of all submissions and for maintaining and preserving the high standards for which ACTIS & NCOBA are justifiably renowned. Regrettably, as a consequence of our rigorous peer review process, we were unable to accept some articles for presentation.

As well as, a debt of gratitude is owed to the eleven co-operative universities for their support and the contributions of staff members by serving in the network committees, executive director committees, and technical program committees. These universities are King Mongkut's University of Technology North Bangkok (KMUTNB), Rajamangala University of Technology Suvarnabhumi (RUS), Rajamangala University of Technology Thanyaburi (RMUTT), Rajamangala University of Technology Krungthep (RMUTK), Chandrakasem Rajabhat University (CRU), Sukhothai

Assistant Professor Dr. Dr.-Ing. Sunantha Sodsee
Dean, Faculty of Information Technology and Digital Innovation
King Mongkut's University of Technology North Bangkok

สารจากคณบดีคณะเทคโนโลยีดิจิทัล มหาวิทยาลัยราชพฤกษ์

การประชุมวิชาการในครั้งนี้ มีวัตถุประสงค์เพื่อเป็นเวทีระดับชาติ และนานาชาติ ให้นักวิชาการ นักวิจัย คณาจารย์ นิสิต และนักศึกษา ได้เผยแพร่ผลงาน ได้รับฟังและแลกเปลี่ยนองค์ความรู้ ผ่านบทความวิจัยและนวัตกรรม ซึ่งเป็นประโยชน์ ต่อการพัฒนาประเทศ เพื่อสร้างเครือข่ายความร่วมมือพัฒนาความก้าวหน้าทางวิชาการและวิจัยกับสถาบันการศึกษาต่าง ๆ

จากความตระหนักในภารกิจของสถาบันอุดมศึกษาที่ต้องวิจัยเพื่อสร้าง องค์ความรู้ใหม่ด้านเทคโนโลยีคอมพิวเตอร์และระบบสารสนเทศประยุกต์รวมถึงการบริหารธุรกิจอันจะส่งผลต่อการพัฒนาความเจริญก้าวหน้าของประเทศ คณะเทคโนโลยี สารสนเทศและนวัตกรรมดิจิทัล มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าพระนครเหนือ และคณะเทคโนโลยีดิจิทัล มหาวิทยาลัยราชพฤกษ์ ได้รับมอบหมายจากเครือข่ายเป็นเจ้าภาพร่วมจัดการประชุมวิชาการระดับชาติและนานาชาติ ด้านเทคโนโลยีคอมพิวเตอร์และระบบสารสนเทศประยุกต์ (ACTIS) การประชุมวิชาการระดับชาติและนานาชาติ ด้านบริหารธุรกิจ (NCOBA) ครั้งที่ 20 ซึ่งการประชุมวิชาการในครั้งนี้ได้รับความร่วมมือจากสมาคมปัญญาประดิษฐ์ ประเทศไทย

สุดท้ายนี้ ขอขอบคุณเครือข่ายการประชุมวิชาการ ACTIS และ NCOBA ทั้ง 11 มหาวิทยาลัย และคณะกรรมการจัดงานประชุมวิชาการจากคณะเทคโนโลยีสารสนเทศและนวัตกรรมดิจิทัล มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าพระนครเหนือ และคณะเทคโนโลยีดิจิทัล มหาวิทยาลัยราชพฤกษ์ ที่มีความมุ่งมั่นและความพยายาม เพื่อให้การประชุมวิชาการ ACTIS และ NCOBA ครั้งที่ 20 ปี 2023-2 นี้เป็นงานที่สร้างความประทับใจและน่าจดจำสำหรับผู้เข้าร่วมทุกท่าน

ดิฉันหวังไว้เป็นอย่างยิ่งว่าทุกท่านจะมีช่วงเวลาที่ดี และได้รับประโยชน์จากการเข้าร่วมการประชุมวิชาการ ACTIS และ NCOBA ครั้งที่ 20 ปี 2023-2 และหวังว่าทุกท่านจะเข้าร่วมการประชุมวิชาการ ACTIS และ NCOBA ครั้งที่ 21 ปี 2024 ต่อไป

ผู้ช่วยศาสตราจารย์ ดร.เรวดี ศักดิ์ดุลยธรรม
คณบดีคณะเทคโนโลยีดิจิทัล
มหาวิทยาลัยราชพฤกษ์

Message from the Dean, Faculty of Digital Technology, Rajapruk University

This conference is held with the purposes in being a stage for scholars, researchers, professors, students to present and disseminate their work for public engagement and knowledge exchange through research articles and innovation which will be beneficial for country development and to build a cooperation network on the development of academic achievement and research with other educational institutions.

Due to the awareness of a mission of higher education institutions in conducting a research study to build a new knowledge in the field of applied computer technology and information system including business administration, which shall affect the development and progress of the country, Faculty of Information Technology and Digital Innovation, King Mongkut's University of Technology North Bangkok and Digital Technology Faculty, Rajapruk University were assigned from the Network to be the co-host for holding the 20th International and National Conference on Applied Computer Technology and Information Systems (ACTIS) and the International and National Conference on Business Administration (NCOBA). This academic conference received good cooperation from Artificial Intelligence Association of Thailand (AIAT).

Finally, I thank the network of the International and National Conference on ACTIS and NCOBA from all 11 universities and the conference joint-organizing committees from Faculty of Information Technology and Digital Innovation, King Mongkut's University of Technology North Bangkok and Digital Technology Faculty, Rajapruk University who have shown great commitment and fantastic team efforts in ensuring that the 20th ACTIS and NCOBA 2023-2 will be an impressive and memorable event for all participants.

I wish all of you a delightful and fruitful time in the 20th ACTIS and NCOBA 2023-2 and I look forward to your participation in the 21th ACTIS and NCOBA 2024.

Assistant Professor Dr. Raywadee Sakdulyatham
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2.1 e-Business Applications and Software
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3.4 Software Component and Prototyping

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1.1 Principle of International Business
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4.3 Labour Economics
4.4 International Economics

Table of Articles

The International Conference on Applied Computer Technology and Information Systems (ACTIS)

Leveraging Three Image Processing Techniques and Machine Learning for Milled Rice Variety Classification

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***Abstract*— In this research, three image processing techniques, namely ridge detection, edge detection using the Canny algorithm, and the Sobel algorithm, are applied along with five machine learning techniques, including Decision Tree, Naïve Bayes, Nearest Neighborhood, Support Vector Machine, and Gradient-Boosted Trees. The objective of the research is to create a model for classifying rice varieties. The study specifically focuses on milled rice grains from five distinct rice varieties: Karacadag, Jasmine, Ipsala, Basmati, and Arborio. The grain images used in the study were obtained from https://www.muratkoklu.com/ datasets/. The research process begins with image processing, where a total of 5,000 images (1000 images for each variety) of milled rice grains are utilized. These images are in JPEG format and have a resolution of 250x250 pixels. The images undergo ridge detection and edge detection using the Canny and Sobel techniques, respectively. The processed images are then employed for classification using RapidMiner Studio. The results of the study indicate that each algorithm exhibits varying levels of efficiency in the classification task. Notably, when the edge detection technique using the Sobel algorithm is combined with the Gradient-Boosted Trees algorithm, the highest accuracy of 97.36% is achieved.**

Keywords*—Image processing, Sobel algorithm, Machine learning, Milled rice grain.

I. INTRODUCTION

Rice is a crucial food staple worldwide. The country with the highest rice exports, ranking first globally, is India. Thailand and Vietnam follow in second and third place, respectively [1]. However, rice exports consist of multiple varieties, and each variety has its own price [2]. Therefore, if there is a systematic examination of rice adulteration during the export process, it would greatly enhance the efficiency of rice export management. In the past, there have been various research studies that applied artificial intelligence systems to assist in tasks related to rice variety classification. For instance, in 2015, Aki Güllü and Uçar utilized image processing techniques along with machine learning methods to classify rice varieties from photographs of four types of rice grains: Baldo, Osmancik, Yasemin, and broken grains [3]. Similarly, in the same year, Zareiforoush Minaei Alizadeh and Banaka employed computer vision in conjunction with metaheuristic methods, namely artificial neural network (ANN), support vector machine (SVM), decision trees (DT), and Bayesian Network, to analyze rice grains obtained through a color-based method. The grains were categorized into four types: high-processed sound grains, high-processed broken grains, low-processed sound grains, and low-processed broken grains [4]. In 2019, Cinar and Koklu utilized seven machine learning techniques for rice classification. These techniques include: 1) Logistic Regression (LR) 2) Multilayer Perceptron (MP) 3) Support Vector Machine (SVM) 4) Decision Trees 5) Random Forest (RF) 6) Naïve Bayes (NB) and 7) k-Nearest Neighbor (kNN).

They applied these techniques to classify two rice varieties, Osmancik and Cameo, from a dataset of 3,810 photographs. The classification was based on seven morphological features of the rice grains, including area, perimeter, major axis length, minor axis length, eccentricity, convex area, and the ratio of rice grain area to the image frame [5]. In the following years, Cinar and Koklu expanded their study by considering five additional rice varieties: Karacadag, Jasmine, Ipsala, Basmati, and Arborio. They collected a dataset of 15,000 images per variety, resulting in a total of 75,000 images. The number of features also increased to 106, including 12 morphological features, 4 shape features, and 90 color features. They employed feature extraction techniques to enhance the efficiency of rice variety classification from images. Furthermore, they compared three classification methods: Analysis of Variance (ANOVA), Chi-square, and Gain Ratio [6]. In the same year, Koklu, Cinar, and Taspinar developed a Python program to implement Artificial Neural Networks (ANN) and Deep Neural Networks (DNN) for rice variety classification. They compared the performance of ANN and DNN with Convolutional Neural Network (CNN) in terms of feature analysis and classification of rice grains from image data. The study revealed that CNN outperformed the other methods [7]. In 2022, Cinar and Koklu once again employed the seven machine learning techniques, including LR, MP, SVM, DT, RF, NB, and kNN. However, this time, they conducted their work using MATLAB programming language. The classification focused on the 106 features of rice grains from all five aforementioned rice varieties [8].

This research aims to apply the combination of image processing and machine learning techniques to classify the varieties of rice grains. The data used in this study consists of JPEG images of five rice varieties: Karacadag, Jasmine, Ipsala, Basmati, and Arborio. It should be noted that the aforementioned data is obtained from "muratkoklu," which is a public dataset provided by Dr. Murat KÖKLÜ. The dataset can be found at https://www.muratkoklu.com/datasets. The image processing operations of milled rice grains will be developed using the Python programming language. Subsequently, the results of the processed images will be utilized for classification purposes. The tool used to apply machine learning for classification in this research is the RapidMiner Platform. RapidMiner is a robust data science and machine learning platform that enables users to extract valuable insights from complex data. It offers a comprehensive set of tools and functionalities that support the complete data analytics lifecycle, encompassing data preprocessing, modeling, evaluation, and deployment.

The performance of all techniques is considered in terms of classification accuracy.

II. IMAGE PROCESSING

In this research, we focus on 3 image processing techniques applying to the milled rice grain images before the classification, which are Sobel edge detection, Canny edge detection, and Ridge detection [9].

A. Sobel Edge Detection

The Sobel Edge Detection method detects the edge of an image using a template. Two 3x3 plates, the first to find the horizontal difference (G_x), and Vertical difference (G_y) are as follows

$$G_x = \begin{bmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{bmatrix} \quad \text{and} \quad G_y = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}.$$

Find the magnitude gradient: $|G| = \sqrt{G_x^2 + G_y^2}$ and the gradient direction is $\theta = \arctan\left(\frac{G_y}{G_x}\right)$.

Sobel edge detection involves the following steps:

1. Convert the image to grayscale.
2. Convolve the image with Sobel kernels to detect edges in horizontal and vertical directions.
3. Calculate the magnitude and direction of the gradient.
4. Threshold the gradient magnitude to remove noise.
5. Locate edges by identifying pixels with high magnitude and consistent direction.

B. Canny Edge Detection

John F. Canny introduced the Canny edge detection operator in 1986 as a means to identify various edges within images. This technique employs a multi-stage algorithm to achieve its objective. The sequential steps of the Canny edge detection algorithm are as follows:

1. Removing the noise by applying a Gaussian filter, which Gaussian filter formula can write as below:

$$G(x,y) = \frac{1}{2\pi\sigma^2}(e^{-\frac{x^2+y^2}{2\sigma^2}}),$$

where x is the variable on the *x*-axis, y is the variable on the *y*-axis, and σ is the deviation.
2. Find the gradient of the image.
3. Find the gradient magnitude and the direction of the edge same as Sobel edge detection.
4. Remove pixels that are not considered part of the edge.
5. Track the edge by hysteresis that rejects the edge pixel which is weak and not connected to the strong edge pixel.

C. Ridge Detection

Ridges typically represent prominent linear or curved features, such as edges, lines, or curves, the ridge detection algorithm analyzes the local intensity variations and gradients in an image to locate regions that exhibit high responses along the desired ridges. It involves enhancing the ridges and suppressing the background or noise. Various mathematical and computational methods, such as filters, convolution, and thresholding, are used to detect and highlight these ridges. The following steps outline the process of ridge detection:

1. Preprocessing: Initially, the image undergoes preprocessing to eliminate noise and smoothen the edges. Various techniques, such as Gaussian blurring or median filtering, can be applied for this purpose.
2. Scale-space representation: The image is represented in scale space, which involves generating a series of images by progressively blurring the original image using different kernels. This technique enables the detection of ridges at different scales.
3. Local maxima detection: Next, the local maxima in the scale-space representation are identified. These points serve as potential candidates for ridges.
4. Ridge thinning: The candidate ridges are then thinned to eliminate any spurious ridges. Several techniques can be employed for this step, including morphological operations or curvature analysis.
5. Ridge tracking: The remaining ridges are tracked to form connected curves. Various techniques, such as dynamic programming or graph search, can be utilized to achieve this goal.

III. MACHINE LEARNING TECHNIQUES

There are 5 machine learning techniques using in this research. There are presented as follows:

A. Decision Tree

The decision tree algorithm is a supervised learning technique suitable for classification and regression tasks. It offers simplicity in understanding, interpretation, and implementation, making it highly recommended for beginners in the field of machine learning. A decision tree classifies a data sample by traversing a tree-like structure, starting from the 'root node' and progressing through various 'decision nodes' until reaching a 'terminal node'. At each decision node, the path to follow is determined based on the values of one or more features of the sample. The class of the sample is determined by the terminal node it reaches. Decision trees are versatile tools capable of solving a wide range of problems. However, it is crucial to be aware of their sensitivity to overfitting. Overfitting transpires when the model becomes excessively tailored to the training data, thereby struggling to generalize well to new, unseen data [10].

B. Support Vector Machine

Support vector machines (SVMs) are a machine learning algorithm utilized for tasks involving classification and regression. They function by identifying a hyperplane that separates the data into distinct classes. The selection of the hyperplane is based on maximizing the distance between the hyperplane and the data points on either side, known as the margin. The primary objective of SVMs is to discover a hyperplane with the most substantial margin possible. This is crucial as a hyperplane with a generous margin exhibits enhanced resilience against noise and outliers within the data. In simpler terms, a hyperplane with a large margin is less prone to misclassifying new data points that were not part of the training set [10]. Recent developments have been made in the field of support vector machines (SVMs). Here are a few notable examples:

- Twin Support Vector Machine (TWSVM): TWSVM is an extension of SVMs that employs two non-parallel hyperplanes. These hyperplanes are positioned close to one class and farthest possible from the other class, enhancing classification accuracy [11].
- Kernel SVMs: Kernel SVMs leverage kernel functions to map data into higher-dimensional spaces. By doing so, SVMs can model complex decision boundaries and capture intricate patterns within the data [12].
- Ensemble SVMs: Ensemble SVMs combine multiple SVM models to enhance overall performance. Techniques like bagging, boosting, and stacking are utilized to integrate the outputs of individual SVMs and improve classification results [13].

C. k-NN algorithm

The k-nearest neighbor algorithm (KNN) is a supervised learning technique that is non-parametric in nature and can be employed for classification and regression tasks. It operates by identifying the *k* most similar instances to a new instance and subsequently predicting the label of the new instance based on the labels of its *k* nearest neighbors. The choice of the *k* value is a hyperparameter that must be determined by the user. When the value of *k* is higher, the average of the labels from the *k* nearest neighbors holds more significance, whereas a lower *k* value emphasizes the individual labels of the *k* nearest neighbors [10].

D. Naïve Bayes

The Naïve Bayes algorithm is a supervised machine learning technique that utilizes Bayes' theorem to estimate the probability of an event. It is widely used for various tasks such as text classification, spam filtering, and medical diagnosis due to its simplicity and efficiency. The algorithm operates under the assumption of feature independence, meaning the presence of one feature in a class is assumed to be independent of other features. By multiplying the probabilities of each feature belonging to a class, the algorithm calculates the probability of a data point belonging to that class. These probabilities are combined to determine the overall probability of the data point belonging to each class, and the class with the highest probability is assigned to the data point. Although this assumption may not always hold true, it is often a practical and reliable approximation in real-world applications [14].

E. Gradient-Boosted Tree

The Gradient-Boosted Tree is a machine learning method employed for classification and regression tasks. It constructs a robust model by amalgamating multiple weak learning models, usually decision trees. These trees are interconnected in a sequential manner, with each subsequent tree aiming to minimize the errors or residuals of the preceding tree. The procedure involves initializing the model with a simple learner, calculating residuals, training subsequent trees to reduce residuals, and updating predictions based on the ensemble of trees. This iterative process gradually improves the model's predictions by adding new trees that focus on reducing remaining errors. Gradient-Boosted trees excel in capturing intricate relationships between features and target variables, surpassing the accuracy of algorithms like random forests. This superior performance is attributed to their ability to comprehend complex relationships and learn from the data [15].

IV. METHODOLOGY

A. Pre-Processing

The data set consists of images of rice grains from the following varieties: Karacadag, Jasmine, Ipsala, Basmati, and Arborio, with a total of 5,000 images per variety, resulting in a total of 75,000 images. The images are in JPEG format with dimensions of 250 x 250 pixels, as shown in Figure 1. In this step, images are randomly selected, with only 1,000 images of each rice variety type, resulting in a total of 5,000 images. These images are used for image processing and classification purposes in the next step of the process.

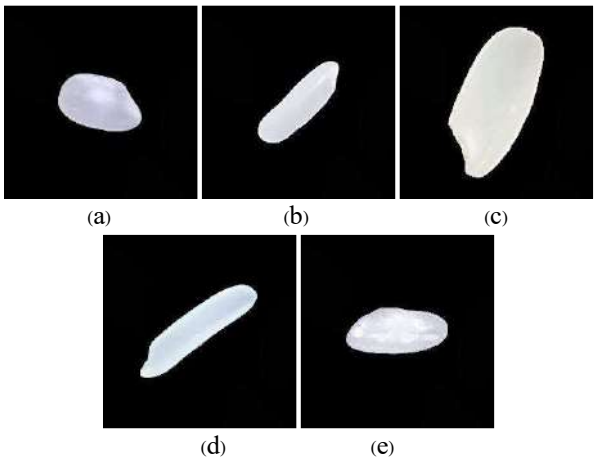

Fig. 1. Example of milled rice grains using in this research (a) Karacadag (b) Jasmine (c) Ipsala (d) Basmati, and (e) Arborio

B. *Image Processing*

The Python code was developed to process all images by 3 image processing techniques: Sobel Edge Detection, Canny Edge Detection, and Ridge Detection, as shown in Figure 2.

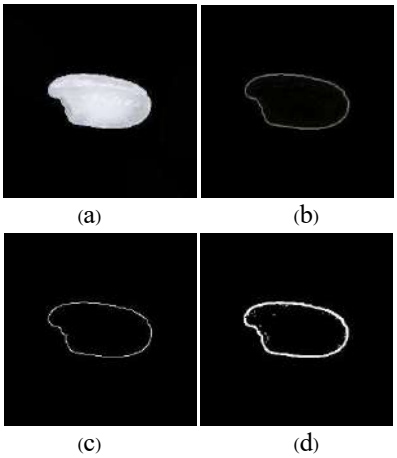

Fig. 2. Example of milled rice grains images applied image processing techniques (a) Original image (b) Sobel Edge Detection (c) Canny Edge Detection (d) Ridge Detection

C. *Classification*

The software used for this process is RapidMiner version 9.9. RapidMiner is a data science platform that is used for various data mining and machine learning tasks. It provides a visual interface to facilitate data preparation, modeling, evaluation, and deployment of predictive models. Overall, the concept of using RapidMiner for making a model of the classification is presented in figure 3.

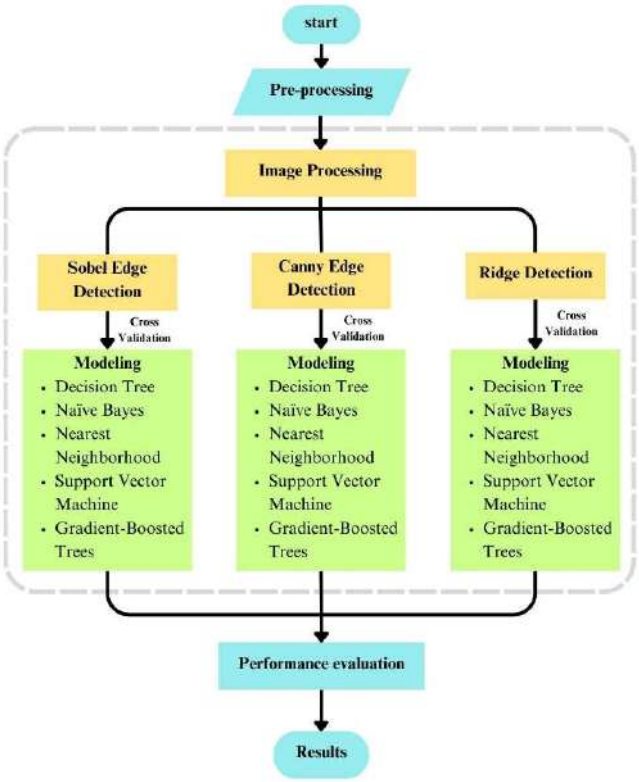

Fig. 3. Overall concept of making the classification model in this research.

In this research, the process of classification model creation in RapidMiner is done as shown in figure 4.

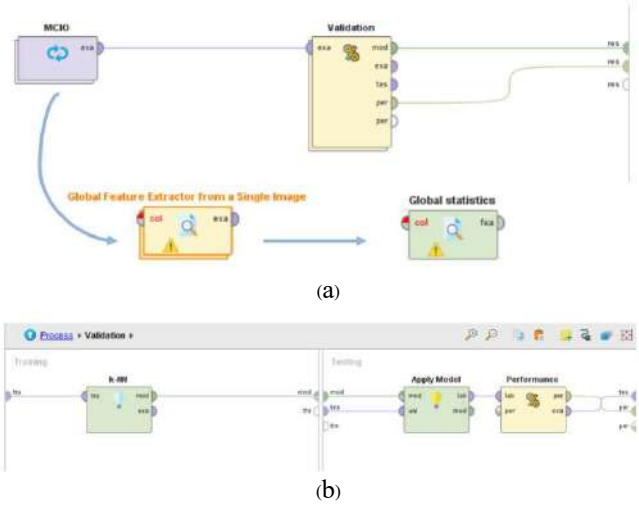

Fig. 4. Process of model creation in RapidMiner (a) The MCIO tool connects with the Validation tool, which includes the Global Feature Extractor from a Single Image and Global Statistic tools within the MCIO tool. (b) Example of a Validation tool for measuring performance in conjunction with classification techniques.

In this study, for utilizing the data as either Training Data or Test Data, the K-Fold Cross Validation method was employed to assist. In this context, the data was divided into 10 subsets (K=10), wherein one subset serves as the test data and the remaining 9 subsets serve as the training data.

Subsequently, the process iterates, with the previous test data becoming part of the training data, and one of the initial training subsets becoming the new test data. This cycle continues until all 10 subsets have been utilized as test data.

V. Research Results and Discussion

A. Results

TABLE I. Performance Test Results of Canny Edge Detection Technique

Machine Learning Techniques	Accuracy
Decision Tree	56.68%+/-2.60%
Naïve Bayes	68.46%+/-2.86%
Nearest Neighborhood	55.38%+/-2.20%
Support Vector Machine	54.60%+/-3.01%
Gradient-Boosted Trees	55.08%+/-2.09%

TABLE II. Performance Test Results of Ridge Detection Technique

Machine Learning Techniques	Accuracy
Decision Tree	68.70%+/-2.87%
Naïve Bayes	62.60%+/-2.71%
Nearest Neighborhood	50.20%+/-2.26%
Support Vector Machine	51.66%+/-2.06%
Gradient-Boosted Trees	73.86%+/-2.20%

TABLE III. Performance Test Results of Sobel Edge Detection Technique

Machine Learning Techniques	Accuracy
Decision Tree	94.66%+/-1.07%
Naïve Bayes	97.36%+/-0.83%
Nearest Neighborhood	81.02%+/-1.25%
Support Vector Machine	88.72%+/-1.25%
Gradient-Boosted Trees	62.06%+/-1.15%

B. Discussion

Overall, Sobel Edge Detection provides significantly better performance in all aspects of machine learning techniques, while Canny Edge Detection and Ridge Detection show only marginal differences in performance. From another perspective, Naïve Bayes achieves the highest accuracy among all image processing techniques. Compared to other previous research [4-8], it is found that the accuracy may be somewhat lower. This demonstrates that, when employing the presented technique, utilizing basic image processing prior to performing the classification yields notably favorable outcomes. However, it is important to note that all techniques have the possibility to perform even better when the parameters of each technique are optimally adjusted and a larger dataset of milled rice grain images is used. That could potentially help achieve accuracy similar to that of other methods used previously.

VI. Conclusion

In this research, a total of 5,000 images of milled rice grains were obtained from five rice varieties, namely Karacadag, Jasmine, Ipsala, Basmati, and Arborio, with each variety consisting of 1,000 images. These images underwent image processing using three techniques: ridge detection and edge detection using the Canny and Sobel techniques. Subsequently, they were classified using five machine learning methods: Decision Tree, Naïve Bayes, k-Nearest Neighborhood, Support Vector Machine, and Gradient-Boosted Trees. Overall, Sobel edge detection significantly provides better classification performance compared to two other techniques. The results revealed that the combination of Sobel edge detection for image processing and Naïve Bayes for classification yielded the highest classification performance. It achieved an accuracy of 97.36%.

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For The Paper Titled

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