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CNN Modeling for Classification of Bugis Traditional Cakes

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Abstract

This research aims to create a classification system that can recognize traditional Bugis cakes using the Convolutional Neural Network (CNN) method. (CNN). Traditional Bugis cakes play an important role in Indonesia's culinary heritage, which is rich in diversity and flavors. However, the lack of adequate documentation and recognition of these cakes can lead to the loss of cultural knowledge. In this study, a collection of images of traditional Bugis cakes was gathered and processed to train a CNN model. This model is designed to recognize and classify various types of cakes based on their visual attributes. The results obtained from the training process using the CNN method are a training accuracy of 99% and a validation accuracy of 90%. The evaluation results show that the CNN model can achieve a high level of accuracy in identifying these cakes, making it a useful tool in preserving and promoting traditional Bugis cakes. This research is expected to contribute to the development of image recognition technology and raise public awareness about the richness of local culinary heritage.
***Keywords** : Convolutional Neural Network (CNN), Bugis Cake, Indonesian Cuisine*

Introduction

Traditional Bugis cakes represent a vital component of Indonesia’s culinary heritage, rich in cultural and historical values. These cakes, with their diverse types and unique flavors, not only serve as delicacies during celebrations but also reflect the identity and customs of the Bugis community. However, as time progresses and globalization exerts its influence, the existence of these traditional cakes is increasingly under threat. Younger generations, in particular, are becoming less familiar with them, leading to a decline in interest and posing risks to the preservation of this invaluable cultural heritage. This phenomenon underscores the need for innovative strategies to sustain and promote the legacy of traditional Bugis cakes as a source of cultural pride.

In the digital era, advancements in artificial intelligence and machine learning provide opportunities to address this challenge. One such approach is the application of the Convolutional Neural Network (CNN), a deep learning method widely recognized for its ability to perform image recognition and classification with high accuracy (Amri, 2024; Fadlia & Kosasih, 2019). CNN has been successfully applied in various domains, including food identification systems (Arnita et al., 2023), the recognition of traditional cakes (Sumarlie et al., 2022; Iskandar & Kristianto, 2023), and even cultural artifacts like batik patterns (Azmi et al., 2023). Its strength lies in extracting key image features through convolutional layers, activation functions like ReLU, and pooling layers, followed by classification processes utilizing Softmax or similar activation methods (Mahaputri & Wisana, 2022; Andreas & Widhiarso, 2023).

Several studies have demonstrated the versatility of CNN. For example, Andreas and Widhiarso (2023) successfully classified cataract eye diseases using the Inception V3 architecture, while Amri (2024) utilized CNN to translate sign language. In the field of culinary heritage, Kurnia et al. (2021) applied CNN to classify Indonesian cakes, and Darojat et al. (2021) explored CNN's potential for identifying Indonesian traditional foods. These works emphasize the adaptability of CNN in diverse applications, including the preservation of cultural heritage. Additionally, approaches like ResNet50V2 have shown great promise for handling complex classification tasks, as demonstrated by Iskandar & Kristianto (2023).

Beyond image recognition, machine learning techniques have also been applied to analyze customer behavior and trends, as demonstrated by Jeffry, Usman, & Aziz (2023). Their work highlights how ensemble methods like logistic regression can be utilized to derive insights from complex datasets. This suggests a broader potential for machine learning in enhancing cultural preservation strategies, including understanding public interest in traditional cuisines through data analysis.

This study aims to develop a classification system for traditional Bugis cakes using the CNN method. By compiling and processing a dataset of Bugis cake images, the system will be trained to recognize and categorize various cake types. Inspired by previous successes in food identification (Rahma et al., 2021; Lusiana et al., 2021) and machine learning applications in cultural preservation (Azmi et al., 2023), this research seeks to combine technical innovation with cultural values to promote and sustain traditional culinary heritage. Furthermore, by leveraging the capabilities of CNN, this study aspires to raise public awareness of the importance of preserving local cuisine and fostering greater appreciation among younger generations for Indonesia’s rich culinary traditions.

Finally, this research is expected to contribute not only to the development of machine learning techniques in cultural contexts but also to the broader discussion on how digital transformation can assist in preserving intangible cultural assets for future generations.

1. RESEARCH METHOD

Convolutional Neural Network (CNN) is a type of neural network that has many layers and is most commonly used for analyzing digital images. (Valueva, et.al., 2020). The structure of a CNN generally consists of input components, feature extraction processes, classification, and output. Feature extraction in a CNN includes several layers or sub-casters, which consist of convolutional layers, activation functions (using ReLU), and pooling layers. The classification process involves layers that consist of fully connected sub-casters and the application of the activation function, namely Softmax. CNN operates in a structured sequence, where the output from one layer is used as the input for the next layer. The final output of the CNN is the classification generated based on the previously input data. The initial process of the CNN algorithm begins with the convolutional layer that performs the calculation.

1.1 Data Collection

Data collection is the initial step and one of the most fundamental aspects in the process of developing a machine learning model. In this case, the recognition of Bugis traditional cake images using CNN, the dataset used consists of 5 categories of Bugis traditional cakes, namely barongko cake, lapis cake, dange cake, taripang cake, and onde-onde cake

1.1.1 Data Splitting

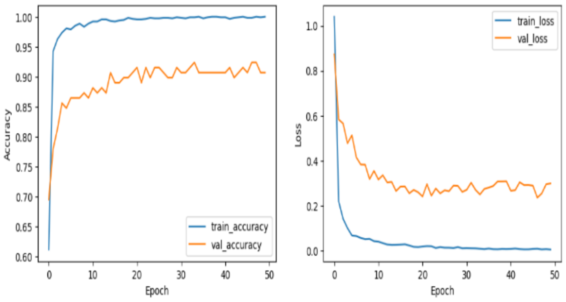
This data was obtained from various sources through the internet and the author's documentation. The data that has been obtained is divided into two parts, namely the training data consisting of 1130 images and the test data consisting of 118 images, which are then placed in Google Drive for future access.

1.2 Figures And Table

In this training, the batch size parameter was tested at values of 16, 32, and 64. Furthermore, the epochs to be used in this model training are 10, 30, and 50. Therefore, several experiments were conducted to obtain the best accuracy value. The following table shows the training results:

No	Batch Size	Epoch	Accuracy	Validasi Accuracy
1	16	10	0.9964	0.7647
2	16	30	0.9973	0.8235
3	16	50	0.9938	0.7843
4	32	10	0.9920	0.8427
5	32	30	0.9956	0.8620
6	32	50	0.9973	0.8716
7	64	10	0.9912	0.8529
8	64	30	0.9982	0.8716
9	64	50	0.9973	0.9067

Based on the training table that produced the most accurate model with a batch size of 64 and 50 epochs. The accuracy and loss graphs for this model are 0.9973 for Training Accuracy and 0.9067 for Validation Accuracy. The loss value during model validation is 0.0048, and the loss value during validation is 0.2988. can be seen in the following image:



The method applied in this research is the Confusion Matrix, which is used to evaluate the performance of classification models in machine learning. The Confusion Matrix provides an illustration of the model's effectiveness in classifying the provided dataset. This method is useful for calculating classification, a method that is very useful for determining recall, precision, accuracy, and F1-score, as well as providing information on the number of predicted classes given

2. Discussion

This research uses the best model from the mode that performs the training process for testing. This model was tested with a batch size of 64 and 50 epochs, achieving a training accuracy of 99% and a validation accuracy of 90%. The testing results of this research based on this best model can be seen in the following image:

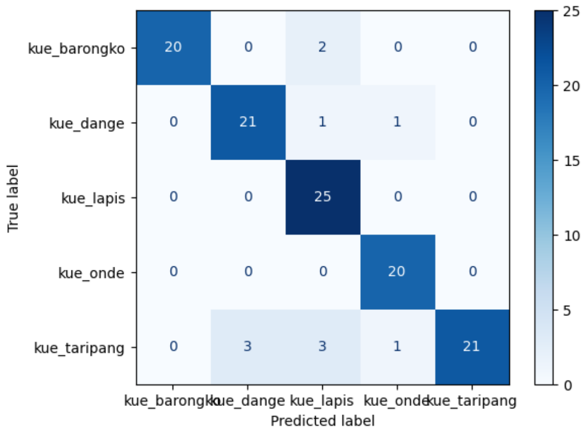


Figura Confusion Matrix Testing

Confusion Matrix testing, which successfully performed image recognition on the provided test dataset using the CNN method, is shown in the figure above. The tested model received the following scores for accuracy, precision, recall, and F1:

3. Result

It is known that True Positive (TP), False Positive (FP), True Negative (TN), and False Negative (FN). Here are the results of the calculations for Accuracy, Precision, Recall, and F1 Score based on each class:

1. Barongko Cake Class
   TP = 20, FP = 0, FN = 2
2. Dange Cake Class
   TP = 21, FP = 3, FN = 2
3. Lapis Cake Class
   TP = 25, FP = 6, FN = 0
4. Onde-Onde Cake Class
   TP = 20, FP = 1, FN = 0
5. Taripang Cake Class
   TP = 21, FP = 1, FN = 7

Below are the formulas and results for Accuracy, Precision, Recall, and F1 Score:

1. Accuracy

Accuracy can be calculated using the following formula: Accuracy = $\frac{TP+TN}{TP+TN+FP+FN}$.

Total test data = 118

Total Correct Predictions = 20 + 21 + 25 + 20 + 21 = 107

Accuracy $= \frac{107}{118} = 0.906\ atau\ 90.6\%$

2. Precision

Precision can be calculated using the following formula.: Precision $= \frac{TP}{TP+FP}$

a. Barongko Cake, Precision $= \frac{20}{20+0} = 1$

b. Dange Cake, Precision $= \frac{21}{21+3} = 0.875$

c. Lapis Cake, Precision $= \frac{25}{25+6} = 0.806$

d. Onde-Onde Cake, Precision $= \frac{20}{20+1} = 0.976$

e. Taripang Cake, Precision $= \frac{21}{21+7} = 0.75$

3. Recall

Recall can be calculated using the following formula: Recall $= \frac{TP}{TP+FN}$

a. Barongko Cake, Recall $= \frac{20}{20+2} = 0.909$

b. Dange Cake, Recall $= \frac{21}{21+2} = 0.913$

c. Lapis Cake, Recall $= \frac{25}{25+0} = 1$

d. Onde-Onde Cake, Recall $= \frac{20}{20+0} = 1$

e. Taripang Cake, Recall $= \frac{21}{21+7} = 0.75$

4. F1-Score

F1-Score can be calculated using the following formula.: F1-Score $= 2\ x\ \frac{Precision\ x\ Recall}{Precision+Recall}$

a. Barongko Cake, F1-Score $= 2\ x\ \frac{1\ x\ 0.909}{1+0.900} = 0.952$

b. Dange Cake, F1-Score $= 2\ x\ \frac{0.875\ x\ 0.913}{0.875+0.913} = 0.894$

c. Lapis Cake, F1-Score $= 2\ x\ \frac{0.806\ x\ 1}{0.806+1} = 0.893$

d. Onde-Onde Cake, F1-Score $= 2\ x\ \frac{0.952\ x\ 1}{0.952+1} = 0.976$

e. Taripang Cake, F1-Score $= 2\ x\ \frac{0.75\ x\ 0.75}{0.75+0.75} = 0.75$

4. Conclusions

Based on the evaluation and observations that have been conducted, we can conclude that the CNN technique is very effective for classifying images of traditional Indonesian food. This can be proven by the good performance of the model that has been trained through several training sessions, where the best model was obtained with the highest accuracy at a batch size of 64 and 50 epochs. This model shows an accuracy of 0.9973 for training accuracy and 0.9067 for validation accuracy. The loss value in validation mode is 0.0048, while the loss value obtained during validation is 0.2988. Testing was conducted using the confusion matrix method to measure the model's accuracy, resulting in a validation accuracy of 90%.

It is hoped that future research can use other methods to classify traditional foods, in order to provide new insights in their studies.

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