Classification of beef and pork meat by using SVM algorithm

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ABSTRACT

Meat is the main parameter in human daily consumption, because the excess protein in meat can increase human intelligence and stamina, but the similarity in color and texture of two types of meat makes it difficult for the human eye to distinguish them. This is used as a loophole by irresponsible meat traders to mix two types of meat, so it can cause serious health conditions in humans. Meat can generally be distinguished by looking at the fibers and colors of certain meats. Therefore, this study will overcome this problem by prioritizing the parameters of different colors and textures of meat which are classified as optimal methods with digital image processing. Among the efficient approaches offered is to apply the support vector machine (SVM) method by extracting HSV features in distinguishing beef and pork categories. This study adopts SVM and HSV feature extraction in finding out the types of beef and pork with fairly good algorithm results of 97% in 510 images, which were divided into training and testing data. The dataset used in the study is taken from Kaggle as an open-source platform for any practitioner. As a result, this technology shows a very accurate opportunity in detecting the type of meat correctly.

Keywords: Meat classification, Beef, Pork, SVM, HSV

1. Introduction

The most commonly consumed staple food by humans is meat. The abundant protein in meat helps improve intellectual and physical stamina, which greatly influences humans in carrying out daily activities [1]. Humans require a variety of nutrients, such as minerals, fats, vitamins, and other essential components, many of which are found in the meat they consume. From an economic perspective, this demand yields substantial profits for meat vendors in the market. Due to high demand, some sellers irresponsible mix beef and pork carelessly to boost their profits [2]. Unfortunately, such practices have the tendency to mislead consumers, downgrade food quality, and lead to health, religious, or dietary restriction-related issues concerning meat intake. This has therefore created a growing need for research as a countermeasure. Several researchers have applied image processing techniques for meat identification and discrimination because differences in parameters such as color and texture [3] make them highly effective.

The Support Vector Machine (SVM) algorithm is the initial classification method applied, along with the extraction of Hue, Saturation, and Value (HSV) features, to differentiate between various types of meat [4]. The application of the HSV color space enhances classification performance by enabling thorough exploration of color features, providing improved differentiation between beef and pork. The technique is most appropriate for differentiation between visually comparable types of meat. Here, SVM serves as the main classifier that takes the feature space as input to fully decide on the color and texture variations between beef and pork. Numerous studies [5] have established the efficiency of SVM classification with high results, such as 91.3% rate of accuracy in wood type detection using Local Binary Pattern texture features.

Another difference with previous research, this study will perform the same SVM classification but with HSV feature extraction aimed at classifying meat category images to determine the type of meat consumed, such as beef and pork, by using processed images of each type of meat that have been separated for data classification purposes. such as cow, goat, horse, pig, which is categorized as red meat. Although it is easily found in the market, not everyone can recognize the type of meat with the naked eye, due to the similarity in color and texture. This is used as an opportunity for crime by irresponsible meat traders in the market by mixing the two meats or even mixing them with other types of meat.

2. Methodology

Figure 1 shows the implementation stage of the research for classifying meat types using the Support Vector Machine (SVM) algorithm.

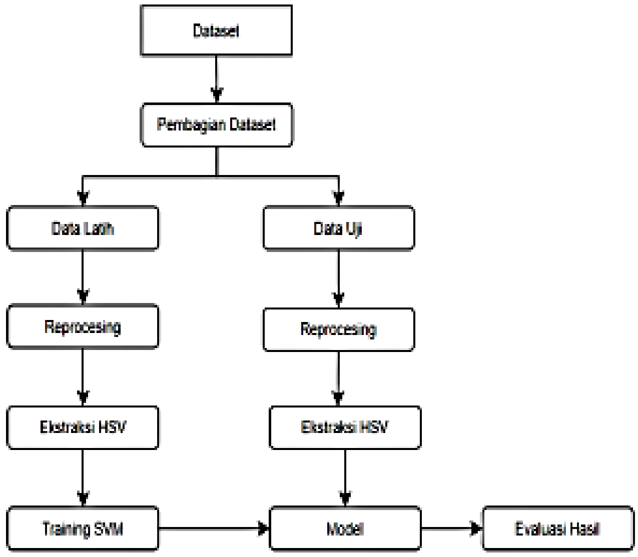


Figure 1. Framework Diagram of Methodologies [6]

Figure 1 shows the workflow for classifying data using the Support Vector Machine (SVM) algorithm starting bt identify the relevant dataset and split it into two parts: training data and testing data. This division is essential for precisely assessing the algorithm's performance. At this point, we can adjust each subset to reach the intended data volume. Subsequent to the feature extraction, the data is transformed from the RGB color space to the HSV color space. The SVM algorithm is then trained on the features that have been extracted from the training set. After the model is trained, it can be used to make predictions on the testing set. Lastly, the evaluation of the overall performance of the model using standard metrics like accuracy, precision, recall, and F1-score.

2.1 Dataset

The dataset used in this study consists of 210 images of meat, split into two categories which are beef and pork. All the dataset images are obtained from Kaggle (www.kaggle.com), a well-known platform for accessing publicly. Out of the total, 200 images were designated for the training set to help develop the classification algorithm, while the remaining 10 images were reserved for testing, allowing us to assess how well the model performs. By cautiously organizing the dataset by class, this study confirms that the classification algorithm can effectively tell the difference between beef and pork.

(1) (2)

Figure 2. Sample image of meat (1) beef, (2) pork.

2.2 Reprocessing Data

In the data preparation stage, reprocessing is a crucial step that takes raw datasets and carefully cleans and organizes them for the subsequent stages of analysis or model training. This phase usually involves several tasks, like normalizing the data to ensure that all features fit within a standardized 512 × 512 range and managing categorical variables to make sure they work well with the algorithms to be used.

2.3 Feature extraction

Feature extraction is a crucial phase of the process in which color information is examined using color space representation to help the classification approach. The goal is to improve the precision of the classification model. Identifying the particular visual features of various items depends on color analysis. Meat varieties will finally raise the caliber and dependability of the classification results [7].

Because it accurately depicts color features, the HSV (Hue, Saturation, Value) color space is frequently employed in digital image processing. Hue defines the specific color type while saturation reflects how intense or vivid that color is, and value represents the brightness. Combining these elements captures essential characteristics that help differentiate between various image classes [8]. Following feature extraction, computations are done in both RGB and HSV color spaces to correctly prepare the information for the following phases in categorization [9].

2.4 Classification

Classification is the task of dividing objects in a dataset into distinct groups based on their appearance [10]. Its most immediate function is to categorize information into established sets based on observable characteristics [11]. In applied uses, a model is trained to discover the hidden pattern of the training samples. After training, the model is able to classify new, unseen samples into their corresponding groups.

2.5 SVM (Support Vector Machine)

Support Vector Machine (SVM) is a widely applied supervised learning classifier and regression algorithm. It operates by determining the optimal hyperplane that distinguishes between two classes, accomplished by maximizing the margin spanned by the distance between two nearest data points, also known as support vectors, that are on the boundary of the hyperplane. Increasing the margin enhances SVM's ability to generalize to new data. While SVM is primarily employed in binary classification, it is possible to utilize one-vs-one or one-vs-rest strategies to apply it to multi-class classification, but these will introduce additional complexity [12]. Another of the key advantages of SVM is the ability to project data into higher dimensions, which can facilitate better classification of complex sets of data [13].

2.6 Evaluation

Based on feature extraction, we thoroughly reviewed if the SVM model could properly classify different types of meat [14]. Confusion Matrix method was utilized to review how the model functioned under this test with particular emphasis on important measures like accuracy, recall, and precision [15].].

Table 1. Confusion Matrix

		Actual score	
		Positive	Negative
Prediction score	Positive	TP	FP
	Negative	FN	TN

$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN}$$

$$\text{Precision} = \frac{TP}{TP + FP}$$

$$\text{Recall} = \frac{TP}{TP + FP}$$

TP = true Positive
TN = True Negative
FP = False Positive
FN = False Negative

3. Results and Discussion

3.1 Image Processing Results

The initial step in image processing is to divide the dataset into training and testing sets. This step is crucial as it ensures that the model is not merely well-trained but also well-tested on unseen data. 200 images were utilized for training, and 10 images were utilized for testing in this research. Through such an approach utilized, the model is able to be trained with a multitude of examples and then demonstrate its proficiency in classifying new and unknown data, a good indication of its actual-world efficacy.

Table 2. Dataset – Done

No.	Data	Total
1.	Dataset	210
2.	Training Data	200
3.	Testing Data	10

3.2 Pre-Processing

The resize function is used to scale all images to a consistent 512 × 512 pixel size during preprocessing. Then the second step is to convert the image color space from RGB (Red, Green, Blue) to HSV (Hue, Saturation, Value) using the 'rgb2hsv' function. So, the resulting images of both types of meat can be seen in the following image.

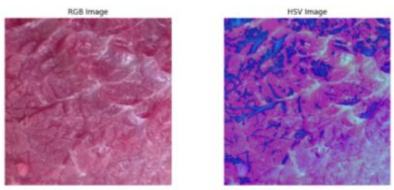


Figure 3. Beef RGB to HSV color conversion

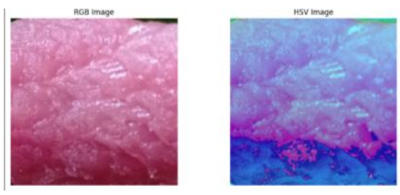
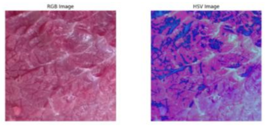
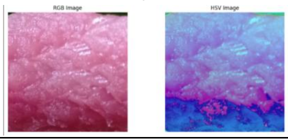


Figure 4. Pork RGB to HSV color conversion

3.3 Feature Extraction

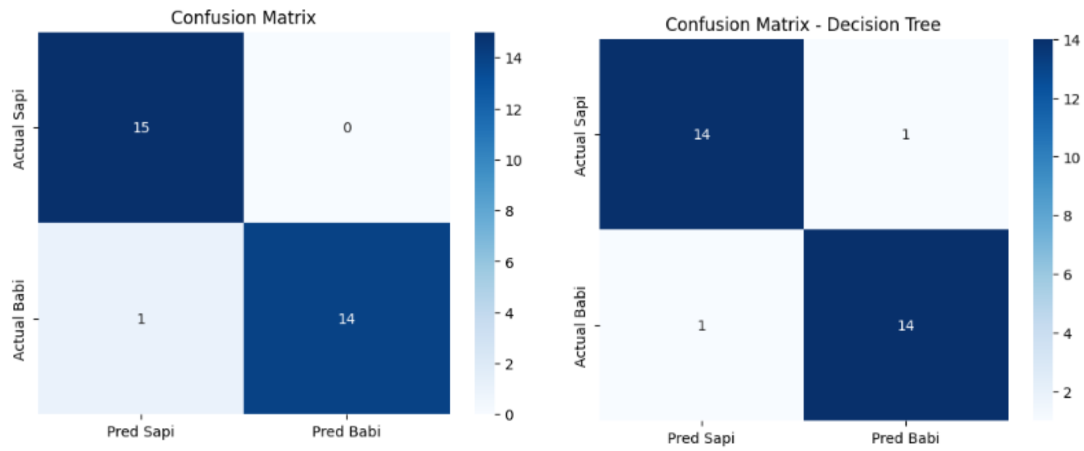
At this level, the extracted features include the average value (Mean), which describes the quality of brightness and color distribution evenly in the image. Mean is an average measure that shows the middle value of the HSV data distribution, then the standard deviation is the stage of measuring the diversity of HSV values from the average, and also the standard deviation shows how much difference in color and brightness in the image, and finally skewness assesses the symmetry of the distribution of HSV values and shows information about the slope of the distribution of the image.

Table 3. Feature Extraction Results

Image of data test	Feature extraction HSV
Beef 	Mean: 165,048 Deviation: 127,975 Skewness: 167,473
Pork 	Mean: 163,383 Deviation: 117,258 Skewness: 188,747

3.4 Result of SVM Classification

In the classification stage using the SVM (Support Vector Machine) method, the model will learn the patterns in the training data to classify between different classes. After going through the data training process, the algorithm will be tested on test data to see its optimal performance. One frequently used evaluation method is the Confusion Matrix, which is used to analyze the classification precision of data classes during the training process on test data. The Confusion Matrix has four main sections that serve as the main evaluation: True Positive (TP) for detecting the correct category, True Negative (TN) detecting the correct one, False Positive (FP) for detecting the wrong type, and False Negative (FN) for detecting errors in the correct type. The following is an explanation of the indicators of the confusion matrix:



(1) (2)

Figure 5. Result of Confusion Matrix (1) SVM, (2) Decision Tree

In the Confusion Matrix above:

- There are 14 data that are correctly classified as beef (True Positive for the beef class).
- There is 1 data that is incorrectly classified as horse meat when it should be beef (False Negative for the beef class).
- There are 14 data points correctly classified as horse meat (True Positive for horse class).
- There was 1 data point that was incorrectly classified as beef when it should have been horse meat (False Negative for horse class).

From the Confusion Matrix above, the following evaluation matrix can be calculated:

- Accuracy (Acc) beef class is:

$$\text{Beef acc} = \frac{TP\ beef + TN\ beef}{Total\ beef}$$

- Precision (Prec) beef class :

$$\text{Beef Prec} = \frac{TP\ beef}{TP\ beef + FP\ beef}$$

- Recall (Rec) beef class :

$$\text{Beef Rec}\ \frac{TP\ beef}{TP\ beef + FN\ beef}$$

- F1-Score (F1) beef class :

$$\text{F1 sapi} = 2x\ \frac{Prec\ sapi\ x\ Rec\ sapi}{Prec\ sapi + Rec\ sapi}$$

Total of beef class data is:
Total beef = TP beef + TN beef + FP beef + FN beef
= 15 + 14 + 0 + 1 = 30

- $\text{Beef Acc} = \frac{15+14}{30} = 0{,}966$
- $\text{Beef Pre} = \frac{15}{15+0} = 1$
- $\text{Beef Rec} = \frac{15}{15+1} = 0{,}938$
- $\text{Beef F1} = 2\ x\ \frac{1\ x\ 0{,}938}{1 + 0{,}938} = 0{,}968$

Table 4. Parameter Confusion

Parameter	Optimizer	
	Beef	Pork
Accuracy	0,966	0,966
Precision	1	1
Recall	0,938	0,938
F1-score	0,968	0,968

3.5 Accuracy

Based on the confusion matrix calculated above, and using the Support Vector Machine (SVM) method for classification, this study demonstrates a satisfactory accuracy of 97%. This result not only demonstrates the algorithm's ability to accurately classify images of the types in the dataset but also demonstrates the superiority of the SVM method in solving classification problems. This high level of accuracy provides a strong indication of the reliability of the model used. This study demonstrates that the approaches used in this study can be effective in distinguishing different image types. On the other hand, when the classification was performed using another method, in this case is a decision tree, the result was 93%. It means that the SVM model is better than the decision tree in classifying the image types.

4. Conclusions

This study demonstrates that utilizing the SVM (Support Vector Machine) method for classifying meat types with HSV feature extraction yields quite good and accurate results, with an accurate rate of 97%. This shows that the method taken is optimal in separating beef and pork. Thus, the conclusion is that the applied method approach can produce a classification algorithm that can be trusted in recognizing the visual characteristics of the type of meat.

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