Image Segmentation of Healthy Food Using Hue Saturation Value

by Arnita Arnita

AIP Conference Proceedings

Image segmentation of healthy food using Hue Saturation Value

Cite as: AIP Conference Proceedings **2659**, 090001 (2022); https://doi.org/10.1063/5.0113438
Published Online: 29 November 2022

Arnita, F. Marpaung, A. Widianto, et al.

Image Segmentation of Healthy Food Using Hue Saturation Value

Arnita[a)], F Marpaung[b)], A Widianto[c)] and M Hidayat[d)]

Mathematic Department Universitas Negeri Medan, Jalan Williem Iskandar Pasar V, Medan North Sumatera Indonesia

[a)] *Corresponding author: arnita@unimed.ac.id*
[b)] *farida2008.unim@gmail.com*
[c)] *aziwidianto0@gmail.com*
[d)] *mhdhidayat@mhs.unimed.ac.id*

Abstract. This study aims to distinguish nine types of food based on the pixel intensity of the HSV image of the food. The segmentation method used is Hue, Saturation and Value (HSV) and compares its performance with RGB and RGB+HSV combinations. The segmentation method used is Hue, Saturation and Value (HSV) and compares its performance with RGB and RGB+HSV combinations. The data used in this study is image of green bean porridge, nuggets, brown rice, white rice, kale, sausage and rendang. The segmentation begins by converting 162 food photos into RGB images, then converting them into HSV images. The image segmentation results were then classified using the KNN algorithm and tested at k = 3, 5 and 7. This is indicated by the value of accuracy, precision. Recall, and F1-scores were 96%, 94%, 94% and 94%, respectively.

INTRODUCTION

The Corona virus pandemic has caused many changes in daily life. The infection causes the victim's body to become feverish, requiring additional energy and nutrients. Good nutrition is very important to maintain immunity when the body is infected, after, or before infection. Maintaining a healthy diet is very important during a pandemic. Although it is not known for certain which foods or dietary supplements can prevent Covid-19 infection, maintaining a balanced nutritional diet is very important in boosting the immune system. Therefore, in dealing with the current situation, one must be able to maintain health so as not to contract the Corona virus.

Food is a source of energy that humans need. The type of food consumed greatly affects the immune system of the human body. However, the many types of food available make it difficult for people to choose the type of healthy food to be consumed. Healthy food is food that contains balanced nutrients such as carbohydrates, proteins, fats, vitamins, minerals and water [1].

Classification of food is important to do to determine which foods are good for consumption. Choosing healthy foods that increase endurance is something that needs to be done. Identification and classification of food is one of the challenges in image recognition. Classification of food images can be done using the methods found in computer vision [2], one of which is through color recognition. Color is the result of perception of light in the visible region of the spectrum by the retina of the eye, and has a wavelength between 400nm to 700nm.

A color space is an abstract mathematical model that describes how a color can be represented as a row of numbers usually with values of three or four colors or components. Some examples of color spaces are RGB, CMY/CMYK, YIQ, YCbCr, HSI, HSL, HSV, CIELAB. In this study, the HSV color space will be used. The HSV color space defines color in terms of Hue, Saturation and Value. The advantage of HSV is that there are the same colors that are captured by the human senses. While the colors formed by other models such as RGB are the result of a mixture of primary colors [3]. The HSV color space has 3 main characteristics, namely Hue, Saturation and Value. Hue represents true colors, such as red, violet, and yellow and is used to define redness, greenness. Saturation,

The 8th Annual International Seminar On Trends In Science And Science Education (AISTSSE) 2021
AIP Conf. Proc. 2659, 090001-1–090001-8; https://doi.org/10.1063/5.0113438
Published by AIP Publishing. 978-0-7354-4256-6/$30.00

sometimes called chroma, is the purity or strength of a color. The brightness value of the color. The value ranges from 0-100%. If the value is 0 then the color will be black, the greater the value, the brighter and new variations of the color will appear [4].

Relevant studies that have been carried out by people related to HSV color features include [4], based on the results of research on the introduction of tomato maturity levels based on HSV color images, the accuracy is 83.75%. Meanwhile, based on the results of research [3], digital image classification using the RGB To HSV method can provide information on the distance of image similarity with an accuracy rate of 87%, precision of 89% and recall of 94%. Likewise, the results of research [5] which stated that the use of the HSV feature got the best accuracy results of 95.24% with a value of k=1.

Based on the results of color extraction using HSV then classification is carried out to identify food. The classification method used in this study is KNN. Based on research [6] the KKN method is able to produce better disease identification than the Backpropagation algorithm. Meanwhile, according to [7] the classification using KNN and the Grayscale Histogram method combined with the SMSD met in producing color images is able to give an accuracy value of 77.8%. Likewise in research [8] which states that the k-Nearest Neighbor (kNN) algorithm applied to consumer data using motor vehicle loan financial services produces an accuracy and AUC value of 81.46% and 0.984, respectively. Based on the background described above, a research on classification and identification of healthy foods was carried out based on HSV color images and KNN classification methods.

RESEARCH METHODOLOGY

The initial stage of this research is to prepare data, by taking photos of several types of food that are used as objects in this study. The following is the research flow.

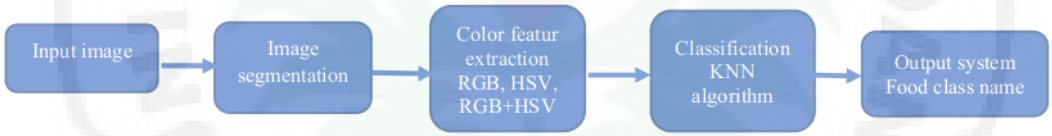


FIGURE 1. Research flow

After setting the input image, the next step is to segment the image by producing a segmented image. After the segmentation process is carried out, color feature extraction is carried out using the RGB, HSV and RGB + HSV combination methods. The next step is to classify using the KNN algorithm and produce an output in the form of food class names.

Data

The data used in this study is primary data obtained from photos of 9 types of food, namely tempe, steak, sausage, rendang, nuggets, rice, red rice, sauteed water spinach, and green bean porridge. Each variety of food was photographed based on 3 different types of food and repeated 6 times from various shooting angles. The number of food samples analyzed in this study were 162. Food photos were obtained using a mobile phone camera with a 48 MP quad camera specification. The model was formed using training data and validated using testing data with a composition of 75%: 25%, taking into account the representation of each type of food [9]. Examples of food images that were sampled in this study are shown in Figure 2.

The data obtained from feature extraction is numerical data, so it is necessary to convert it first into categorical data. The conversion of numeric data into categories is represented in equations 1 to 3 [5].

1. Finding Range (R)

$$R = max\text{-}min \quad (1)$$

2. Search for many classes (C)

$$C = 1 + 3.3\ x\ log\ n, \text{ where n is the number of data} \quad (2)$$

3. Calculating length of the class (L)

$$L = J/K \tag{3}$$

4. Entering data into categories

Preprocessing

Pre-processing in this study by segmenting images using the Hue, Saturation, and Value (HSV) method with the steps as shown in Figure 1.

FIGURE 2. Sample data

Hue, Saturation, Value (HSV)

Hue is a measure of the wavelength of the dominant color based on the perception of the human eye. Saturation is the amount of white light in the Hue channel. Value is the intensity of the object's reflection received by the eye. This intensity means a change in color from white to gray to black [10]. Following are the steps for converting RGB images to HSV [3].

1. Normalize the image, by dividing its value by 118 which is shown in Equations 4 to 6.

$$H = H\ 118 \quad (4)$$
$$S = S\ 118 \quad (5)$$
$$V = V\ 118 \quad (6)$$

2. Convert to HSV, using Equations 7 to 9.

$$V = max\ (R, G, B) \quad (7)$$
$$S = \begin{cases} \frac{V - min(R,G,B)}{V}, if\ v\ != 0 \\ 0\ otherwise \end{cases} \quad (8)$$
$$H = \begin{cases} \frac{60(G-B)}{(V-min(R,G,B))}\ if\ V = R \\ \frac{120+60(B-R)}{(V-min(R,G,B))}\ if\ V = G \\ \frac{240+60(R-G)}{(V-min(R,G,B))}\ if\ V = B \end{cases} \quad (9)$$

3. Convert the image to an 8 bit image, using equations 10 to 12.

$$V = V\ x\ 118 \quad (10)$$
$$S = S\ x\ 118 \quad (11)$$
$$H = \frac{H}{2} \quad (12)$$

Information:
H: HSV pixel value on channel H
S: HSV pixel value on channel S
V: HSV pixel value on channel V

K-Nearest Neighbor (KNN)

K-Nearest Neighbor (kNN) belongs to the instance-based learning group. This algorithm is also a lazy learning technique. KNN is done by looking for groups of k objects in the training data that are closest (similar) to the objects in the new data or testing data through the measure of proximity [11]. There are many ways to measure the proximity between new data and old data (training data), including the Euclidean distance and Manhattan distance, in this study using the Euclidean distance [12], namely

$$d(a_i, b_j) = \sqrt{(a_1 - b_1)^2 + (a_2 - b_2)^2 + \cdots + (a_n - b_n)^2} \quad (13)$$

where:
a_{il} = the i-th test data on the first variable
b_{jl} = the i-th training data on the first variable
$d(ai,bj)$ = distance
N = dimension of independent variable
$d(a_i, b_j)$= dissimilarity

Validation

Cross-validation or often referred to as rotation estimation is a model validation technique to assess the optimization of the analysis results, besides that cross-validation is also a compositional technique in determining the amount of training data and testing data to be used. One of the commonly used cross validation methods is the holdout method. In this study, the holdout method is used, where the initial data that is labeled is partitioned into two random sets called training data and testing data. The proportion of data reserved for training data and testing data is 75% : 25%.

Evaluation

Evaluation aims to determine the level of success of a study. Evaluation in this study uses accuracy, precision, recall and F1-Score in the confusion matrix as shown in Figure 3.

		Predicted Class: P	Predicted Class: N
Actual Class	P	True Positives (TP)	False Negatives (FN)
	N	False Positives (FN)	True Negatives (TN)

FIGURE 3. Confussion Matrix

The higher value of accuracy, precision, recall and F1-Score, the better the system created [12][13]. To calculate the evaluation used equations 14 to 17.

$$\text{Recall} = \frac{TP}{TP+FN} \times 100\% \quad (14)$$

$$\text{F1-Score} = \frac{1}{2}\left(\frac{1}{precison} + \frac{1}{recall}\right) \times 100\% \quad (15)$$

$$\text{Precision} = \frac{TP}{TP+FP} \times 100\% \quad (16)$$

$$\text{Accuracy} = sensitivity\frac{P}{(P+N)} + specificity\frac{N}{(P+N)} \times 100\% \quad (17)$$

formation:
TP = number of true positives
TN = number of true negatives
P = number of positive records
N = number of negative tuples
FP = number of false positives

RESULTS AND DISCUSSION

The result of this research is that image segmentation using HSV is better than RGB and RGB+HSV in identifying food. In Figure 4, it can be seen that the original photo was converted to RGB, HSV and a combination of RGB+HSV.

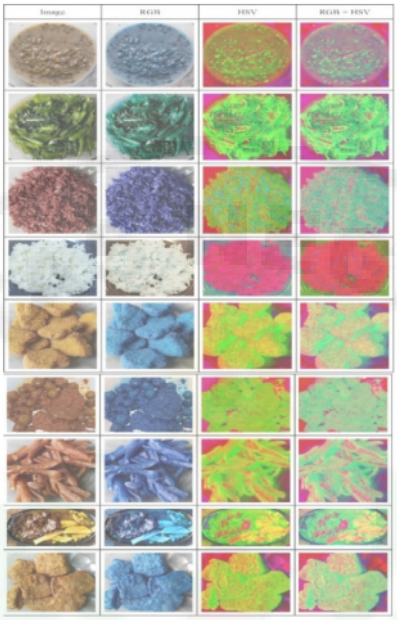


FIGURE 4. Color Segmentation

Several trials were conducted to see the effect of the extraction method and the value of k in selecting the best classification model. The results of the scenario of testing the effect of the extraction method, the HSV method shows better performance than the RGB method and the RGB+HSV combination. Likewise, the results of the test scenario of the effect of the value of k on the classification method. Based on the results of testing the value of k, it is obtained that the value of k=3 has the best model performance compared to k=5 and k=7, as shown in Figure 5.

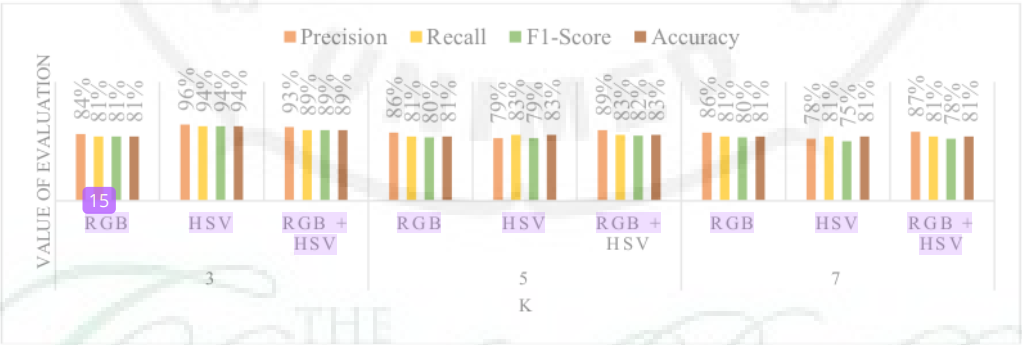


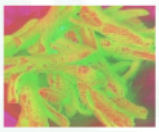
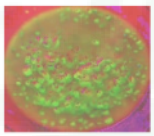
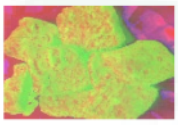
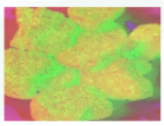
FIGURE 5. Test Result

It can be seen from Figure 5 based on the evaluation value of precision, recall, F1-score and the highest accuracy produced by the HSV extraction method with k = 3 respectively 96%, 94%, 94% and 94%. The results of the model trial using 36 data samples with the HSV k=3 extraction method resulted in 2 image objects containing misclassification, namely tempeh and sausage objects. Based on the confusion matrix as shown in Table 1, the color feature in the HSV method assumes that sausage and mung bean porridge have similar colors, as well as tempeh and nuggets so that 1 sausage object is classified as green bean and 1 tempe object is classified as nugget.

TABLE 1. Confussion Matrix for HSV – KNN and k = 3.

Actual	Prediction								
	Green Bean Porridge	Sauted Water Spinach	Red Rice	Rice	Nugget	Rendang	Sausage	Steak	Tempe
Green bean porridge	4	0	0	0	0	0	0	0	0
Sauted water spinach	0	4	0	0	0	0	0	0	0
Red rice	0	0	4	0	0	0	0	0	0
Rice	0	0	0	4	0	0	0	0	0
Nugget	0	0	0	0	4	0	0	0	0
Rendang	0	0	0	0	0	4	0	0	0
Sausage	1	0	0	0	0	0	3	0	0
Steak	0	0	0	0	0	0	0	4	0
Tempe	0	0	0	0	1	0	0	0	3

TABLE 2. Misclassification object at model HSV-KNN (k=3)

No	Input	Output
1	Soussage 	Green bean porridge 
2	Tempe 	Nugget 

The results of the HSV color segmentation shown in Table 2 show the similarity of the color characteristics of the object so that there is a misclassification. Based on the analyzed data, it can be concluded that the average HSV feature value between soussage and green bean porridge images and tempe and nuggets have similar values, so that if the nearest neighbor with a k value of more than one makes it possible to enter a class that has color is similar to the test data. The results of the evaluation of the HSV-KNN model (k=3) for each food sample are shown in Table 3.

TABLE 3. Evaluation of the HSV-KNN model (k=3) on each object

Value of Evaluation	Accuracy (%)	Precision (%)	Recall (%)	F1-Score (%)
Green bean porridge	100	100	100	100
Sauted water spinach	100	100	100	100
Red rice	100	100	100	100
Rice	100	100	100	100
Nugget	100	100	100	100
Rendang	100	100	100	100
Sausage	75	100	100	100
Steak	100	100	100	100
Tempe	75	100	100	100

CONCLUSION

This study introduces a color segmentation framework to identify foods. The segmentation method used in this study is RGB, HSV and a combination of RGB+HSV. The input image obtained from the three segmentation methods is then simulated to produce a classification model using the KNN algorithm using k 3, 5 and 7. the best. This is indicated by the value of accuracy, precision. Recall, and F1-scores were 96%, 94%, 94% and 94%, respectively.

ACKNOWLEDGMENTS

We would like to thank the Medan State University for providing funds for the implementation of this research. especially the rector, LPPM, the dean of FMIPA, the head of the department who have provided support and facilities for the implementation of this series of research. although not perfect, hopefully the results of this research will be useful for the development of knowledge and many people

REFERENCES

1. R. F. Siahaan, Jurnal Keluarga Sehat Sejahtera**15(2)**, pp. 57–64 (2017).
2. S. Jahan, S. R. H, and S. A. Quadri, Int. J. Latest Technol. Eng. Manag. Appl. Sci**8(3)**, pp. 153–159 (2018).
3. J. F. Fauzi, H. Tolle and R. K. Dewi, J. Pengemb. Teknol. Inf. dan Ilmu Komput**2(6)**, pp. 2319–2325 (2018).
4. M. A. Anggriawan, M. Ichwan and D. B. Utami, J. Tek. Inform. dan Sist. Inf**3(3)**, pp. 550–564 (2017).
5. F. Y. Nabella, Y. A. Sari and R. C. Wihandika, J. Pengemb. Teknol. Inf. dan Ilmu Komput**3(2)**, pp. 1892–1900 (2019).
6. S. Rejeki, "Perbandingan Algoritma Backpropagation dan K-Nearest Neighbor (K-NN) untuk Identifikasi Penyakit," in *Seminar Nasional Aplikasi Teknologi Informasi (SNATI)*, (2013), pp. 1–5.
7. M. R. Setiawan, Y. A. Sari and P. P. Adikara, J. Pengemb. Teknol. Inf. dan Ilmu Komput**3(3)**, pp. 2726–2731 (2019).
8. H. Leidiyana, J. Penelit. Ilmu Komputer, Syst. Embed. Log**1(1)**, pp. 65–76 (2013).
9. E. Darwiyanto, Indones. J. Comput**2(1)**, p. 59 (2017),
10. R. D. Kusumanto, A. N. Tompunu and S. Pambudi, J. Ilm. Tek. Elektro**2(2)**, pp. 83–87 (2011).
11. J. Wu, Z. H. Cai and S. Ao, Int. J. Comput. Appl. Technol**43(4)**, pp. 378–384 (2012).
12. M. Bramer, *Principle of Data Mining* (2016).
13. J. Han, M. Kamber and J. Pei, *Data Mining: Concepts and Techniques* (2012).

Image Segmentation of Healthy Food Using Hue Saturation Value

ORIGINALITY REPORT

19%	13%	13%	10%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	repository.potensi-utama.ac.id Internet Source	3%
2	Submitted to Universitas Muhammadiyah Yogyakarta Student Paper	3%
3	abecindonesia.org Internet Source	3%
4	www.ijctjournal.org Internet Source	1%
5	jurnal.kdi.or.id Internet Source	1%
6	Devie Rosa Anamisa, Budi Dwi Satoto, Muhammad Yusuf, Moch. Kautsar Sophan, Nurwahyu Alamsyah, Arif Muntasa. "Web-based Rice Pest and Diseases Detection Using Hybrid Fuzzy and K-Nearest Neighbor Methods", 2022 6th International Conference on Informatics and Computational Sciences (ICICoS), 2022 Publication	1%

7	archive.org Internet Source	1 %
8	Triyanna Widiyaningtyas, Ilham Ari Elbaith Zaeni, Putri Yula Wahyuningrum. "Self-Organizing Map (SOM) For Diagnosis Coronary Heart Disease", 2019 4th International Conference on Information Technology, Information Systems and Electrical Engineering (ICITISEE), 2019 Publication	1 %
9	Dedi Sepriana, Kusworo Adi, Catur Edi Widodo. "Determining the Threshold Value for Identification of the Goblet Cells in Chicken Small Intestine", 2019 International Conference of Artificial Intelligence and Information Technology (ICAIIT), 2019 Publication	1 %
10	Faron, Matthew L., Blake W. Buchan, Christopher Coon, Theo Liebregts, Anita van Bree, Arjan R. Jansz, Genevieve Soucy, John Korver, and Nathan A. Ledeboer. "Automatic Digital Analysis of Chromogenic Media for Vancomycin Resistant Enterococci Screens using the Copan WASPLab™", Journal of Clinical Microbiology, 2016. Publication	1 %

11	Eki Ahmad Zaki Hamidi, Mufid Ridlo Effendi, Firman Febrianto Asmoro. "Design and Implementation of Model Autonomous Sentry Gun Using Image Processing and Motion Tracking", 2019 IEEE 5th International Conference on Wireless and Telematics (ICWT), 2019 Publication	<1 %
12	erepo.unud.ac.id Internet Source	<1 %
13	Submitted to Rochester Institute of Technology Student Paper	<1 %
14	Mojtaba Khanzadeh, Sudipta Chowdhury, Mohammad Marufuzzaman, Mark A. Tschopp, Linkan Bian. "Porosity prediction: Supervised-learning of thermal history for direct laser deposition", Journal of Manufacturing Systems, 2018 Publication	<1 %
15	www.davidpublisher.com Internet Source	<1 %
16	comengapp.unsri.ac.id Internet Source	<1 %
17	www.thestudentroom.co.uk Internet Source	<1 %

18	ejurnal.unmerpas.ac.id Internet Source	<1 %
19	el.art1lib.org Internet Source	<1 %
20	internetworkingindonesia.org Internet Source	<1 %
21	journal.universitasmulia.ac.id Internet Source	<1 %
22	www.ijert.org Internet Source	<1 %
23	S Edy Victor Haryanto, M. Y. Mashor, A. S. Abdul Nasir, H. Jaafar. "Malaria parasite detection with histogram color space method in Giemsa-stained blood cell images", 2017 5th International Conference on Cyber and IT Service Management (CITSM), 2017 Publication	<1 %

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	On		