Jurnal Teknologi Informasi Dan Terapan (J-TIT) Vol. 11 No. 2 Tahun 2024 ISSN: 2580-2291

Received January 3rd, 2025; accepted January 16th, 2025. Date of publication January 18th, 2025 Digital Object Identifier: https://doi.org/10/25047/jtit.v11i2.5793

Classification of Chicken Meat Freshness Using Support Vector Machine and Hue Saturation Intensity

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ABSTRACT Chicken meat is a popular source of animal protein in Indonesia due to its high nutritional value, affordable price, and easy processing. The identification of chicken meat freshness is currently still done manually through visual or tactile inspection, but this method has limitations, especially if consumers are less skilled in distinguishing the quality of chicken meat freshness. Therefore, an automated system is needed to classify the freshness level of chicken meat based on images. This research aims to develop an image processing system in classifying the freshness level of chicken meat by utilizing the Support Vector Machine (SVM) method with Hue Saturation Intensity (HSI) based color feature extraction. This process is done by converting the RGB image into HSI, then extracting the Hue, Saturation, and Intensity values and classifying using a polynomial kernel. This study used 450 chicken meat images, with 360 training data and 90 test data. The developed system successfully achieved an accuracy of 65.56%. The test results show that the system is reliable in classifying the freshness level of chicken meat. This system has the potential to support the identification of meat freshness efficiently and objectively, while at the same time improving food safety.

KEYWORDS: Freshness, Chicken Meat, HSI, Classification, SVM, Multi-Class

I.INTRODUCTION

The rapid development of technology in this modern era has a significant influence on developments in several sectors, including the food sector. One of the food products that consumers are very interested in is chicken meat, because it can be obtained anywhere, both in traditional markets and modern markets with various quality chicken meat. Chicken meat is one of the most popular sources of animal protein among Indonesians. When compared to other sources of animal protein, chicken meat tends to be more affordable. Therefore, chicken meat is the main choice by the community in meeting the needs of animal protein consumption, especially in urban and rural communities [1].

However, in the modern food industry, quality is a very important factor because high-quality products are the key to competing in an increasingly competitive market, including livestock products such as poultry meat [2].There are four main factors that affect meat quality, including the number of microorganisms, chemical composition, physical characteristics, and the level of satisfaction when consumed (eating quality). Of these four factors, consumers tend to prioritize physical characteristics and eating quality over the other two factors. Eating quality relies on the sensitivity of the human senses, such as sight, smell, taste and touch, as it involves assessing the color, smell, taste, texture and overall impression of the meat [3]. As the demand for chicken increases while the supply is limited, this gap is exploited by rogue traders by selling chicken at low prices compared to other fresh chicken. They mix fresh chicken meat with spoiled meat in order to get greater profits, even though it is not halal, this is certainly very detrimental to consumers. This is certainly very detrimental to consumers [4].

For this reason, the public is expected to be more vigilant when choosing chicken meat to be consumed and ensure guaranteed quality and not be tempted by unreasonable prices, which are far below the average price. Currently, the process of determining the freshness level of chicken meat is still often done manually. This method is generally based on visual observations such as checking the aroma and texture of the meat. This method has limitations in several ways. First in terms of accuracy, it is difficult to detect small changes in meat freshness manually. Secondly objectivity, subjective judgment can be affected by external factors such as lighting, fatigue, or deficiencies in the human sense of sight and smell. Thirdly efficiency, the manual process requires more time and effort. Chicken meat freshness identification system is an important solution to improve food quality and safety. By utilizing computer technology and using image processing techniques, the process of classifying the freshness of chicken meat can be done more efficiently and quickly, even by ordinary people without requiring special skills. Therefore, in this research, the author will apply several theories to facilitate the identification of chicken meat freshness through visuals alone, this is expected to help minimize the risk of disease for consumers and increase efficiency in the food supply chain [5].

This computerized process utilizes visual capture, which is by using a camera to obtain an image of chicken meat and after that it will be processed using machine learning. One of the digital image processing techniques that can be applied to detect color characteristics is the HSI color space transformation. This method can provide information about color characteristics that are a benchmark for distinguishing between fresh, not fresh and rotten chicken meat (not suitable for consumption) through input images of the meat to be tested. With the development of current decision-making technology, the classification of meat freshness levels can now be done through digital image processing. After identifying the color characteristics of chicken meat freshness using the HSI color space transformation, the next process is the process of classifying image data. The image clustering process can be done by utilizing machine learning algorithms. In this research, the method used is SVM.

This method is used because it offers significant advantages over other machine learning methods. The SVM algorithm is known for its ability to handle noise effectively by using hyperplanes optimally. It can separate two groups of data from different class categories and determine the distance for each data set by leveraging support vectors, which makes the computation process faster. Several studies have demonstrated the application of SVM in classifying freshness based on color characteristics. For example, examined the freshness level of squid using the SVM method in their study titled “Classification of Squid Freshness Levels Based on Texture and Color Features Using the Support Vector Machine Method.” Their system model achieved an accuracy of 67.75% in classifying the freshness levels of squid (Bimantoro, 2021) [6]. Similarly, developed a vision-based chicken meat freshness recognition system using RGB color moment features and the SVM method. Their study, titled “Vision-Based Chicken Meat Freshness Recognition System Using RGB Color Moment Features and Support Vector Machine (SVM),” aimed to support the selection of high-quality chicken meat to ensure better food quality. This system achieved a commendable accuracy of 71.6% when applied to a balanced dataset (Avianto, 2023) [7].

This study is motivated by gaps identified in previous research. While earlier studies used RGB color feature extraction for identifying chicken meat freshness, this approach needs improvement to achieve higher accuracy. To address this, the authors will use a more specific feature extraction technique. HSI, which is expected to yield better classification performance. Additionally, previous studies relied on smaller datasets for training the SVM model, which can limit the ability of the algorithm to find an optimal hyperplane with a maximum margin. This research will use a significantly larger dataset, aiming to improve the system's accuracy and reliability.

II. METHOD

In conducting a research, a research methodology is needed for a research model. In a research framework there are structures or stages carried out by researchers and applied when conducting research. This aims to make the research carried out run systematically and the expected goals can be achieved. The framework of this research is shown in Figure 1 below:

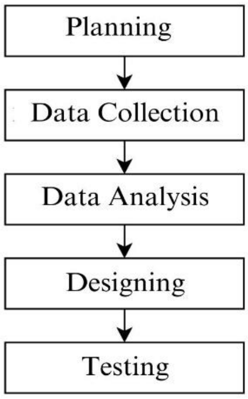

FIGURE 1. Research Outline

The research framework, as shown in Figure 1, outlines the systematic steps taken to develop the classification system for chicken meat freshness using SVM and HSI features. It begins with planning, followed by data collection through literature review and observation, data analysis involving HSI conversion and SVM classification, system design, and testing. This structured approach ensures a comprehensive investigation into the proposed methodology.

A. Topic Selection

The research process begins with selecting a suitable topic for investigation. In this study, the chosen topic is the Classification of Chicken Meat Freshness Level Using Support Vector Machine and Hue Saturation Intensity.

B. Data Collection

Some data collection techniques that will be done in this study are as follows:

1) Literature Study: Literature is a process that includes activities that involve collecting references, reading, recording, and processing research data and looking for theories that are in accordance with the problems associated with this research. The objectives presented in the form of hypotheses are temporary answers proposed to overcome research problems.

2) Observation: Observation is a data collection technique where researchers directly observe objects and activities in their surroundings, utilizing their senses to gather data. For example, this may include representative sampling to capture

various levels of meat freshness. In this study, sample data were collected directly from the market.

C. Data Analysis

In this research, data analysis is a process carried out to identify the information needed to build a system so that it can function properly. This process includes analyzing the requirements involving hardware and software. In image analysis systems, the features used focus on image processing techniques derived from two main applications, namely to convert image data into information that can be understood by humans and for data processing for automatic machine perception. Image capture is done by taking photos of several pieces of chicken meat that are fresh, not fresh and several pieces of chicken meat that are not suitable for consumption (not fresh). The image of chicken meat is taken using a smartphone camera. In one class there are 150 images, 30 as training and 30 testing images so that the total image data used in the classification of all types of classes is 510 images. In this study, data analysis was carried out with the aim of classifying the results of the RGB color space transformation which was then converted to the HSI color model, then classified using the SVM method which was determined based on the hyperplane.

MATLAB implementation is carried out to use the SVM method and HSI color model in analyzing the freshness of chicken meat through the MATLAB R2016b application. Some of the program steps that will be carried out include first, inputting chicken meat images. Second, after the chicken meat image is entered into the program, the next step is to convert the image from RGB to HSI using the MATLAB R2016b application. Third, after being transformed from RGB to HSI, the program will produce identification of color characteristics in the image then the identification results will be classified according to the color space using the SVM method through non-linear calculations using polynomial kernels. After processing, a hyper plane will appear according to the classification, then the classification results of the identification of the chicken meat image will appear. Then if tested by entering test data and training data on the system, the MATLAB system can already classify chicken meat as fresh, less fresh, or rotten.

D. Designing

Design is the first step in the process of developing a product or structure that plans the subsequent stages. Designing is a way that involves the use of various approaches and norms that aim to explain the complete device, cycle, or structure with respect to accurate recognition. This phase is a major part of system programming. In this research, the design is done by designing a software system using MATLAB R2016b application to analyze the freshness level of chicken meat. The process begins by entering the image obtained through image acquisition, which is taking pictures using a smartphone camera, then converting the RGB image into an HSI color image. After the conversion of RGB to HSI features is done, the system will automatically calculate the average HSI value that has been obtained previously. Then, these results will be classified by forming a model first in the SVM method and the results obtained will produce a system which can process image data input including fresh, not fresh or rotten image classes. Classification in this study uses the SVM method because it will be classified based on the color space in chicken meat images.

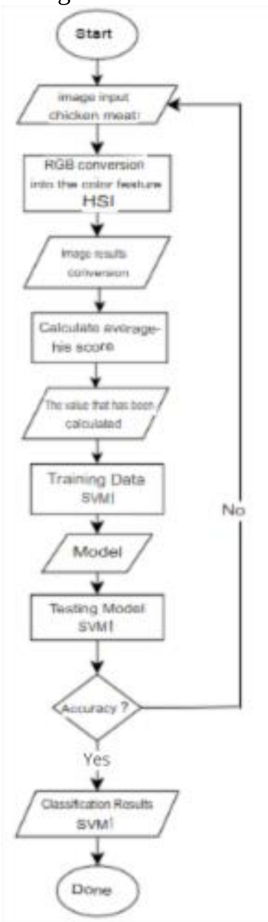

FIGURE 2. Classification Flowchart SVM

Figure 2 illustrates the SVM-based classification flowchart, detailing the conversion of RGB images to HSI format, feature extraction, training, and testing phases. Each phase is critical for accurately categorizing chicken meat into fresh, not fresh, and rotten classes, as described in the methodology section.

E. Testing

Testing is done to test the work execution and find new innovations in determining the freshness of chicken meat. The system will be tested by selecting some chicken meat arbitrarily in each test. Testing will begin by determining 3 types of chicken meat freshness levels, namely fresh, not fresh and rotten. This test is used to test how much the accuracy value obtained on the chicken meat freshness classification system by applying the SVM method to be compared with other methods so that it can be concluded that the SVM method is a method that has the best accuracy value or not.

III. RESULT AND DISCUSSION

Based on the observations made, the author found three categories of chicken meat freshness that are well known by the public, namely rotten, fresh, and not fresh. The purpose of this observation is to collect image data of the three categories of chicken meat freshness in jpg format, which will be tested further. This research involves data analysis to classify the results of RGB color feature extraction which is then converted to HSI, then processed using the Support Vector Machine method. The implementation uses MATLAB 2016 to apply the SVM method with the Hue Saturation Intensity color model in analyzing the freshness of chicken meat. The program steps include: a. Inputting chicken meat image as initial data. b. Extracting color features by converting the image from RGB to HSI. c. Classifying the freshness level of chicken meat using the non-linear SVM method with a polynomial kernel. Display the final result of classification in the form of labeling the freshness class of chicken meat.

A. Representation of Data

The dataset used for manual calculation consists of one sample chicken meat image. The following is an image display of the chicken meat sample image that will be used in the manual calculation process:

FIGURE 3. Chicken Meat Image Sample

After the text edit has been completed, the paper is ready for the template. Duplicate the template file by using the Save As command, and use the naming convention prescribed by your conference for the name of your paper. In this newly created file, highlight all of the contents and import your prepared text file. You are now ready to style your paper; use the scroll down window on the left of the MS Word Formatting toolbar. Based on the picture above, the author performs the process of extracting RGB images into HSI images. The freshness classification stage of chicken meat involves two main processes, namely training and testing. The training process is carried out by extracting the entire chicken meat image using the HSI model, then saving the extraction results into the dataset. Meanwhile, the testing process is carried out by testing the freshness classification of chicken meat through HSI extraction and matching the extracted value with the training dataset to determine the classification of chicken meat. Based on Figure 3, to simplify manual calculations in RGB to HSI image extraction, an example of chicken meat image with a resolution of 3x3 pixels is taken. The RGB value of the sample chicken meat image is as follows:

TABLE 1. RGB Value of 3X3 Chicken Meat Image

X/Y	0	1	2
0	210 212 213	212 211 210	214 212 215
1	211 213 214	213 212 211	215 213 216
2	213 215 216	215 214 213	217 215 218

Next, the average value of the Red, Green, and Blue components of the 3x3 image of fresh meat sample 1 is calculated with the following steps: Average Value of RGB Fresh Meat Image 1:

After obtaining the RGB value of the sample image,

FIGURE 4. Computation of average R (Red), G (Green), and B (Blue) color intensities for 9 sample points.

$$R = \frac{210 + 212 + 214 + 211 + 221 + 215 + 213 + 215 + 217}{9} = \frac{1920}{9} = 213{,}33$$

$$G = \frac{212 + 211 + 212 + 213 + 212 + 213 + 213 + 212 + 213}{9} = \frac{1917}{9} = 213$$

$$B = \frac{213 + 210 + 215 + 214 + 211 + 216 + 216 + 213 + 218}{9} = \frac{1926}{9} = 214$$

the next step is to convert the RGB value into an HSI value. The HSI color space model is a system that resembles the way the human eye works. This system combines colors or grayscale elements contained in the image. HSI color space has three main components namely Hue (H), which includes basic colors such as red, blue, yellow, and mixtures of these colors. Saturation (S), indicates the brightness or density of the color in hue; and Intensity (I), describes the level of luminance in hue and saturation. The HSI color space is considered to be more natural and intuitive as it matches human visual perception. The transformation from RGB to HSI color space can be done through calculations using the following formula:

1. HSI Conversion Process of Chicken meat sample image

$$\theta = cos^{-1}\left\{\frac{(R-G)+(R+B)}{2\sqrt{(R+G)^2+(R+B)(G+B)}}\right\}$$

$$\theta = \cos^{-1}\left\{\frac{(213{,}33-213)+(213{,}33+214)}{2\sqrt{(213{,}33+213)^2+(213{,}33+214)(213+214)}}\right\}$$

$$\theta = \cos^{-1}\{948121{,}2\}$$

$$\cos = 0{,}45$$

$$\theta = Arc\cos(0{,}45) = 62{,}35$$

Calculate *Hue*,

$$H = \begin{cases} \theta & If\ B \leq G \\ 360-\theta & If\ B > G \end{cases}$$

Because the value of $B > G$, so $H = 360 - 62{,}35 = 297{,}65$

Calculate *Saturation*

$$S = 1 - \frac{3}{(R+G+B)}[\min(R,G,B)]$$

$$S = 1 - \frac{3[213]}{(213{,}33+213+214)}$$

$$S = 0{,}002$$

Calculate *Intensity*

$$I = \frac{(R+G+B)}{3} = \frac{213{,}33+213+214}{3} = 213{,}44$$

The training process is done manually using samples of fresh, not fresh, and rotten chicken meat images with a resolution of 3x3 pixels. Furthermore, each HSI value of the image is stored into a dataset. This dataset includes the HSI values for each category, namely fresh, not fresh, and rotten chicken meat, as shown in the following table:

TABLE 2. HSI Value of Chicken Meat Image Sample

Name of Image	Characteristics	Value
Daging Ayam Segar	H	297,65
	S	0,002
	I	213.44

B. Data processing with SVM

To classify chicken meat images using the SVM algorithm, the author first extracts chicken meat images using the HIS method discussed above. To extract all chicken meat image data on each class label, the author uses MATLAB software. The following are the results of extracting meat images using the HIS method:

Description:

X1 : Average value Hue

X2 : Average value Saturation

X3 : Average value Intensity

Y : Class Labels

TABLE 3. Average Value of Chicken Meat Image Extraction Using HIS

Name of Image	X_1	X_2	X_3	Y
IMG_1312.jpeg	0,09493	0,05393	0,65905	Ayam Segar
IMG_1313.jpeg	0,09447	0,06005	0,06005	Ayam Segar
IMG_1314.jpeg	0,09837	0,06148	0,70101	Ayam Segar
IMG_1315.jpeg	0,09554	0,06192	0,66177	Ayam Segar
IMG_1316.jpeg	0,09568	0,06121	0,65224	Ayam Segar
IMG_1317.jpeg	0,07063	0,05971	0,69352	Ayam Segar
IMG_1318.jpeg	0,09277	0,05913	0,68398	Ayam Segar
IMG_1319.jpeg	0,09617	0,05931	0,67361	Ayam Segar
IMG_1320.jpeg	0,10797	0,08860	0,64340	Ayam Segar
IMG_1321.jpeg	0,09522	0,10654	0,62313	Ayam Segar
IMG_1322.jpeg	0,13251	0,10543	0,64608	Ayam Segar
IMG_1323.jpeg	0,10052	0,11194	0,60538	Ayam Segar
IMG_1324.jpeg	0,12540	0,09120	0,63722	Ayam Segar
IMG_1325.jpeg	0,08495	0,10736	0,61810	Ayam Segar
IMG_1375.jpeg	0,18174	0,07375	0,61975	Ayam Tidak Segar
IMG_1376.jpeg	0,18319	0,07076	0,60225	Ayam Tidak Segar
IMG_1377.jpeg	0,21446	0,07040	0,68121	Ayam Tidak Segar
IMG_1378.jpeg	0,14334	0,07411	0,66761	Ayam Tidak Segar
IMG_1379.jpeg	0,10375	0,06719	0,66178	Ayam Tidak Segar
IMG_1380.jpeg	0,20244	0,06729	0,6655	Ayam Tidak Segar
IMG_1437.jpeg	0,16013	0,13539	0,62868	Ayam Busuk
IMG_1438.jpeg	0,17158	0,11977	0,62729	Ayam Busuk
IMG_1439.jpeg	0,14527	0,13430	0,65193	Ayam Busuk
IMG_1440.jpeg	0,19326	0,10661	0,68487	Ayam Busuk
IMG_144	0,15972	0,13177	0,63202	Ayam

1.jpeg				Busuk
IMG_1445.jpeg	0,16797	0,11766	0,65845	Ayam Busuk
IMG_1446.jpeg	0,15386	0,13656	0,64370	Ayam Busuk
IMG_1447.jpeg	0,15918	0,12167	0,62745	Ayam Busuk
IMG_1448.jpeg	0,19312	0,14234	0,60313	Ayam Busuk
IMG_1449.jpeg	0,17191	0,12983	0,61837	Ayam Busuk
IMG_1450.jpeg	0,19547	0,13540	0,63872	Ayam Busuk
IMG_1451.jpeg	0,18945	0,12872	0,63308	Ayam Busuk
IMG_1452.jpeg	0,22849	0,13736	0,63874	Ayam Busuk
IMG_1453.jpeg	0,18678	0,13230	0,61167	Ayam Busuk
IMG_1454.jpeg	0,25539	0,13192	0,64500	Ayam Busuk

Table 3 shows the results of HSI value extraction from chicken meat images consisting of three class labels, namely *ayam segar*, *ayam tidak segar*, and *ayam busuk*.

C. SVM Training

In the SVM training process, nine samples data will be taken from 450 total data.

TABLE 4. Chicken Meat Image Data Used

Name of Image	X_1	X_2	X_3	Y
IMG_1312.jpeg	0,09493	0,05393	0,65905	Ayam Segar
IMG_1313.jpeg	0,09447	0,06005	0,06005	Ayam Segar
IMG_1314.jpeg	0,09837	0,06148	0,70101	Ayam Segar
IMG_1375.jpeg	0,18174	0,07375	0,61975	Ayam Tidak Segar
IMG_1376.jpeg	0,18319	0,07076	0,60225	Ayam Tidak Segar
IMG_1377.jpeg	0,21446	0,07040	0,68121	Ayam Tidak Segar
IMG_1437.jpeg	0,16013	0,13539	0,62868	Ayam Busuk
IMG_1438.jpeg	0,17158	0,11977	0,62729	Ayam Busuk
IMG_1439.jpeg	0,14527	0,13430	0,65193	Ayam Busuk

From Table 4, six data will be used as training data and three data as testing data, which will represent each class label, namely *ayam segar, ayam tidak segar,* and *ayam busuk.* The training data can be seen in Table 5.

TABLE 5. Training Data Sample

Name of Image	X_1	X_2	X_3	Y
IMG_1312.jpeg	0,09493	0,05393	0,65905	Ayam Segar
IMG_1313.jpeg	0,09447	0,06005	0,06005	Ayam Segar
IMG_1375.jpeg	0,18174	0,07375	0,61975	Ayam Tidak Segar
IMG_1376.jpeg	0,18319	0,07076	0,60225	Ayam Tidak Segar
IMG_1437.jpeg	0,16013	0,13539	0,62868	Ayam Busuk
IMG_1438.jpeg	0,17158	0,11977	0,62729	Ayam Busuk

In the SVM training process in this study, there are three levels of data, each representing a different class with a certain amount of training data At each level, the class being processed will be labeled with the number 1, indicating that it is a positive class. On the other hand, the class that will be processed at the next level will be labeled as -1, indicating that it is a negative class. A more detailed explanation of the training data for each level will be provided in the next section.

1) Training data level 1
   In level 1 SVM calculation, the processed data is data from class 1, which is fresh chicken. The processed data will be assigned a system class value = 1, which indicates a positive class, while data that does not belong to the fresh chicken class will be assigned a system class value = -1.
2) Training data level 2
   In the level 2 data training process, data from the fresh chicken class will no longer be processed. Therefore, in level 2 training data, the positive system class (1) will be assigned to non-fresh chicken.
3) Training data level 3
   In level 3 training data, the class with a medium stress level is removed, and the positive system class (1) is then assigned to the high stress level.
4) Training Data Kernel Calculation Process
   The kernel applied in this study is a polynomial kernel.The calculation of this polynomial kernel involves the use of a polynomial of degree 2, which means the value of p or power = 2. To provide an example of calculation, the formula will be used
   $K(u,v)=(1+u,v)^d \quad ,d \geq 1$.
5) Calculation Process of Testing Data using SVM

The testing data used is data that is not included in the training data that has been processed previously in the SVM training process. Test data that is not included in the training data is tested using the trained model. The prediction value is based on the highest confidence value in the polynomial kernel. The prediction accuracy of the fresh category is quite high, but some errors occur in the "Not Fresh" and "Rotten" categories. The model achieved good accuracy with some prediction errors in certain classes.

D. Designing

This system is designed using MATLAB with the aim of creating an interface that is easier for users to apply the system that has been created. The interface design that is made will also affect the specifications of the computer used, so that the appropriate hardware specifications are needed to run it properly. This interface is specifically designed to input images of chicken meat images that will be processed using the Support Vector Machine algorithm with Hue Saturation Intensity.

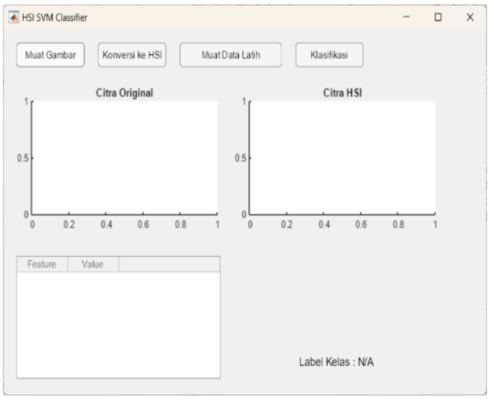

FIGURE 5. Chicken Meat Image Sample

The explanation of the GUI above with the following steps:

1) Load Image: Namely to input the RGB image or the original image of chicken meat that has been obtained previously.

2) Convert to HIS: After the RGB image input process, it is then converted into HSI format and the extraction of Hue, Saturation, and Intensity features is carried out on the converted image.

3) Load training data: This aims to input the training data that has been divided in preparation, namely there are 360 chicken meat images as training data in this study.

4) Classification: After the training data is input and the model is initialized, in this process the image that has been converted to HSI format and has been extracted features will be classified into 3 types of class labels, *ayam segar*, *ayam tidak segar*, and *ayam busuk* using the SVM algorithm that uses a polynomial kernel.

After the data analysis process and design design stages have been carried out, it is certain that the next stage is system testing. System testing starts from the interface implementation stage, test implementation. The interface design that has been carried out will begin to be practiced in making this system. The implementation of this interface can be seen in the next stage below.

E. App Home Page

The figure below shows the application interface for predicting orchid flower images. There is one image input button for processing with SVM. In addition, there is a classification prediction button and a classification prediction result output. The display of this application corresponds to the image seen below.

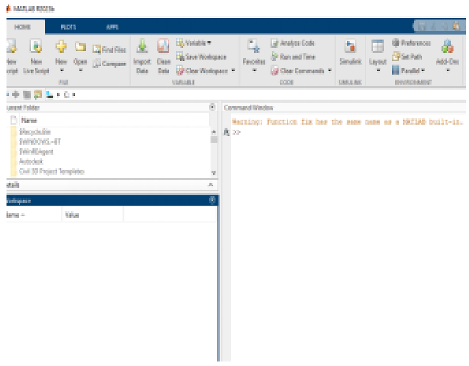

FIGURE 6. MATLAB App Home Page

Then open the source code to create a GUI display in the MATLAB software, can be seen below

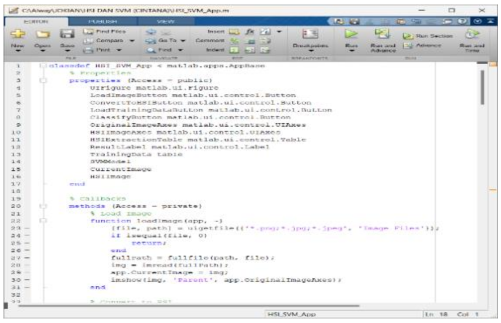

FIGURE 7. Home Page GUI Source Code

Then run the GUI source code above, the display will appear as in Figure 7. The author will try the GUI by using 1 sample of chicken meat image that is still in RGB format to be converted into HSI and classified so that it can be seen on which label the chicken meat image is.

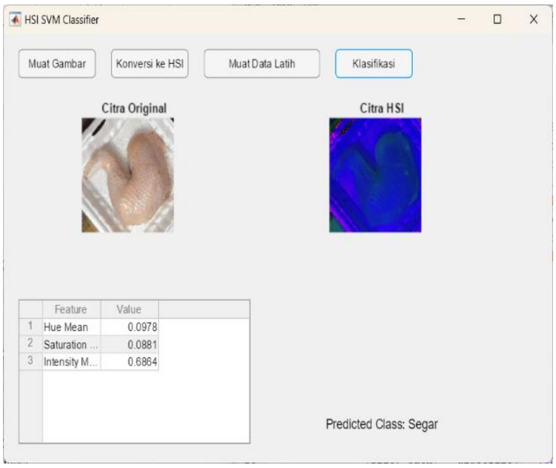

FIGURE 8. GUI Usage

It can be seen that the predicted class in the GUI image above states that the sample image is labeled with the Fresh class with Hue extraction features 0.0978, Saturation 0.0881, and Intensity 0.6864.

F. Designing Display of Support Vector Machine Classification Results

SVM classification for all test data will be done using MATLAB software as well. The kernel that will be used is the non-linear polynomial kernel. The accuracy calculation of the classification results on the confusion matrix is shown as follows:

Confusion Matrix:

	Busuk	Segar	Tidak_Segar
Busuk	24	2	4
Segar	12	12	6
Tidak_Segar	0	7	23

FIGURE 9. Confusion Matrix with polynomial kernel

Figure 9 displays the confusion matrix used to evaluate the classification accuracy of the developed system. It highlights the distribution of correctly and incorrectly classified samples across the three categories of chicken meat freshness. This analysis, discussed in the results section, reveals an overall accuracy of 65.56%, emphasizing the effectiveness and limitations of the approach.

Based on the calculation of the confusion matrix in Figure 9, there are 24 rotten classes that are actually predicted as rotten, there are 2 samples that are actually fresh but predicted as rotten, and there are 4 samples that are actually not fresh but predicted as rotten. There are 12 samples that are actually rotten but predicted as fresh, the model predicts 12 samples that are actually fresh as fresh, and there are 6 samples that are actually not fresh but predicted as fresh. There are no samples that are actually rotten but predicted as not fresh, there are 7 samples that are actually fresh but predicted as not fresh, and the model predicts 23 samples that are actually not fresh as not fresh. So that the accuracy calculation is obtained as follows:

$$accuracy = \frac{\text{the number of correct predictions}}{\text{the total number of samples}}$$

$$= \frac{24 + 12 + 23}{22 + 12 + 6 + 2 + 7 + 4 + 23} \times 100\%$$
$$= 65{,}56\%$$

The results of this study, achieving a classification accuracy of 65.56%, are comparable to those of prior research in similar domains. For instance, the study by (Bimantoro, 2021) on squid freshness classification using SVM attained an accuracy of 67.75%. Meanwhile, (Avianto, 2023) reported a higher accuracy of 71.6% for chicken meat freshness recognition using RGB color moments and SVM. In comparison, the use of HSI color features in this study provides a unique perspective by focusing on human-like color perception. Although the accuracy is slightly lower than the highest reported, the approach demonstrates potential for improvement, particularly by refining preprocessing techniques and expanding the dataset size. This differentiation underscores the novelty and applicability of HSI in food quality assessment.

IV. CONCLUSION

This study successfully demonstrated the application of the Support Vector Machine (SVM) method for classifying chicken meat freshness levels using HSI color features by converting RGB images to HSI and employing a polynomial kernel, achieving an accuracy of 65.56%. The method effectively categorized chicken meat into fresh, not fresh, and rotten classes, fulfilling the research objective of creating an automated, efficient, and objective system for freshness classification. Despite certain limitations, such as slightly lower accuracy compared to some previous methods, the approach shows potential for further refinement. Enhancements to improve the system's accuracy and robustness include increasing dataset size and diversity through data augmentation techniques like rotation, scaling, and flipping, incorporating additional features such as texture and edge detection, and exploring advanced machine learning models like Convolutional Neural Networks (CNNs) or hybrid models combining CNNs with SVM to leverage their strengths. Optimizing preprocessing techniques by standardizing image capture conditions, implementing cross-validation to minimize overfitting, and tuning hyperparameters like kernel type and degree could also enhance performance. Moreover, integrating additional sensors, such as smell or temperature, could complement visual data and further improve classification accuracy. By adopting these strategies, the system can achieve higher accuracy, addressing its current limitations and paving the way for broader adoption in real-world food quality monitoring and safety applications.

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