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Image Processing Detecting Chili Fruit Based on Maturity Level Using Backpropagation Method

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Abstract

Red chili is one type of vegetable that has a high economic value. Chili is usually used in the form of fresh or dried or cooked, for ingredients for kitchen spices, medicinal ingredients, the needs of the food industry, and home industries. . However, it is common for farmers to harvest red chilies that are not yet ripe or even ripe, such as reddish-brown, red-black (rotten). This can lead to a lack of maturity level of red chili and the quality of the red chili. From the input pattern/image of chili as training data and training targets, it is possible to identify the ripeness of chilies using the backpropagation method. Based on the image data of chilies, it can recognize the pattern of chilies that have a maturity level that is in accordance with the digital image by using the backpropagation method and using the MATLAB application, with an accuracy level of training and testing data that is 97,78%.

Keywords: Identification, Red Chili, Backpropagation

INTRODUCTION

Red chili is one type of vegetable that has a high economic value. Chili is usually used in the form of fresh or dried or cooked, for ingredients for kitchen spices, medicinal ingredients, the needs of the food industry, and home industries. Chili contains a variety of compounds that are useful for health, including antioxidants that function to protect the body from free radical attacks. Chili is one of the vegetable commodities that are widely cultivated by farmers in Indonesia because it has a fairly high selling price.

To produce chilies that have good quality, farmers usually harvest chilies by looking at the ripeness of the red chilies based on color, namely red. . This can lead to a lack of maturity level of red chili and the quality of the red chili. In addition to the quality, errors in harvesting chili can also cause losses to farmers, for example, tree damage and fruit rot can occur.

RESEARCH METHODS

This research method uses the scientific method to solve a problem in research, of course the researcher must have a method or method that is applied in solving the problem so that the research carried out can be resolved properly and in accordance with the expected results. The research method is carried out to find something systematically using scientific methods and applicable sources.

The results of the conceptualization will be poured into a complete research method with a literature study pattern, collecting data needed to analyze the detection system that will be made, namely to detect chilies based on the level of maturity using the Backpropagation method.

In detecting a data, of course, previous data is needed which will be a support for analyzing the calculation of a method so that later the best alternative can be obtained based on the data that has

been determined. In the chili detection system based on the level of maturity. The data used are image data of unripe, green and ripe chilies.

The data used in the detection analysis process using the Backpropagation method is the image data of unripe, green and ripe chilies. Then the data is extracted features to be used as transfer data. The feature ecstasy process is carried out by finding the RGB (Red Green Blue) mean, entropy and variance values. The process of extracting the chili fruit image was obtained using Matlab software. Target data is data specified by the user to achieve the desired target. The following is the target data for detecting chili based on the level of maturity as shown in the table below.

Table.1 Training Data and Target Image of Red Chili Fruit

No	Red	Green	Blue	Mean	Entropy	Varians
1	0,775079	0,786734	0,793962	199,9258	6,621412	1496,674
2	0,795858	0,808941	0,814551	205,4764	6,811749	1962,219
3	0,848553	0,863960	0,866841	219,2483	6,233171	2148,548
4	0,866697	0,876867	0,878134	222,8704	5,850931	2158,262
5	0,855387	0,868058	0,868206	220,4090	6,063296	2123,738
6	0,805544	0,820855	0,824389	208,2712	6,732955	2470,835
7	0,666630	0,675963	0,687987	171,9849	6,417320	1863,743
8	0,796184	0,811362	0,818642	206,0117	6,734390	2025,429
9	0,766778	0,784193	0,786984	198,7436	6,740593	2433,925
10	0,739043	0,750079	0,755948	190,6283	6,419566	1707,305
11	0,788842	0,804468	0,814494	204,2766	6,672336	2072,943
12	0,738044	0,748926	0,754720	190,2687	6,841186	1898,394
13	0,787512	0,803618	0,812367	203,9984	6,362457	1392,049
14	0,869543	0,882611	0,884599	224,1768	5,781607	1927,407
15	0,788446	0,807290	0,812541	204,6039	6,707149	2282,305
16	0,764964	0,778762	0,786664	197,8319	6,673727	2007,201
17	0,843549	0,859684	0,859422	218,0114	6,025277	2840,633

18	0,778055	0,790396	0,801308	200,9637	6,569932	1635,110
19	0,778083	0,795042	0,799903	201,6456	6,666101	2051,563
20	0,817081	0,829480	0,840683	210,9530	6,495571	1548,565
21	0,714352	0,726985	0,724668	184,3327	6,404608	1573,490
22	0,745767	0,757853	0,763872	192,5716	6,247823	1461,924
23	0,855403	0,866701	0,870266	220,2598	5,982590	1997,051
24	0,654265	0,663265	0,660981	168,3316	6,514612	1811,874
25	0,852813	0,865398	0,867146	219,7900	6,024050	2320,609
26	0,799332	0,807300	0,825772	205,7676	6,762974	1827,062
27	0,726893	0,740891	0,740889	187,8701	6,504694	1675,441
28	0,799302	0,813412	0,823610	206,6416	6,712336	1907,380
29	0,780069	0,792683	0,796813	201,3025	6,692921	1907,053
30	0,806360	0,819702	0,829596	208,3013	6,723324	1956,224

Table.2 Training Data and Image Targets for Immature Chili Fruit

No	Red	Green	Blue	Mean	Entropy	Varians
1	0,659882	0,662673	0,709473	170,2033	5,863707	1055,728
2	0,774851	0,774531	0,846214	199,6448	6,389264	2061,470
3	0,706758	0,706590	0,810205	183,2323	6,098033	1579,936
4	0,722027	0,718003	0,823935	186,4691	6,016422	1417,889
5	0,679620	0,683503	0,780696	176,8977	6,072279	1457,158
6	0,717463	0,708654	0,791756	183,7831	6,008700	1422,846
7	0,642305	0,639769	0,726128	165,7871	5,853216	1099,981

8	0,711802	0,707258	0,811926	183,7877	6,137206	1669,026
9	0,715030	0,711192	0,815166	184,6742	6,111847	1802,508
10	0,653611	0,660326	0,745068	170,3226	5,945574	1475,066
11	0,702945	0,701911	0,791645	181,6553	5,899690	1244,111
12	0,719546	0,726077	0,822557	187,4506	6,295663	1678,850
13	0,773534	0,774557	0,835260	199,2427	6,446351	2073,565
14	0,709677	0,702294	0,779723	181,9084	6,067736	1578,869
15	0,708687	0,713826	0,763686	183,0928	6,212207	1818,652
16	0,713118	0,716861	0,768076	184,0192	6,185863	1554,425
17	0,734706	0,734065	0,798530	189,1301	6,017000	1404,767
18	0,785613	0,781010	0,844598	201,3928	6,190524	1492,537
19	0,715937	0,706661	0,761291	182,5108	6,304054	1880,157
20	0,763898	0,753761	0,843712	195,5940	6,336887	1794,933
21	0,631493	0,630532	0,679329	162,2779	6,171263	1774,595
22	0,638505	0,635983	0,710280	164,5688	6,051436	1702,746
23	0,767653	0,777695	0,841425	199,4536	6,320598	1666,752
24	0,716561	0,720776	0,781328	185,2878	6,484073	1619,470
25	0,681064	0,683595	0,777341	176,8723	6,115835	1681,953
26	0,633951	0,636092	0,727029	164,7138	5,980294	1747,172
27	0,745948	0,748950	0,863635	194,1153	6,214703	2032,708
28	0,653681	0,656742	0,750625	169,9870	5,797771	1101,364
29	0,725849	0,726130	0,832896	188,2346	5,875505	1208,334
30	0,677135	0,677688	0,748307	174,8613	6,079088	1691,726

Table.3 Training Data and Target Image of Green Chili Fruit

No	Red	Green	Blue	Mean	Entropy	Varians
1	0,659882	0,662673	0,709473	170,2033	5,863707	1055,728
2	0,774851	0,774531	0,846214	199,6448	6,389264	2061,470
3	0,706758	0,706590	0,810205	183,2323	6,098033	1579,936
4	0,722027	0,718003	0,823935	186,4691	6,016422	1417,889
5	0,679620	0,683503	0,780696	176,8977	6,072279	1457,158
6	0,717463	0,708654	0,791756	183,7831	6,008700	1422,846
7	0,642305	0,639769	0,726128	165,7871	5,853216	1099,981
8	0,711802	0,707258	0,811926	183,7877	6,137206	1669,026
9	0,715030	0,711192	0,815166	184,6742	6,111847	1802,508
10	0,653611	0,660326	0,745068	170,3226	5,945574	1475,066
11	0,702945	0,701911	0,791645	181,6553	5,899690	1244,111
12	0,719546	0,726077	0,822557	187,4506	6,295663	1678,850
13	0,773534	0,774557	0,835260	199,2427	6,446351	2073,565
14	0,709677	0,702294	0,779723	181,9084	6,067736	1578,869
15	0,708687	0,713826	0,763686	183,0928	6,212207	1818,652
16	0,713118	0,716861	0,768076	184,0192	6,185863	1554,425
17	0,734706	0,734065	0,798530	189,1301	6,017000	1404,767
18	0,785613	0,781010	0,844598	201,3928	6,190524	1492,537
19	0,715937	0,706661	0,761291	182,5108	6,304054	1880,157
20	0,763898	0,753761	0,843712	195,5940	6,336887	1794,933
21	0,631493	0,630532	0,679329	162,2779	6,171263	1774,595

22	0,638505	0,635983	0,710280	164,5688	6,051436	1702,746
23	0,767653	0,777695	0,841425	199,4536	6,320598	1666,752
24	0,716561	0,720776	0,781328	185,2878	6,484073	1619,470
25	0,681064	0,683595	0,777341	176,8723	6,115835	1681,953
26	0,633951	0,636092	0,727029	164,7138	5,980294	1747,172
27	0,745948	0,748950	0,863635	194,1153	6,214703	2032,708
28	0,653681	0,656742	0,750625	169,9870	5,797771	1101,364
29	0,725849	0,726130	0,832896	188,2346	5,875505	1208,334
30	0,677135	0,677688	0,748307	174,8613	6,079088	1691,726

Table.4 Target Data

No	Description	Target	
1	Unripe Chili	Immature	1
2	Green Chili	Green	2
3	Red Chili	Ripe	3

The process of manually calculating the Backpropagation method is done using the followin image.

Figure.1 Image Train

From the training image above, it is assumed that the image feature extraction value is as follows.

Table.5 Training Data and Training Target

Image	Training Data						Target
Training Image	0,5995	0,5730	0,5704	0,1700	0,6251	0,0258	1

Next is to determine the initial weight that connects the neurons in the input layer and the hidden layer (V11, V1-n, V21, V2-n) and the bias weights V01, and V0n are chosen randomly in the system, in manual calculations, in this analysis, made freely by the researcher. Similarly, the initial weights connecting the neurons in the hidden layer and output layer (W11, W12, ..., W1n) and the bias weight W01 were also randomly selected.
The following is a training calculation using the Backpropagation method.

Backpropagation.

Initialization is set as follows:

1. Learning rate (α) = 0.2

2. Target error = 0.01

3. MaximumEpoch = 10000

4. Target (T) = 1

The random initialization of weights is as follows:

$Y_1 = \frac{1}{1+e^{-y\_in_1}} = \frac{1}{1+e^{-0,886918186}} = 0,708254$

Cek *error*(literacy stops when *error*<0,01)

*Error*lapisan $Y_1 = 1 - 0,708254 = 0,2917462$

sum of squares *error* = $(0,2917462)^2 = 0,085115854$

For one iteration using the backpropagation method, the result is 0.708254 with the number of squares of error = 0.085115854, so the results achieved are not in accordance with the target. Because it has a difference of 0.2917462 so it must be done again until it converges or until the maximum epoch or square error < target error (0.01).
Repeat the iteration in the same way and update the input until the 42nd iteration and the target error (0.01) is reached as shown below.

Y1= 1/(1+e^(-〖y_in〗_1)) = 1/(1+e^- (1.80629257)) = 0.8589132

Check error(iteration stops if error<0.01)

Y1 layer error = 1 – 0.8589132 = 0.1410868

The sum of the squares of error = (0.14108688)2 = 0.019905

From the calculation example above, the results of the detection of chili fruit training images are 0.8589132 or equal to 1. With the provision that if the detection result is more than <0.5 then the result is 0, if the identification result is > 0.5 then the detection result is 1. Thus The results of the training image detection of chili fruit are immature.

Figure.2 Main course Citra

Ekstraksi		Target	Detection
Red	0,5995		
Green	0,5730		
Blue	0,5704		
Mean	0,17	1	1
Entropy	0,6251		
Varians	0,0258		

RESULTS AND DISCUSSION

A. Analysis And Design

A program list is a collection of several data structures or computer code. Furthermore, it can be structured into a kind of programming command that is used in compiling a command in building a software or application. In the discussion of the program list, we will discuss the source code of the chili ripeness detection system using the Backpropagation method. The system built using Matlab GUI and Microsoft Excel software as a database storage for the feature extraction process of chili fruit images. The list of programs for each menu of this system will be explained as follows.

1. Home Menu

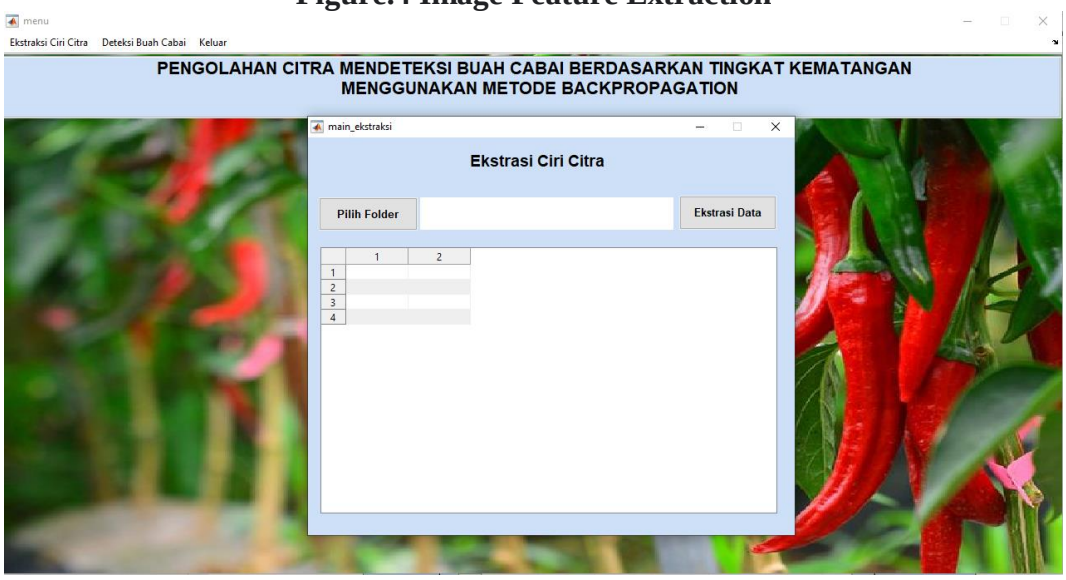
The main menu is the main display when the system is first run, the main menu has several menus such as image feature extraction, chili detection and exit. The home menu display is as shown in the image below

Figure.3 Main Menu

2. Image Feature Extraction

The feature extraction menu is used to extract the image features of chili peppers which will later be used for the training process. This image feature extraction uses image feature extraction of red, green, blue, mean, entropy, variants, skwenesss and kurtosis. To perform the extraction process, it is done by clicking the select folder button and then clicking the feature extraction button, wait until the process is complete, then the extraction results will be displayed in the table. The view of the feature extraction menu is as shown in the image below.

Figure.4 Image Feature Extraction



3. Detect Chili Fruit

The chili fruit detection menu is used to detect the maturity level of chilies. The process begins by inputting training data and training targets then do the training process by clicking the training data button, wait until the training data training process using the Backpropagation method is complete, then the accuracy results from the data training process that have been carried out will appear. To detect the maturity level of chili, it is done by clicking the select image button, after the image appears, the next process is segmentation, then select feature extraction. After the extraction process is complete, then the identification process by clicking the detection button will display the results of

detecting the level of ripeness of chili, ripe, immature or green. The detection menu display is as shown in the image below.

Figure.5 Detect Menu

B. Implementation

At this implementation stage, it will be explained about the results of system testing regarding the algorithm for digital image processing, namely the detection of the maturity level of chilies with the Backpropagation method. Tests are carried out to determine the extent to which the system's performance in processing and recognizing chili image data is so that it is able to produce the desired information or target, namely the detection of the maturity level of chilies.

The process of detecting the maturity level of chili is carried out in 2 stages, namely the stage of training the data to be trained and testing the data with a new image. The training data consists of 90 X 8 image data, while the target data used is 1 X 90 data. Then the data will be trained until the training process is complete.

The training data used is the result of image feature extraction with the following process.

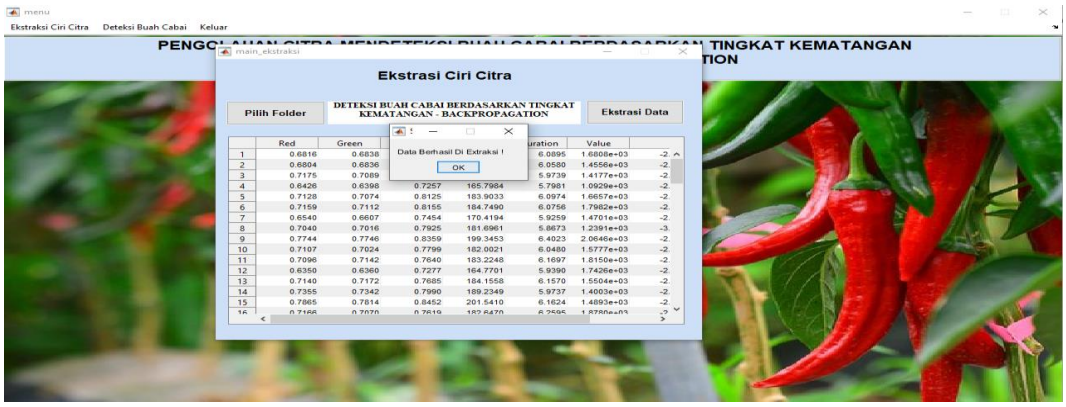
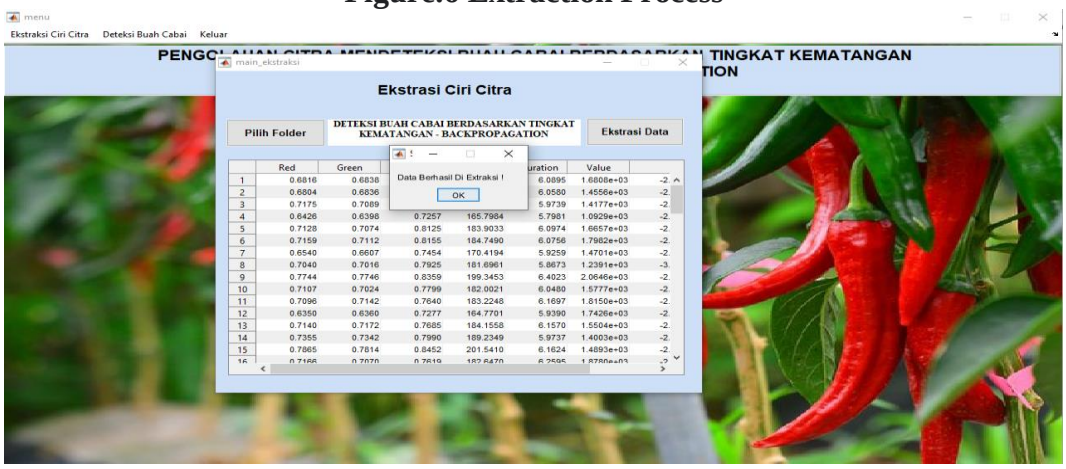


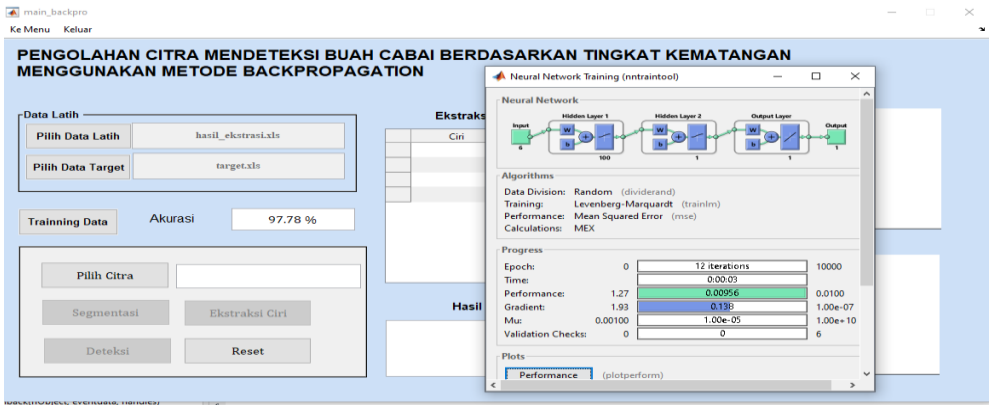
Figure.6 Extraction Process



From the results of the image feature extraction above, it can be seen that the data that will be used as training data and training target data are as shown in the table below.

Furthermore, the data above will be processed by training using the Backpropagation method. The data training process that will be carried out can be seen as shown in the image below.

Figure.7 Data Training Process



From the above process, the training data process is obtained with an epoch of 10000 target error or performance of 0.00956 with an accuracy value of 97.78%. The next step is to test new data on chili image data to detect the maturity level of unripe, green and red chilies.

To detect the level of ripeness of chili, it is done by:

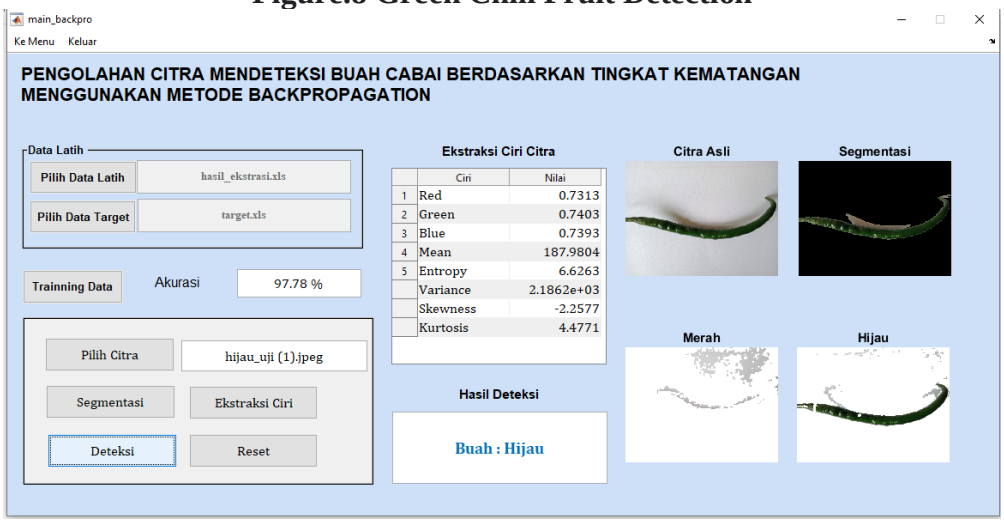
1. Select the image button
2. Select the Image Segmentation button
3. Select the Image feature extraction button, after the image feature extraction is carried out next.
4. Select the Detect button, to detect the maturity level of the chili.

The display of the process for detecting the maturity level of chili is as follows.

1. Detect Green Chili

Detection of green chilies is carried out to test the system whether the system can get the level of maturity based on the color of the ripeness level of chili. The process of detecting the maturity level of chili fruit can be seen as shown in the image below.

Figure.8 Green Chili Fruit Detection

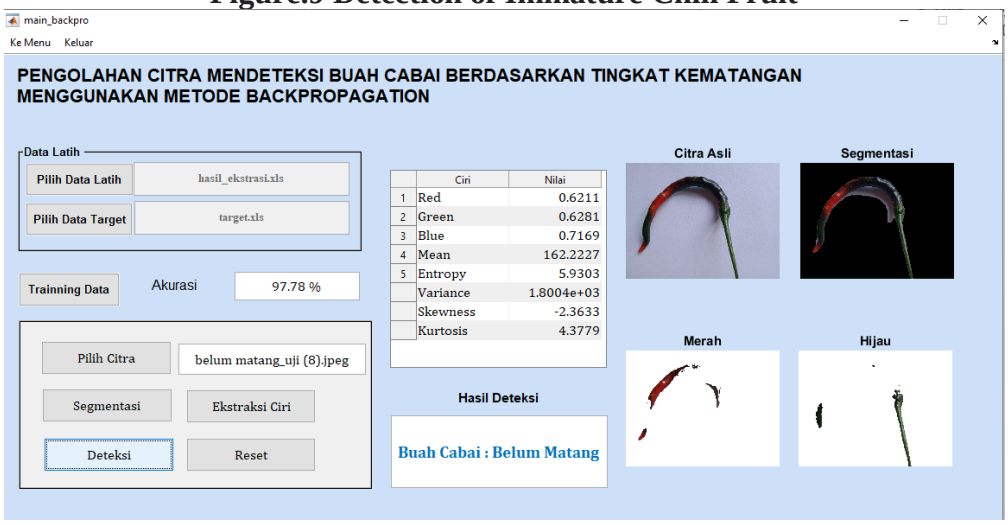


From the above process, the system detects the image that is inputted is the taste of green chilies in accordance with the input image, namely green chili.

2. Detection of Immature Chilies

The next step is to detect the maturity level of unripe chilies. The process of detecting the maturity level of unripe chilies can be seen as shown in the image below.

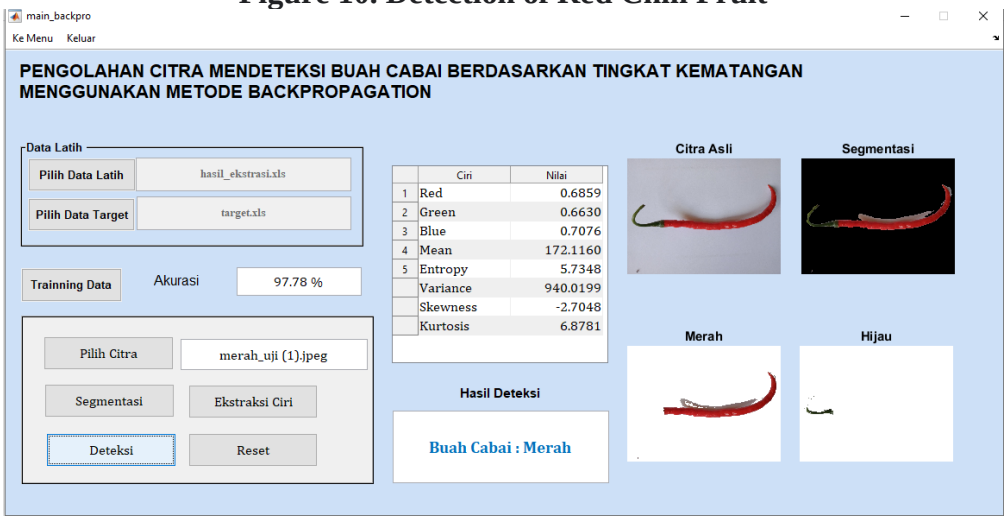
Figure.9 Detection of Immature Chili Fruit



3. Detect Red Chili

The next step is to detect the maturity level of red chilies. The process of detecting the level of maturity of red chilies can be seen as shown in the image below.

Figure 10. Detection of Red Chili Fruit



From the above process, the detected image data is the red chili fruit image data according to the input image, namely red chili.
From the test image process that has been carried out above, it can be concluded that the system can recognize and detect the maturity level of unripe, green and red chilies. With the value of the accuracy of the training process that is equal to 97.78%.

C. System and Program Trial

Testing can mean the process of checking whether the resulting software can be run according to certain standards. The standard that is used as a reference can be according to certain institutions or adapted to the needs of the user or user. Testing is done to get software with good quality.

Black box testing is a complementary approach to white box techniques, because black box testing is expected to reveal a wider class of errors. The testing of this system is as follows:

1. Main Page

The following are the results of tests carried out for the main menu.

Table 6. Main Page Test

Test Activity	Expected realization	Test result	Conclusion
Click the Image Feature Extraction Menu	The system displays the Image Feature Extraction page	System Runs as expected	Accepted
Click the Chili Fruit Detection Menu	The system displays the Chili Fruit Detection page	System Runs as expected	Accepted

Test Activity	**Expected realization**	**Test result**	**Conclusion**
Click Exit	The system will display a notification, are you sure you want to exit the system? if yes then the main page will be closed	System Runs as expected	Accepted

2. Image Feature Extraction Page

The following are the results of the tests carried out for the image feature extraction menu.

Table.7 Image Feature Extraction Page Test

Test Activity	Expected realization	Test result	Conclusion
Click the button Select a folder	The system displays a browse page for the image data folder to be input	System Runs as expected	Accepted

3. Chili Fruit Detection Page

The following are the results of the tests carried out for the chili fruit detection menu.

Table.8 Chili Fruit Detection Page Test

Test Activity	Expected realization	Test result	Conclusion
Click the Button Select Training Data	The system displays the training data file browse page	System Runs as expected	Accepted
Click the Select Target Data Button	The system displays the target data file browse page.	System Runs as expected	Accepted

Test Activity	**Expected realization**	**Test result**	**Conclusion**
Click the Button Select Training Data	The system performs the data training process and displays the accuracy results of the data training process.	System Runs as expected	Accepted
Click the Select Image Button	The system displays an image file browse page	System Runs as expected	Accepted

	that will be detected		
Click the Segmentation Button	The system will perform image color segmentation	System Runs as expected	Accepted
Click the Feature Extraction Button	The system displays the results of image feature extraction in the table	System Runs as expected	Accepted
Click the Detect Button	The system displays the results of detecting the level of ripeness of chilies	System Runs as expected	Accepted
Click the Reset Button	The system resets the data that has been inputted	System Runs as expected	Accepted

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CONCLUSION

From the results of research conducted, namely detecting the maturity level of chili fruit using the Backpropagation method. From the training and testing process that has been carried out, the following conclusions can be drawn.

1. The Backpropagation method can be applied to detect the maturity level of red, immature and green chilies using Matlab software.
2. The results of the image data training process are 90 inputted image data, the training results are 12 iterations with a maximum epoch of 10000, the target error or performance is 0.00956 with a training accuracy value of 97.78%. From the test image process that has been carried out, the system can recognize and detect the maturity level of chilies based on the input image of unripe, green and red chilies.

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