Optimizing Woven Curtain Fabric Defect Classification using Image Processing with Artificial Neural Network Method at PT Buana Intan Gemilang

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Abstract. The textile industry is one of the industries that provide high export value by occupying the third position in Indonesia. The process of inspection on traditional textile enterprises by relying on human vision that takes an average scanning time of 19.87 seconds. Each roll of cloth should be inspected twice to avoid missed defects. This inspection process causes the buildup at the inspection station. This study proposes the automation of inspection systems using the Artificial Neural Network (ANN). The input for ANN comes from GLCM extraction. The automation system on the defect inspection resulted in a detection time of 0.56 seconds. The degree of accuracy gained in classifying the three types of defects is 88.7%. Implementing an automated inspection system results in faster processing time.

1 Introduction

Textile industry is one of the industrial sectors that ranks third largest exporter of export value that can increase foreign exchange. In order to produce products that conform to standards and quality based on consumer demand, it takes inspection process on the fabric. Inspection process at the company at this time is still done manually using the human eye with the help of lighting in the form of lights. After calculating the processing time to the manual inspection process obtained the average scanning time of 19.7 seconds. In addition, the limitations of human vision and human error affect greatly in the process of manual inspection, such as the defects that are missed when the fabric is inspected. Based on the company's production data, the volume of production and inspection volume are not balanced, since the total fabric produced is not entirely inspected on time.

This has an impact on the unfulfilled consumer demand within the specified time. This research designs a proposal system in the form of an integrated automation system that aims to optimize the inspection process with the help of image processing. The purpose of this research is to be able to classify defects in fabric using artificial neural network method by substituting the function of human vision into digital image processing. The use of artificial

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neural network methods is done to reduce the inspection time and increase the accuracy level in classifying defects.

2 Basic Theory

Quality is an important factor affecting products and services. The higher the quality of a cloth the less the defects are in the fabric and vice versa. Improving quality is a major factor in achieving business success, growth and enhancing the competitiveness of enterprises [1-7]. To determine the type of defects in the fabric based on Indonesian national standard (SNI) 08-0277-1989 consisting of 17 types of defects as contained in Table 1. The type of fabric defects observed generally found in textile companies based on SNI 08-0277-1989 data can be seen in Table 2.

Table 1. Types of defects on fabrics based on SNI 08-0277-1989

	Defect Type	Defect Definition
1	Nep	Nep
2	Sub	Yarn twisted, slab broken yarn, dirt plaster, knot yarn
3	Uneven yarn	Large yarn, small yarn
4	Broken yarn	Broken warp, broken feed
5	Tight yarn/saggy	Wrinkled woven fabric, arches
6	Line fold	Folded fabric
7	Warp line	Different yarn structure, comb lines, double weld, usi rapat, dense meetings, rare warp, different types of fibers, large yarns, small yarns.
8	Feed line	Double feed, stop mark, feed meetings, rare feed, large yarns, small yarn.
9	Incorrect pattern	Pattern defects, incorrect stamped shapes, wrong webbing, stamped marks, wrong color coractenun
10	Bare	Different thread structures, different types of fibers, feed meetings, rare feed
11	Stripped	Unevenness of color, color difference
12	Tear	Hole, tear
13	Unfinished yarn	Skipped yarn
14	Stains	Rust stains, color stains
15	Wide defects	
16	Feed bias	Feed bias include the curved feed
17	Flaw defects	

Artificial Neural Network (ANN) is one of the branches of Artificial Intelligence. ANN is an information processing system that has characteristics resembling a biological neural network. Neural networks are inspired by human biology and consist of several processing units called nerves. ANN can be interpreted as information processing that implies the input vector data and the output vector data.

Table 2. Similarity of type of fabric defect based on SNI and observation result

No	Defect Similarity	
	SNI	Observation Result
1	Nep	Hairy Feed
2	Slab	Brittle Feed

3	Broken Yarn	Broken Warp
4	Tight Yarn	Tight Wrap
5	Warp Line	Comb Defects
6	Incorrect Pattern	Broken Card
7	Unfinished Yarn	Plotting

The most significant advantage of ANN is the mapping function of the results can be determined through the training vector, as ANN can perform the learning process from the provided training data. There are two types of Artificial Neural Network architecture commonly used, namely: Single-Layer Networks and Multilayer Networks. Single - layer networks are used to classify and work well when classes are linearly separated. During the training phase, the input and output pairs are used to train the network. Figure 1 shows the inputs ($x1, x2 \dots xn$) and output ($y1, y2, y3 \dots ym$). Using the input vector, the actual output is compared to the desired output, and the error between the actual output and the desired output is used to update the load.

Fig 1. Single-Layer Networks

To make more complex decisions, a multilayer perceptron model is required. The architecture of the multilayer network in Figure 2 shows three types of layers: the input layer, the hidden layer, and the output layer. Multilayer network can be trained by using back propagation learning algorithm. The actual output vector is compared with the desired output vector, if there is no change then no load is changed, in contrast if any then the weight is updated [8-11].

Fig. 2. Multilayer Networks

3 Methodology

To get the automated fabric defect classification using neural network some steps are needed. The step can be seen at Figure 3. First is capturing the defect image using camera, the camera that used in this research is webcam logitech C525. This research capture 30 data for each defect and 30 data for each normal fabric. After captured the fabric, then the captured image must be converted to grayscale image to make the defect classification process faster. Then the grayscale image is extracted using GLCM feature extraction as input for neural network. Next is train the network using the result of extraction feature. On this research the input is 12 factors of GLCM and the hidden layer that used is 20 hidden layer. The result then will be tested using the new data from defective fabric to make sure the system can detect the defect.

Fig. 3. Flowchart artificial neural network to obtain data

4 Results and Discussion

Extraction is done using Graphical User Interface (GUI) as Figure 5. The extraction results are used as ANN input. The amount of data used is as much as 120 data for training on ANN. The results of training data in the form of vectors, for defective spark plugs in the form of 1 0 0 0, defective feed 0 0 0 0, oil defects 0 0 0 1, and normal 0 0 1 0. The accuracy of ANN training can be seen in Figure 6. Accuracy ANN training is 95.8%, where in all confusion matrix there are five data that are in wrong class.

Fig.4. Accuracy of ANN training results

Furthermore, the results of the training will be the tested data as much as 80 data that is 20 defective warp, 20 defects of empty feed, 20 oil defects, and 20 normal. The result of classification test using ANN offline can be seen in Table 3. Accuracy is obtained by calculating using the following formula.

Accuracy = (Amount of data true) / (Total data count) x 100% (1)

Based on the offline classification results there are three incorrect data on warp defect and four incorrect data on empty feed defects. From the data, the accuracy of offline system to classified the defect on the fabric is 91%.

Table 3. Offline defect classification results

Input Type	Warp Defect	Empty Feed Defect	Normal	Oil Defect
Warp Defect	17	3	0	0
Empty Feed Defect	4	16	0	0
Normal	0	0	20	0
Oil Defect	0	0	0	20

After the inspection process, the processing time to classify three types of offline defects in the fabric can be seen in Table 4. The average processing time obtained to identify 80 types of defects is for 0.73 seconds.

Table 4. Offline classification time defects

Data Number	Process Time	Data Number	Process Time	Data Number	Process Time	Data Number	Process Time
1	0.770076	21	0.621023	41	0.535614	61	0.269596
2	0.592154	22	0.735082	42	0.524071	62	0.425395
3	0.571321	23	0.644239	43	0.528035	63	0.444889
4	0.646883	24	0.526157	44	0.572965	64	0.446793
5	0.576134	25	0.598328	45	0.641985	65	0.517335
6	0.541896	26	0.626834	46	0.620484	66	0.552104
7	0.626375	27	0.61664	47	0.642352	67	0.461299
8	0.570773	28	0.569393	48	0.630881	68	0.517712
9	0.286475	29	0.534994	49	0.600921	69	0.535475
10	0.334813	30	0.54379	50	0.637243	70	0.535781
11	0.530931	31	0.631401	51	0.581212	71	0.518743
12	0.299761	32	0.717383	52	0.653937	72	0.522677
13	0.575409	33	0.619605	53	0.587051	73	0.518001
14	0.340483	34	0.596116	54	0.638098	74	0.469349
15	0.516364	35	0.618333	55	0.582841	75	0.472082
16	0.651765	36	0.616771	56	0.566419	76	0.451548
17	0.609998	37	0.551801	57	0.631268	77	0.578512
18	0.743218	38	0.577327	58	0.652896	78	0.536244
19	0.653092	39	0.659496	59	0.546835	79	0.516837
20	13.4025	40	0.696695	60	0.553047	80	0.438055

Furthermore, the results of the real-time test will be tested data as much as 80 data that is 20 defective warp defect, 20 defects of empty feed, 20 oil defects, and 20 normal. The result of classification test using ANN offline can be seen in Table 5. Based on the result of real time classification there is one wrong data on the defect of breaks and eight wrong data on empty feed defect. Accuracy result obtained is equal to 88.75%.

Table 5. Results of real time defect classification

Input Type	Warp Defect	Empty Feed Defect	Normal	Oil Defect
Warp Defect	19	0	1	0
Empty Feed Defect	8	12	0	0
Normal	0	0	20	0
Oil Defect	0	0	0	20

After the inspection process, the process time to classify the three types of defects in real time on the fabric can be seen in Table 6. After testing of 80 data obtained average time classification process defects in real time for 0.56 seconds

Table 6. Timing of real time classification process defects

Data Number	Process Time	Data Number	Process Time	Data Number	Process Time	Data Number	Process Time
1	0.582776	21	7.4924	41	0.289456	61	0.304845
2	0.54779	22	0.736126	42	0.2976	62	0.295765
3	0.565936	23	0.632174	43	0.301907	63	0.279409
4	0.552999	24	0.633404	44	0.280222	64	0.293552
5	0.557814	25	0.54855	45	0.294041	65	0.270983
6	0.623224	26	0.635446	46	0.286486	66	0.289948
7	0.59373	27	0.694331	47	0.286644	67	0.282137
8	0.631674	28	0.647753	48	0.276272	68	0.276991
9	0.610841	29	2.96714	49	0.287542	69	0.309945
10	0.524721	30	0.620036	50	0.279349	70	0.270983
11	0.576364	31	0.657134	51	0.281802	71	0.281802
12	0.598072	32	0.697748	52	0.284347	72	0.284347
13	0.472274	33	0.7457	53	0.305232	73	0.305232
14	0.588562	34	0.559747	54	0.284995	74	0.291053
15	0.561275	35	0.517545	55	0.294033	75	0.301907
16	0.56842	36	0.521062	56	0.285294	76	0.280222
17	0.660343	37	0.623472	57	0.272616	77	0.294041
18	0.587955	38	0.68808	58	0.270013	78	0.286486
19	0.566684	39	0.519799	59	0.273119	79	0.293087
20	0.548564	40	0.51098	60	0.291053	80	0.275745

Results Recap data from MATLAB which is connected with excel software can be seen in Table 7. From the data recap, it can be known that the average data recap time for 80 data is 2.96. The recap time of the proposed data is faster than the time of recap of the existing data.

Table 7. Results of recapitulation of defect classification data

Data Number	Process Time	Data Number	Process Time	Data Number	Process Time	Data Number	Process Time
1	2.84671	21	2.78742	41	2.72373	61	3.08017
2	2.97526	22	2.82463	42	2.74481	62	3.16672
3	3.88056	23	3.07639	43	2.82579	63	3.1096
4	3.05133	24	2.89045	44	3.07321	64	2.7942
5	2.83511	25	2.93238	45	2.77318	65	3.05807
6	3.08693	26	2.80888	46	2.83453	66	3.05117
7	3.17767	27	2.99983	47	2.85975	67	3.20491
8	2.89033	28	2.81963	48	3.08696	68	3.0247
9	3.00807	29	2.96695	49	2.92583	69	2.93309
10	3.06618	30	2.97499	50	2.77245	70	2.74482
11	3.11074	31	2.84647	51	3.13556	71	3.06182

12	3.04461	32	2.90035	52	2.91712	72	2.96934
13	2.78062	33	3.21018	53	2.85838	73	3.0847

Table 7. Results of recapitulation of defect classification data (continued)

Data Number	Process Time	Data Number	Process Time	Data Number	Process Time	Data Number	Process Time
14	2.81724	34	2.80832	54	3.03216	74	3.06013
15	2.84362	35	2.72155	55	2.99249	75	3.13935
16	3.19836	36	3.08313	56	3.09187	76	3.02288
17	2.87577	37	2.79001	57	2.79276	77	2.75014
18	2.95698	38	3.05507	58	2.80411	78	2.89962
19	3.01999	39	2.83755	59	2.77501	79	2.74452
20	3.02631	40	2.89411	60	3.09436	80	2.92068

Based on the results of the research, the comparison of the existing manual process and the time of the proposed process can be seen in Table 8. In Table 8 it can be seen that scanning defects are faster than the existing process of 0.56 seconds, as well as the recap of the proposed defect faster than the existing process time is 2.96 seconds. The total process time of the proposed system is 3.5 seconds, 29.8 seconds faster than the existing system with a total processing time of 33.57 seconds.

Table 8. Comparison of total results of proposed and existing process time

No	Activity	Existing (second)	Automated (second)
1	Defect Scanning	19.87	0.56
2	Defect Recap	13.5	2.97
Total (second)		33.37	3.52

5 Conclusion

The manual inspection process has several drawbacks so that an automated inspection process that minimizes manual inspection is needed. One way to use is to use image processing to improve process accuracy and reduce the average time of the inspection process. In this research used artificial neural network method with GLCM extraction feature and processed by using MATLAB software. In the extraction feature used 12 parameters to get the best results on the process of classification of fabric defects. The proposed system is capable of generating an overall accuracy of 88.75% and an average processing time of 0.56 seconds. The proposed system is capable of producing faster processing time than the existing time. The timing of the proposal is 29.8 seconds faster, so the use of defect classification with ANN can be applied to speed up the inspection process time.

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