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Development of Plastics Defect Inspection System using Vision System

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Abstract

Recently, the production amount of automobile parts is gradually increasing as the market grows and plenty of parts are substituted by plastic products for efficient energy consumption.

Thus, systematic control of mass production and management on plastic products is inevitable. Plastic products for the car are manufactured by injection molding process because of the attributes of plastic materials.

During injection molding process, defective products can be broken out by internal or external environment change. Currently, most of inspections for the defective products are performed by visual inspection. The authors developed an automatic *inspection system that can detect the defects of plastic product using vision system.* The authors *also developed image processing algorithm in automatic inspection system to detect various type of defects and scratch.*

Keywords*: Vision System, Defect Inspection System, CCD camera, image processing algorithm, Pattern matching algorithm*

1. Introduction

Plastic parts for the car are produced by injection molding method, and the instability of the process can make defects. Therefore, defect detection system that can upgrade the productivity is so important especially in inspection system that can detect defects in real time under the environment of unstable conditions and diverse disturbance.

During the process of injection molding, if one product has a defect, then the defect rate is gradually increasing as time pass by. Thus to find out the reason for the defects , all of the injection molding processes should be analyzed and it is usually takes a long time to find out an accurate reason of defects.[1]-[4]

In this study, the authors implemented a Defect Inspection System that can detect defects in real time at the end of injection molding processes and especially implemented image processing algorithm to detect the defects under LabView2015 environment. In it , the authors set limits as 4 points which have high rates of defect and divided these locations into 2 parts that helps to inspect defects in real time after installing 2 CCD cameras exclusively working on USB3.0 environment.[5]-[7]

The authors analyzed the implemented result and tested all of the processes including image processing algorithm to verify adaptability in the industry fields and obtained a good result.

2. System Modeling

Figure 1 shows the specific location of 4 points that have high rates of defect on the plastic products

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Figure 1. The Four Areas of High Failure

Overall structure of Defect Inspection System is shown in Figure 2.

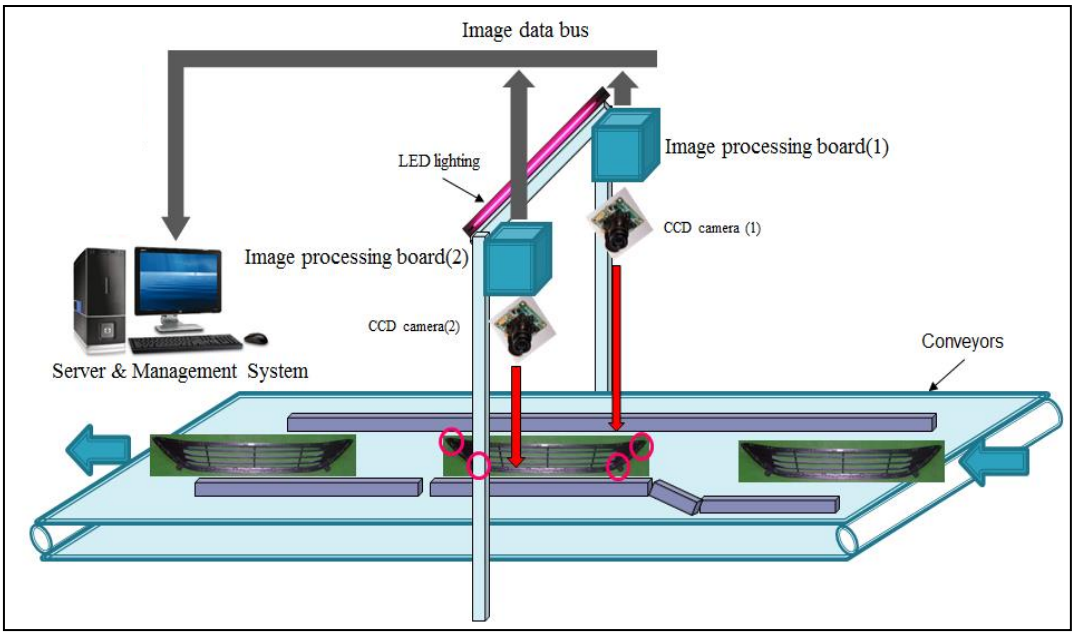


Figure 2. Overall System Structure

As shown in Figure 1 and 2, the plastic product transferred by the conveyor belt has 4 points. CCD(1) camera takes charge of upper 2 points, while CCD(2) assumes lower 2 parts for the inspection of defect. The authors designed an experimental jig to adjust the height and position of CCD cameras depending on the characteristic of product model.

The authors also include an LED lighting device in that inspection system to acquire qualified image.

Specifications of 2 CCD cameras are 1,296x966, 30fps. The vision system supports precise inspection using high-resolution lens.

Pattern matching algorithm is applied in image processing system for the defect detection based on LabView2015. This pattern matching algorithm can measure the degree of similarity as it store qualified reference template off-line and perform pattern matching with new image data.

As the similarity of pattern matching goes lower, the possibility of a defect in that product is going higher while conformity come true in case similarity goes higher .

3. Implementation Results and Analysis

The experimental jig that is made for this study is shown in Figure 3. There are two kinds of plastic products in the experiment. The authors obtained 2 non- defective products for the reference template.

The image processing system calculates the similarity between reference template and new input image and then judge whether the product has defects or not. *i.e.*, in case of less similarity, it has a possibility of more defects.

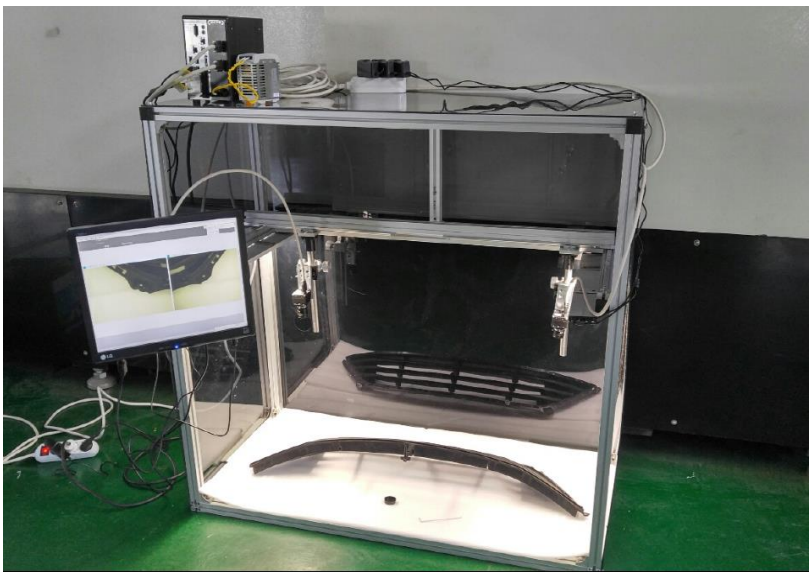


Figure 3. Configuration of Inspection System for the Unshaped Plastic Product

Figure 4 shows the structure of kinematics. CCD camera should be moved for the inspection of diverse plastic products. To move CCD camera freely, the authors designed a fixed pin to be affixed on the desired location as linear slider makes the location of CCD camera freely for the 3 axis of x,y,z.

Finally, the authors designed the angle of CCD camera to be adjusted by adding one degree of freedom.

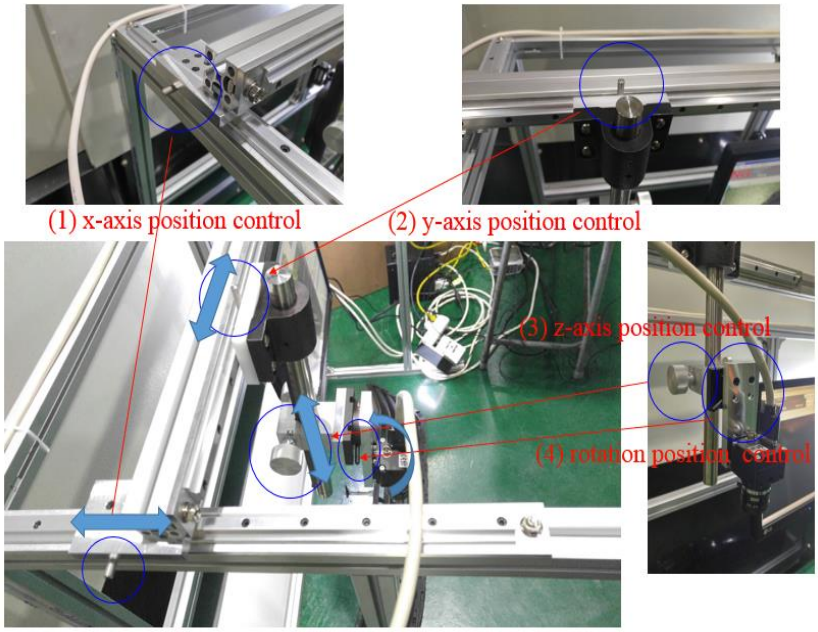


Figure 4. The Camera Angles and Position Settings Using CCD Camera Positioning Fixed Pins.

Figure 5 shows the scratched plastic part. The authors took picture this scratched image as the injection of LED light to test defect detection algorithm.

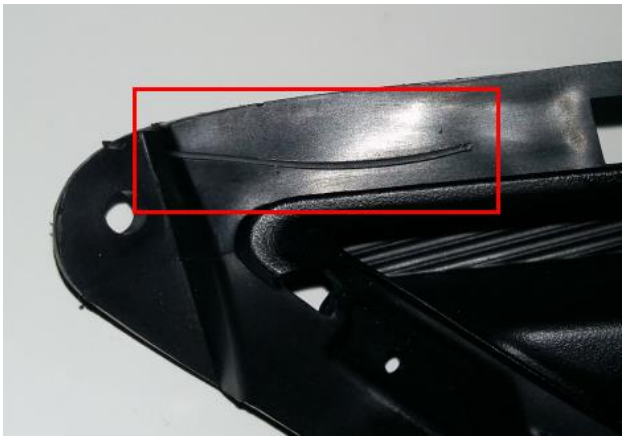


Figure 5. Test Images for Defect Detection Algorithm

We can see the scratch detection result by using LabView2015 tool in Figure 6.

That picture is the result of measured scratch which reflects the vertical image using " Find Straight Edge" function of LabView2015 tool. The authors tested detection ability of straight edge using " Find Straight Edge" in LabView function.

The authors selected the searching area from 1 of 4 area that has high rate of defect as shown in Figure 6. The authors set up the detection search condition as " Best Edge" and all of the edge attributes are included for the best detection.

With the test results, the authors found out that there is a flaw that exists on the line that pass the coordinate(539, 952)-(3019, 626). The slope of the line that pass

two different points is 7.40[Deg], and pixel length is 185.72, SNR(signal-to-noise ratio) is 6.04[dB] as we have seen in Figure 6.

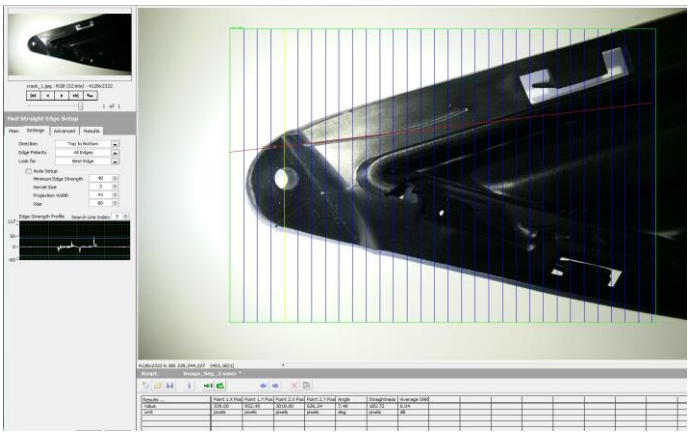
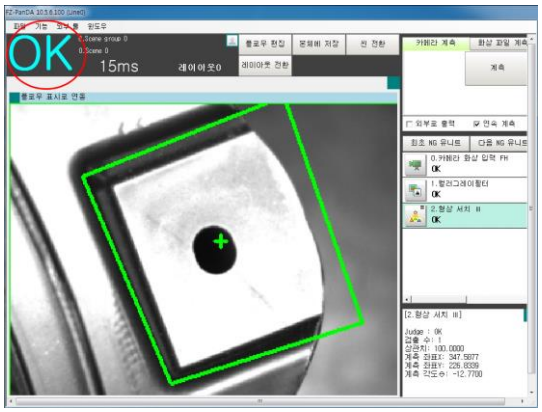


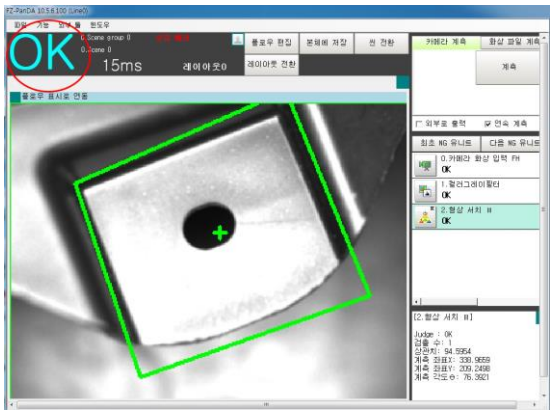
Figure 6. The Result of Scratches Recognition

The authors presented the test result of implemented image processing algorithm for the verification in Figure 7. If the degree of similarity is low in comparison of reference template, print out NG(not good), and print out OK when it belongs to within boundary of similarity.

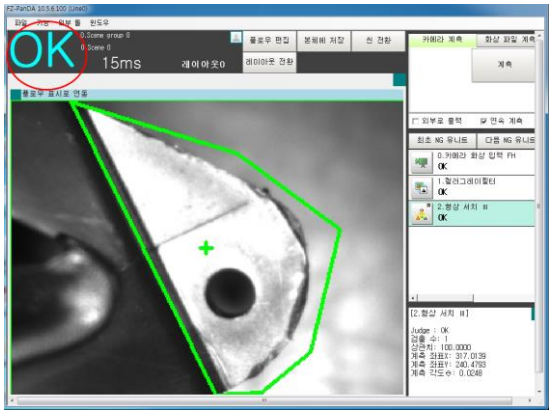
(a) Not good case



(b) Good case(1)



(c) Good case(2)



(d) Good case(3)

Figure 7. The Result of Image Processing Algorithm about Fault Detection in Good Case and Not Good Case

5. Conclusion

The authors suggested Defect Inspection System that can detect the defect of plastic parts for cars in real time with the vision system of 2 CCD cameras.

The authors found out that this image processing algorithm could recognize the defects of plastic by utilization of pattern matching algorithm. In addition to that, it could recognize even little scratch that might happen in the searching area as the injection of proper light.

We could find out the adaptability in industry fields thru several tests including hardware and software. However, it was difficult to find out typical rules from the flaws because the flaw sizes and patterns are so diverse. In the near future, the authors would like to develop a more generalized image processing system that can adapt to various type of plastic products, and it would include more intellectual inspection system.

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