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Development of Dross Height Measurement System By Using 3D Measurement Sensor

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Abstract. This paper presents a development of dross height measurement system to achieve even distribution of dross in a box in a robotic dross removal system. The current system uses a point light source to measure and needs an installment of sensor system on the end of the robots resulting an increase in the measurement time. To overcome this limitation, this work uses a 3D sensor with a surface light source to replace the current laser measurement module. Using the 3D sensor, the system measures dross height in the box and using 3D information and color images, it measures outer edges of the box. With this, a measurement algorithm for outer edges, divisions and average height of a dross box was developed.

Keywords; Dross Height Measurement, Dross Box Boundary Detection, Robotic Dross Removal System

1. Introduction

In this paper, our goal is to develop a measurement system to gauge a location to pour dross (thick metal oxide films or solid impurities floating on a molten metal) for a robot. This is required to pour dross evenly in a box for a dross removal and pouring

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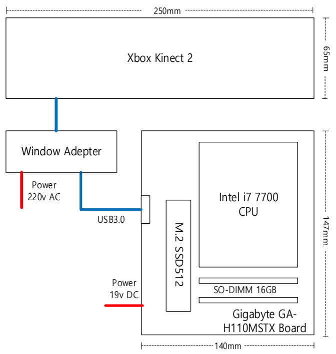
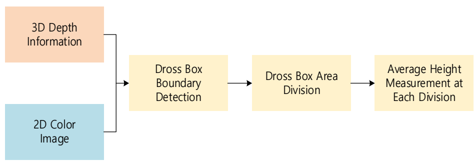
system. The current system uses scanning methods with a point light source laser. [1,2] Also, with a point light source laser scan, the laser source needs to be installed on the end of the robot for movement to obtain an average height for the entire outer surface of the box. Thus, the measurement time increases exponentially with the increase in the surface area and it has a drawback with regards to time consumption when changing the laser system. Therefore, in this paper, we apply a sensor system (Kinect) that enables 3-dimensional measurement system and color images at the same time. The goal is to develop an algorithm that measures boundary area of a dross box, divides a dross box into sections, and measures average dross height in each section.

2. Proposed Hardware Setup and Algorithm



(a) Proposed H/W setup



(b) Proposed algorithm for dross height measurement

Fig 1. HW and algorithm for a dross box height measurement

Fig. 1(a) shows a schematic illustration of the hardware required for the measurement system. We have chosen KINECT (2D image of 1920×1080 and Depth information with 512×424 in size), a system capable of acquiring 3-dimensional measurement and color images at the same time. Also, we had to use a small processor that could work in a harsh environment and a limited space, therefore, we used STX system(Intel i7 7700 CPU, 16GB RAM, m2 type ssd512).

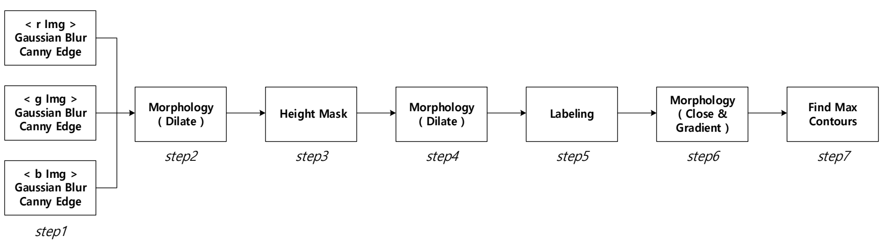


Fig 2. Algorithm for segmentation of a dross box edge boundary

Fig. 1(b) shows the algorithm to measure the average dross height. 1) Using 3-dimensional height and color information to obtain area of a dross box. 2) Dividing areas of a dross box in sections. 3) Measuring the average height of each divided section using three-dimensional information.

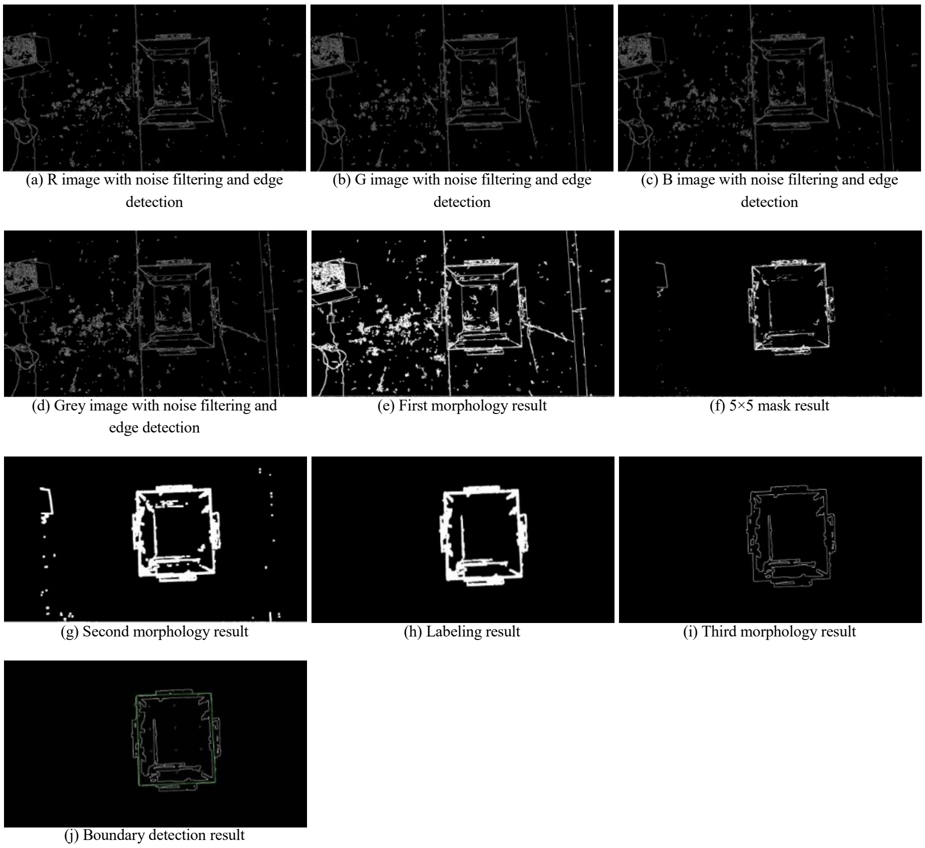
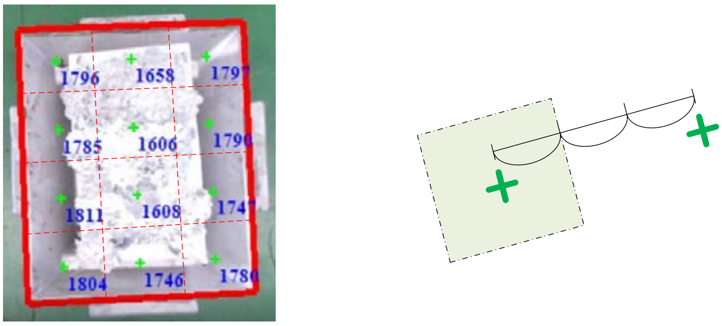


Fig 3. Results from an algorithm of extracting dross box area

Fig. 2 displays the main point of the algorithm that extracts the area of a dross box. Step 1) We performed Gaussian blurring of RGB video to remove noise followed by extraction of outer boundary using Canny Edge Detection as shown in Fig. 3(a), (b), and (c). Step 2) We performed expansion of pixels of summed up images using morphology Dilate. as shown in Fig. 3(e). Step 3) By using binary images after morphology and depth information, we masked 5×5 in height to remove any pixel that had trivial difference as shown in Fig. 3(f). Step 4) By repeated use of morphology Dilate, extracted lines are expanded as shown in Fig. 3(g). Step 5) By using binary images after morphology, we performed labeling. From the results of labeling, only the largest object is left and the rest is deleted as shown in Fig. 3(h). Step 6) By repeatedly using Close & Gradient from

Morphology, only the outer shell of an object is remained as shown in Fig. 3(i). Step 7) It finds the four corners of the largest rectangle in an object and draws line as shown in Fig. 3(j).



(a) A Dross in 12 sections

(b) Method of defining a divided area for average height measurement

Fig 4. Dividing sections of a dross box and measuring the average height

Fig. 4 illustrates an algorithm of extracting area of a dross box followed by dividing the box into sections. It divides the extracted edge areas into 12 sections. With respect to the four corners of the rectangle, it finds points that divide the short sides into 3 equal segments each and the long sides into 4 equal segments each. By connecting these points with a straight line, it divides area based on the points of intersection. As shown in Fig. 4(a), it finds centers of the divided areas. Then, it extracts the average height of a rectangle with a margin of one third the length between the center point and the closest neighboring center point

3. Experimental Results

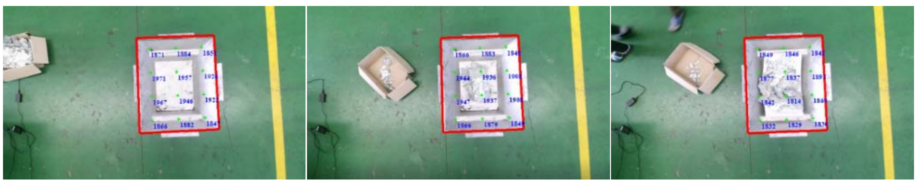


Fig 5. Experimental results using the developed system.

We performed experiments by stacking dross specimens with different height in the box as shown in Fig. 5. From all the results, it was shown that the boundary area was well extracted and measurement and algorithm processing time was approximately 1 sec. Fig. 6 shows the measured dross box in 3dimension.

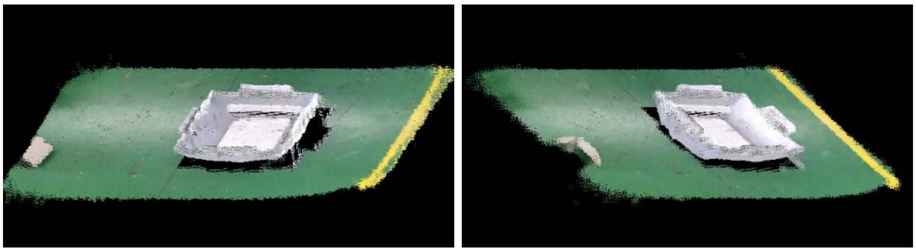


Fig 6. Measured 3D dross box image

4. Conclusions

In this paper, we developed a system that extracts the outer shell of a dross box and measures the average height of the inside. We suggested a HW system for measurement and developed a new measurement algorithm. As a result, speed improved with respect to the current system and measurements were performed with better flexibility to the external environment. However, there is a discrepancy in accuracy when the system was perpendicular to a recorded object or not. There were conditions where the edges of the box were reflected by external light causing light scattering and resulting in measurement difficulties. In the future, we look forward to perform further research to improve these drawbacks.

Acknowledgment

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