# NON-RIGID OBJECT SEGMENTATION BASED ON DISTANCE TRANSFORMATION

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**Abstract** - As the meat intake increases, the demand for broiler poultry also increases every year. Broilers used for cooking are shipped before they are fully grown, and there is small weights difference depending on the kind of dish. Thus the breeder must check from time to time whether poultry are grown to the target weight. However, frequent contact reduces the growth and quality of poultry, and pollutants in enclosed spaces adversely affect the health of the breeder. Therefore, it is necessary to measure the weight without directly contacting with poultry. However, it is difficult to know the average weight of the poultry because there is a problem to segment each object due to the nature of the poultry which is always massed. In this paper[1], we propose a non-rigid algorithm for segmenting gathered poultry. This algorithm detects the number of poultry by calculating the center of poultry through Mean-shift clustering, and it is expected to be used for poultry automation with accuracy of 91.17%.

**Index Terms** - Poultry automation, Object detection, Object segmentation, Mean-shift

## I. INTRODUCTION

As meat consumption increases in worldwide, the consumption of broiler poultry also has been increasing. In Korea, chickens and ducks are mainly consumed, and the consumption of chicken per capita is about 13.8Kg per person in a year, which means that the consumption of chicken is much higher. There are twelve species of broiler chickens consumed in Korea. The difference in weights between cultivars is 100g, and the difference in breeding period is small. Thus poultry farmers need to constantly observe whether their poultry are grown to the target weight. However, frequent contact reduces the growth and quality of poultry, and pollutants in enclosed spaces adversely affect the health of the breeder. Therefore, they need a system that minimizes contact with poultry and automates the poultry breeding environment so that the breeder does not enter the poultry facilities.

Although it is most effective to use a camera and a scale to measure the weight without contacting the poultry, it is difficult to measure the weight of poultry separately. Therefore, it is alternative to detect the number of poultry in a specific area and to recognize the weight and measure the average weight.

The poultry tends to move together and take a rest on the scrum. This phenomenon is equally shown on the scale, and it makes difficult to detect the number of poultry by the naked eyes. If the number of poultry is detected incorrectly, the average weight will have an error, making it difficult to determine the shipment date. For this reason, in this paper, we propose an object segmentation algorithm to detect the number of poultry on the scale after the image is correctly processed based on the poultry density in the ROI.

The proposed algorithm uses a scale and an IP camera to detect the weight without contacting the poultry. Binarization was used to separate poultry from the scale board, and the distance transform is applied to shade the object outline and brighten object center. After detecting the brightest part by Mean-shift clustering, each object was segmented by merging the mode based on the object size.

This paper is organized as follows. Section 2 describes how to segment the each poultry on the scale. Section 3 describes experiments and results of the proposed algorithm. And then Section 4 presents conclusions and future research directions.

## II. NON-RIGID OBJECT SEGMENTATION ALGORITHM

The non-rigid object segmentation of poultry is proposed in the following order.

### A. Pre processing Input Image

On the scale, where is a poultry detection area, there are many noises due to contaminants such as feces, dust, and sawdust which are generated during the breeding process, and they make difficult to segment poultry from the scale board due to similar brightness. To remove these noises, we apply Gaussian blur. After then, the stretching algorithm is applied to increase the accuracy of binarization by increasing the contrast between the scale board and the poultry. Finally, the binarization is performed after transforming the stretched image into a LUV color space which has wide range of brightness values.

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**B. De-noising**

In order to clarify the results of the distance Transform, we reduce noises that have not been removed in the preprocessing step. And small white spots are removed by the Opening operation, and small black spots in the poultry area are filled by the hole filling operation as shown in Fig. 1.




**Fig. 1. (a) Binarization result, (b) After Opening result, (c) After Hole filling result**

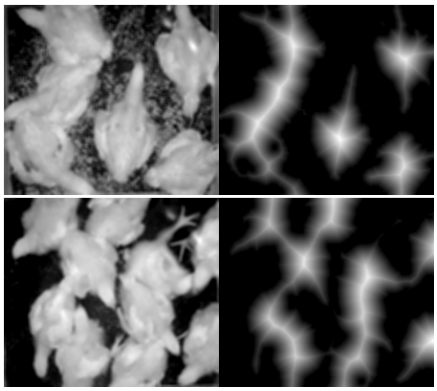


**Fig. 2. Result of Distance transform**

**C. Distance Transform**

In order to estimate the center of the each poultry through Mean-shift clustering, the distance transform algorithm is applied to the binarization image to brighten the center of the poultry and shade the border. However, when the poultry are attached to each other, or when several poultry are gathered together, they are expressed like the contours of mountains shown in Fig.2.

**D. Mean-shift Clustering**

Mean-shift clustering is applied to search for the center of poultry expressed brightly to search for local maximum. The initial points for clustering are arranged at regular intervals along the edge line on the binarized image before applying the distance transform. The Mean-shift operation that moves to the bright direction in the window area from the initial point is repeated until reached to the local maximum shown in Fig.3.

**E. Estimate Poultry Size**

The size of the poultry is estimated to segment adjacent poultry before merging modes gathered at the local maximum through the clustering method. And the merging method saves distances from all modes to the initial point in the array. Any distance r is voted to the radius $r_n$ if there are black pixels more than one half of pixels passing through the circumference of the circle which center is the one of modes and radius is $r_n$. The voting method at all initial points is used to determine the highest $r_n$ as the poultry radius.

***F.* Modes Merging and Non-rigid Object Segmentation**

Based on the estimated radius, the poultry are segmented or merged considering the adjacency between modes and the number of adjacent modes.

**Table 1. Candidates of radius**

| $n$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| $r$ | 32 | 36 | 40 | 44 | 48 | 52 | 56 | 60 |
| $n$ | 8 | 9 | 10 | 11 | 12 | 13 | 14 | |
| $r$ | 64 | 68 | 72 | 76 | 80 | 84 | 88 | |

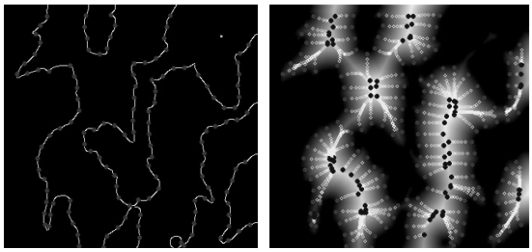



**Fig. 3. (a) Canny edge and initial point, (b) Result of Mean-shift clustering**

Merging process consists of two steps as shown in Fig. 4 and Fig. 5. The first merging step is based on the estimated radius $r_n$. And the second merging step considers number of modes contained in the candidate object that are adjacent but not merged. The first merge is performed when the distance between two modes is less than the radius $r_n$, the distance between modes is smaller than the diameter, and the absolute value of the difference between the diameter and mode is larger than 1/2 of the radius. The second merge is performed to prevent the head or tail of the poultry from being detected as a candidate object in the first step. This is done for candidates whose distance from the center of the candidates object is shorter than the diameter. As shown in the Fig.4, candidate objects having a mode lower than the threshold value between two candidate objects are merged into one candidate object having a mode higher than the threshold value. Conversely, they are not merged if both candidate objects has mode more than the threshold value shown in Fig. 5.

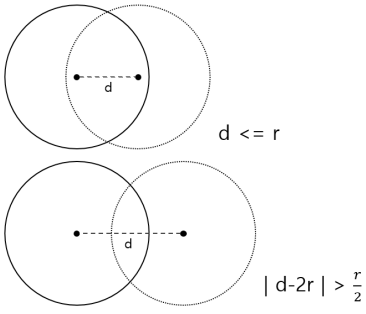



**Fig. 4. Condition of merging step1**

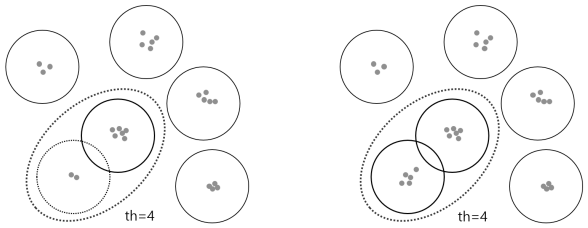



**Fig. 5. Condition of merging step2**

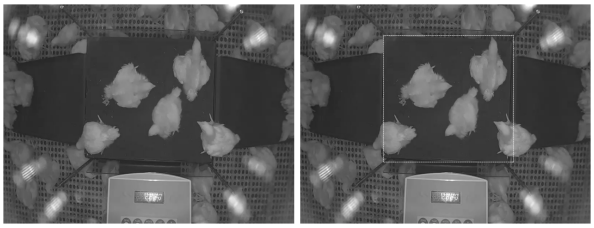



**Fig. 6. (a)Source Image, (b) ROI of scale board**

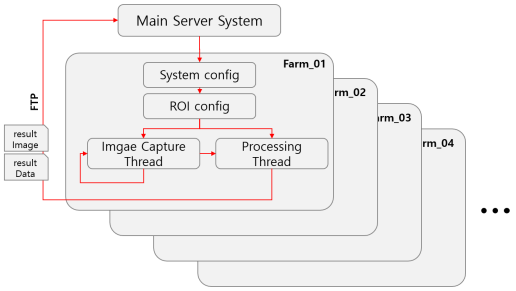



**Fig. 7. Flow chart of proposed algorithm**

## III. EXPERIMENTS AND RESULTS

In this paper, we proposed the non-rigid object segmentation algorithm to segment the gathered poultry. This algorithm proceeds in the following order. First, the binarization algorithm is used to separate the scale board and poultry. The distance transform is executed before detecting the center of poultry by Mean-shift clustering. Based on object size, modes from Mean-shift clustering are merged. In order to evaluate the proposed algorithm, we installed IP camera and scales with ramps and walls on the poultry facility shown in Fig. 6(a).

### A. Experimental Environment Setting

We chose a wireless IP camera considering mobility and scale board set to black color. There is a problem in binarization due to the shadow caused by the light source when acquiring the image from the camera. To solve the shadow problem, the camera was converted to the Infrared light mode. The image captured from IP camera is a single channel greyscale image with 800 x 600 resolution. The non-rigid object segmentation is executed after setting initial points. In addition, the ROI image is divided into 4 regions as shown in the Fig. 8, and then object segmentation is performed only when the density of poultry is less than 60% in each area.

The experiments were progressed on actual chicken farm, and the performance of the algorithm was evaluated with respect to images collected for 25 days.

### B. Algorithm Flow Chart

Flow chart of proposed algorithm is shown in Fig. 7. We composed multi-thread program to consider multiple cameras on multiple facilities. Each thread performs a poultry object segmentation algorithm. After detecting them, source image and result image are transferred to FTP server to save them.

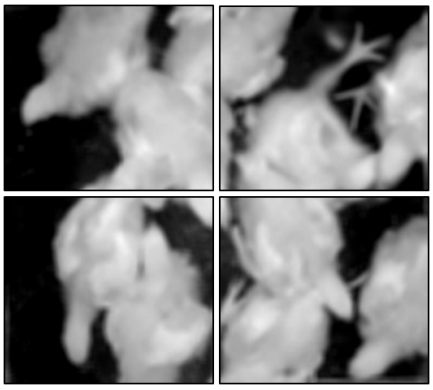


**Fig. 8. Measuring the poultry distribution density in quadrant**

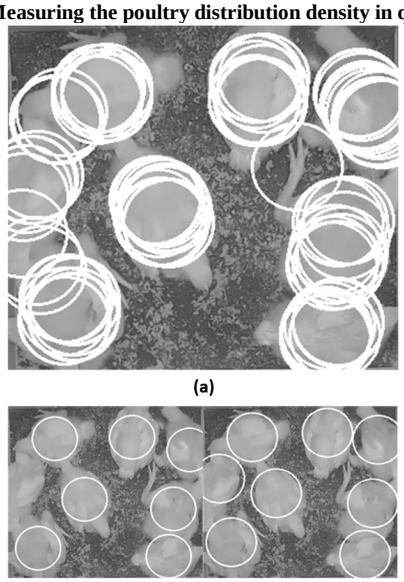



**Fig. 9. (a) Circles that can be center of poultry, (b) Result of merging by Gaussian distribution, (c) Result of merging by proposed merging method**

**Table 2. Experiments Result**

| Images | Correct | Accuracy |
|---|---|---|
| 600 | 547 | 91.17 |

### C. Performance Evaluation of Proposed Algorithm

The performance of proposed algorithm was conducted on 600 images. The biggest problem in the algorithm development is to segment poultry that are excessively gathered together. If the poultry cannot be segmented, it is also difficult that the mean-shift clustering algorithm collects its modes to the center of the each poultry. The Fig. 9(a) shows circles that are

on center of the poultry in an image that is not segmented yet. Fig. 9(b) shows the result of merging the circles using Gaussian distribution. As shown in Fig. 9(b), poultry was not detected in the low mode distribution area. Fig. 9(c) and Table.2 show results of the proposed segmentation algorithm.

The proposed algorithm showed high accuracy in low poultry density as shown in Fig. 10, but it showed low accuracy in the case of the heavy contamination and the excessive density of poultry on the scale board as shown in Fig. 11.

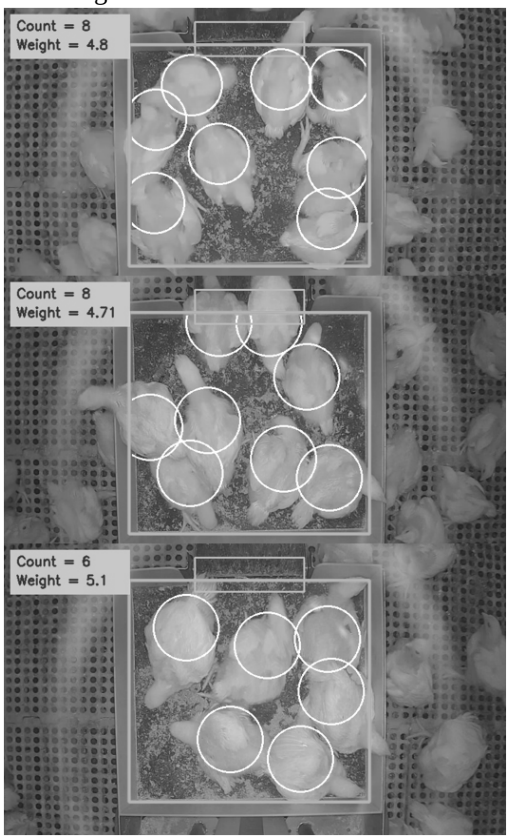



**Fig. 10. Success detection case**

Although the processing time varies depending on the area of poultry on the scale board, the average processing time is 270 ms per frame.

## CONCLUSION

In this paper, we proposed non-rigid object segmentation algorithm for a poultry automation system that can determine the shipment date of poultry without direct contact between poultry and breeders. For the reliability of the proposed algorithm, we excluded non-segmentable image which is not satisfied the criterion.

And we applied the distance transform and Mean-shift clustering to estimate the center of poultry. After then, we segmented the gathered poultry from the scale and merged the clustered modes based on poultry size. The accuracy of the proposed algorithm is 91.17%. Since the experiments were conducted at the actual poultry farm, it can be applied directly to poultry farms where automation is required.

In the future, it is necessary to study how to effectively segment the gathered poultry by deep learning classifier using inherent feature of poultry, and to improve the processing speed and the algorithm to be applicable to various environments.

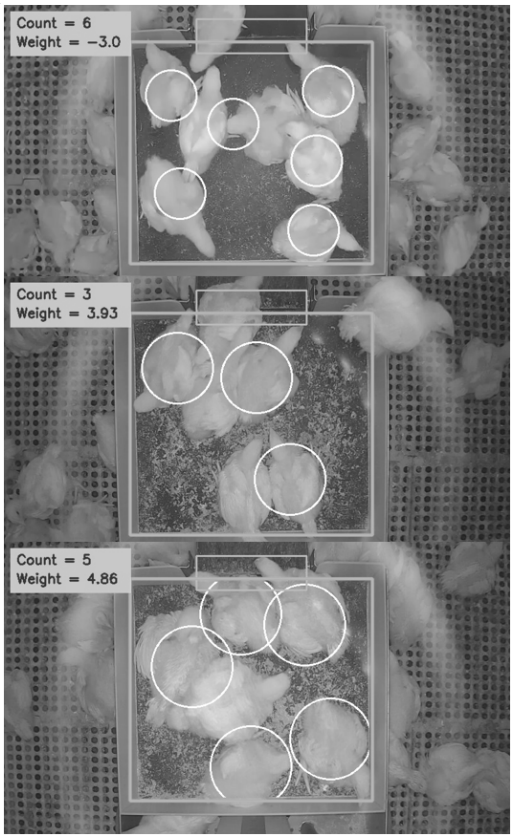



**Fig. 11. Failed detection case**

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