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A simple way to determine the sex of one-day poultry chickens (basic principles)

Abstract
In this work describe the experiments, which shows the principal possibility to develop cheap computerized optical separator for determining the sex of one-day chickens. This can help to improve the income of poultry industry.

Introduction
An important part of the modern poultry industry is the separation of one-day chicks regarding to their sex/ 1 /. For breeding quantity cocks must not exceed 10 % of the flock, for the production of meat broilers female chickens are not used at all. Currently in use around the World "Japanese method, in which specially trained people perform sorting on the basis of labor-intensive visual inspection of the genital organs.
To simplify this process, based on the use of genetic factor "K" / 2 / specially were bred species, which in the first days after hatching , sprouts flight feathers on the wings of males and females have different in design and size / 3 /. Look Fig.1 and Fig.2 /4/. However, sorting on this topic is also carried out manually.

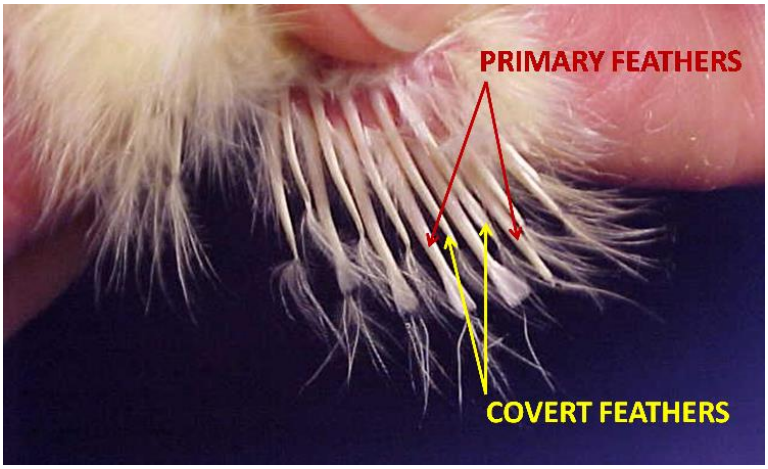

Fig. 1. Feathers of female chick

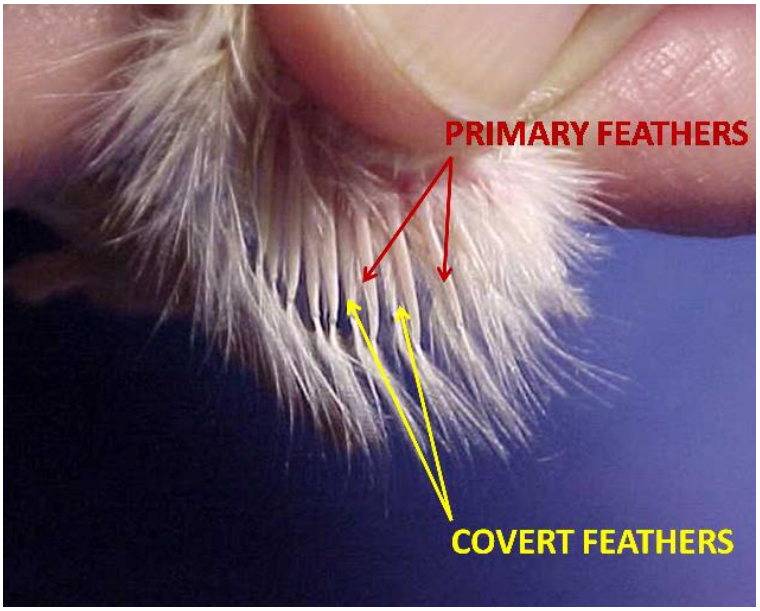

Fig. 2. Feathers of male chick

Were proposed mechanized methods, based on the spectral analysis of the cry of a chicken / 5 /, on the difference of glow germ flight feathers of the wing in their illumination by UV / 6 / or visual light /7/, which includes inducing the chick to lose its equilibrium and voluntarily spread its wings.

For this chick is placed on a surface, with the possibility of a sharp fall under its own weight, in which he reflex reveals the wings. At this moment he is photographed with a digital camera, and data will is transmitted to the computer. After processing it determines the sex of the chicken and computer gives a signal to the executive mechanism to direct it into the corresponding container.

And if the first proposal is unlikely to find a practical application, the second and third seems more serious. Our own tests confirmed the possibility of the principal efficiency of this methods, however, has identified the following shortcomings:

- expensive UV cameras and lighting equipment that must be extremely stable and durable in an industrial environment;
- upper position of B/W camera can't provide pictures, good quality for separation by image processing;
- the difficulty of obtaining high-quality images, as chickens open wings different and not always (5 -10%).

Prerequisites solutions

To resolve these issues, we suggested to check the following decisions, which lets you see and measure the difference in the plumage of male and females:

1. To take pictures of chicks with open wings by simple cheap digital camera with white backlight.
2. To push plate with chick down more speedy than the acceleration of free fall **(g)**.
3. To place the chicken on a metal surface to with high voltage, due electrization the initial feathers stand up and becomes perpendicular to the body, that will give the option to see the difference in their plumage.

It is logical to propose, that in order to secure the symptoms of reflex opening of the wings legs should lose support faster than they can move down.

As we observed in our fast filming, reaction of chicken libs irritation occurs very quickly, approximately 30-40 msec. If we assume that, the claws can pubescent 10 mm and this movement is uniformly accelerated, can be calculated that, acceleration of plate must be equal 12-15 m/sec2. It is only a little more than free-fall acceleration and easily imitated by sharp lowering his human hands.

These allowed to suggest the following algorithm for chick's sexing, where it is divided into 2 stages - learning and sorting:

1 stage

1. From the total mass of sexed chickens randomly selected 20 male and 20 chickens, visually separated by sex.
2. Chicken are placed on a moving plate and are photographed during the fall.
3. Received images will passed to the computer and begin their examination by using image processing software as Inspector Matrox /8/ or any other.
4. Determine the value of 'Threshold", with which all of the images have the maximum blob.
5. For each blob calculate the center of gravity and the angle to the Principal Axis.
6. Is rotate the image to get the vertical position of the Principal Axis.
7. From the center of gravity calculate position of Secondary Axis and define by the coordinates of its intersection with the line blob.
8. To choose higher from 2 distances from the center of gravity to this points.

9. Divide this distance of 6, coordinates of the shorter part take as horizontal borders of Region of interest (ROI) for further analysis.
10. Coordinates of vertical borders of ROI will be arranged symmetrically regarding to Secondary Axis at the distance of 1/2 the length from the center of gravity to the extreme horizontal point ROI.
11. In ROI from image is subtract constant value, selected experimentally, with follow target - internal line of the blob must to cross the edge of a body of chicken, where begin to grow feathers.
12. With the function "Analysis-Blob-Segmentation" select " Threshold" with option that the line of blob took place approximately in the area of the middle of the flight feathers of the wing; (for a more simple way to select this parameter is possible to look on the profile line from an external contour image of the wing to the beginning of the wing.
13. For each image to calculate the values of built-in functions "Compactness" and "Roughness", where
    - Compactness = Perimeter / Convex perimeter;
    - (Convex perimeter is an approximation of the perimeter of the convex hull of a blob);
    - Roughness = Perimeter^2/12.566 x Area
14. By using Microsoft Excel, will build the graph of the relationship between these functions and manually draw 2 polygons, limiting the areas of males and females, and to place this data in memory of computer.

2 stage

After will begin automatic sorting - for each chicken by described image processing techniques will be calculated values of "Compactness" and "Roughness" and to decide, inside which polygon it will be sent. Small part of flock may be sent in uncertain area for repeatedly separation. If some chicks not will be separated twice, they must be inspected and sorted manually.

It is obvious, that this idea can simply adapted on to the lines that are wide used for counting and packaging hatching chicks in industrial incubators.

It will be necessary only to perform upgrading on their exit part - to add nodes lighting, electrooptic unit, computer, moving plates with corresponding springs, activator, air ejectors for blowing chickens and appropriate bins.

Materials and methods

For testing were used 200 one-day chickens breed Ross (100 males and 100 females), produced in the kibbutz Kvutzat Yavne, Israel, in summer of 2011.

Image processing were used B/W CCD camera Jeveline, frame grabber "Matrox-Corona ", software "Matrox inspector 1.71" and PC " Pentium-4 under Windows 7.

Plate was made from milk-white plastic PVC.

For back lighting was used led white light source "Lampbay" with the following parameters:

The light source..... ..... 24pcs Epistar
Luminous flux(LM)..... 2500Lm(as well Halogen 200W)
CCT(K)..... W(3000K)/NW(4500K)/CW(6000K)
CRI(RA)..... more 75Ra

Chickens were placed on plate manually and was pushed down from a height of 20 cm on the shock absorbers (Fig.3).

To check the possibility to observe the difference in plumage of males and females after their electrification, the chicken was placed on an isolated metal surface on which it was served high voltage (25 kV) from own made Cockcroft-Walton generator.

Fig.3 Chick on plate. Light radiates from the bottom

To determine the moment of maximum disclosure of wings we propose to use two possibilities - to take a picture after a certain time after beginning of plate falling (specified during initial adjusting of separator), or by using electronic circuit, that defines the moment, when the first derivative of the value of the light reflected signal from chicken becomes zero. The sensor can be made from simple photodiode and a collecting lens, Fig.4.

To ensure sharp fall of plate it is possible to use mechanical activator (for example, a cylinder with a flexible wheel at the end of the pusher), which will provide the initial acceleration, a little more than **g**. In the result of

this feet of chicks will be without support and they reflexively will open their wings.

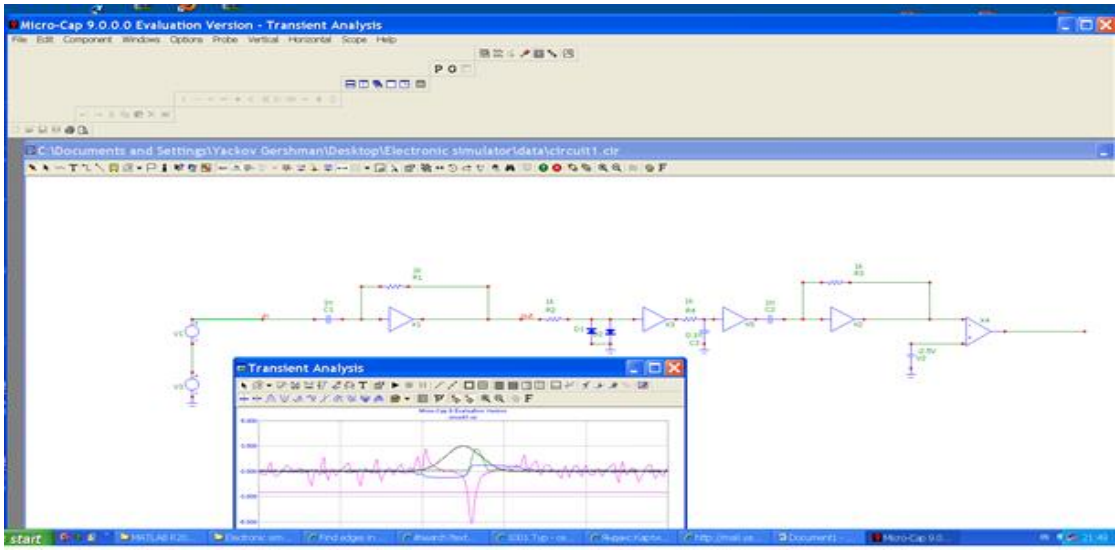

Fig.4 Principe of electronic circuit for shutting the chick with maximum open wings

Results

1. All tested chickens would open their wings.
2. It was observed significant effect of standing up of initial feathers due to electrization, but this was not stable enough regarding to difference in humidity of surface of chicks.
3. Following to described algorithm were carried out the appropriate tests, shown in Fig. 5 – Fig.11. Here in the displayed photos during learning stage was selected follow parameters:
   Initial Threshold -210;
   Constant value for subtract – 100;
   Threshold for calculation "Compactness" and "Roughness" - 60.

Our tests also showed the possibility of blowing chick from a plate with compressed air (1.6 ATM) without any damage.

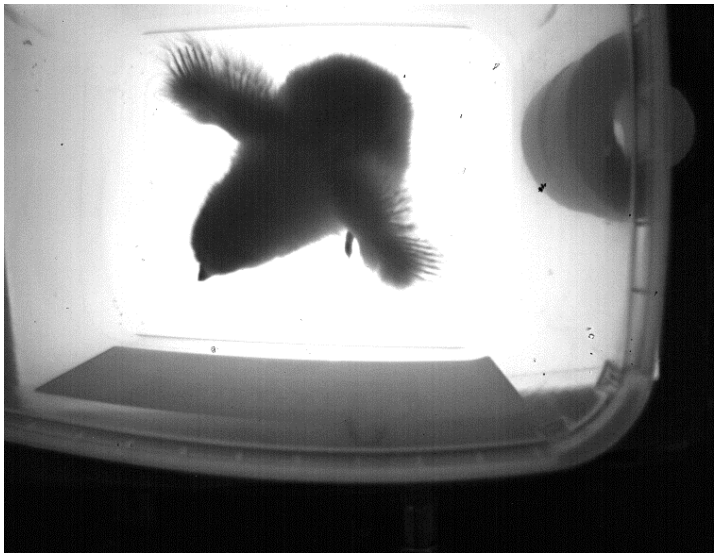

Fig. 5. Falling female chick

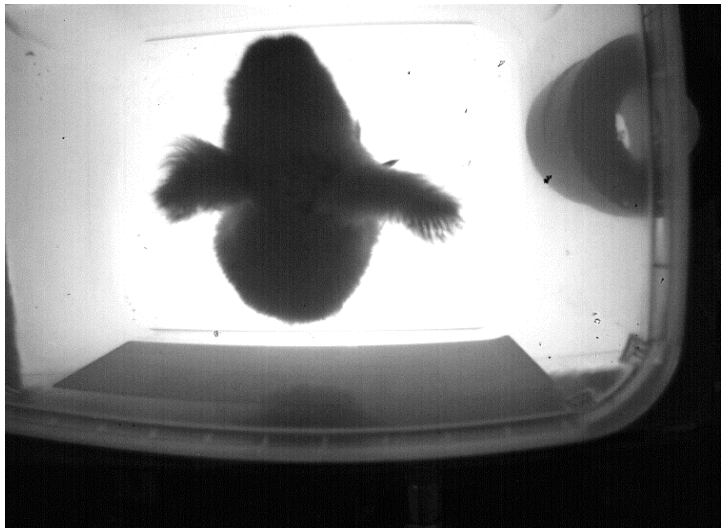

Fig. 6. Falling male chick

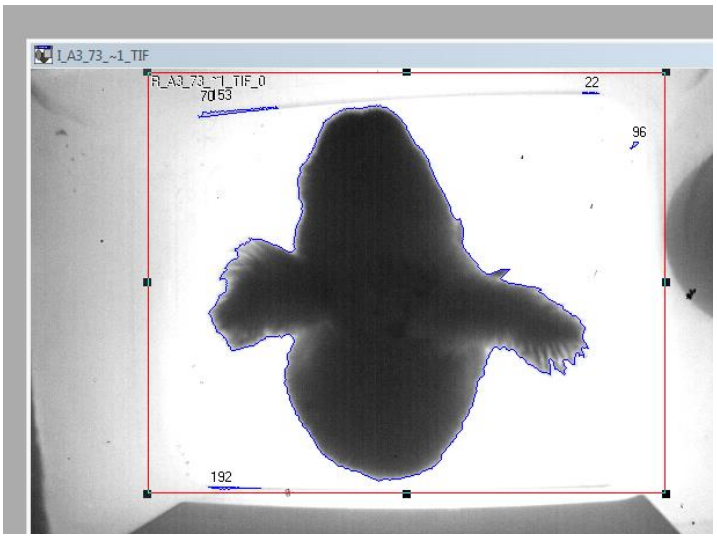

Fig.7 Internal blob of image of falling chick ("Threshold" = 200)

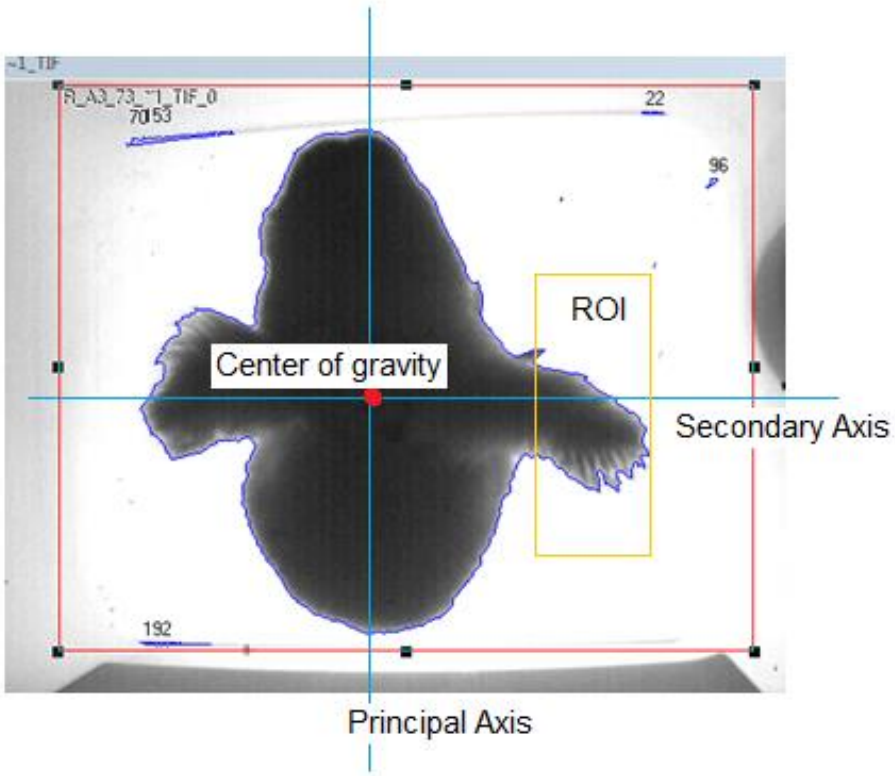

Fig. 8. Designation of ROI

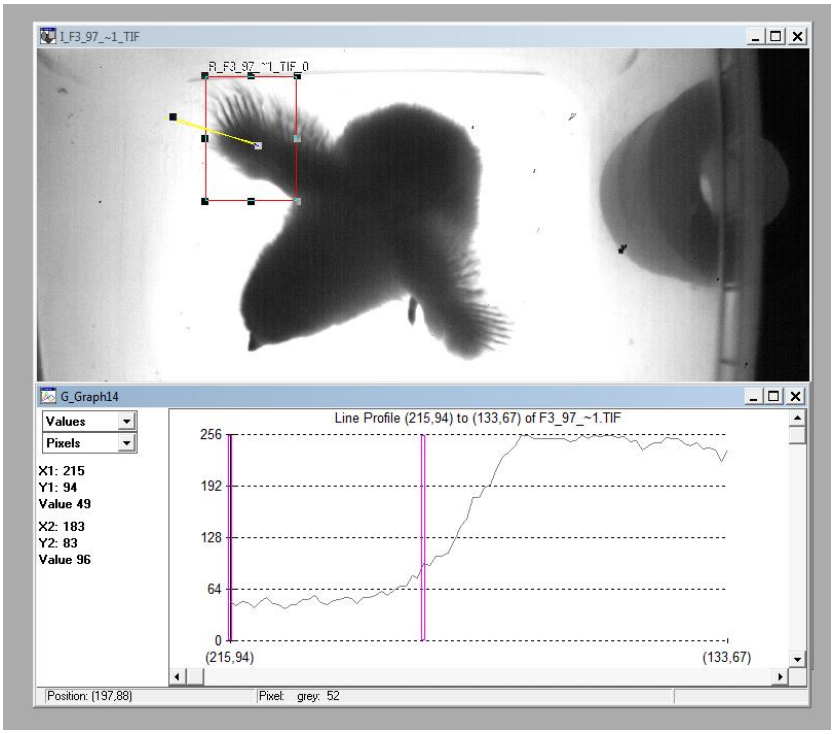

Fig.9 Determination of value of threshold of external contour (in this sample: 96)

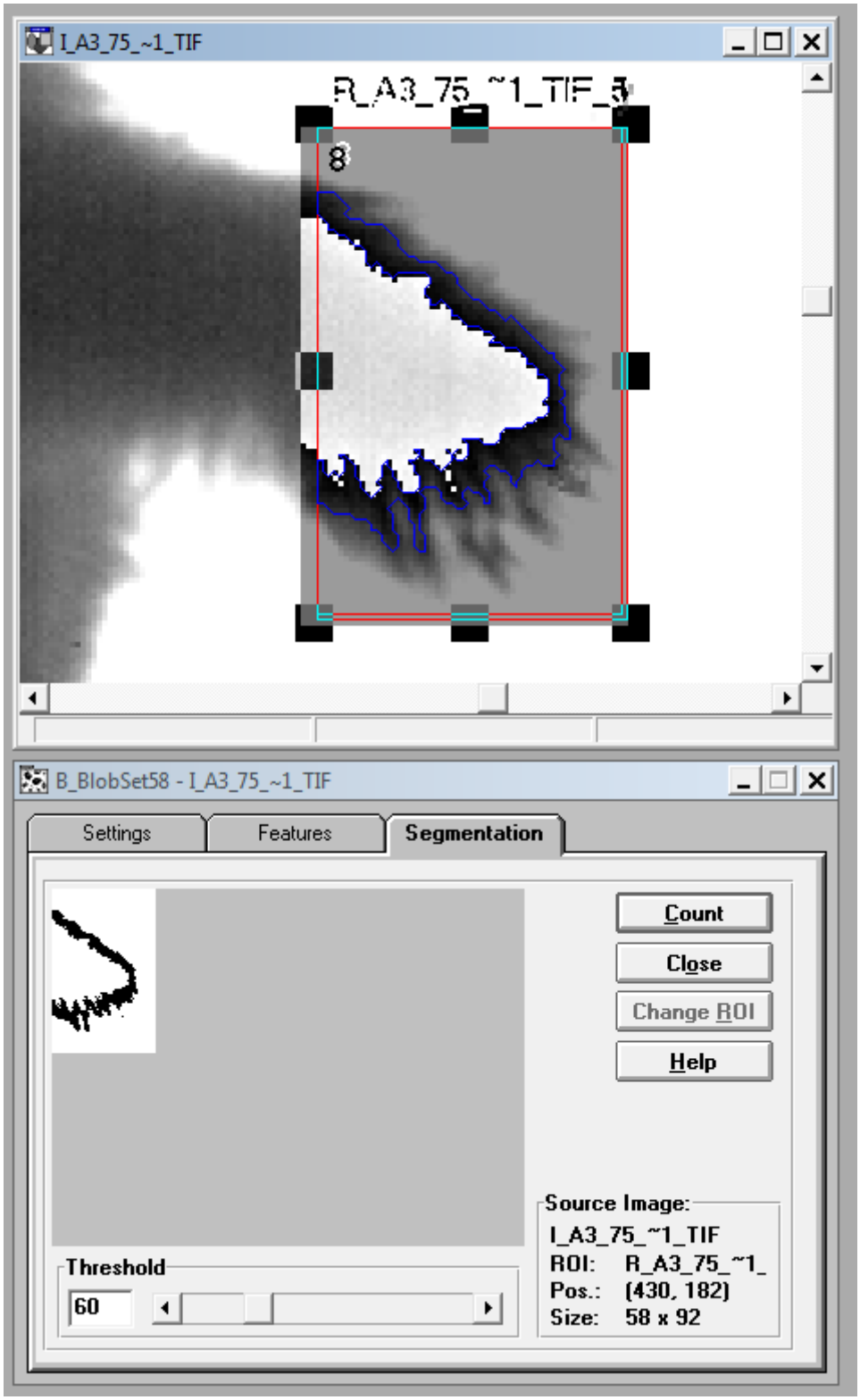

Fig.10 Analyzed area (ROI) of the chick

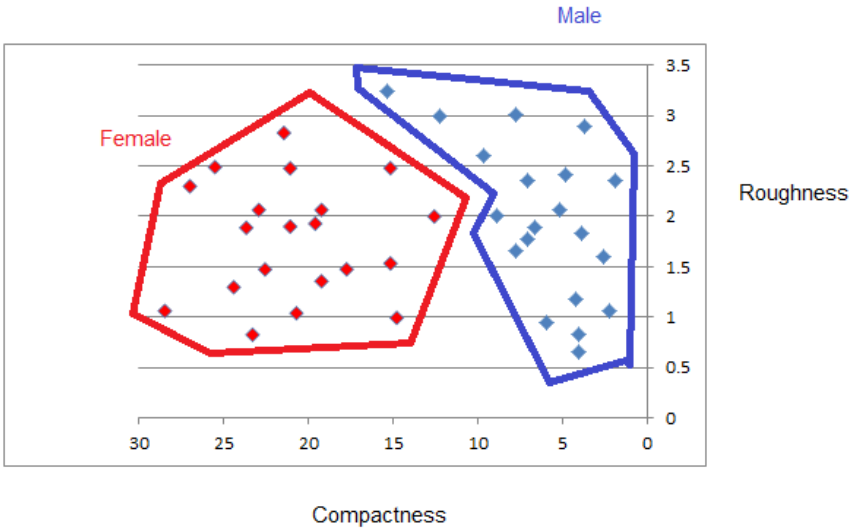

Fig.11. Virtual polygons of sorting parameters (Relation between "Compactness" and "Roughness" for 1 stage – learning)

Tabl.1 Results of separation (200 chickens)

Gender	Q-ty,%	Accuracy, %
Male	48.5	100
Female	50.5	99
Unknown	1	-

Conclusions

Our tests have shown possibility to conduct industrial sexing of one-day chickens, falling with acceleration more than **g**, by cheap B/W cameras with backlight and digital image processing.

It is obvious, that this idea can simply adapted on to the lines that are wide used for counting and packaging hatching chicks in industrial incubators.

It will be necessary only simple modernization - to perform upgrading on their end - to add nodes lighting, electro optic unit, computer, moving plates with corresponding springs, activator, air ejectors for blowing chickens and appropriate bins.

For author clear, also, that described information it is only beginning of real penetration in poultry industry and needed a lot of effords.

Therefore and he will be happy to find strategic partner.

Acknowledgment
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