15th INTERNATIONAL CONGRESS ON AGRICULTURAL MECHANIZATION AND ENERGY IN AGRICULTURE
October 29-November 1, 2023 - Antalya, Türkiye

ANKARA UNIVERSITY 1946

OP-41. Sexing of Chicken Egg in the Early Incubation Based on the Analysis of Transmission Image

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All male chicks are killed immediately after hatching in conventional hen-laying hen production because male chicks cannot lay eggs. The number is estimated to be more than 7 billion birds per year worldwide, which is problematic from the viewpoint of animal welfare and the energy or labor required during the egg incubation period. Many researchers have been studying non-destructive or minimally invasive methods to determine the sex of embryos before hatching. Our research group has already found a significant difference between male and female embryos around day three based on time series spectroscopic spectra. This difference was found at a wavelength related to the absorption of hemoglobin, which is included in the blood. Therefore, we assumed that there might be a difference in vascular growth in the initial period of incubation. It is also preferable to be able to identify the sex of the embryo as soon as possible, considering that the chick embryo may be capable of pain transmission from day 7 of incubation and that a lot of costs are involved. As one of the methods to observe the process of angiogenesis from multiple angles, an imaging system was constructed to visualize blood vessels in the early stages of egg incubation. A green illumination around 550 nm selected based on the spectroscopic properties of chicken eggs was used to acquire the transmission images, and we succeeded in the precise observation of embryos and blood vessel growth during the early incubation period. It was also possible to confirm the drastic changes in the distribution of blood vessels, which was consistent with a previous biological study. Application of noise removal using Gaussian and Laplacian filters and Otsu binarization to the images enabled the extraction of the areas where embryos and blood vessels were captured. On the basis of these findings, more than 100 eggs were incubated, and their transmission spectra at 450 to 900 nm and images were obtained. The spectra were measured with the eggs placed in a vertical position, and images were taken in a horizontal position. Since the amount of light transmitted decreased day by day because of the embryo growth, the exposure time was increased as the incubation progressed. Two days after hatching, their sex was determined by the feather. Linear support vector machine was used to create a classifier and full cross-validation was performed. When the absorbance at 500 to 625 nm on incubation day four and the area of the embryo and blood vessel shadow region at the same time were used as variables, the percentage of the correct sex determination was found to be approximately 5% higher than when only the absorbance information was used. This suggests that transmission image data may also be helpful for sex identification before hatching, and we hope to utilize more features from the images to achieve more accuracy. In this presentation, we will introduce the result of a larger-scale incubation experiment, focusing on the image data. Transmission images of over 300 fertilized white eggs (Julia lite) were captured from just before the start to the seventh day of incubation. Morphological features of embryos and blood vessels, which include area, shape, and perimeter, were extracted by image analysis. We examined how these characteristic values change with growth and the relationship between features and sex. The possibility of sex determination of early embryos was also investigated using a deep learning system.

Keywords: sexing of chicken embryo, blood vessels, transmission image, machine vision, deep learning