Long term Chicken Cockscomb Color Detection of the Video Surveillance in a Poultry House

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Keywords: Color calibration, Artificial Intelligence, Poultry surveillance, Poultry health

ABSTRACT

This paper aims to observe the color chicken cockscomb in a long term during growing. To achieve that, the color correction algorithm was applied to surveillance system in the poultry house to suppress the affection due to the changing daylight. Based on the color-corrected video, the YOLOv4 AI model is used to detect the chicken cockscomb automatically and collect the color for analysis of the growth state of a group of chickens.

1 Introduction

Digitalization technology has been applied to livestock industry for decades [1-3], and it provides a powerful solution to reduce the cost of human resource. However, so far, the digitalization for poultry industry and agriculture application in Taiwan is still not very popular yet. There are several technical issues which need to improve.

1.1 Background

Because of the Covid-19 pandemic, many demands for remote management and monitoring of livestock farms are getting important. The development of computer vision technology makes it possible to monitor the situation of the poultry house in real-time. However, the “color” from surveillance cameras is too unstable to analyze the chicken situation because the illumination of the poultry house is changing due to its semi-open structure. Fortunately, many camera color correction studies have been done [4-5], and they provided excellent performance. Our previous study applied the color correction algorithm based on a polynomial matrix to surveillance systems. On the other hand, the development of artificial intelligence (AI) has been growing up rapidly since 2016, and many studies are focusing on detecting animals [6]. In this paper, we try to applicate this part in our research to improve performance. We also provide a overall framework and deal with every deals with the integration of 5G, computer vision of AI and color science.

1.2 Purpose

In this study, the data were collected by a 4K pan-tilt-zoom (PTZ) surveillance system. This data were used to find the best correction parameters to correct the color difference to under a value of 8 in changing daylight environment. Based on this situation, the detection of the chicken cockscomb utilized artificial intelligence(AI) technology to retrieve the cockscomb color during their growth period which is up to 80 days.

2 Experiment

This section describes the details of the setup of the poultry house surveillance system, the condition of the experiment, and the using method.

2.1 Our Surveillance System in Poultry House

In the experiment environment, the poultry house surveillance system comprises a minicomputer, WIFI router, network-attached storage server (NAS), 5G network receiver, one 4K camera (Axis-Q6128E 4K IP camera), and four Full-HD cameras (D-link DCS-8630LH). The primary data were captured by the 4K camera and stored in the NAS server. All components of the system are shown in Fig. 1, and the location is in middle of Taiwan.

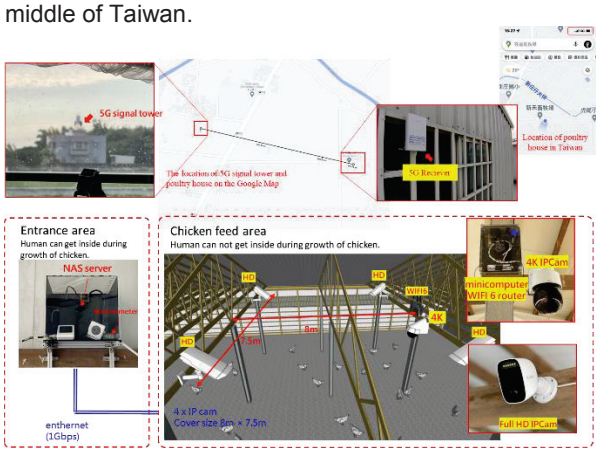

Fig. 1 Detail of Surveillance System

2.2 Color Data Collection Setup

The video stream of surveillance is backup in NAS during the days from 2022/1/7 to 2022/3/1. To relate the camera responses and standard sRGB, in our previous study, the measured color samples were placed in the working area of surveillance cameras. This color samples were selected by considering the Macbeth color checker, cockscomb, and the poultry house environment. The sampled RGB data are listed in Fig. 2. The 4K

camera was set at patrol mode to capture the overall situation in the poultry house and was stored in the NAS server.

Red R = 171 G = 86 B = 80	Green R = 102 G = 153 B = 82	Blue R = 62 G = 96 B = 153	Magenta R = 174 G = 104 B = 143	Cyan R = 48 G = 145 B = 164	Yellow R = 220 G = 187 B = 54
White R = 233 G = 238 B = 245	Neutral 8 R = 209 G = 217 B = 212	Neutral 6.5 R = 182 G = 192 B = 182	Neutral 5 R = 132 G = 135 B = 124	Neutral 3.5 R = 129 G = 132 B = 123	Black R = 103 G = 104 B = 99
CH1 R = 221 G = 154 B = 153	CH2 R = 202 G = 83 B = 95	CH3 R = 194 G = 156 B = 152	CH4 R = 146 G = 95 B = 99	GD1 R = 228 G = 225 B = 205	GD2 R = 194 G = 221 B = 246
GD3 R = 87 G = 85 B = 90	Moderate Red R = 179 G = 105 B = 102	Blue Flower R = 131 G = 146 B = 178	Blue sky R = 114 G = 137 B = 132	Light skin R = 185 G = 158 B = 130	Dark skin R = 125 G = 101 B = 86

Fig. 2 Color Sample and sRGB data

2.3 Color Correction Algorithm

To have better regression results, the polynomial transform method is applied to the surveillance video. To reserve the real-time color correction of surveillance video, the RGB to RGB polynomial transform was chosen. The polynomial functions were used to perform a mapping between a vector of camera responses **c** and a vector of standard sRGB color **s** by a matrix **A** as equation 1.

$$\mathbf{s} = \mathbf{A}\mathbf{c} \quad (1)$$

Where **A** is the color correction matrix, for the linear transform, **A** is polynomial matrix, and **c** is a 3×1 matrix. The values of matrix **A** are easily determined by linear algebra methods. However, there are several types of color correction matrix. By Considering the calculation time, there are 7 types polynomial functions were chosen as the Table 1. On the other hand, the weather and daylight situation are considered to analyze, too. Finally, the performance of polynomial functions are judged by color difference.

Table 1:Definition of Polynomial Transforms Used

A	Augmented matrix
3×3	$[R\ G\ B]$
3×4	$[1\ R\ G\ B]$
3×6	$[R\ G\ B\ RG\ GB\ RG]$
3×8	$[1\ R\ G\ B\ RG\ GB\ RG\ RGB]$
3×9	$[R\ G\ B\ RG\ GR\ RG\ R^2\ G^2\ B^2]$
3×10	$[1\ R\ G\ B\ RG\ GB\ BR\ R^2\ G^2\ B^2]$
3×11	$[1\ R\ G\ B\ RG\ GB\ BR\ R^2\ G^2\ B^2\ RGB]$

2.4 Chicken Cockscomb Detection

The YOLOv4 AI model was applicated to detect the cockscomb automatically [7]. There are around 400 training samples to reach 70% successful rate. AI technology helps us collect a large number of data to analyze the growth of chickens. However, the AI model used only for 4K high-resolution videos, which will benefit calculation cost. In this part, we try to figure out the best resolution for detecting the cockscomb with the balance of accuracy and calculation cost.

3 Results

There are three parts to the analysis results. First, the performance of different types of color correction matrices is analyzed. Second part talks about AI model accuracy with varying video resolution. The final part focuses on the relationship between the chicken growth state and cockscomb color and provides a better way to distinguish the chicken's health in their growth period.

3.1 Color Correction Result

The same condition color corrected results of different size polynomial matrixes are shown in Fig. 3. The time at 12:00 PM was selected to be the standard because it was the brightest period in a whole day. After the color correction calculation, the best math model is to us a 3 × 10 size matrix as in Table 1.

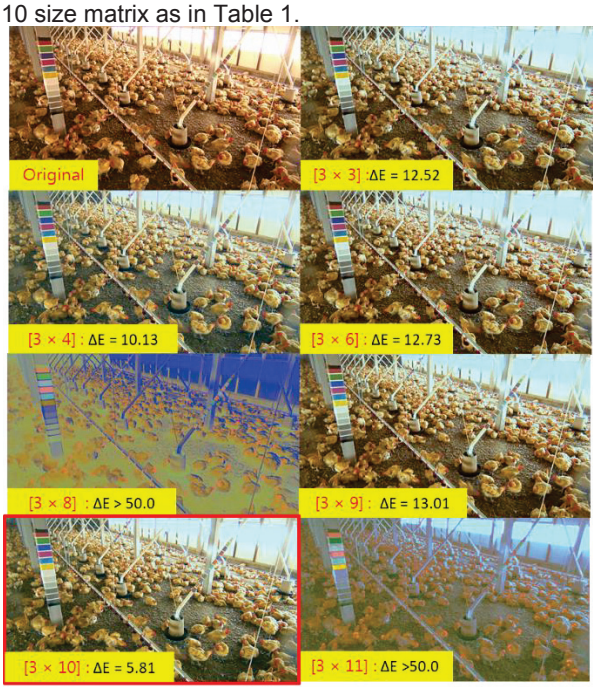

Fig. 3 The Color Correction Results of 12:00 PM

In this study, we also use different daylight conditions, including weather and time, to analyze the stability of color calibrations with different size matrices. These results are shown in Table 2. According to the results, time plays an essential factor during the change of daylight. On the other hand, the weather did not affect the daylight condition a lot.

Table 2:The Color Correction Results of different weather and time

Time	07:00		09:30		12:00		15:00		17:00	
item	Mean ΔE	Std	Mean ΔE	Std	Mean ΔE	Std	Mean ΔE	Std	Mean ΔE	Std
Sunny	11.64	4.93	11.47	5.32	8.30	3.48	8.34	4.92	6.51	4.62
Cloudy	14.64	6.86	10.96	6.29	9.28	4.28	11.39	6.15	10.78	5.42
Rainy	12.81	6.12	9.08	4.28	9.64	3.03	9.40	3.06	8.85	3.51

3.2 Accuracy of AI model

To get enough color data of chicken cockscomb, the YOLOv4 AI model is applicated to each frame of the surveillance videos. The corrected color cockscomb image is the standard of the training model. The accuracy of the model is analyzed with different image resolutions and scenes. Four typical zoom-in scales are shown in Fig. 4. They have different view angles, covered regions, daytime, and weather. The chosen image resolutions are 4K(3840x2160), WQHD(2560x2160), FHD(1920 x1080), qHD(960x540), and nHD(640x360). The analysis results of counting numbers are shown in Fig. 5 and all the confidences are over 70%. According to the result, scenes A, B, and C have a stable accuracy to detect chicken cockscombs. However, the scene D results in too low accuracy and encounters an unstable situation. It might be caused by the shiny daylight.

Fig. 4 The Scenes of AI Accuracy Analysis

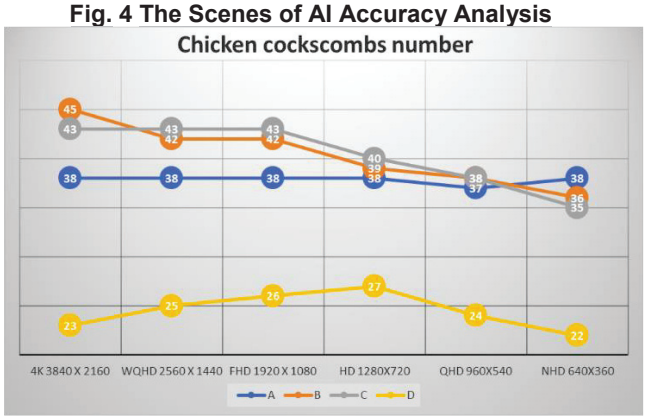

Fig . 5 The chicken cockscombs detection numbers with different scenes and image resolutions.

3.3 Chicken Cockscomb Color Analysis

After these works, cockscomb color data with whole chicken growth time were collected to analyze the relationship between them. The color data of cockscomb were shown in Fig. 6 in CIELab color space. It shows that the chicken cockscomb is getting reddish during its growth period.

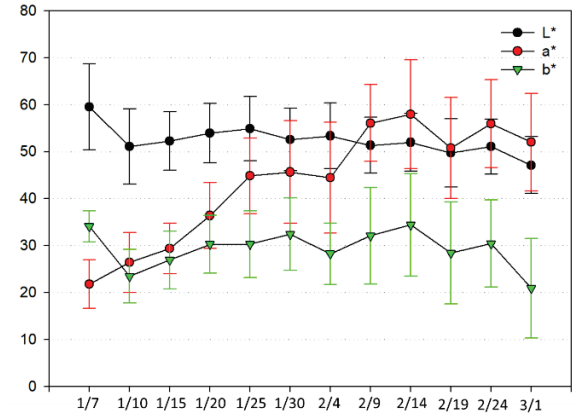

Fig. 6 The chicken cockscomb color with growth time

4 Discussion

The video of surveillance systems are severely affected by the change of daylight. It shows the shiny daylight makes the picture too bright to correct their color, and it will damage the detection rate of the chicken cockscombs. However, our solution still can cover the most daytime situation during the period from AM10:00 to PM2:00. And the purpose of analysis of chicken color in growth time is carried out.

5 Conclusions

In this study, the color correction algorithm and YOLOv4 AI model are applicated in the surveillance system in our experimental poultry house. These solutions successfully overcame unstable illumination of the semi-open structure and discovered that the chicken cockscomb's color is getting reddish through the growth time. In the future, this system and result will be used to identify chickens' health to help the poultry industry.

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