

The 16th International Workshop on Nondestructive Quality Evaluation
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Development and application of artificial intelligence and automation technology in poultry farms

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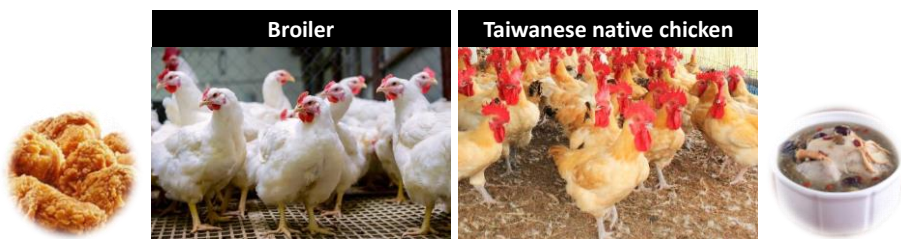
Outline

- Introduction to Taiwan's Poultry Farms
- AI Laser Wild Bird Repellent System
- AI Poultry Weight Scale
- Chicken Activity and Laser Response Assessment System
- AI Chicken's comb and eyes identification technologies
- Conclusion and Future Works



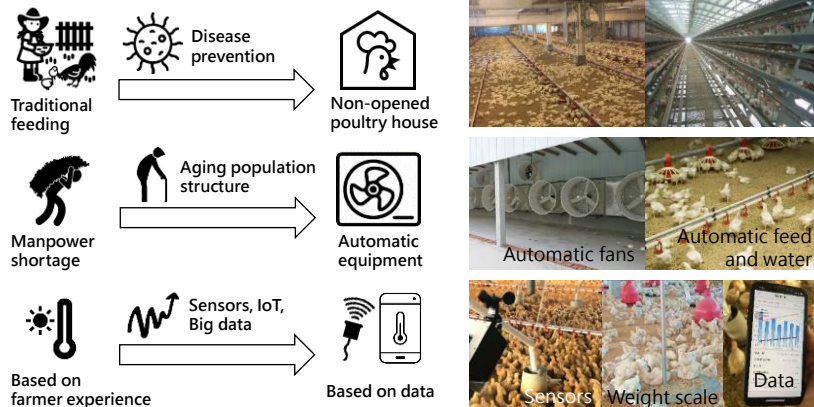
Introduction to Taiwan's Poultry

- For Taiwan **poultry meat**, two important types are **broiler** and **Taiwanese native chicken**.
- For the **broiler**, the feeding duration is shorter and about 5-7 weeks.
- For the **Taiwanese native chicken**, the feeding duration is longer and about 13-24 weeks.
- The selling weights are around **2.0-3.0 kg for broiler** and **2.5-3.5 kg for Taiwanese native chicken**.
- Due to the animal's behaviors, the **feeding density** for Taiwanese native chicken is lower than it for broiler.



Introduction to Taiwan's Poultry Farm Development

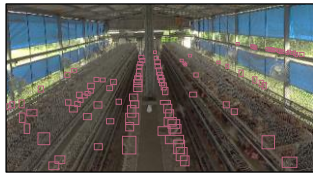
- The Taiwanese poultry houses are gradually changed from **outdoor farming** to **indoor house**. To provide poultry with suitable growth conditions, many **environmental control systems** have been installed within poultry houses.
- To save farmer labor, many poultry houses have adopted **automatic feeding and watering systems**. In recent years, **environmental sensing and automatic control systems** have been applied for achieving automated control of the poultry house environment.



Issues for the Taiwanese Poultry Industry

- ❑ In today's automated poultry houses, there are still **some challenges** that need to be addressed. These challenges include:
 - **The risk of avian influenza from wild birds:** When wild birds are closed with poultry, the risk of the transmit diseases such like avian influenza would be increased.
 - Currently, **poultry farm managers still need to enter and exit poultry houses to observe the growth and health of the poultry.** This frequent entry and exit not only increase the labor intensity for farmers but also increase a risk of pathogen transmission.
 - **Observation criteria depended on the farmer's experience.** The absence of scientific data-driven support may lead to inaccurate management and low efficiency.

▼ The issue of wild birds in poultry houses



▼ Farmers still need to enter the poultry houses to observe the condition of the chickens



Development of the Taiwanese poultry house

- ❑ In order to improve the poultry house from **traditional and automatic** types to **smart poultry house**, the **wild birds issue** and **poultry health condition assessment system** is necessary.

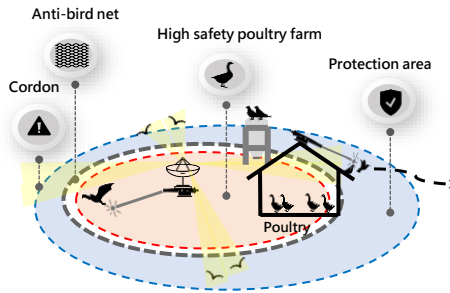
Development of the poultry house			
	Traditional	Automatic	Smart
House type	Opened and non-opened	Non-opened (wild birds) and closed	
Environmental control equipment	Fans	Automatic fans, water curtain and ...	
Sensor and feedback control	No	Temperature and humidity sensor	+Wind and Gas sensors
Feed and water	By manpower	Automatic	
Feed and water monitoring	No	No	Yes
Management records	No	Pen and paper	Digitization
Poultry weight measurement	Only the average weight of the final chickens are known or the human weight measurement		Automatic measure everyday
Poultry health assessment and warming	By manager or farmers		By video, image and sound

AI Laser Wild Bird Repellent System

- ❑ In the world, the **wild bird** is an important and difficult issue in the poultry farm.
- ❑ The wild bird made not only the **feed loss** but also the **spread of avian influenza**.
- ❑ Therefore, how to decrease and avoid the wild birds to appear in the poultry farm and to contact with poultry is a necessary work.



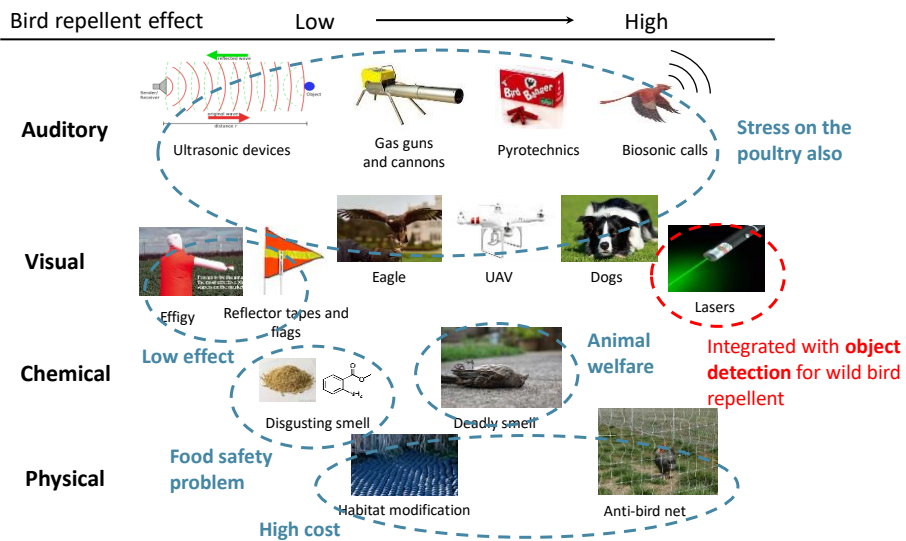
Wild birds appear in the poultry house and farm.



High safety poultry farm is necessary to the poultry health and the farmer.

AI Laser Wild Bird Repellent System

- ❑ There are **many wild bird repellent methods** were proposed. However, these method would have the disadvantages for using in the poultry farm.



AI Laser Wild Bird Repellent System

- According to the experiment result, the wild birds were repelled when they see the laser spot light around them.
- The wild birds feel the laser spot light as the **physical attack** and fled away from the laser.



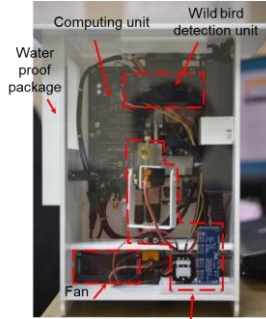
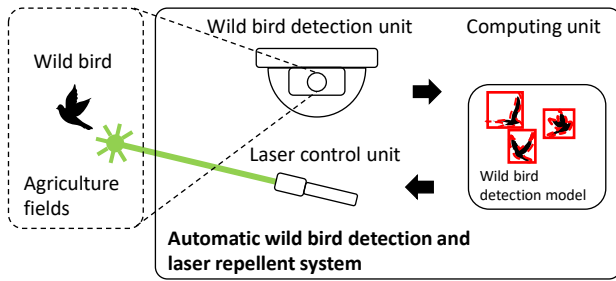
AI Laser Wild Bird Repellent System

- The poultry are interesting on the laser spot. The laser would not make the stress on the feeding poultry.

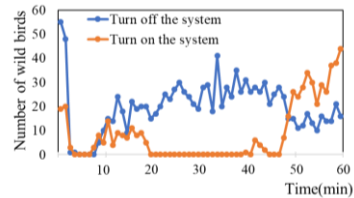


Fields	Poultry	0.5 mW	2 mW	5 mW	100 mW	200 mW	250 mW
Indoor	Chicken	Interesting	Interesting	Interesting	Interesting	Interesting	Interesting
Semi-outdoor	Duck	x	x	x	Interesting	Interesting	Interesting
Semi-outdoor	Goose	x	x	x	Interesting	Interesting	Interesting
Outdoor	Wild bird	x	x	x	Repellent	Repellent	Repellent

AI Laser Wild Bird Repellent System



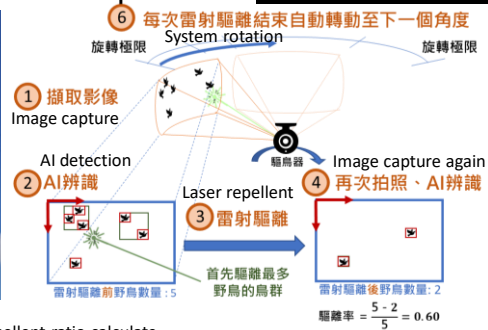
Prototype Laser control unit



System test result in field

AI Laser Bird Repeller – Commercialization completed AI Bird Detection and Automated Laser Repellent

Operational workflow



Test result



☐ According to the test results, the wild birds could decreased 50%-70%.

AI Poultry Weight Scale - Important of poultry weight

- ❑ The increase of **poultry weight** is one of the important index for the **poultry growth and health condition** and **farmer's income**.
- ❑ The poultry production performance such as growth rate, feed meat exchange rate is related to the poultry weight.
- ❑ If the poultry weight could not be known, it is difficult to understand the feeding situation.

Floor scale



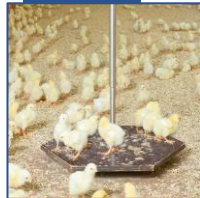
Hanging type



Floor type



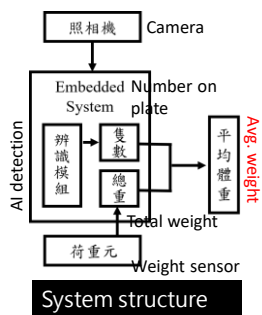
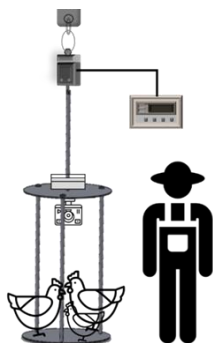
Plate type



- ❑ The **floor scale measurement** is only done **once when the chickens are released**. The disadvantage is that **the feeding situation is not known until the end**, and it is difficult to adjust the feeding strategy in time.
- ❑ The scales currently used in poultry houses all have their **shortcomings**, such as **labor consumption, durability, safety, and accuracy**.

AI Poultry Weight Scale

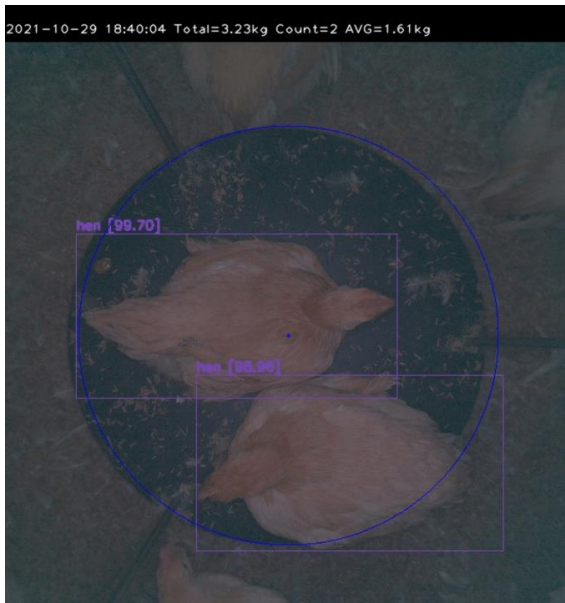
- ❑ Integrating the **camera** into the weighing machine, the AI algorithm could be used to know **how many poultry are on the weighing platform** to further obtain accurate poultry average weight.
- ❑ Collect poultry images for machine learning and train a poultry identification model.
- ❑ Mechatronic integration technology integrates weight sensors, cameras, and computing units.
- ❑ Integrated wireless communication function, the measured data can be automatically uploaded to the cloud. This system equipped with automatic zero correction function.



Average weight =

$$\frac{\text{Total weight}}{\text{Number of chickens on the platform}}$$

AI Poultry Weight Scale – AI poultry detection model



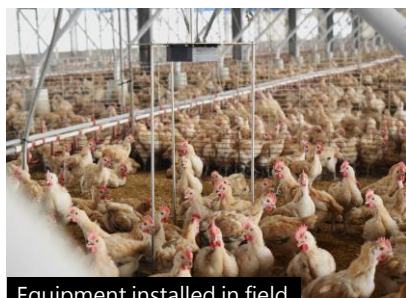
- YOLO was used as the poultry detection train model.
- So far, the labelled images are Taiwanese native chicken, broiler, turkey, goose, duck for 5000, respectively.

IoU = 0.5	Predict-Yes	Predict-No
Actual-Yes	TP = 426	FN = 32
Actual-No	FP = 8	TN

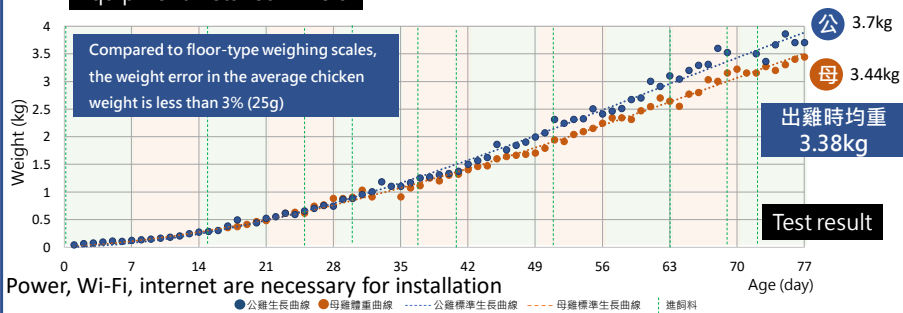
- The accuracy of Taiwanese native chicken detection by AI is over than 95%.

AI Poultry Weight Scale – Automated Chicken Weight Measurement and Daily Weight Monitoring

Commercialization completed

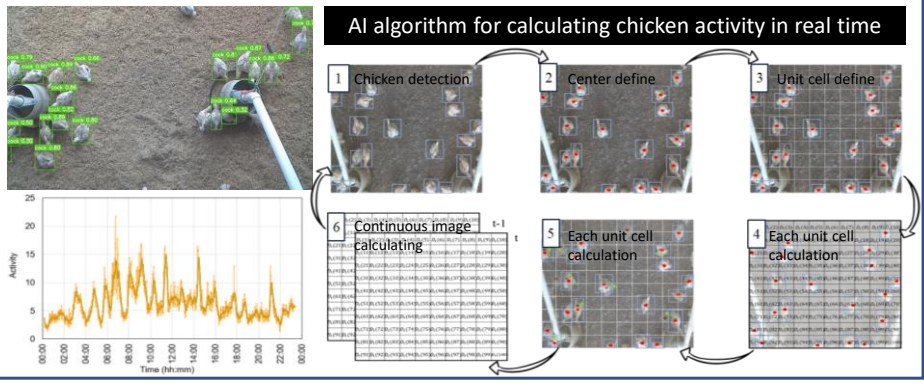


Equipment installed in field



Chicken Activity and Laser Response Assessment System

- ❑ **Chicken activity** is one of important index that the farmer need to observe everyday.
- ❑ The **activity algorithm based on density change** was used to quantify the **chicken activity** in the continuous images in real time.
- ❑ However, there are **too many factors would effect the chicken activity** such like environmental conditions, chicken age, event (feeding time..), daily routine behaviors, health condition and ...
- ❑ Therefore, if we want to **make the warning based on chicken activity**, the **big data about activity** should be collected firstly.

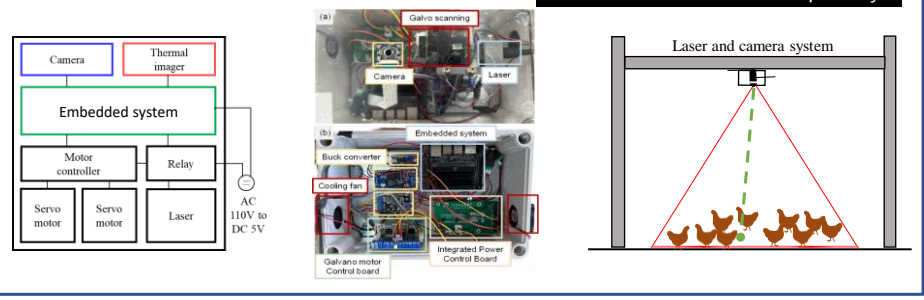


Chicken Activity and Laser Response Assessment System

- ❑ The **response** means the **chicken activity condition during the stimulation process**.
- ❑ **Laser** was used as the **stimulation** for replacing the farmer stimulation.
- ❑ Using laser as a stimulation and integrating AI image processing technology to develop a chicken laser response assessment system.



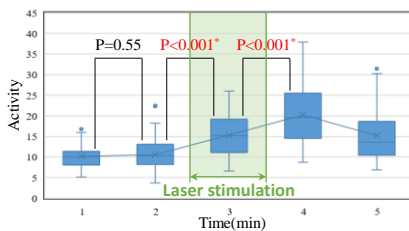
Farmer as a stimulation to poultry



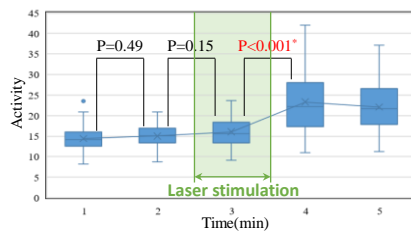
Chicken Activity and Laser Response Assessment System

- ❑ Laser response tests were carried out up to 3 times a day, with at least 3 hours between each tests.
- ❑ For health chicken, the chicken have **RESPONSE to the laser stimulation**. The **activity were increased** at or after laser stimulation process.

Health chicken at 4-6 weeks age



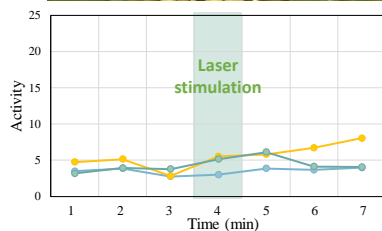
Health chicken at 7-10 weeks age



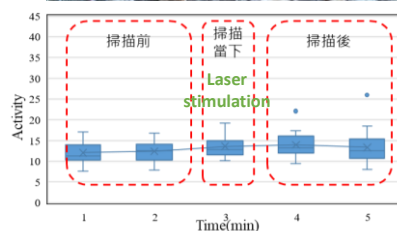
Chicken Activity and Laser Response Assessment System

- ❑ For **unhealthy chicken** or chicken **on heat stress condition**, these chicken were **not have RESPONSE** to the laser stimulation.
- ❑ So far, we have test for **3 months** for health Taiwanese native chicken. With **laser stimulation 3 times a day**, the chickens still have interest to the laser and will **not become habituated**.

Chicken on heat stress



Unhealthy chicken



Chicken's comb and eyes identification technologies

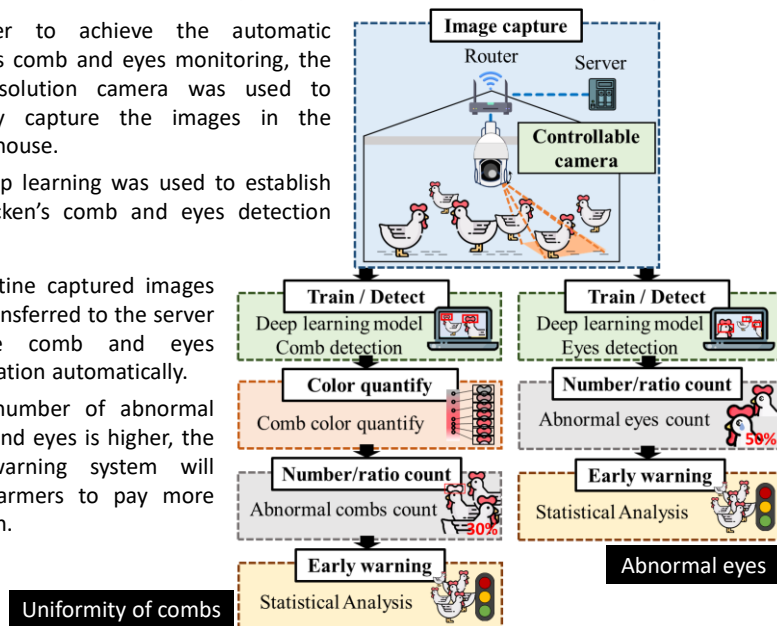
- For farmers' daily work, in addition to observing the response of poultry, the appearance of poultry is also an important observation indicator.
- Among the appearance of poultry, **combs** and **eyes** are two important points.



- For chicken combs, **uniformity** is an important quantitative indicator.
- If there are some combs that are too dark or too white often means the feeding management problem or the risk of disease.
- Due to the **comb and eyes are much smaller objective**, the **high resolution and zoom controllable camera** should be used in the poultry house.
- For chicken eyes, **abnormal eyes** need to be attended.
- Diseased chickens often have abnormalities in the eyes, and the disease spreads very quickly.

Chicken's comb and eyes identification technologies

- In order to achieve the automatic chicken's comb and eyes monitoring, the high resolution camera was used to routinely capture the images in the poultry house.
- The deep learning was used to establish the chicken's comb and eyes detection models.
- The routine captured images were transferred to the server for the comb and eyes identification automatically.
- If the number of abnormal combs and eyes is higher, the early warning system will notify farmers to pay more attention.

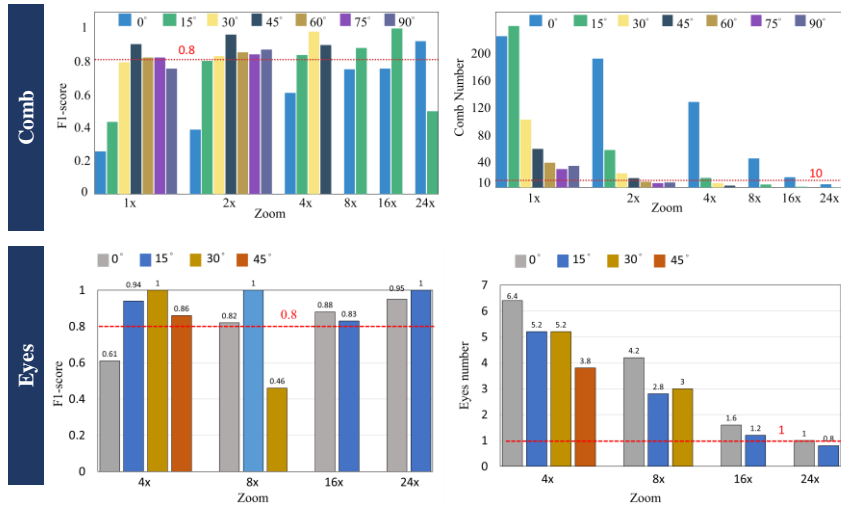


Chicken's comb and eyes identification technologies

F1-score =

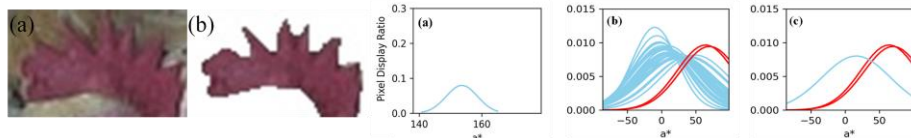
$$\frac{2 \times \text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}}$$

- For the combs, the useful images are defined as the AI detection F1-score higher than 0.8 and the number of combs is much than 10.
- For the eyes, the useful images are defined as the AI detection F1-score higher than 0.8 and the number of combs is much than 1.



Chicken's comb and eyes identification technologies

- For combs monitoring, the uniformity of combs is important. Therefore, each comb color was quantified for the uniformity analysis.
- Otsu binarization was used to remove the background part of the image and the a^* value of CIELAB color space for each comb was calculate for obtaining the comb number of outliers.



Video: High-Resolution Imaging + AI Comb Recognition



Video: High-Resolution Imaging + AI Eyes Recognition



Conclusions and Future works

- ❑ To upgrade from an **automatic poultry house** to a **smart poultry house**, **automatic monitoring of the poultry body** is a very important issue.
- ❑ With the technology development, **artificial intelligence and automation technology were introduced and applied into the poultry industry**.
- ❑ **AI laser wild bird repellent system, AI poultry weight scale, chicken activity and laser response assessment system and AI chicken's comb and eyes identification technologies** were proposed and developed for poultry application.
- ❑ The application of artificial intelligence and automation technology could effectively **save manpower and improve poultry production efficiency**.
- ❑ For the successful technology development, the **cooperation between different field teams** is necessary.

Thank you for your attention

