SUPPLEMENTARY

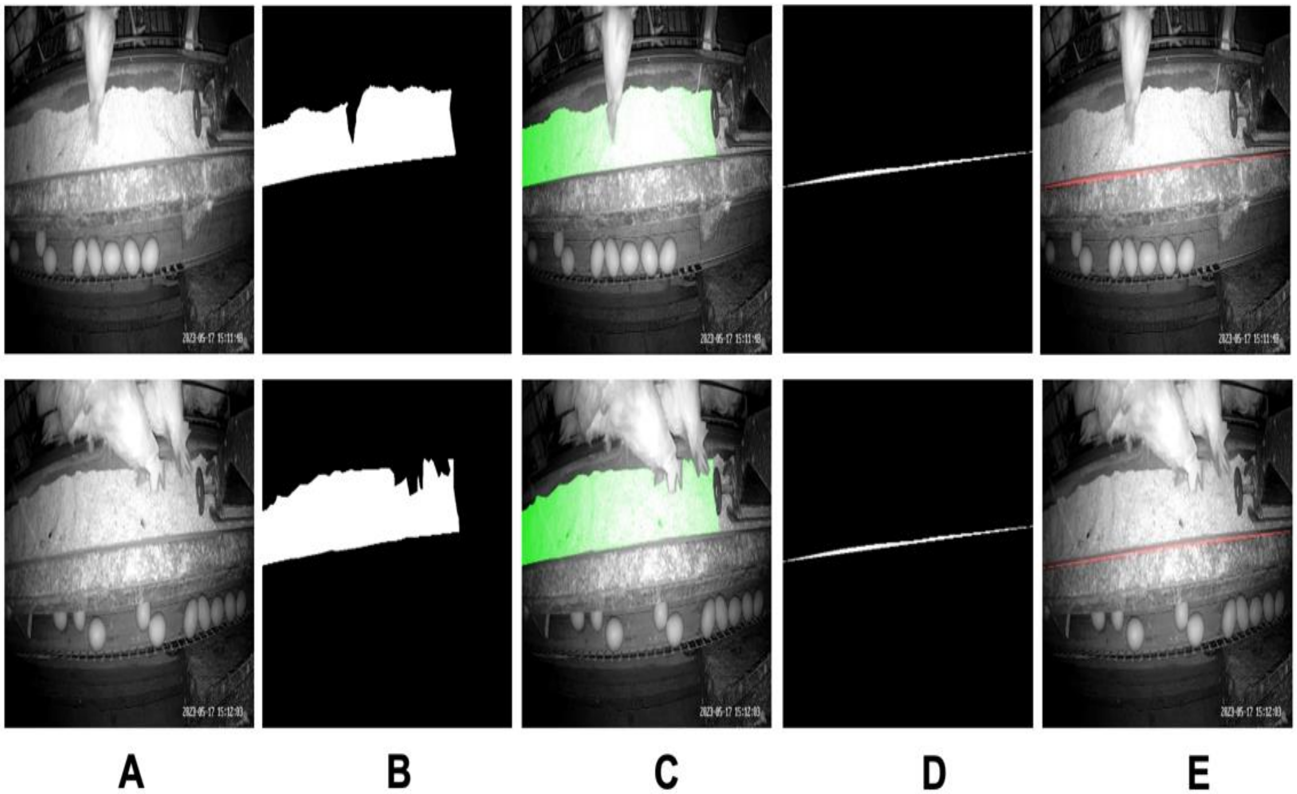

Figure 1. Feed area and feed line. A show the original images. B and D show that the mask of feed area and feed line, respectively. C and E show that the visualization of feed area and feed line, respectively.

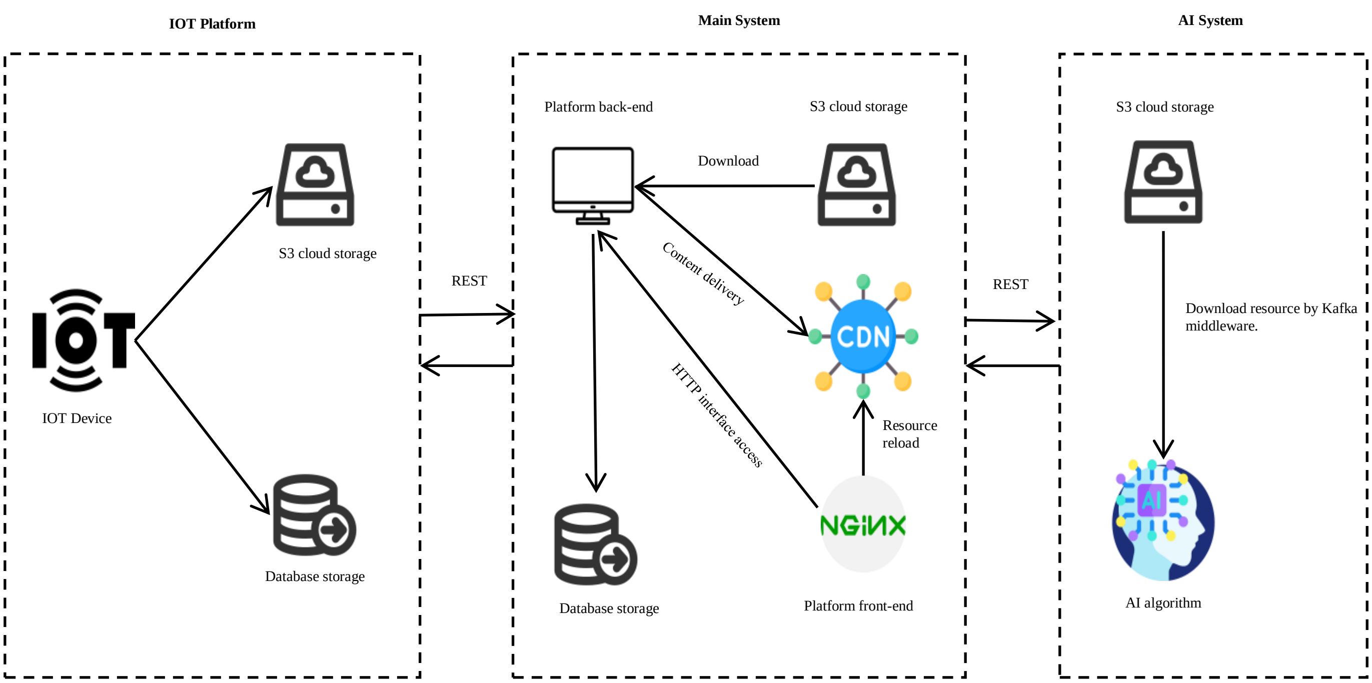

Figure 2. Development of the smart chicken farming platform

P1 P2

A

B

Figure 3. The webpage of chicken farming platform

TABLE I. ALGORITHM OF HEALTH ANALYSIS MOUDULE

Input: Detection sequence $D = \{d_1, d_2 \ldots, d_m\}$, Track
Compute matching: $Hungarian(D,T)$ using Eq.
Compute prediction $predict()$ using Eq. 13
Compute update $update(T_i)$ using Eq. 14-17

While video in progress
  if T is $None$
    Compute $OpticalTracks$ using Eq. 7-9
    $T = predict(OpticalTracks)$
  else
    $Hungarian(D,T)$
  $\rightarrow Matched_{Tracks}, Unmathed_{tracks}, Unmatched_{detections}$
    for $mt_i \in Matched_{Tracks}$ **do**
      $OpticalTracks \leftarrow update(T_i)$
    for $ud_i \in Unmatched_{detections}$
      Compute $OpticalTracks$ using Eq. 7-9
    for $ut_i \in Unmatched_{tracks}$
      Select ut_i by max_age into
  $T = predict(OpticalTracks)$
until video finish

TABLE II. ALGORITHM OF MOVING NORMAL VECTOR METHOD

Input: Sequence of mask area in video sequence:
$Seq(m) = \{m_1, m_2 m_3 \ldots m_n\}$;
Current frame mask m_i;
Moving threshold: ths
Moving Detection Function $D(m_i, m_{i-1})$
Cage object horizontal ordinate: c_x
Feed fixed horizontal ordinate: f_x
Initialed Vertical line: $VerticalLine$
Output: Well estimate feed area of each cage: $F(S; cage)$

Procedure $m_i \rightarrow Seq(m)$
  repeat
    if $ths < D(m_i, m_{i-1})$
      $VerticalLine += m_i(f_x, :)$
      if $c_x = f_x$:
        $S = VerticalLine$
        $VerticalLine := 0$
  until $m_n \rightarrow Seq(m)$
end Procedure
Return Each cages result $F(S; cage)$

TABLE III. STATISTICAL TESTING OF CKTRACK AND CLASSICAL METHODS

Model	Matric	Shapiro	P-value (T-test)	P-value (Nonparametric)
ResNext	Sensitivity	0.636470318	-	0.00390625
CKTrack		**0.022059433**		
ResNext	Specificity	0.678435385	-	0.835156615
CKTrack		0.401722282		
ResNext	Precision	0.685249746	0.654788	-
CKTrack		0.736854434		
ResNext	Accuracy	0.310656816	0.267413	-
CKTrack		0.064519487		
ResNext	Speed	0.328451842	-	0.000976563
CKTrack		0.037564632		
MobileNetV2	Sensitivity	0.307281286	-	0.00390625
CKTrack		0.022059433		
MobileNetV2	Specificity	0.136877924	0.55002	-
CKTrack		0.401722282		
MobileNetV2	Precision	0.498032033	0.990822	-
CKTrack		0.736854434		
MobileNetV2	Accuracy	0.117012478	0.599761	-
CKTrack		0.064519487		
MobileNetV2	Speed	0.043124001	-	0.000976563
CKTrack		0.037564632		
EfficientNet-b7	Sensitivity	0.01387128	-	0.00390625
CKTrack		0.022059433		
EfficientNet-b7	Specificity	0.279030621	0.55002	-
CKTrack		0.401722282		
EfficientNet-b7	Precision	0.055184528	0.852747	-
CKTrack		0.736854434		
EfficientNet-b7	Accuracy	0.123130299	0.599761	-
CKTrack		0.064519487		
EfficientNet-b7	Speed	0.610497773	-	0.000976563
CKTrack		0.037564632		
Deepsort	Sensitivity	0.040498711	-	0.009765625
CKTrack		0.022059433		
Deepsort	Specificity	0.892798603	0.983184	-
CKTrack		0.401722282		
Deepsort	Precision	0.458195865	0.980987	-
CKTrack		0.736854434		
Deepsort	Accuracy	0.095873207	0.822335	-
CKTrack		0.064519487		
Deepsort	Speed	0.254999846	-	0.000976563
CKTrack		0.037564632		

TABLE IV. FOUR MEASUREMENT DEFINITION

Measure	Definition	Formula
IOU_1	IOU for continuous regions	$\frac{\left(\frac{gt^{bg} \cap pt^{bg}}{gt^{bg} \cup pt^{bg}} + \frac{gt^{fa} \cap pt^{fa}}{gt^{fa} \cup pt^{fa}}\right)}{2}$
		gt^{bg}: the ground truth of back-ground
		gt^{fa}: the ground truth of feed area
		pt^{bg}: the prediction of back-ground
		pt^{fa}: the prediction of feed area
IOU_2	IOU for discrete instances	$\frac{\left(\frac{gt^{bg} \cap pt^{bg}}{gt^{bg} \cup pt^{bg}} + \frac{gt^{fl} \cap pt^{fl}}{gt^{fl} \cup pt^{fl}}\right)}{2}$
		gt^{fl}: the ground truth of feed line
		pt^{fl}: the prediction of feed line
IOU_3	IOU for both continuous regions and discrete instances	$\frac{(\mathrm{IOU\_1} + \mathrm{IOU\_2})}{2}$
		IOU_1: the IOU (Eq. 11) of feed area
		IOU_2: the IOU of feed line
Mape	Mean absolute percentage error, which is often used to compare the accuracy of model prediction. The smaller the value, the higher the prediction accuracy of the model.	$\frac{1}{n} \cdot \sum_{i=1}^{n} \frac{(pt^{re} - gt^{re})}{gt^{re}}$
		gt^{re}: the real number of residuals for each cage
		pt^{re}: the prediction of residuals for each cage
		n: the number of cages