

Toward Building a Data-Driven System For Detecting Mounting Actions of Black Beef Cattle

Yuriko Kawano¹, Susumu Saito^{1,2}, Teppei Nakano^{1,2}, Ikuno Kondo³, Ryota Yamazaki³, Hiromi Kusaka³, Minoru Sakaguchi³, Tetsuji Ogawa¹
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Summary

Motivation:

To build a pattern recognition-based system that detects cattle's mounting actions using video .

Approach:

1. Constructing a mounting action image dataset using crowdsourcing
2. Building a tandem-layered mounting action detector with small training data

Background

Cattle Estrus Signs:

The best indicator of estrus is when a cow mounts another cow or stands to be mounted, called "mounting actions".



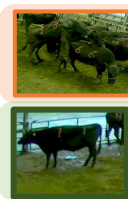
Challenges of Patter Recognition-based Approach :



1. There is no published dataset containing two cattle interactions.
2. Large-scale dataset collection for End-to-End system is challenging because mounting actions do not occur frequently.

Image Dataset Construction (details in supplements)

Detection of cattle pairs using YOLOv3



Two cattle regions

Single cattle regions

Annotation using crowdsourcing

17/10

Please answer about the cows in the target image (the figure to the right).

Is there a cow mounting (bending over) the bottom of another cow, mainly seen in the target image?

Yes No / Can't tell

Is there a cow?

Is there a cow with more than 90% of its body seen?

Are there other cows, with more than 90% of their body seen?

Are there two or more cows, with more than 90% of their body seen?

Mounting Complete multiple Complete one Incomplete multiple Incomplete one No cow/ Too blurry to tell

► Images were divided into 6 classes

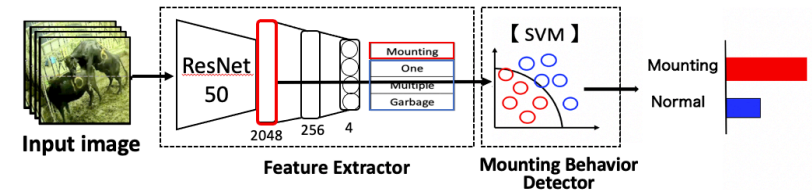
- MT
- Complete One (CO)
- Incomplete One (IO)
- Complete Multiple (CM)
- Incomplete Multiple (IM)
- Garbage (GR)

Mounting Annotation Image Dataset

Labels	Mounting	One		Multiple		Garbage
		CO	IO	CM	IM	
# of images	760	1,221	669	914	1,322	134

Mounting Action Detection Experiment

Proposed system is built on "tandem"-layered architecture.



Experiment (details in supplements)

- Dataset**
- Constructed mounting action image dataset including 29 mounting actions
 - Dataset was divided into 5 subsets to perform five-fold cross validation.
- Systems**
- E2E [baseline] - an End-to-End system for both feature extraction and mounting action detection
 - Tandem [proposed]
- Results** Outperformed the E2E system on small training data

Model	Precision	Recall	F-value
E2E	0.36	0.13	0.19
Tandem	0.80	0.76	0.78

Toward Building a Data-Driven System For Detecting Mounting Actions of Black Beef Cattle **【Supplement】**

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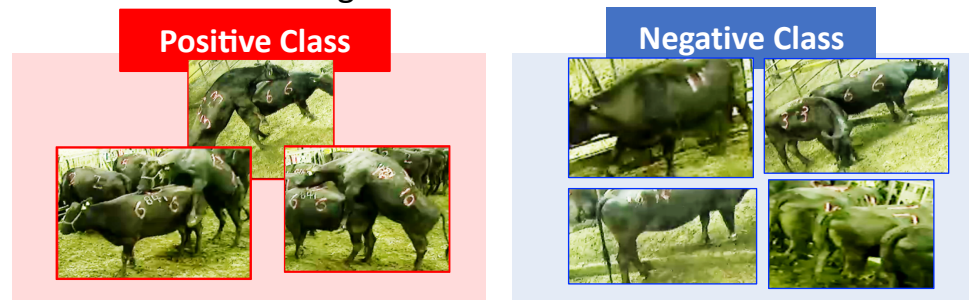
Annotation Using Crowdsourcing

Problem with annotating cattle images

1. The number of images that contain mounting actions (**positive examples**) are much fewer than that of images without them (**negative examples**)
👉 **Subdividing the negative examples based on the number of cows**
2. It is difficult to determine the number of cows in diverse images.
👉 **Classifying the negative examples according to the portion of the visible cow's body**
3. There are some spammers and careless workers.
👉 **Testing whether workers understand mounting actions before actual annotation tasks**

Qualification test

Objective: To eliminate spammers and careless crowd workers
Test images: 3 images from positive class and 4 images from each negative class



Passing criteria: Workers who answered correctly **5 or more**

Results: ✓ qualification tests were effective in selecting workers who understand mounting actions

All workers : 111 workers

Workers who passed: 51workers (46%)

precision	recall	F-value	precision	recall	F-value
0.93	0.72	0.81	1.00	0.97	0.98

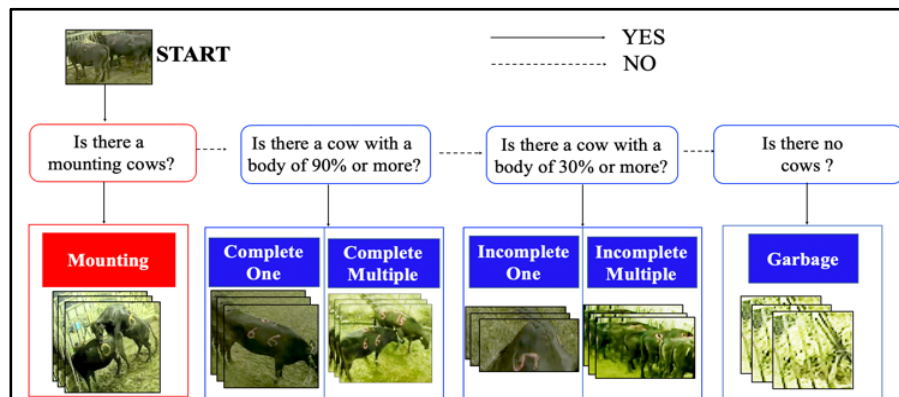
Main task

- Labels were annotated by 4 workers per image
- Final label was determined by a weighted majority on the estimated worker's ability.

Mounting Annotation Image Dataset

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Annotation workflow

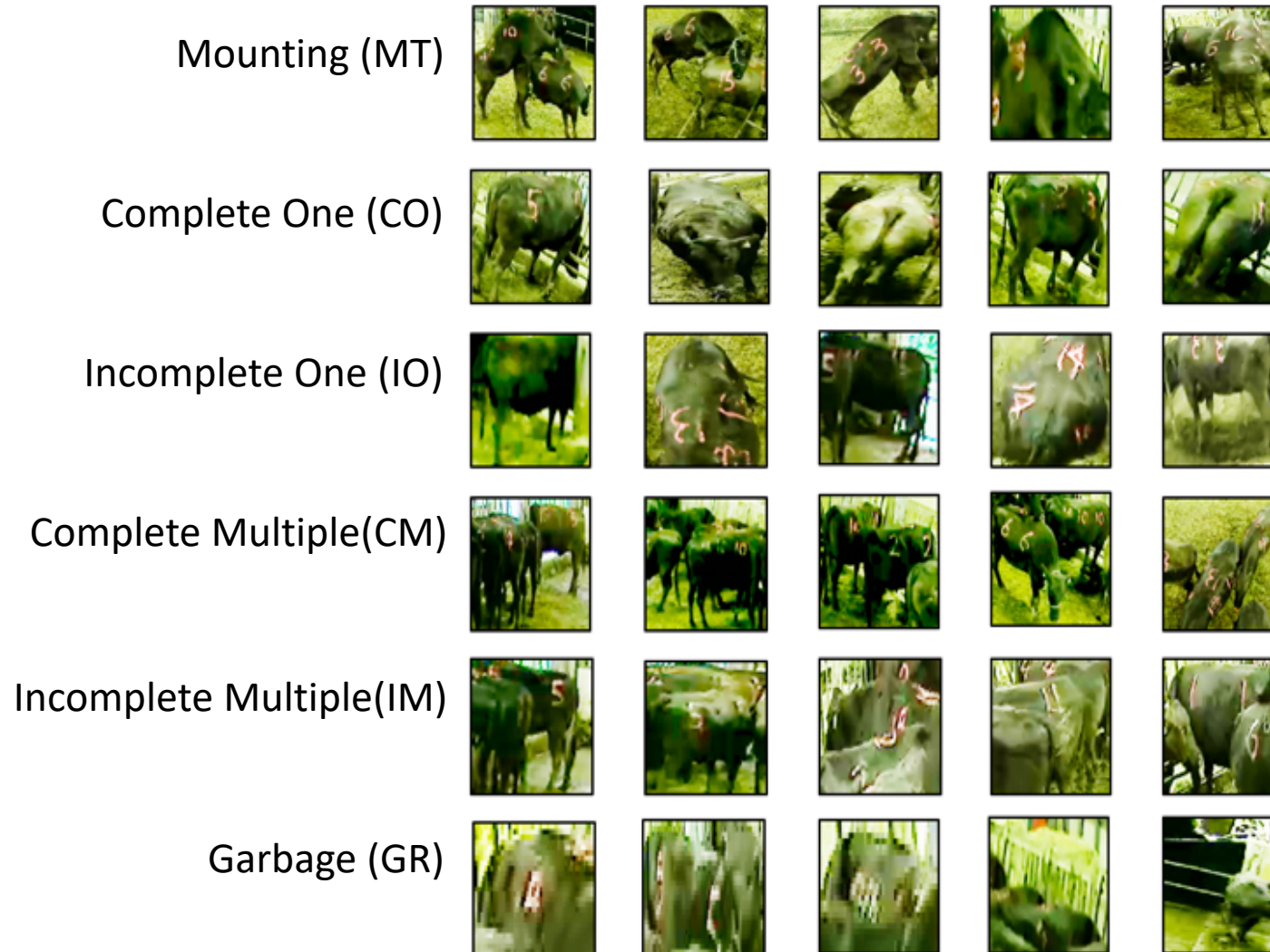


- Workers were required to give labels to 20 different images in a row before receiving a reward of 80 cents..
- crowdsourcing platform: Amazon Mechanical Turk (AMT)

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Mounting Action Image Dataset



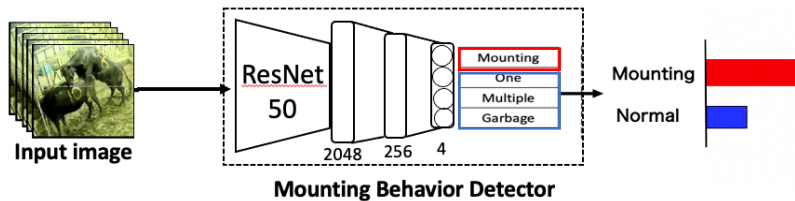
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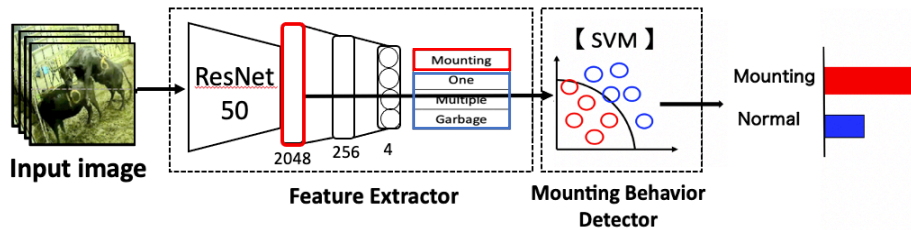
Mounting Action Detection Experiment

Systems to compare

➤ End-to-End System [baseline]



➤ Tandem-layered System



Input image • cattle regions detected by YOLOv3
• resized to 224×224
• color tone correction using gamma correction

Dataset

A constructed image dataset included 20 mounting actions was divided into 5 to perform 5-fold cross validation

idx	Mounting	One	Multiple	Garbage
1	164	452	430	56
2	161	334	397	20
3	182	382	394	14
4	141	389	571	39
5	141	327	422	4
Total	789	1884	2214	133

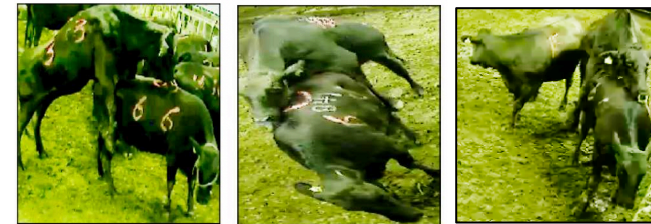
Results ✓ Outperformed the E2E system on small training data

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Qualitative results with the positive-class label (MT)

➤ True-Positive Detection Results

✓ Mounting actions were detected correctly when images included a mounting cow obviously.



➤ False-Negative Detection Results

✓ Mounting actions seemed difficult to be detected when images included only a part of a mounting cow or they were blurry.

