Computer vision for automated calf respiratory health scoring

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Introduction

- Respiratory diseases threaten animal welfare and cause economic losses due to reduced growth and early culling (Buczinski et al., 2021).
- Health scoring systems make use of multiple visible respiratory disease indicators such as ocular and nasal discharge, ear posture, and head carriage (Poulsen and McGuirk, 2009)
- Manual scoring is subjective, labor-intensive, and hard to scale. Observer variability and delayed detection of subtle symptoms limit the reliability and efficiency.

Objectives

Develop an automated, scalable, and objective system for respiratory health scoring in calves using computer vision.

Materials

Study setting

- Conducted on a commercial dairy farm in central New York.
- Enrolled 100 group-housed female Holstein calves.

Data collection

- Weekly video recordings using DJI Pocket 2 camera.
- Camera held ~0.5 meters from calf face.
- Key frames selected, cropped, resized to 640×512 pixels.

Annotation protocol

- Annotated regions: 👁 Eye, 👃 Nose, 👂 Ear.
- Scoring range: 0 (normal) to 3 (severe).
- Consensus labels used to address annotator variability.

Table 1. Annotation distribution across health scores

Indicator	Score 0	Score 1	Score 2	Score 3	Total	Images
Ocular discharge	964	694	180	56	1894	1883
Nasal discharge	1097	537	179	4	1817	1817
Ear posture	2292	657	311	137	3397	1674

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AI can be used to identify visual signs of respiratory disease in calves

Methodology

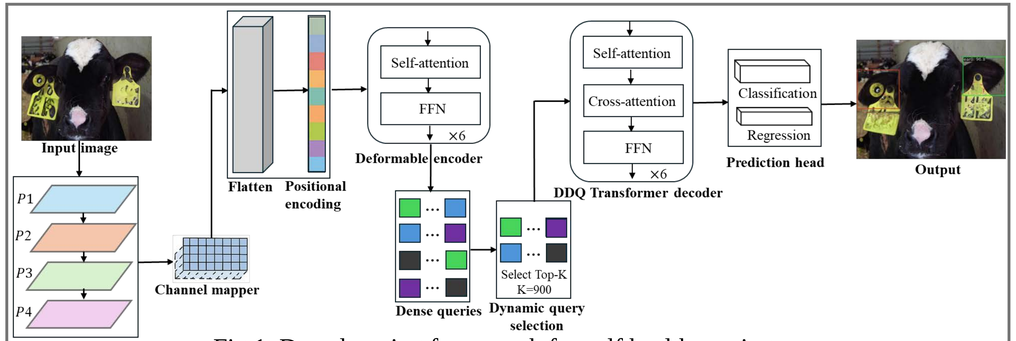

Fig.1. Deep learning framework for calf health scoring

- Swin Transformer extracts multi-scale spatial features from facial images.
- Deformable Transformer encoder focuses attention on key regions (eye, nose, ear).
- Dynamic query selection enhances prediction by filtering the most relevant features.

Conclusion

- ✅ The proposed model accurately scores key respiratory health indicators in calves.
- ✅ Ocular and nasal discharge yielded higher performance and consistency than ear posture.
- ✅ Annotation quality is critical for model reliability in veterinary AI applications.

Future work

- ⚠️ Limitations include dataset imbalance and subjectivity in human-labeled scores.
- 🔄 Future work will focus on dataset expansion, improved annotation protocols.

Results

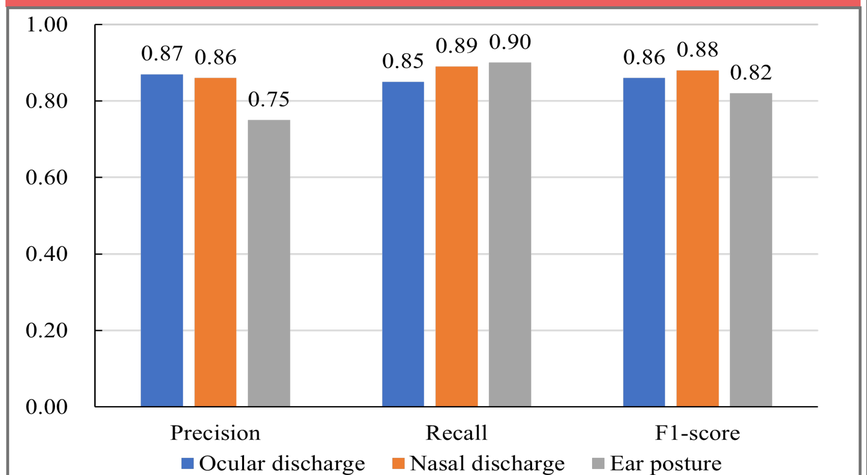

Fig.2. Model performance on health indicators

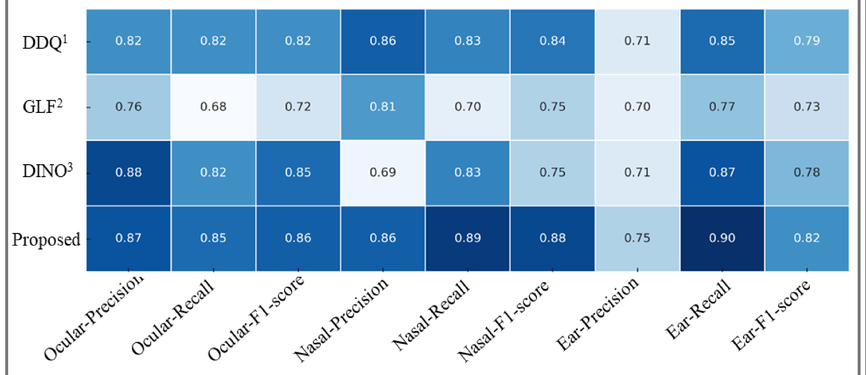

Fig.3. Comparison with baseline models on health indicators

[1]Dense Distinct Query Network (Zhang et al., 2023); [2]Generalized Focal Loss Network (Li et al., 2020); [3]DETR with Improved Denoising Anchor Boxes (Zhang et al., 2022).

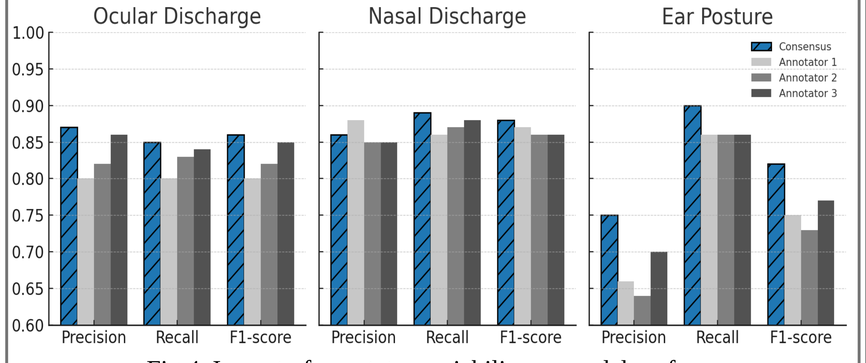

Fig.4. Impact of annotator variability on model performance