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INTEGRATION OF A REAL-TIME DAIRY COW EYE TEMPERATURE MONITORING SYSTEM BASED ON DEEP LEARNING AND THERMAL IMAGING

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ABSTRACT

Early detection of heat stress and illness in dairy cows is critical for maintaining herd health and optimizing milk production. Among various physiological signals, body temperature is a key indicator of health status. In this study, we present a real-time, non-contact monitoring system that integrates dual-channel thermal imaging and deep learning for precise and automated surveillance. The system processes RGB and thermal video streams in parallel: in the RGB channel, YOLO detects faces, ByteTrack maintains tracking across frames, and a ResNet-50 model with ArcFace loss performs face recognition, achieving 99.7% accuracy across 242 identities. In the thermal channel, a YOLOv11-based model detects eye regions, and the maximum temperature within each region is extracted. The thermal model achieved a mean average precision (mAP@50) of 92.4%, ensuring reliable eye localization. By synchronizing spatial and temporal information across channels, the system continuously associates each cow's identity with its eye temperature profile. Field deployment at both a commercial-scale dairy farm and a university experimental farm confirmed stable operation, with the herd averaging 37.2°C (SD = 0.8°C) over ten days. Beyond real-time monitoring, the system supports long-term statistical analysis of herd- and individual-level temperature patterns, facilitating the identification of abnormal fluctuations and enabling automated health alerts. The integrated approach demonstrates strong potential for precision livestock farming, reducing manual labor while enhancing efficiency and responsiveness in herd health management.

Keywords: dairy cow health monitoring, thermal imaging, object tracking, YOLO, deep learning

INTRODUCTION

Heat stress and illness reduce dairy cow productivity, with body temperature as a key health indicator. Traditional measurements are invasive and unsuitable for continuous use, whereas thermal imaging and deep learning offer non-contact alternatives. This study presents a real-time dual-channel system that combines face recognition with eye temperature monitoring to track individual cows and support early detection (Little et al., 2025) of health issues in precision livestock farming.

MATERIALS AND METHODS

HARDWARE SETUP

A dual-channel thermal camera (Dahua TPC-BF1241) was mounted obliquely above the milking corridor at both a university experimental farm and a commercial dairy farm. Monitoring was performed twice daily during routine passages.

COW FACE RECOGNITION

A ResNet-50 model with ArcFace loss (Deng et al., 2019) was trained on 242 cow identities. During operation, YOLO detected faces in RGB frames, and ByteTrack maintained sequences across frames. Frame-level predictions were aggregated by a voting method to assign the final cow identity.

COW EYE TEMPERATURE MONITORING

A YOLOv11 model detected eye regions in thermal frames, and the maximum pixel temperature was extracted using the Dahua SDK. These detections were synchronized with face recognition outputs to link temperatures to individual cows, enabling continuous monitoring and both herd-level and individual-level analysis.

RESULTS & DISCUSSION

MODEL PERFORMANCE

The cow face recognition model using Arcface accurately distinguished 242 cow identities, achieving 99.7% in accuracy and F1 score on 9,869 test images, indicating strong feature separability. The YOLOv11 thermal eye detection model achieved mAP@50 of 90.5%, precision of 88.1%, and recall of 87.4%, demonstrating reliable eye localization.

EYE TEMPERATURE MONITORING AND STATISTICAL ANALYSIS

Thermal detections were consistently matched with RGB-based face recognition, enabling continuous eye temperature tracking for individual cows. Over a 10-day monitoring period, the herd exhibited an average eye temperature of 37.2°C with a standard deviation of 0.8°C. Such analysis highlights the system's potential for detecting abnormal patterns, including outlier cows with elevated temperatures that may indicate early signs of heat stress or illness.

CONCLUSIONS

This study developed a real-time dual-channel system for dairy cow health monitoring. The face recognition model achieved 99.7% accuracy across 242 identities, and the thermal eye detection model reached an mAP@50 of 90.5%, enabling reliable identity-temperature association. Field deployment confirmed automated monitoring feasibility, with the herd averaging 37.2°C (SD = 0.8°C) over ten days. The system supports herd- and individual-level analysis, offering potential for early detection of heat stress and illness.

REFERENCES

- Deng, J., Guo, J., Xue, N., & Zafeiriou, S. (2019). Arcface: Additive angular margin loss for deep face recognition. In Proceedings of the IEEE/CVF conference on computer vision and pattern recognition (pp. 4690-4699).
- Little, M. W., Weller, J. E., & Buijs, S. (2025). The impact of the dairy cow's position on eye and udder temperatures obtained with infra-red thermography within a walk-trough system. *animal*, 101523.