3D Visual Reconstruction-Based Method for Comprehensive Morphological Scoring of Dairy Cows

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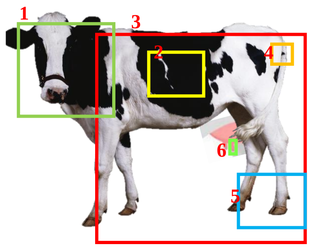
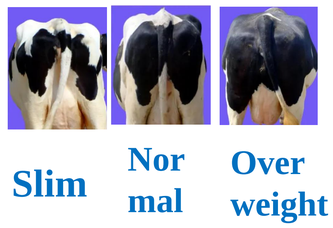
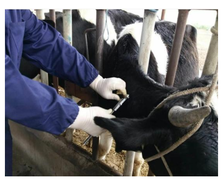
Introduction

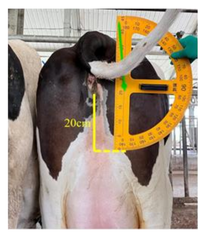
Comprehensive morphological assessment of dairy cows is a crucial tool for evaluating fat reserves, nutritional status, and reproductive performance. By monitoring body condition scores (BCS) at different stages, management strategies can be optimized in a timely manner, effectively reducing metabolic disorders and reproductive issues, thereby improving production efficiency and increasing farming benefits.





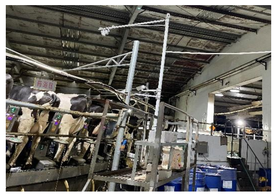
Current morphological assessments in most dairy farms still rely on manual scoring, which is subject to inconsistency, low efficiency, and high labor costs due to the extensive training required. Additionally, direct contact with cows may induce stress, affecting animal welfare and making manual scoring impractical for large-scale farming operations.

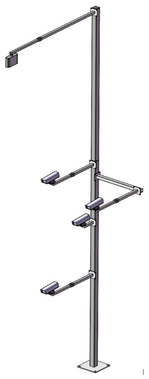




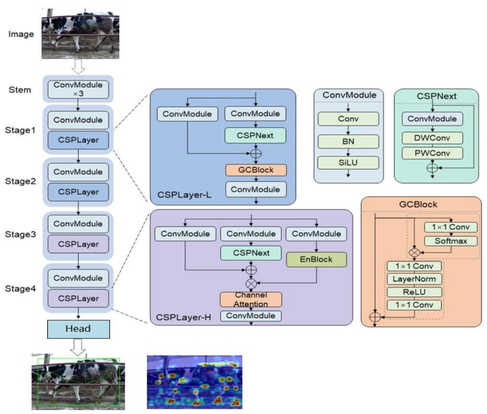
This study addresses the urgent need for high-quality phenotypic data collection in dairy cattle breeding and health management. By overcoming the limitations of traditional manual assessment—such as low efficiency, high labor costs, and inadequate quality control—our approach provides a practical and intelligent monitoring solution for improving dairy farming practices.

Method



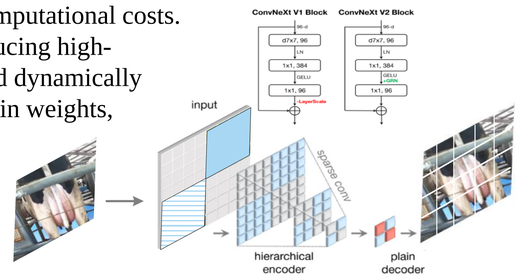


We designed a data collection scheme to obtain individual travel data, with experimental data coming from milking equipment and cow return channels

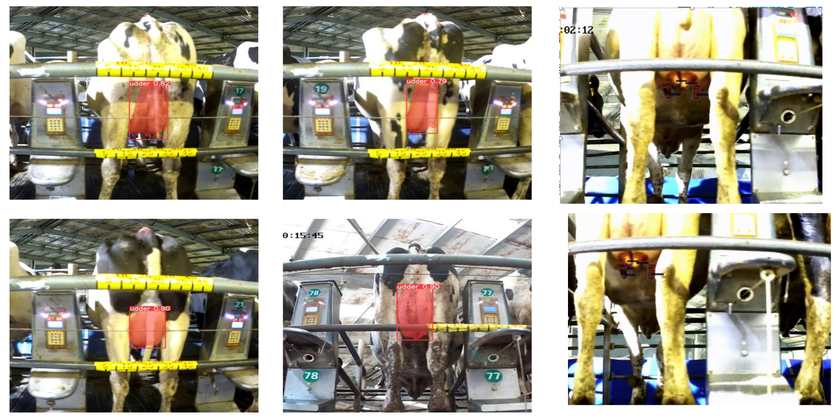


We propose a keypoint detection model for identifying dairy cow morphological traits and extracting structural features. The model determines whether the cow maintains a proper stance, including head position and limb alignment. To improve performance, we adopt a cross-stage partial network (CSPNet) design, which enhances computational efficiency by segmenting gradient flows while preserving feature information.

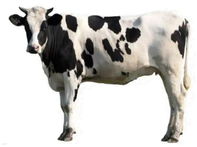
We introduce a background suppression training strategy that effectively eliminates non-target regions, improving reconstruction accuracy and reducing computational costs. By removing aliasing-inducing high-frequency components and dynamically adjusting frequency-domain weights,



Contributions



Our model achieves significant performance gains on a multi-view dairy cow image dataset: MAE reduced from 0.0739 to 0.0645, Sm improved from 0.8370 to 0.8628, and Em increased from 0.9066 to 0.9147, ensuring more precise boundary predictions while minimizing false foreground segmentation.



Dairy cattle

Breeder

We developed a cow body appearance scoring application system to serve dairy farming and breeding experts. This system automates the collection of cow physical appearance data and implements automated body condition scoring (BCS). Additionally, it can integrate expert experience to facilitate remote assessment. By integrating multiple research findings, the system achieves a scoring error margin of plus or minus one point.

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