Automated Claw Locomotion Scoring System for Dairy Cows

Lee Chia Xin[1], Wang Ko Shyan[2], Ting Wen Hung[2], Huang Fei Ping[2], Wamg Szu Ham[1], Shiau Jen Wen[1], Huang Jeng Fang*[3]

[1] Northern Region Branch, Taiwan Livestock Research Institute, Ministry of Agriculture, Miaoli, Taiwan, [2] Smart Sensing and Systems Technology Center, Industrial Technology Research, Tainan, Taiwan, [3] Taiwan Livestock Research Institute, Ministry of Agriculture, Tainan, Taiwan

Lameness is a major health problem in dairy cows and a leading cause of reduced productivity, compromised animal welfare, and involuntary culling, particularly in intensive dairy systems under hot and humid climates such as Taiwan. Conventional locomotion scoring relies on subjective visual observation, is labor-intensive, and often fails to detect lameness at an early stage. The objective of this study was to develop and evaluate an automated, image-based claw locomotion scoring system for dairy cows using artificial intelligence.

Data were collected from a commercial dairy farm in central Taiwan over a 10-month period (January–October 2025). Holstein dairy cows housed in free-stall barns and fed a total mixed ration were monitored across different stages of lactation. Side-view walking images were recorded twice daily using synchronized 2D and 3D cameras installed along the milking parlor exit alley, yielding 21,334 walking image samples. Locomotion scores were assigned by experienced experts using a five-point scoring system. An automated lameness analysis framework integrating image segmentation and deep learning was developed. Sixteen anatomical skeletal key points were defined and annotated from lateral-view images to characterize posture and limb movement. Gait was classified into three categories—normal, mild lameness, and severe lameness—corresponding to the conventional five-point locomotion scoring system. The proposed model combined a convolutional neural network and a long short-term memory network to capture spatial and temporal gait features. Model performance was evaluated using temporally separated training and testing datasets across ten independent periods.

Across all test datasets, 22,228 labeled lameness samples were analyzed, of which 19,932 were correctly classified, resulting in an overall accuracy of 89.67%. The proposed image-based system demonstrated stable and reliable performance in automated lameness classification. These findings indicate that the system provides an objective, non-invasive, and effective approach for early lameness detection, with strong potential to enhance precision dairy management, improve animal welfare, and reduce involuntary culling in commercial dairy farms.