Challenging the norm – lameness on dairy and beef cattle operations with particular focus on digital dermatitis

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Abstract

After a (very) brief introduction to digital dermatitis (DD) prevention and control, different approaches to AI-enhanced detection tools for DD and lameness in cattle will be discussed regarding their challenges and potential for informed decision-making in bovine practice.

Introduction to digital dermatitis

Bovine digital dermatitis (DD) is a significant cause of lameness in cattle worldwide, affecting both dairy and beef cattle. The disease is characterized by ulcerative lesions, often located on the hindfeet near the coronary band. Endemic DD outbreaks are common, especially after introducing new cattle into herds. Prevention, control and early detection of DD are critical in minimizing its impact on livestock.

Prevention and control of DD

Common preventive measures include walk-through disinfecting footbaths, used to maintain herd health. In the U.S., solutions like 3% formalin or 2-5% copper sulfate are employed, typically three times per week. However, these methods are preventive, not curative. While alternative products, such as organic acids, show varying levels of success, they often fail to prevent outbreaks, especially during high-risk periods like late summer and early fall. Treatment is most effective when lesions are addressed promptly in a restraining chute using treatments like copper chelate gels, but not copper sulphate salts applied to open lesions directly because of their caustic effect.

Functional hoof trimming and recognition of associated problems, such as heel horn erosions or ulcers, also contribute to an effective DD control strategy. Early detection and treatment of large M2 lesions (greater than 2 cm in diameter) are key to successful management. Misuse of harsh treatments or aggressive lesion scraping can exacerbate the condition by causing proliferative skin responses.

AI detection and automated monitoring

Advances in artificial intelligence (AI) and computer vision provide new opportunities for early DD detection and trend monitoring. Computer vision models, trained on annotated images, are now accessible to both academic and commercial sectors. These models can enhance decision-making processes, whether applied for immediate real-time detection or using cloud-based applications. Challenges such as false positives, cattle movement, and occlusion of shapes need to be addressed to ensure accuracy in real-time detection systems.

AI-enhanced detection models may need to handle different cattle movements and lighting conditions, especially for fast-moving animals or objects. Labeling data accurately is crucial for effective training of these models. AI tools like Meta's Segment Anything Model (SAM) offer potential for improved labeling and prediction performances of computer vision models, but challenges remain in terms of overfitting and detecting small DD lesions in large images.

Challenges of implementing AI detection

Reliable internet access is critical for cloud-based systems, which can be challenging in remote cattle environments. Many producers prefer portable systems that operate locally, without the need for constant web connectivity. Systems must also be durable, capable of withstanding harsh conditions on farms, and require lightweight, portable hardware solutions like NVIDIA Jetson or Raspberry Pi. Hand-held devices such as mobile phones also show promise, but may have limitations in field use.

Model choices and commercial considerations

Complex AI models offer high accuracy but may not meet the speed requirements for real-time decisions. Simpler models like tiny-YOLO or TensorFlow Lite offer faster processing but may sacrifice prediction accuracy. Producers must also consider costs, data security and environmental challenges when choosing between cloud-based or local AI-enhanced DD detection systems.

Outlook

The future of AI-enhanced DD detection lies in combining computer vision with expert systems and large language models (LLMs). Multimodal models incorporating visual, audio, and text inputs will provide more accurate disease detection and expert guidance, promoting animal welfare and productivity through AI-driven prevention and control strategies.

