Dairy Cows Teat-End Condition Classification Using Deep Learning

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1 Introduction

Mastitis is a commonly occurring disease in dairy cows which is caused by infections in their mammary glands via the teat canal. However, accurately determining the severity of Mastitis from images can prove to be a challenging task. Previous studies have utilized GoogLeNet transfer learning and Separable Confident Transductive Learning to classify hyperkeratosis severity with a four-level classification scheme, yielding accuracy rates ranging from 46.7

In this study, a novel deep learning model has been proposed that utilizes various architectures such as CNNs, Inception, and Resnets to improve the accuracy of Mastitis severity classification. The approach also employs a technique called pseudo-labeling adjustment, which involves retraining the model using high-confidence images that were correctly predicted. This fine-tunes the network and improves its accuracy. The aim of this study is to develop an efficient and effective approach for precisely classifying the severity of Mastitis in dairy cows.

2 Related Work

2.1 Transductive learning

Transductive learning is a machine learning technique that uses both labeled training data and unlabeled test data to improve classification performance. The primary objective is to find an appropriate function that utilizes the unlabeled data to improve predictions for specific, unlabeled data points. This method considers the predicted labels for the test samples as optimization variables that can be iteratively updated in the training process.

Transductive learning is beneficial in scenarios where there is a limited amount of labeled data available. It enables the model to use the existing labeled data to make predictions for a specific set of unlabeled data points, rather than training on the entire dataset. This feature makes it highly useful in semi-supervised learning situations.

2.2 Pseudo Labeling

Pseudo Labeling is a technique used in semi-supervised machine learning where a model is initially trained on a small set of labeled data. Then, the model is used to predict labels for a larger set of unlabeled data. These predicted labels are then combined with the labeled data set, and the model is retrained on the entire combined set.

In the study, images with high-confidence predictions by the model were identified and used for retraining. This process fine-tunes the network and ultimately improves its accuracy.

3 Methods

3.1 Motivation

Mastitis is a costly and common disease in dairy cows, and accurately identifying its severity through image classification is a significant challenge. My objective is to create a unique deep learning model

that utilizes various architectures, including CNNs, Inception, and Resnets, to enhance the accuracy of Mastitis severity classification. Additionally, the model will incorporate the pseudo-labeling adjustment technique to fine-tune the network and further improve its accuracy

3.2   Neural Network

I created a deep neural network model with a variety of layers, including convolutional layers, pooling layers, fully connected layers, batch normalization layers, and specialized blocks such as InceptionBlock and ResNetBlock. The input of the model is an image with three channels, and the output is a softmax classification of the predicted probabilities for each class. The architecture of the model is designed to extract features from the input image through convolutional layers, combine them using InceptionBlocks, and then pass them through a series of ResNetBlocks to generate an abstract feature representation for classification.

The InceptionBlock in my model includes five convolutional layers with different kernel sizes, batch normalization, and ReLU activation. The output of these layers are concatenated to extract features at different spatial scales. This design enables the network to recognize complex patterns in the input data by capturing both fine-grained and coarse-grained features simultaneously.

The ResNetBlock is a residual block that consists of two convolutional layers with batch normalization and ReLU activation in between. The second convolutional layer's output is added to the input of the block, allowing the network to learn residual mappings that bypass the identity mapping. This approach prevents the gradient vanishing problem that can occur in very deep networks, allowing the network to learn deeper and more complex representations. The ResNetBlock is used in the model to further refine the features extracted by the InceptionBlock, leading to better classification performance.

4   Results

4.1   Please add this section

5   References

1] Thorsten Joachims. "Transductive learning via spectral graph partitioning". In: Proceedings of the 20th international conference on machine learning (ICML-03). 2003, pp. 290–297.

[2] Kaiming He et al. "Deep Residual Learning for Image Recognition". In: CoRR abs/1512.03385 (2015). arXiv: 1512.03385. url: http://arxiv. org/abs/1512.03385.

[3] Christian Szegedy et al. "Going Deeper with Convolutions". In: Computer Vision and Pattern Recognition (CVPR). 2015. url: http://arxiv.org/ abs/1409.4842.

[4] Eric Arazo et al. "Pseudo-labeling and confirmation bias in deep semisupervised learning". In: 2020 International Joint Conference on Neural Networks (IJCNN). IEEE. 2020, pp. 1–8.

[5] I.R. Porter, M. Wieland, and P.S. Basran. "Feasibility of the use of deep learning classification of teat-end condition in Holstein cattle". In: Journal of Dairy Science 104.4 (2021), pp. 4529–4536. issn: 0022-0302. doi: https : / / doi . org / 10 . 3168 / jds . 2020 - 19642. url: https : / / www . sciencedirect.com/science/article/pii/S0022030221001375.

[6] Youshan Zhang et al. "Separable confident transductive learning for dairy cows teat-end condition classification". In: Animals 12.7 (2022), p. 886.