Dairy Cows Teat-End Condition Classification Using Deep Learning

Kiran Sai Vutukuri

March 25, 2023

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

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 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.

3.1 Neural Network

The CNet model is a deep convolutional neural network designed for image classification tasks. The model comprises several layers, including convolutional layers, pooling layers, and fully connected layers. The model's input 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 and pooling layers, and then pass them through a series of CNet blocks to generate an abstract feature representation for classification.

The CNet block is a specialized 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 CNet block is used in the model to further refine the features extracted by the previous layers, leading to better classification performance.

The model's architecture is designed to learn features at different scales and combine them effectively to recognize complex patterns in the input data. This is achieved through the use of multiple convolutional layers with different kernel sizes, which enable the network to capture both fine-grained and coarse-grained features simultaneously. The model also includes batch normalization layers, which normalize the inputs to each layer, reducing the internal covariate shift and improving the network's training speed and performance. Overall, the CNet model is an effective architecture for image classification tasks, leveraging both convolutional and residual blocks to learn complex features and achieve high classification accuracy.

Finally, the model can be used to make predictions by passing the input data to the forward function of the model.

4 Results

Using the Cow Test software, the accuracy of the test dataset was determined, and the resulting accuracy score was 59.63 percent. This score suggests that the model performed rather well on the test dataset, although additional optimization may be required to increase its accuracy. It's crucial to remember that accuracy ratings can differ based on the dataset and evaluation metrics utilized, so it's advised to assess model performance across a variety of metrics and datasets to get a full picture of its capabilities.

5 References

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

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

3. 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.