A computer vision pipeline that uses thermal and RGB images for the recognition of Holstein cattle

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Motivation

- The monitoring of cattle in farms is important as it allows farmers to keep track of the performance indicators and any signs of health issues
- The ear-tagging approach has been called into question on numerous occasions because of physical damage [1] and animal welfare concerns

Data acquisition

- The data acquisition was carried out at the **Dairy campus** in Leeuwarden over a period of **9 days** using the **FLIR E6 thermal Camera**

Dairy Campus

Dairy Campus, Leeudwarden, The Netherlands

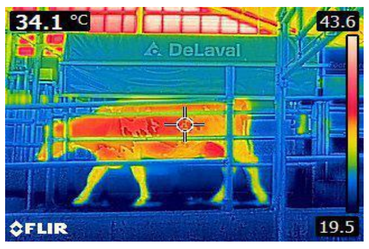
- Campus with interdisciplinary culture for innovation of dairy farming

Thermal Camera

FLIR E6 thermal camera

- FLIR E6 is a thermal imaging camera which utilizes straightforward point and shoot operation
- The camera generates two images for each shot:
  - Thermal image of size 320 x 240 pixels
  - RGB image of size 640 x 480 pixels

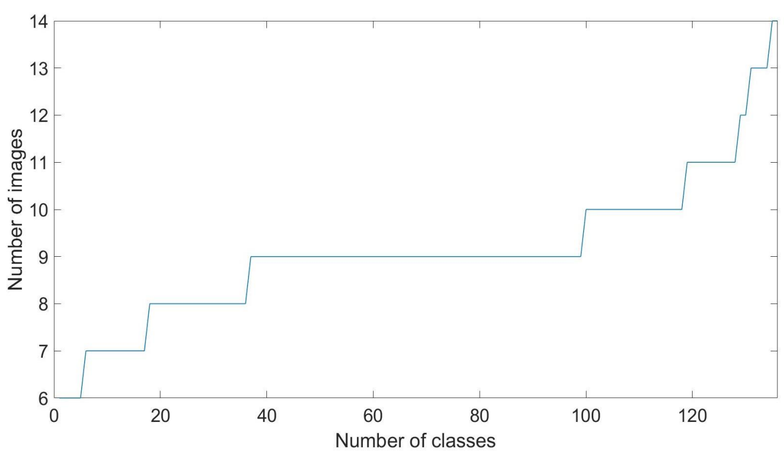
Dataset



Thermal Image

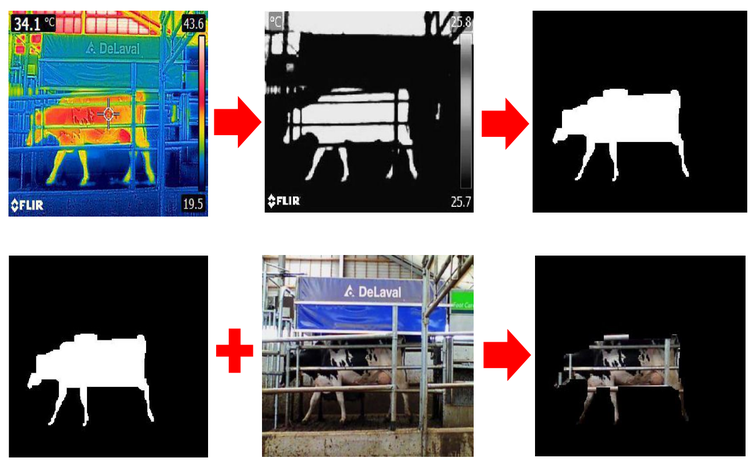
RGB Image

- 1237 thermal and RGB images
- 136 labelled classes
- Average of 9 images per cattle

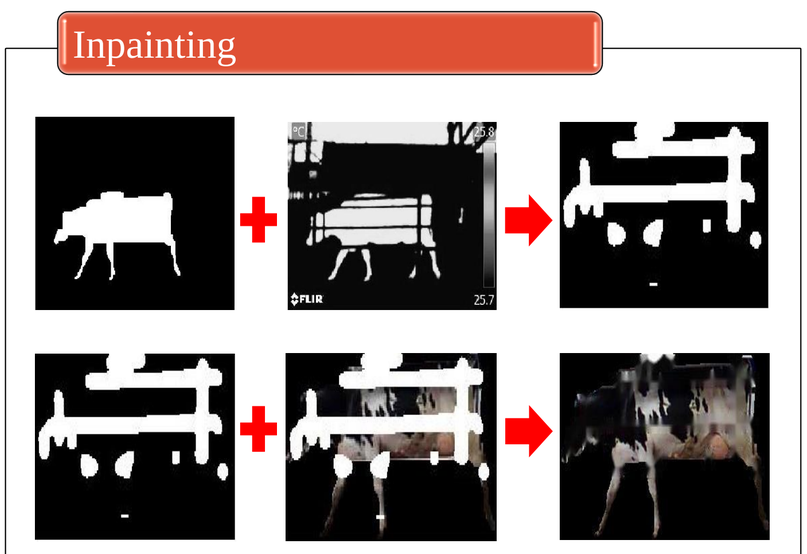


Data pre-processing

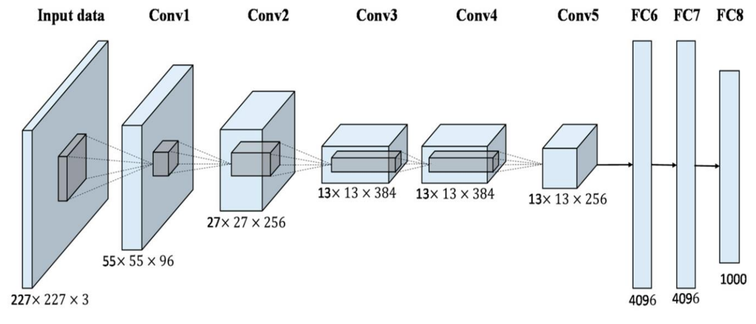
Segmentation



Inpainting



Classification

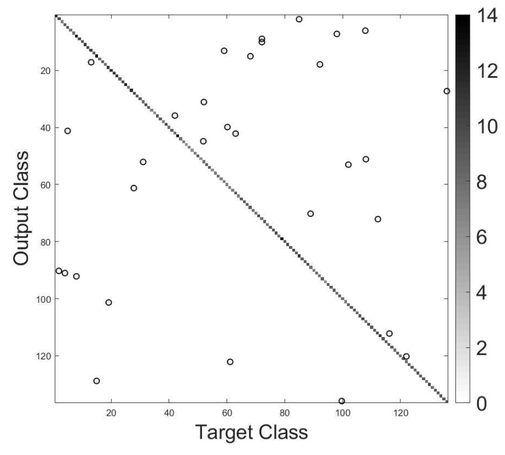


- AlexNet [2] with transfer learning
  - Pre-trained on ImageNet of 1000 classes
  - Last layer changed to 136 classes and re-trained with our training data

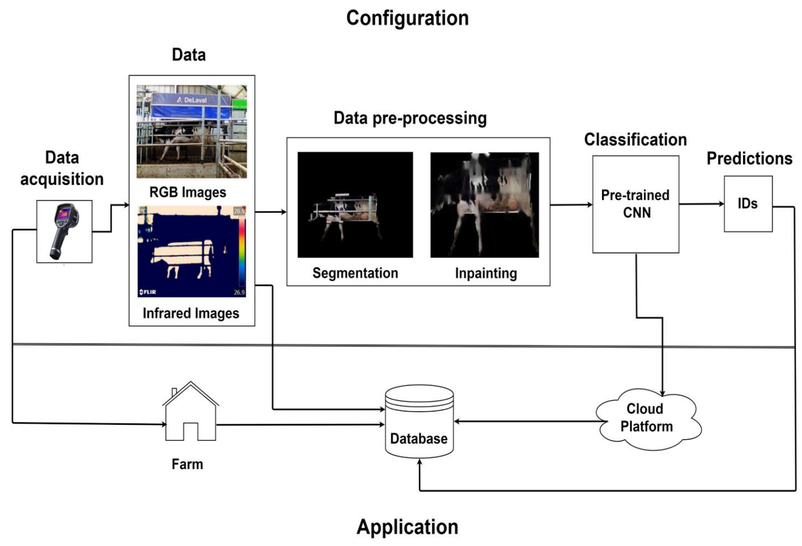
Results - 5-fold cross validation

Acc	Pr	Re	F1-score	Total no. of misclassified images
0.975 ± 0.01	0.980 ± 0.006	0.976 ± 0.008	0.978 ± 0.006	31

Confusion matrix



System overview



Challenges

No coat pattern

ID - 7600

ID - 0675

Multiple cattle

ID - 0098

Incorrect Inpainting

ID - 7600

ID - 7600

Multiple cattle

ID - 9884

Future work

- Thermal camera with video recording
- Use high resolution images
- Use larger dataset
- Data augmentation
- Discard images with multiple cattle in a frame
- Explore different inpainting techniques
- Explore different deep learning architectures

Conclusions

- Individual identification of cattle is possible based on the coat pattern by the use of transfer learning
- Convolution based architectures and side view of the cattle are well suited for learning and distinguishing the properties of coat patterns
- This process can be automated and can take place non-intrusively in practically pertinent settings

References

1. Johnston, A. M., et al. "1418001. Welfare implications of identification of cattle by ear tags." *The Veterinary Record* 138.25 (1996): 612-614.
2. Krizhevsky, Alex, Ilya Sutskever, and Geoffrey E. Hinton. "Imagenet classification with deep convolutional neural networks." *Advances in Neural Information Processing Systems*. 2012.