OPTISCORE project - Case: Body Condition Scoring"

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Introduction

- The **OptiScore** project "**Applying new electronic sensors to create animal condition scoring protocols for the automated measurement of health and welfare traits for use in sustainable organic dairy cow breeding programmes**"
- A pilot study was conducted to evaluate automatic body condition scoring
- An image-processing model was designed and implemented, and its output was validated against ultrasonic measurement of the thickness of the fat and muscle layers, and manual body condition scoring (BCS)

Importance of BCS

- Body condition scoring (BCS) estimates mobilization of energy reserves of cattle – fatness or thinness according to a 5-point scale *(Edmondson et al., 1989)*
- BCS is used as a **feed management tool**
- BCS **influences** productivity, reproduction, health and longevity
- Excessive loss of energy reserves during early lactation, generally associated with cows of higher BCS at calving, often results in **impaired health and reproductive performance** (i.e. ketosis)
- Renewed emphasis or difficulties with reproduction, transition cow disorders, and animal well-being have **increased interest** in BCS recently
- Moreover, **genetic differences in cows' abilities to manage energy reserves** have increased interest for BCS in genetic analysis

Practical use of BCS

- The current method of measuring BCS is manual and subjective
- Manual estimation of BCS is time consuming and requires well trained experts
- Therefore, the development of a device for automatic, objective monitoring of body condition scoring may be of economic interest
- Several attempts to automate BCS are reported in the literature: use of digital images (Coffey, 2003), use of multiple images (Ferguson, 2006), digital camera (Bewley, 2007), use of Visual Image Analysis (Onal, 2008)
- In the future, automatic cow BCS may be part of milk recording service – important management tool

Objective

- **The aim** of the present study was to develop an apparatus and methods for automatic and objective monitoring of BCS

- **The hypothesis** tested was that the body shape of a fatter cow is more likely to be round than that of a skinny cow; therefore, a parabolic shape may fit it better

- The hooks and the tailhead of a skinny cow diverge from the rounded shape defined by the parabola

Materials and Methods

- Data were collected at the Scottish Agricultural College (SAC), Crichton Royal Farm in Dumfries, Scotland in September 2007 (1st experiment) and December 2008 (2nd experiment)
- The study involved 186 HF cows
- The thickness of the muscle and fat layers was measured by **Ultrasound** device, Sonovet 2000 (1st experiment)
- The **manual BCS** was obtained by 2 different technicians (1st experiment) and by one single expert (2nd experiment)
- **Thermal Camera and Image Processing**: in 1st experiment an off-the-shelf model InfraCAM SD thermal camera was used; in 2nd experiment a L3-Thermal-Eye camera model TSC4500 was used

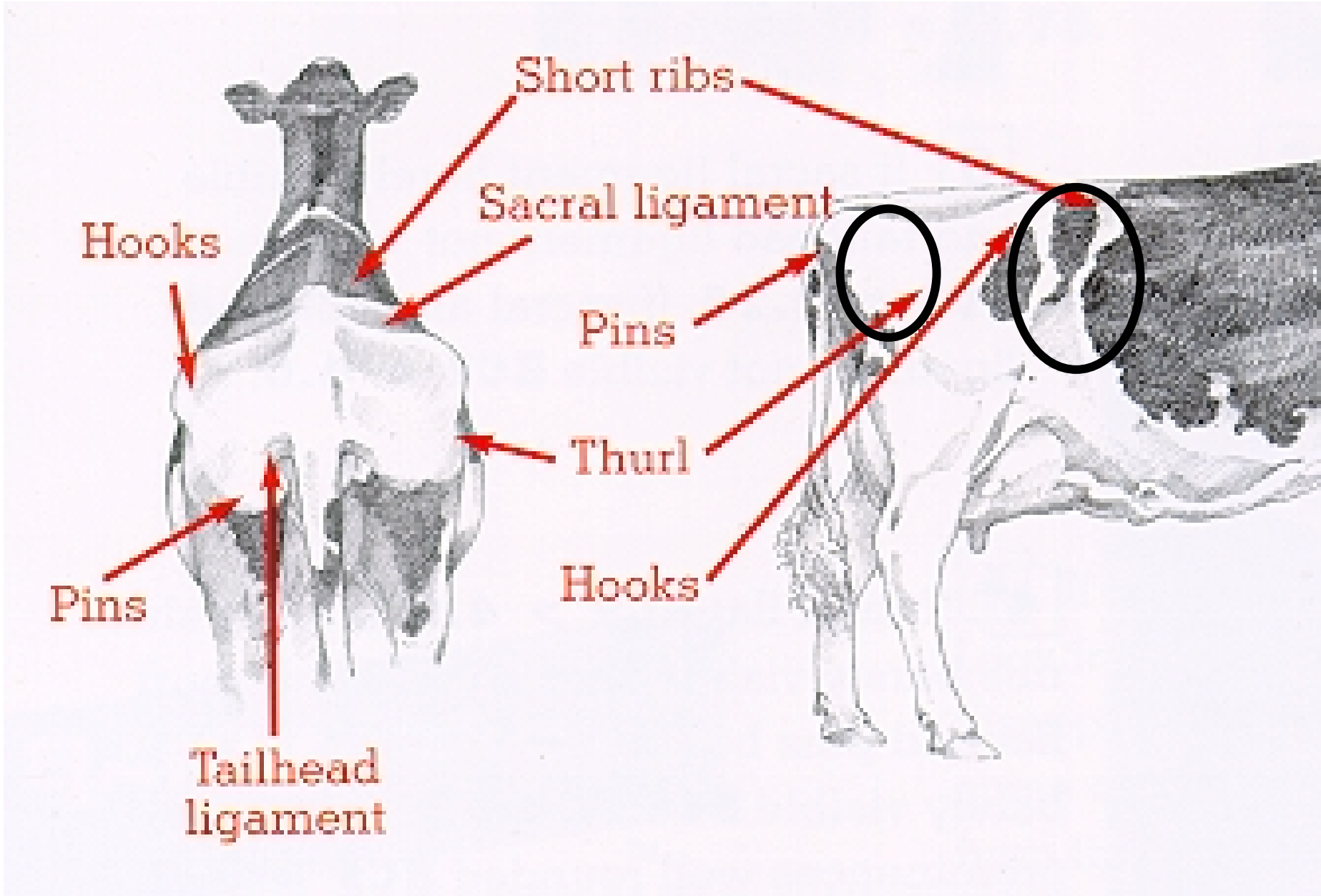
Materials and methods (1)

September 2007
December 2008
186 dairy cows

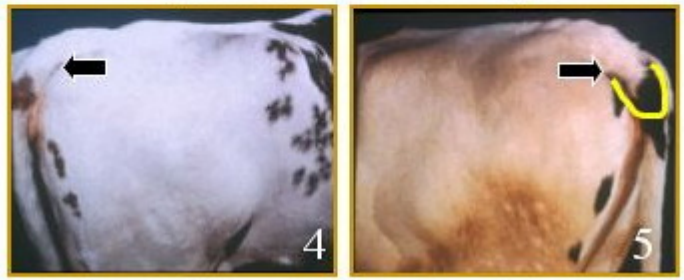
Materials and methods(2)

Chrichton Royal Farm

Manual Body Condition Scoring (BCS)



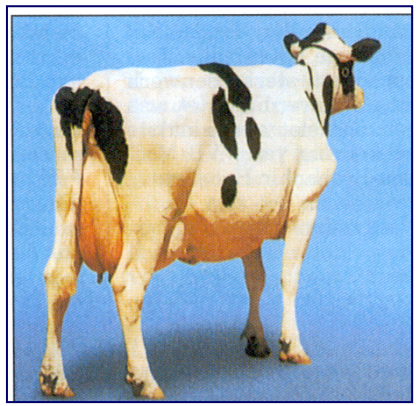
Manual Body Condition Scoring (BCS)



Problems with manual BCS:

- Hard work
- Labor & Time consuming
- Subjective
  - Technician
  - Previously seen cows

1
Very thin

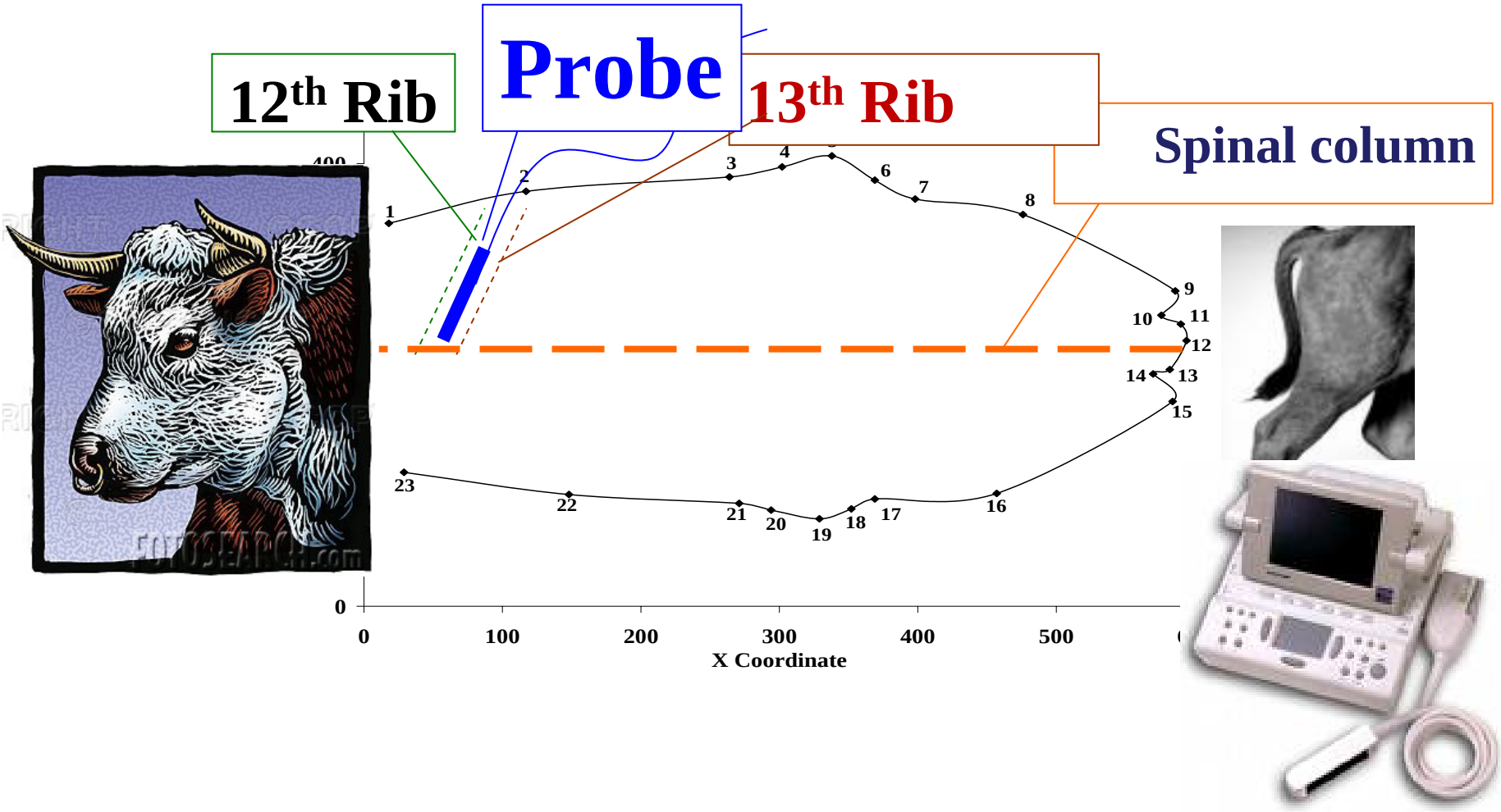


3
average

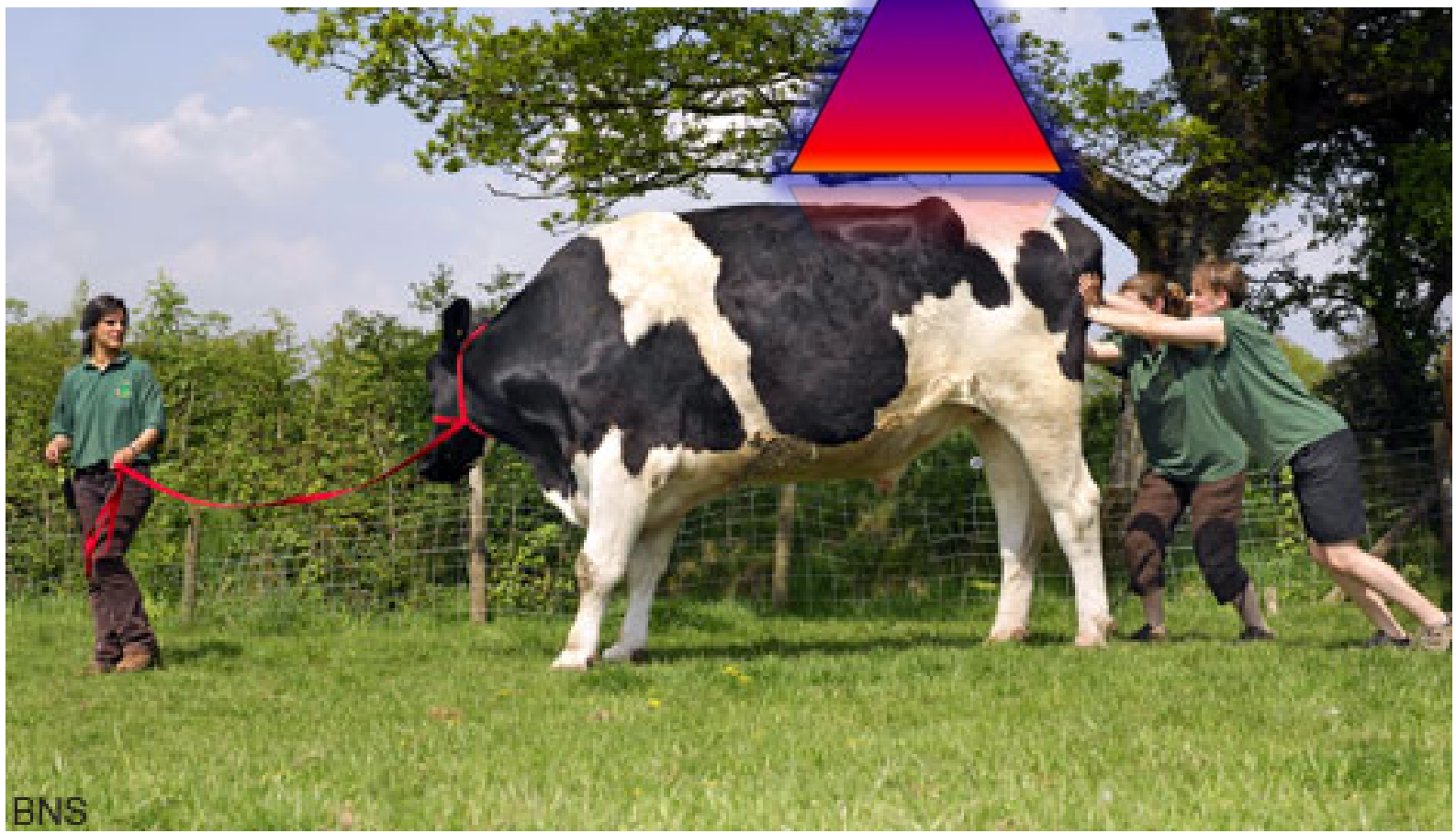
5
Very fat

Ultrasound Use

from bird's-eye-view

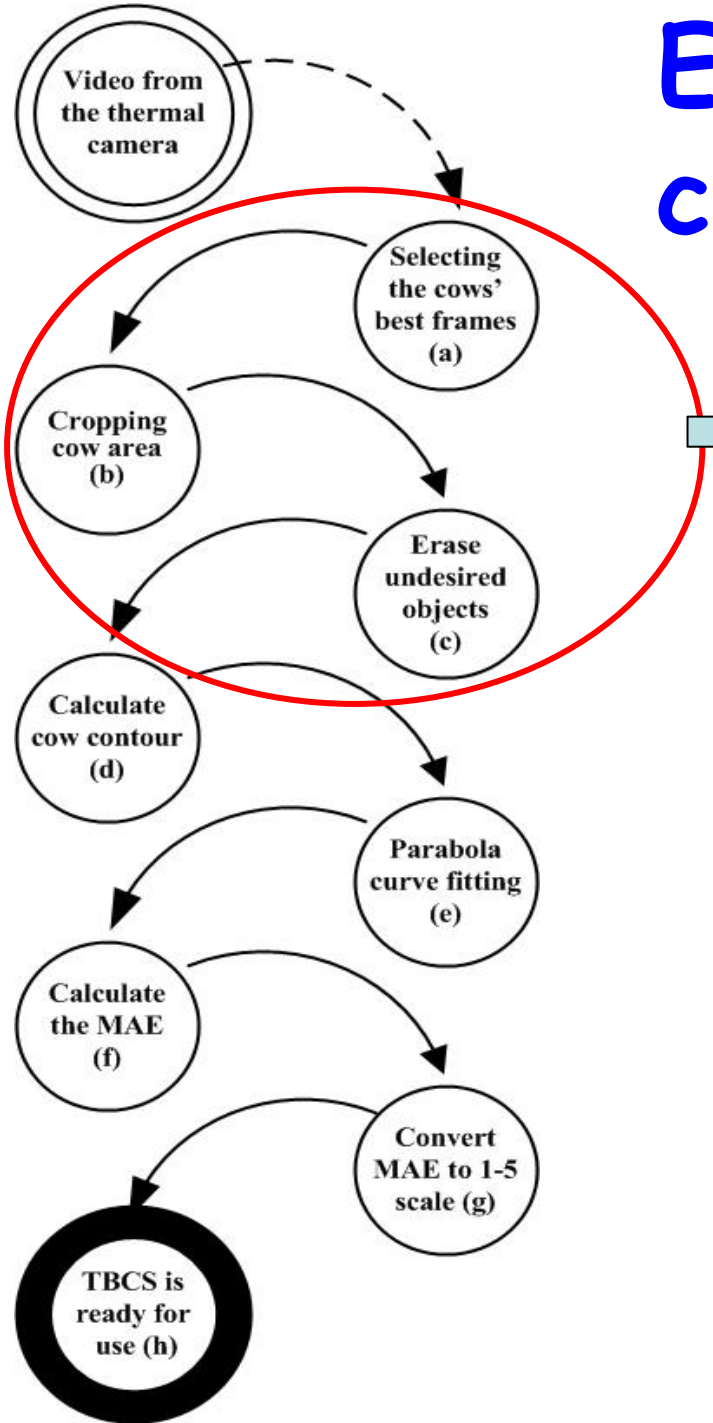


Location of the Thermal Camera



Thermal Camera Use

- In both experiments, the thermal camera was attached to the barn ceiling, above the weighing scale at the exit of the milk parlour.
- The cows were identified electronically by weighing scale's radio frequency identification (RFID)
- In the 1st experiment, the video imagery from the camera was divided by using Movie Plus 4 software (Serif, 2007)
- In the 2nd experiment, the frames were selected automatically with Matlab software.



Equations and computer software

Only for 1st Experiment

The "distance from a parabola" was converted to the 1-5 BCS scale by:

TBCS = 5 × 9 × (1/MAE)

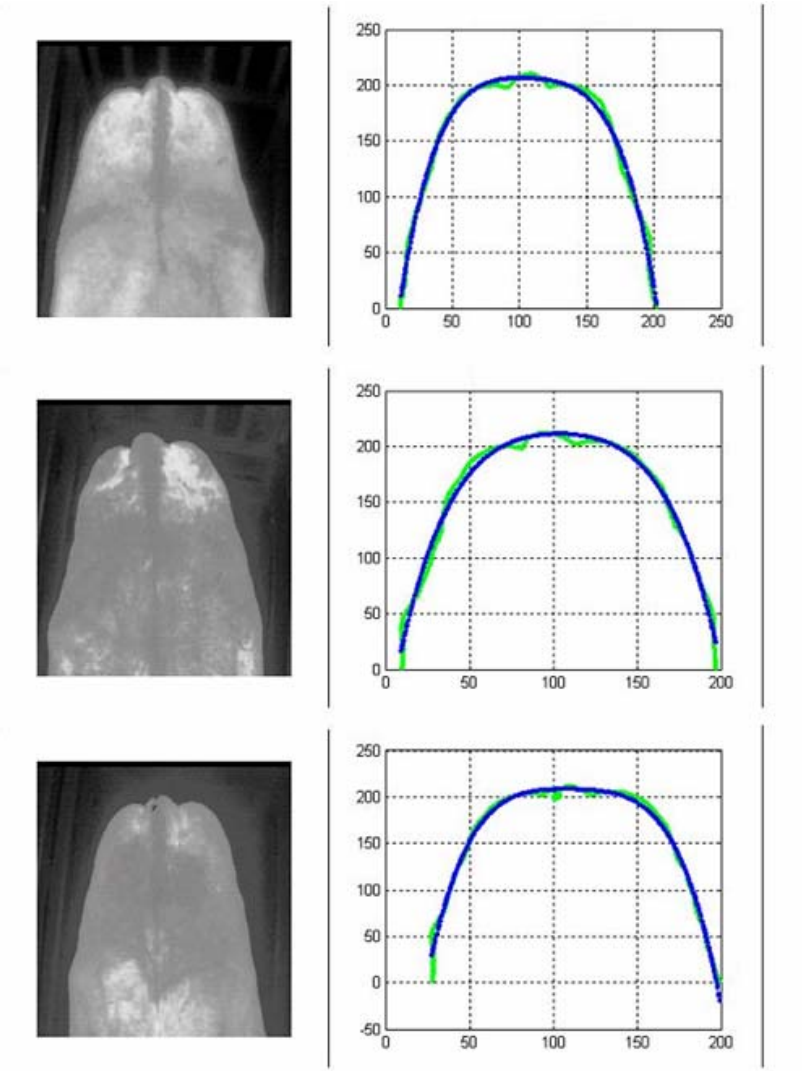
MAE = mean absolute error

TBCS = Thermal BCS

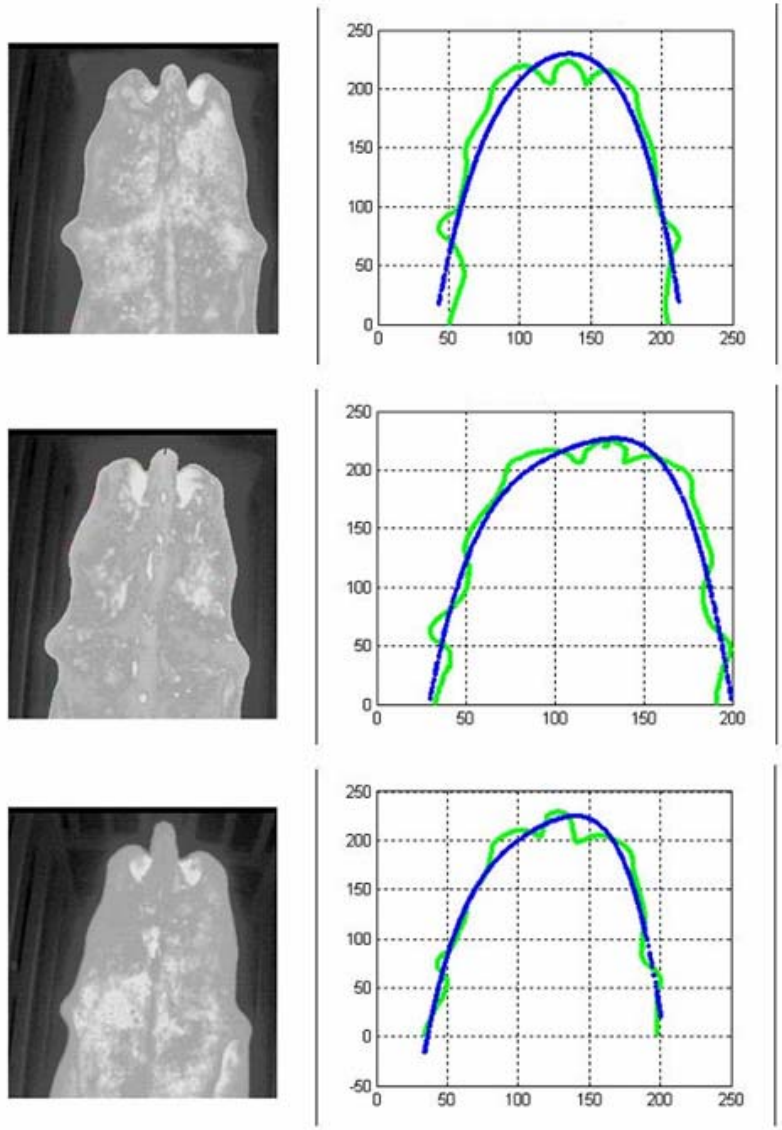
9 = the best fit achieved in study herd

5 = the normalization factor from model output to the 1-5 BCS scale

Results – Model inputs and outputs

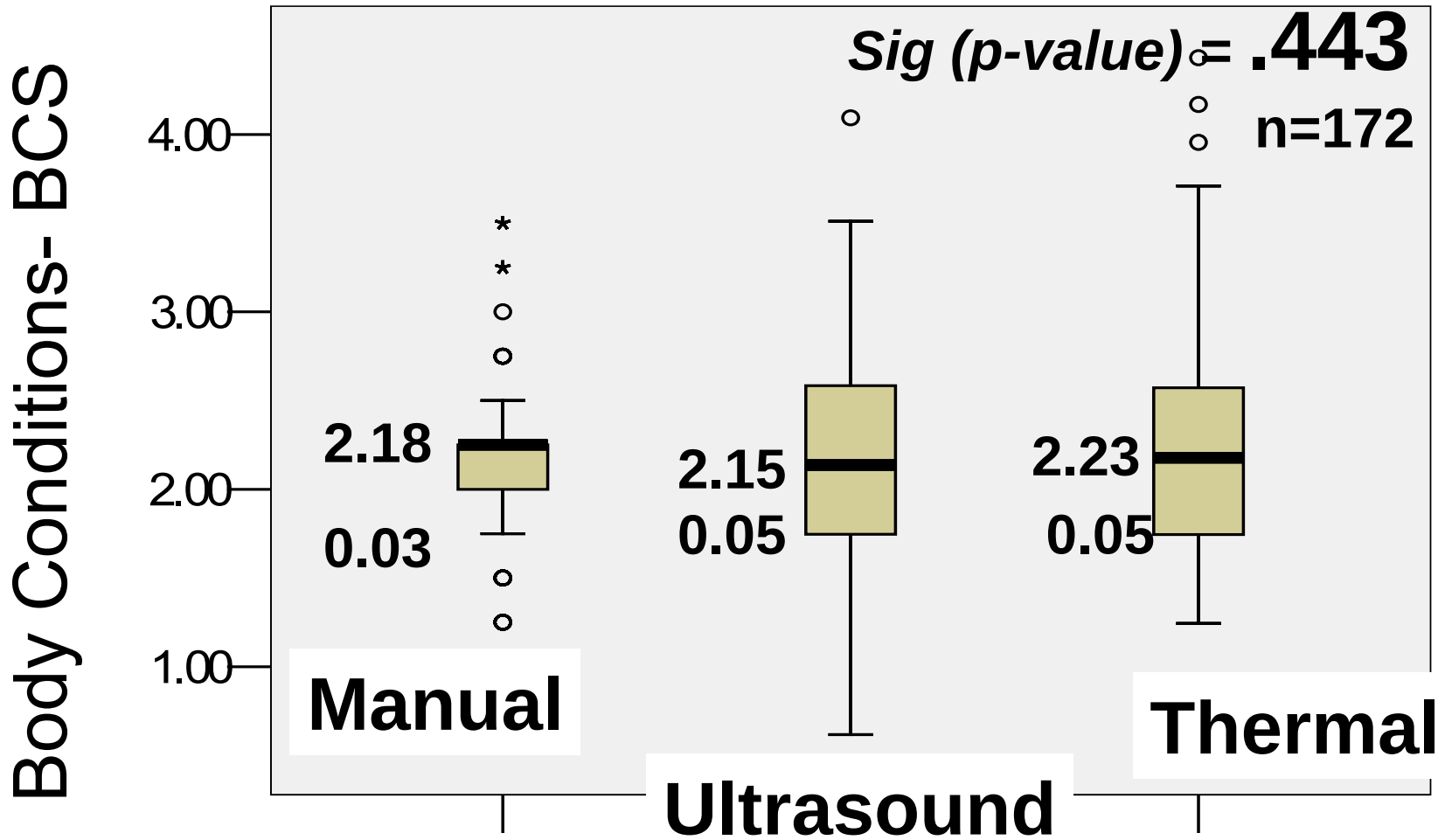


Fat cows

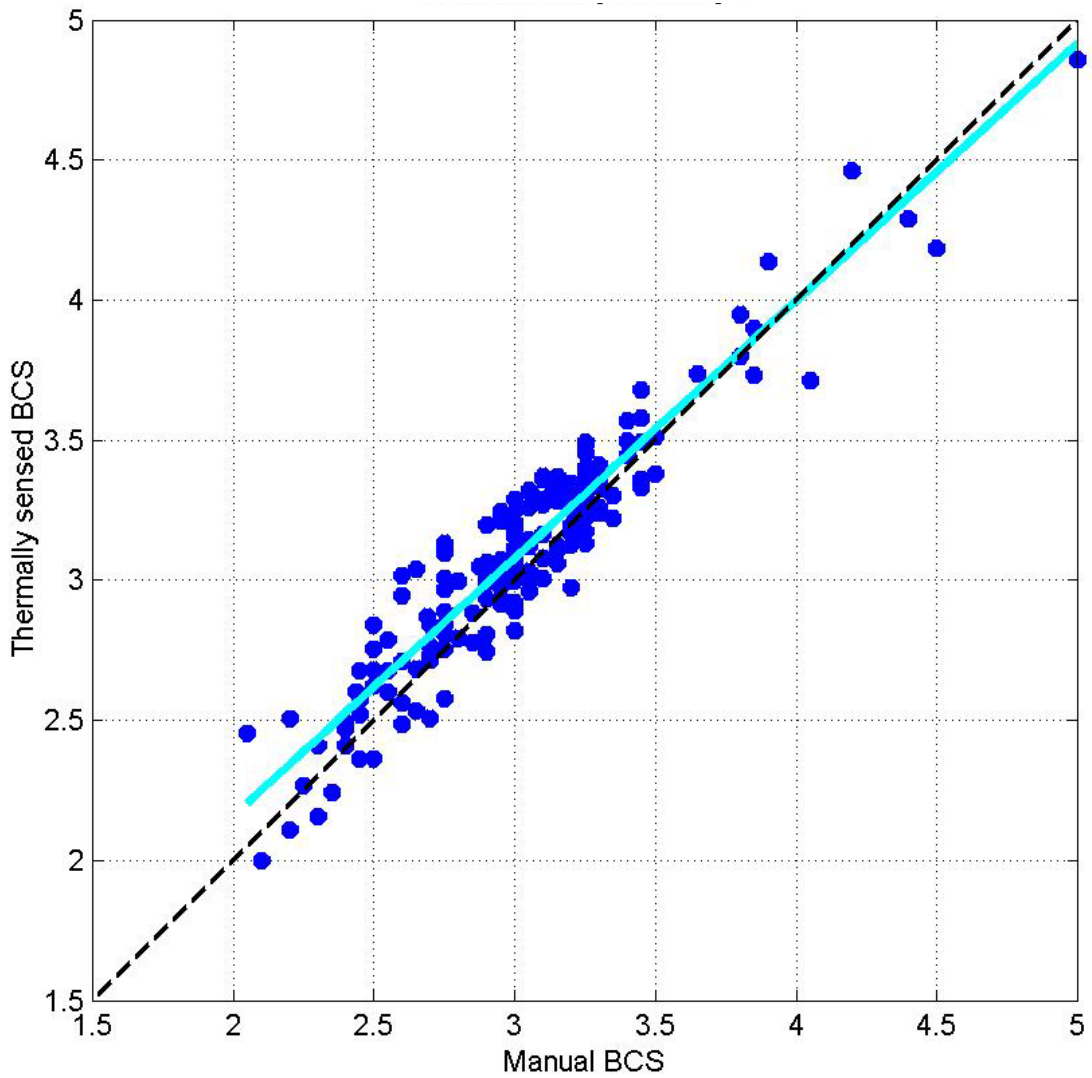


Thin cows

Results – 1st experiment

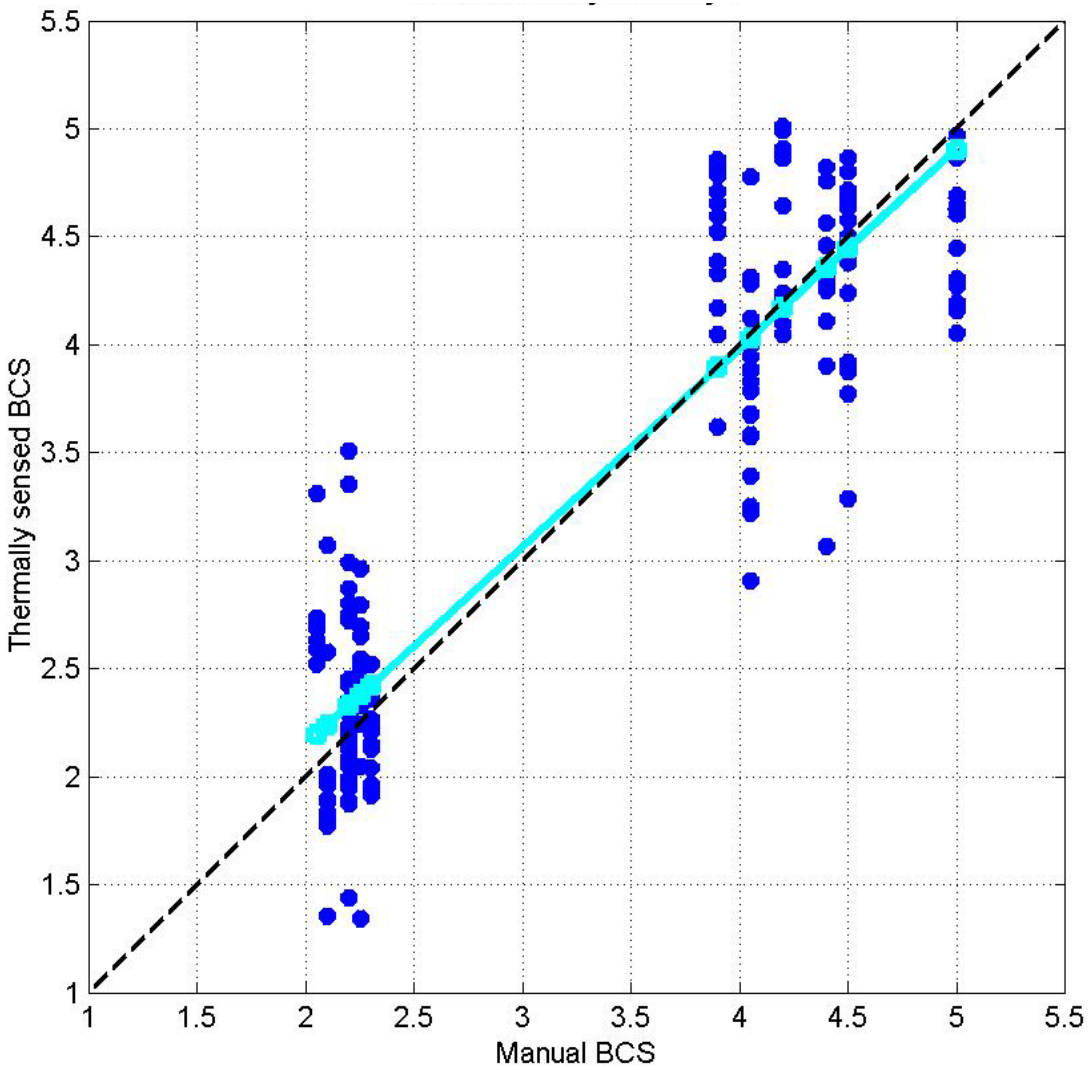


Results – 2nd experiment



- Validation across all the cows in the herd.
- The Y-axis is the thermally sensed BCS.
- The X-axis is the manual observations, the average of 5 manual scorings were used for model validation.
- The blue points are the BCS extracted from the thermal imaging.
- The cyan line is the regression line of the thermally sensed BCS.
- R^2=0.89

Results – 2nd experiment



- Validation over the twelve extremes: six thinnest and the six fattest cows in the herd.
- The Y-axis is the thermally sensed BCS of each single observation.
- The X-axis is the manual observations, the average of 5 manual scorings used for model validation.
- The blue points are the BCS extracted from the thermal imaging, one value per each picture.
- The cyan line is the average of the thermally sensed BCS.
- In our case, the 12 extremes cases resulted in R^2=0.90.

Statements

- The 1st experiment was a preliminary study
- The 2nd experiment was designed to study accuracy and therefore incorporated more data and a less variable reference BCS
- The utility of a “low-cost, automatic and accurate BCS” in dairy herd management is not in question
- Additionally, inexpensive and mobile devices could be, after its parameters have been calibrated to beef breeds, applied also to the beef sector
- The “beef model” may support decisions such as:
  - When to move a group from one pasture to another
  - In feedlots to help to determine the optimal marketing time

Conclusion

- A model based on thermal camera and image processing algorithms, intended for evaluation of cows' body condition was designed and was implemented
- The further study with more cows may lead to a means for automating body condition scoring
- The onus is now on the industry to further develop the methodology described in this research and to find a low cost thermal camera

Selected literature

Sharony (2003) patented a three-dimensional imaging method

Coffey et al. (2003) captured digital images

Ferguson et al. (2006) multiple images, at an angle of 0 to 20°, and 3 advisors assessed BCS from the images

Bewley et al.(2008) identified up to 23 anatomic points, for potential influences on BCS

Bewley J.M. & M.M. Schutz, 2008. Review: An Interdisciplinary Review of Body Condition Scoring for Dairy Cattle. The Professional Animal Scientist, 24: 507-529

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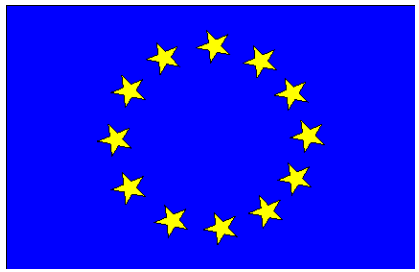

IceRobotics

Thank you for your attention!