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Development of a multi-Kinect-system for gait analysis in dairy cows

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Zuchtqualität mit Zukunft!
RSH
Rinderzucht Schleswig-Holstein eG

TiDa GmbH

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Introduction & motivation

Successful camera-based studies

- on lameness detection:
  - via step overlap [Song *et.al.* (2008)] or motion range analysis extracted from 2D video material partially in combination with a pressure mat [Pluk *et.al.* (2012)]
  - examination of back's posture [Viazzi *et.al.* (2013) & (2014)] on 2D (side view) or 3D (top view) recordings
- body condition determination:
  - using cow shapes, reconstructed with PCA-methods [Azzaro *et.al.* (2011)] or by fitting parabola in thermal images [Halachmi *et.al.* (2013)]
  - from angles and lengths between anatomical points [Bewley *et.al.* (2008) & Bercovich *et.al.* (2012)]
  - backfat thickness estimation using traits extracted from 3D time-of-flight recordings [Salau & Weber *et.al.* (2014)]

These are indicative lists and do not claim completeness.

Introduction & motivation

Necessity for a holistic solution

- cameras mounted in either side view or top view position

  $\Rightarrow$ Systems are either usable for body condition determination or lameness detection, but livestock holders need to monitor both.

- camera distances in side view installations ranged from 3 to 6 meters

  $\Rightarrow$ Systems are not applicable on most commercial dairy farms.

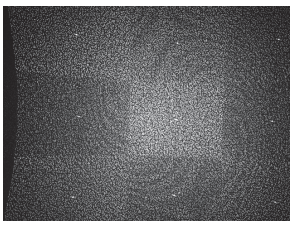
$\Longrightarrow$ Feasibility and concept of a system are analyzed, that enables gait analyses and the measurement of body characteristics and fits into pre-existing cow barns.

Materials & methods

Microsoft Kinect[1] 3D camera

- combined RGB and 3D camera
- "Structured Light": depth values are calculated from the deformation of an infrared pattern projected by the Kinect

[2]



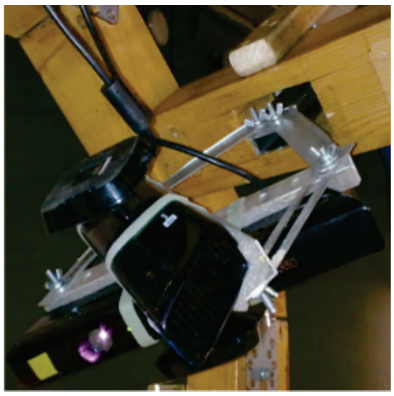
- horizontal field of view: 57°; vertical field of view: 43°
- frame rate: 30 images per second; resolution: 640×480 pixels

1: www.microsoft.com/en-us/news/press/2010/mar10/03-31primesensepr.aspx, accessed: 2nd of June 2014
2: http://cnet3.cbsistatic.com/hub/i/2010/11/04/de990dd0-f0f8-11e2-8c7c-d4ae52e62bcc/5fc4c0312531d3b66e7cf63c39c2c793/kinect.JPG, accessed: 27th of July 2014

Materials & methods

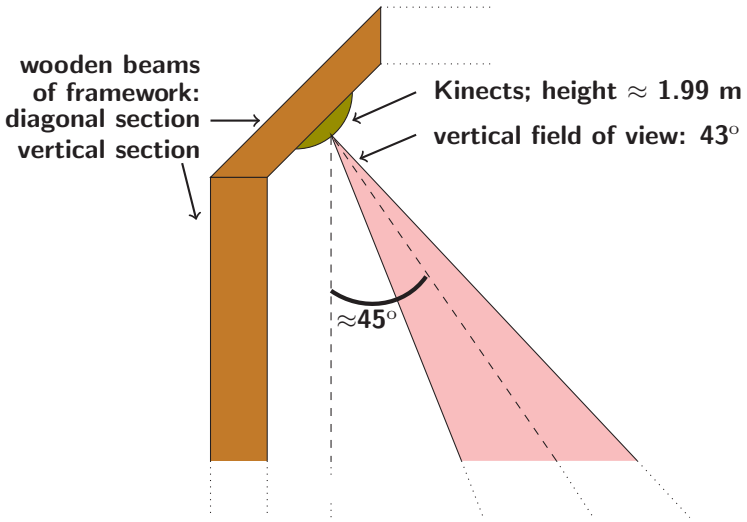
Recording unit: preliminary prototype

- wooden framework – passage width: 2.05 m, height: 2.08 m
- equipped with 6 Kinect cameras



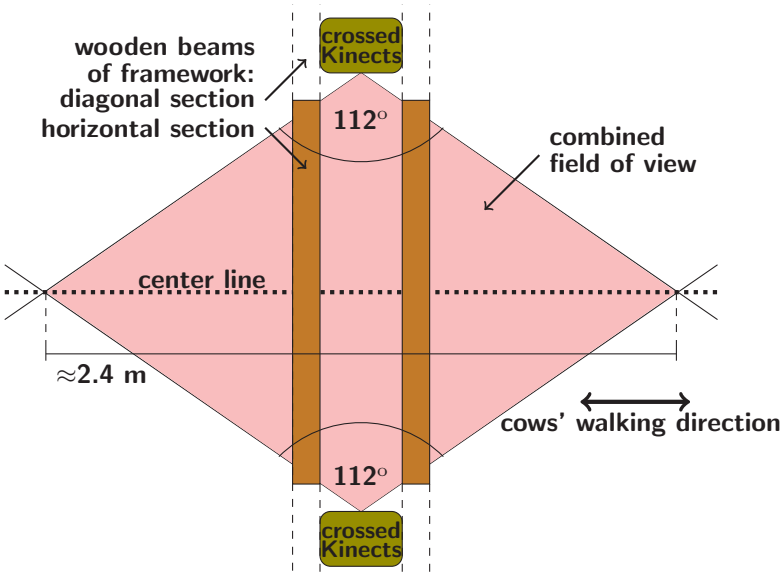
Materials & methods

Recording unit: preliminary prototype



Materials & methods

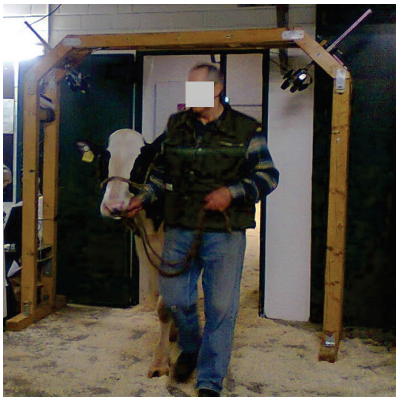
Recording unit: preliminary prototype



Materials & methods

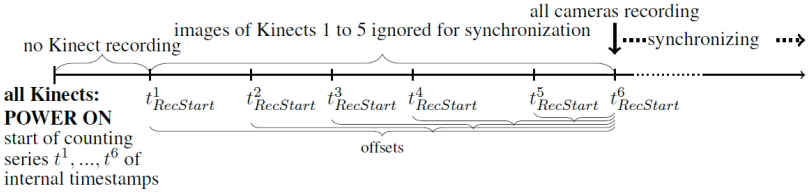
Data collection

- data collection at cattle auction and cattle show organized by Rinderzucht Schleswig-Holstein eG
- $\approx$ 6 hours of Holstein Friesian cows led by rope were recorded



Alpha versions of software and results:

Synchronization



- recording is not started simultaneously; synchronization begins when all cameras are recording
- the offsets in recording starts provide orientation where to look for synchronous images
- images are said to be synchronous, when they lie within a time window specified by a threshold (in milliseconds)

ms	<15	15	17	19	20	23	24	27	31	≥ 45
%	0	82.0	87.1	90.1	90.2	90.4	90.7	90.9	91.0	91.1

Alpha versions of software and results:

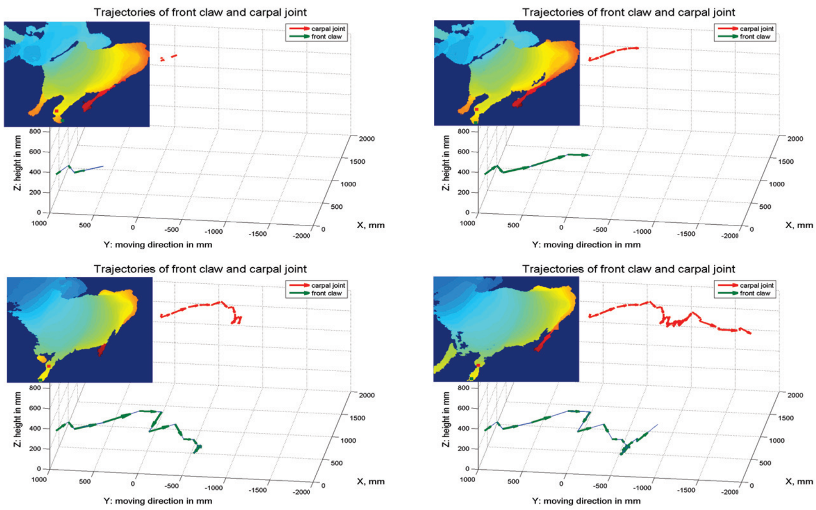
Claw determination

- the depth maps' background (framework, floor,...) is set to zero; the moving objects remain as foreground (cow, arms of leading person)
- foreground parts that touch the background are marked as claws

number of tested images	error rates			
	sorting images into			determination
	cow	parts	empty	of claws
30,000 (randomly chosen)	0%	7.2%	4.8%	1.2%

Outlook

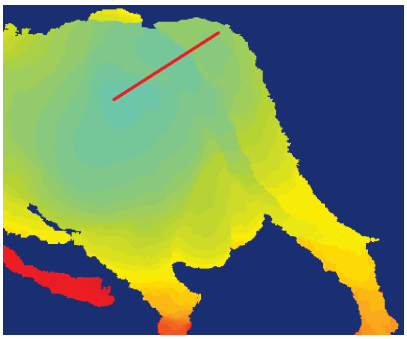
Gait analyses via trajectories

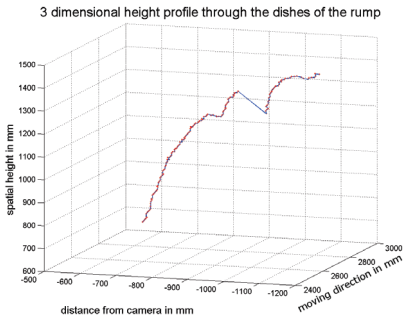


Outlook

Body condition determination

- information on the principal descriptors for body condition can be extracted from the recordings
- exemplarily: a height profile through the dishes of the rump was taken





Thank you!

Zuchtqualität mit Zukunft!

RSH

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TiDa GmbH

Thank you for your attention!