Effect of cow traffic on an implemented automatic 3D vision monitor for dairy cow locomotion

Outline

- Why 3D vision?
- Aim
- Material & Methods
- Results
- Discussion
- Conclusion
Why 3D-vision?

• Non-invasive
• Cheap
• 1 sensor for entire herd
• New information: depth
Aim of research

3D Video
Cow segmentation
Back detection
Back spine extraction
Curvature parameters extraction
Classification
Aim of study

• AIM
  o Evaluate the performance of a fully automatic 3D vision monitor for dairy cow locomotion in a commercial farm

• Value creation
  o Research → practice
Commercial farm layout

- Waiting area
- Alley
- Pen Group 1
- Pen Group 2
- Treatment
Performance per session

- **20/09/2013 – 15/07/2014**
- **566 recording sessions**

<table>
<thead>
<tr>
<th>Step in Process</th>
<th>Absolute number</th>
<th>Relative Number [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cows milked</td>
<td>226 ± 9</td>
<td>100</td>
</tr>
<tr>
<td>Number of cows RFID</td>
<td>224 ± 10</td>
<td>99,1 ± 1,3</td>
</tr>
<tr>
<td>Number of recorded videos</td>
<td>197 ± 16</td>
<td>87,2 ± 6,2</td>
</tr>
<tr>
<td>Number of video-cowID links</td>
<td>178 ± 14</td>
<td>78,8 ± 5,7</td>
</tr>
<tr>
<td>Number of analysed videos</td>
<td>110 ± 24</td>
<td>48,7 ± 11,0</td>
</tr>
</tbody>
</table>
Performance per session: video analysis

Proportion of cows

Analysis = automatic BPM-score

Scored videos

cowID linked videos

= 62%
Performance during session

Video ID = 77.7%
BPM-score = 48.2%
Cow traffic: crowding in alley

Cow 1

Cow 2
Optimal traffic intervals

Video cow identification rate

Video analysis rate

Proportion of cows in the herd

Interval between cows [seconds]

15 sec

35 sec

Analysis Rate

Merging Rate

EAAP Copenhagen - August 2014
Performance on cow-level (1 week)

80% has at least 5 scores per week

Proportion of cows

session number

EAAP Copenhagen - August 2014
Trade-off for selected window size

Number of videos in data window

Number of obtained scores from videos
## Risk factors for system performance

<table>
<thead>
<tr>
<th>Factor</th>
<th>Correlation coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Positive correlation</strong></td>
<td></td>
</tr>
<tr>
<td>Recording session duration</td>
<td>0,43</td>
</tr>
<tr>
<td>Lactation stage DIM 151 - 180</td>
<td>0,28</td>
</tr>
<tr>
<td>Lactation stage DIM 0 - 30</td>
<td>0,25</td>
</tr>
<tr>
<td>Lactation stage DIM 91 – 120</td>
<td>0,23</td>
</tr>
<tr>
<td>Proportion of 3\textsuperscript{rd} parity</td>
<td>0,18</td>
</tr>
<tr>
<td>Proportion of 4\textsuperscript{th} parity</td>
<td>0,16</td>
</tr>
<tr>
<td><strong>Negative correlation</strong></td>
<td></td>
</tr>
<tr>
<td>Proportion of 1\textsuperscript{st} parity</td>
<td>- 0,50</td>
</tr>
<tr>
<td>Lactation stage DIM 241 - 270</td>
<td>- 0,44</td>
</tr>
<tr>
<td>Lactation stage DIM 271 – 305</td>
<td>- 0,43</td>
</tr>
<tr>
<td>Herd size</td>
<td>- 0,31</td>
</tr>
<tr>
<td>Proportion of 2\textsuperscript{nd} parity</td>
<td>- 0,16</td>
</tr>
</tbody>
</table>
Discussion

• Seasonal effect
  o ~ system?
  o ~ time of farmer?

• Optimal traffic intervals for free cow traffic

• How many scores do we need for lameness detection?

• Type of milking parlour ~ location of recording system
Conclusions

- The system scored 48.7% of the cows in herd per session
- System performance better for old cows in early lactation than young cows in late lactation
- Optimal cow traffic interval = 35 sec.

Thank you!

Corresponding author:
tom.vanhertem@biw.kuleuven.be

Credit to www.sheptonmalletjournal.co.uk

Funding: Industrial Research Fund (IOFHB/13/0136) of the Flemish Government, Israeli Agricultural Ministry Chief Scientist Fund 459-4426-10 and 459-4369-10
Commercial farm layout

• Commercial Belgian dairy farm
• 40-stand rotary milking parlor
• 210 - 240 cows
• 2 production groups [high - low]
Process flowchart

- Fully automatic video recording & processing

During milking

Rotary  Corridor  Cow ID  Trigger  Store Video

Post-milking

Merging  Processing  Data storage

EAAP Copenhagen - August 2014
Process automation

- Fully automatic video recording & processing
  - Automatic trigger → photocell
  - Automatic identification
    - RFID-antenna
    - Timestamp correlation
      - Recording time stamp
      - RFID time stamp
      - Time delay (every session re-estimated!)
  - Automatic analysis (BPM-measurement)
    - Offline
    - After the milking + recording session
    - Filter to select good videos
ALD0-setup

- Back Posture Measurement BPM

Fig. 7 Parameters $\theta_1$, $\theta_2$, $\theta_3$ and $L_1$ extracted from the reconstructed back curvature of the cow.

Comparison of a three-dimensional and two-dimensional camera system for automated measurement of back posture in dairy cows

Computers and Electronics in Agriculture Volume 100 2014 139 - 147

EAAP Copenhagen - August 2014
Performance per session: link video-cowID

Proportion of cows

Photocell errors

79.4%

Number of Recording Sessions

Proportion of cows

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1

0 100 200 300 400 500

EAAP Copenhagen - August 2014
Seasonal effect on analysis rate