Lely’s vision in automation and sensor development

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1948
Our mission statement

“To be the company in the dairy and cattle market that is the front runner in state-of-the-art farming solutions, striving for improvement of the financial and social wellbeing of its customers”
Transition to automation

Increased farm size – reduced labour force – increased labour costs
Mechanisation

- Mechanization of routine activities
Automation

- Automation of routine activities
Goals

- Milk/FTE
- Profits
- Costs
Focus on the individual cow:

- Increase individual cow performance and production
- Optimise profits per cow
- Management by exception

More milk/FTE – increase profitability
How to automate human senses?
Automation of human senses

Who are you? (ID)

What do you do? (sensors)

What can be improved? (software analyses)

Research & Innovation
Optimisation of performance

Individual optimisation of health and production

Sensors and software for recording and analysis

Individual cow parameters
Sensor development

- Cheap, reliable, non-invasive sensors
- Smart algorithms to improve accuracy
- Multi-use of one sensor
- Use of sensors from other industries
  - Automotive
  - Medical
  - Communication
- Management by Exception
Exact or not?

- Is it relevant to know if you drive 120,462 km/hour or is it sufficient when you know that you drive 120 km/hour +/- 5 km?

- This means that as a user of the data you have to understand the meaning of the data.
Are the algorithms important…? 

\[ Y_t = M_{it} = \left( c_{0, it} + c_{1, it} C_{it} + c_{2, it} C_{it}^2 \right) I_{it}^{(1)} + b_{2, it} I_{it}^{(2)} + v_{it} \]

\[ = c_{0, it} I_{it}^{(1)} + c_{1, it} C_{it} I_{it}^{(1)} + c_{2, it} C_{it}^2 I_{it}^{(1)} + b_{2, it} I_{it}^{(2)} + v_{it} \]

\[ = F_r \theta_t + v_t \]

\[ \gamma_t \sim \text{Beta} \left[ \delta_{V_t, n_{i-1}} / 2, (1 - \delta_{V_t, n_{i-1}}) / 2 \right] \]

\[ R_t = GC_{t-1} G' \delta_t = \begin{pmatrix} c_{11, t-1} / \delta_{t, 1} & c_{12, t-1} \\ c_{21, t-1} & c_{22, t-1} / \delta_{t, 2} \end{pmatrix} \]

\[ C_{\text{opt}, it} = -\left( \pi_{M, it} \hat{c}_{1, it} - \pi_{R, it} \hat{d}_{1, it} \right) / 2\pi_{M, it} \hat{c}_{2, it} \]
Sensors in practice

- Udder health
- Weight
- Rumination
- Body temperature
- Activity
- Milk, fat, protein yield
- Feed intake
- Visit behaviour
- Udder health
## Smart algorithms: mastitis detection

### Performance Results

<table>
<thead>
<tr>
<th></th>
<th>TP quarter</th>
<th>FN quarter</th>
<th>TN quarter</th>
<th>FP quarter</th>
<th>TP case</th>
<th>FN case</th>
<th>SE quarter</th>
<th>SP quarter</th>
<th>SE quarter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm 1</td>
<td>41</td>
<td>30</td>
<td>117949</td>
<td>693</td>
<td>12</td>
<td>2</td>
<td>57.75%</td>
<td>99.42%</td>
<td>85.71%</td>
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<tr>
<td>Farm 2</td>
<td>7</td>
<td>50</td>
<td>32237</td>
<td>161</td>
<td>4</td>
<td>0</td>
<td>12.28%</td>
<td>99.50%</td>
<td>100%</td>
</tr>
<tr>
<td>Farm 3</td>
<td>3</td>
<td>8</td>
<td>39292</td>
<td>399</td>
<td>2</td>
<td>0</td>
<td>27.27%</td>
<td>98.99%</td>
<td>100%</td>
</tr>
<tr>
<td>Average</td>
<td>51</td>
<td>88</td>
<td>189478</td>
<td>1253</td>
<td>18</td>
<td>2</td>
<td>36.69%</td>
<td>99.34%</td>
<td>90%</td>
</tr>
</tbody>
</table>

- ISO demand: 99+% SP, 70+% SE
- Practical results: 99+% SP, 90% SE
- 9 out of 10 mastitis cases detected
- 993 out of 1000 milkings correctly classified
Smart algorithms: weight

What is the weight of a cow??
Natural variation of +/-60kg in 24 hours.
By the use of a dynamic filter we are now accurate by 0.8% of the life weight (4-5 kg).
Where will we go?

Critical parameters for succes:

- General health
- Udder health
- Fertility
- everything else is a consequence....
Future developments

- Health – Cow “events”
- Behaviour and well-being
- Milk components
- Environment: carbon footprint
Future developments

- Further improvement of reliability
- Reduction of down time (lower service cost)
- Reduction of maintenance
- Offer “more for the same €”
- And obviously “smart algorithms” to get the maximum information out of the available data.
Balance

- Reproducable/simplicity
- Support / 24/7 service
- Durable
- Costs vs. Labour reduction
- Respect:
  - Animal / cow
    (animal well being / interaction)
  - Environment
    (energy consumption)