Analysis of static and dynamic position determination accuracy of Location System "Ubisense Series 7000"

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Introduction

- Rising impact of cow-individual and automatic behaviour analysis in dairy production

- Real Time Location System (RTLS) – growing use in manufacturing and control processes

- RTLS in dairy production
  - Improvement of herd management (e.g. worker productivity or detection of lameness)
  - Advances in experimental technique

- **Aim of this laboratory investigation:**
  Determination of main influences on accuracy of RTLS „Ubisense Series 7000"

Material and Methods

- **RTLS Ubisense Series 7000**
  - „Sensors" + „Tags"
  - UWB – signal (6-8 GHz) + 2.4 GHz for controlling
  - Methods: *Angle of Arrival* and *Time Difference of Arrival*
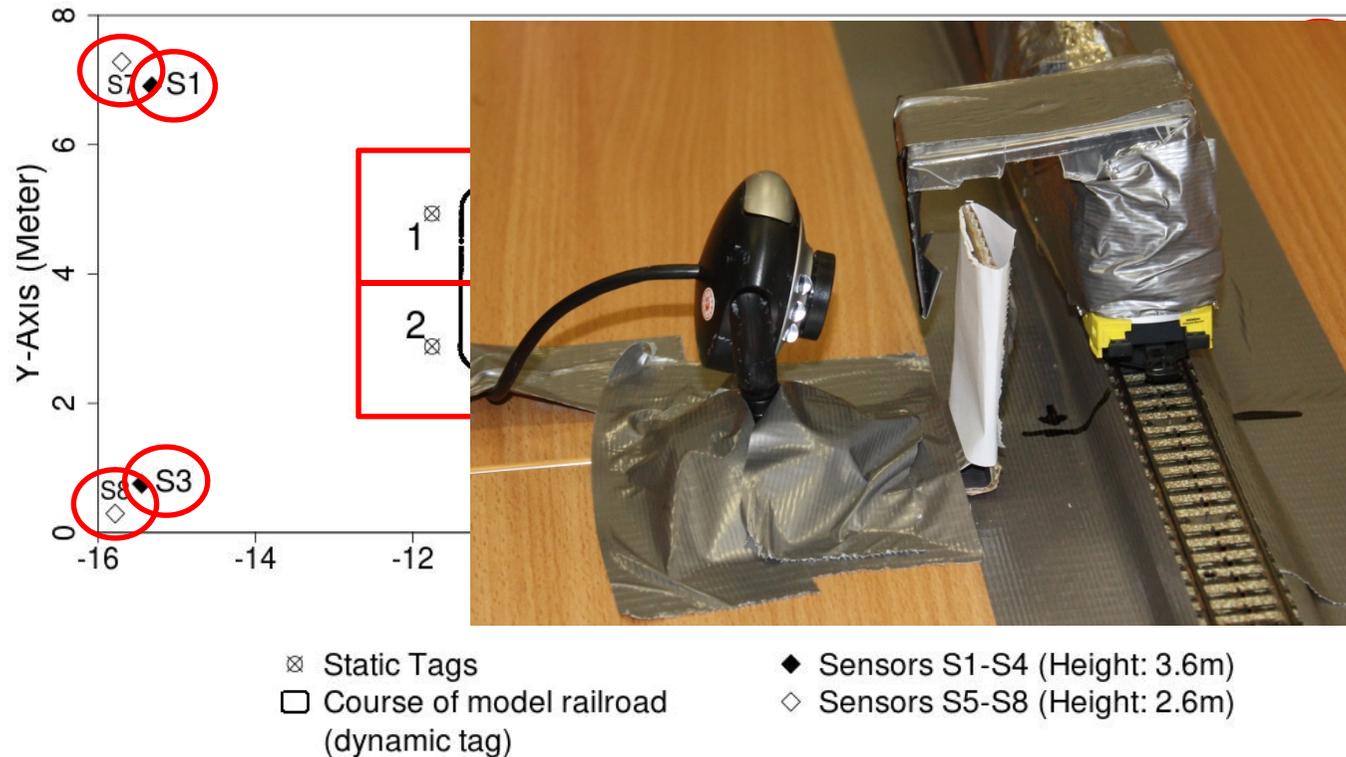 - Accuracy by manufacturer: 30 cm

Sensor   Tag

20 cm   4 cm

N.N., 2009a

Static Tags ⊠
Course of model railroad ▢
(dynamic tag)

Sensors S1-S4 (Height: 3.6m) ◆
Sensors S5-S8 (Height: 2.6m) ◇

- Experimental Design
  - Calibration point „M"
  - **Sensorlayout=**
    2-8 Sensors (S1-S4: Height 3.6m,
    S5-S8: Height 2.6m) in 15
    different combinations (=layouts)
  - **Square** (1-8)
  - **Status of Tags**
    static / dynamic (3 Tags)
  - **Speed**
   (0.4m/s, 0.5m/s, 0.6m/s)

Material and Methods

- Logarithms of euclidean distance in meters (2D)

- SAS procedure Mixed

- Fixed effects (n=112.908)
  - Sensorlayout (SL, 1-15)
  - Speed (1-3)
  - State of Tags (ST, 1-4)
  - Square (1-8)

- Interactions:
  - Sensorlayout * State of Tags
  - Sensorlayout * Square
  - Speed * State of Tags
  - Speed * Sensorlayout

- Random Effect (Sensorlayout * Speed * Round)

- All considered interactions were significant

Lsmeans (backtransformed) for the interaction of sensorlayout and state of the tags – 2D for dynamic tag 1 and static tag (a,b: Different letters show significant differences (p<0.05) within tag)
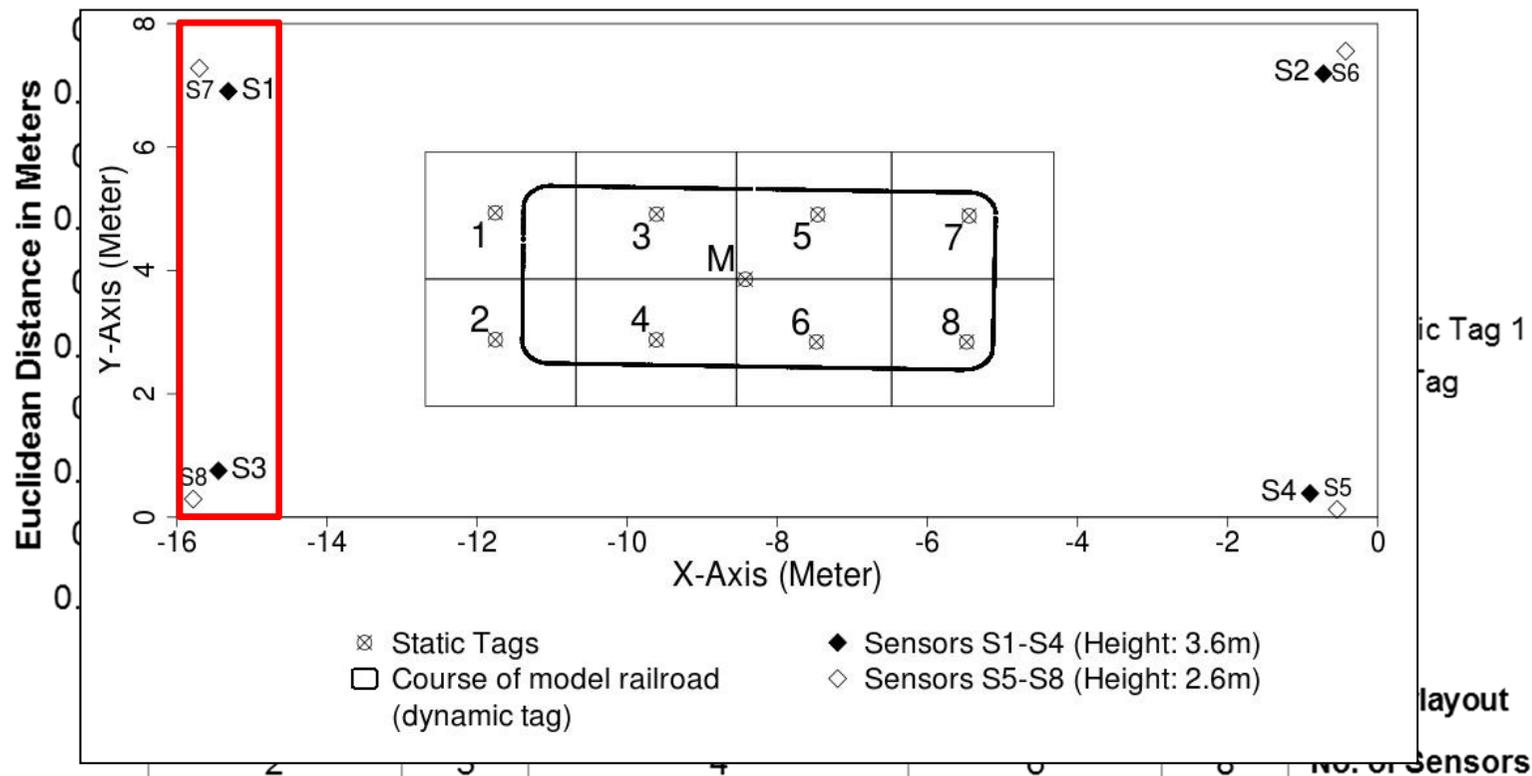
- One-sided layouts perform on lower accuracy level
- Dynamic accuracy not influenced by amount of sensors
- Static accuracy increases with higher amount of sensors

Results & Discussion

Lsmeans (backtransformed) for the interaction of state of the tags and speed

Speed	Dynamic tags			Static tag
	1	2	3	
0.4m/s	0.187 ^{a}	0.199 ^{a}	0.191 ^{a}	0.083 ^{c}
0.5m/s	0.198 ^{a}	0.201 ^{a}	0.202 ^{a}	0.081 ^{c}
0.6m/s	0.234 ^{b}	0.237 ^{b}	0.235 ^{b}	0.084 ^{c}

a,b: Different letters show significant differences (p<0.01) in the logarithm of the euclidean distance

- Static tag not influenced and on high level
- No significant differences within speed between the dynamic tags
- Only small influence (not significant) of speed 0.5m/s, higher influence of speed 0.6m/s
- Effect of speed is higher while using only 2 or 3 sensors

Conclusion

- Ubisense RTLS performs on a high accuracy level
- Diagonal layouts showed the highest accuracy
- Higher amount of sensors only increased the static accuracy (conclusion to calculation method possible)
- More sensors can reduce the effect of a higher moving speed

→ Improvement of accuracy in the barn by considering these results

- Open questions:
  - Influence of metal and liquids on the high frequency UWB-Signal
  - Accuracy of the behaviour observation of cows in the barn in comparison to video