Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Department of Home Affairs FDHA
Federal Food Safety and Veterinary Office FSVO
Research Management

Tierschutz **Verschiedenes**

Methodological bases of the localisation of individual animals in barns with freely moving herds for monitoring welfare and health

Philippe Hindermann[1], Stefan Nüesch[1], Lorenz Gygax[2], Daniel Früh[1], Andreas Rüst[1]
[1]ZHAW School of Engineering, CH-8401 Winterthur, [2]Agroscope, CH-8356 Ettenhausen

Key words
Welfare, large groups, dairy cows, dry sows, Real-Time Location System (RTLS), Ultra-Wideband (UWB), Time Difference of Arrival (TDoA), multimode scalability

Aim of the study
In this project, a relatively simple and low cost indoor Real-Time Location System (RTLS) has been developed to provide accurate real-time estimates of where nodes (animals) are located. The main objectives of this project were to demonstrate that the system can achieve sufficient accuracy (< 0.5 m) and that several nodes can be located simultaneously. This proof of concept will pave the way for addressing the effect of large groups on welfare and will also allow to expand early health warning system approaches that rely on detailed individual data. Such knowledge will serve as the basis for recommendations of how to best keep large numbers of livestock animals.

Material and methods
The developed RTLS is based on the Ultra-Wideband (UWB) technology from a DecaWave RTLS evaluation kit and was adapted for a Time Difference of Arrival (TDoA) procedure to estimate the nodes positions. During the project improvements were made on the software- and hardware-side. The localization of the nodes is estimated in 2D on a given height using a constrained Gauss-Newton algorithm to increase accuracy and stability. In addition, the RTLS can now handle up to a hundred nodes simultaneously using a pure ALOHA random access method at 1-second intervals. On the hardware side, a new electronic node-circuitry has been developed to easily increase the number of nodes in the system. In addition, the connection of the anchors to the locating unit was realized with a single cable per anchor that supplies power and handles the data exchange.
The performance of the overall system was evaluated during field tests in dairy barns. To determine the precision of the system, the positions measured at withers height of a cow (1.5 m) and on the ground were compared with a reference system and evaluated in terms of bias and dispersion. In addition, the scalability in respect to the number of nodes and the size of the observed area was examined in situations with ten nodes. The collision rate for 100 nodes was simulated and compared with the behaviour of 10 nodes with 0.1 s transmission interval.

Results and significance
According to the field test, the system as developed can be used for the individual localization of animals. At withers height, for 95 % of the measured locations, the bias was smaller than 35 cm and the dispersion in X- and Y-direction was smaller than 15 cm. On the ground, 95 % of the measured locations had a bias smaller than 0.6 m and a dispersion smaller than 0.2 m. The measured collision rate of 11 % for 100 nodes was low. The node hardware as developed can be attached directly to the animals' collars, as the electronics are installed in a housing designed for this purpose. The system on the whole is therefore promising and ready for a next step using real animals on working farms.

Publications, posters and presentations
Publication planned in “Computers and Electronics in Agriculture”

Project *2.17.03*

Project duration *April 2017 – November 2017*