Rößler, Benjamin; Stekeler, Tobias; Herd, Daniel and Jungbluth, Thomas

RFID multi-reader for simultaneous identification of FDX-B transponders

With the currently used low-frequency RFID systems for electronic animal identification, animals can only be identified individually in the group, but not simultaneously. Multiple low-frequency RFID readers which are operated at space-division multiplexing allow simultaneous detection, but are not used for animal identification. In the present study a self-developed and built multi-reader with FDX-B compatible reader modules was tested on a test stand and evaluated by using the detection rate. The transponder speed, number of readers and the number of transponder ear tags are varied. The average identification rate over all tests was 94.7 %.

Keywords

Electronic animal identification, RFID, Precision Livestock Farming, transponder

Abstract

Landtechnik 66 (2011), no. 3, pp. 209–212, 6 figures, 1 table, 4 references

The use of low frequency systems (LF, 134.2 kHz) according to ISO 11785 [1] represents the current standard in electronic identification of animals. This kind of system does not permit simultaneous identification by reader device of several animals within a group. If several animals or transponders are present within the scanning range of the reader device, a data collision can result. This means that not all transponders are identified. For reliable results, animals have to pass through the magnetic field of the LF reader device one at a time.

For industrial applications, various methods have been developed to avoid data collisions [2]. But due to the ISO Standard 11785 these are seldom applied in livestock production. A practical trial was set up with the aim of identifying several feeding pigs simultaneously [3] but no satisfactory result was achieved when a time-division multiplex method was applied to avoid data collision.

RFID multi-readers operated with the space-division multiplex method also enable simultaneous identification of transponders. With this type of anti-collision method comprehensive cover is achieved through operating several reader devices and antennas simultaneously and alongside one another in array [4]. This method is mainly applied at athletic events.

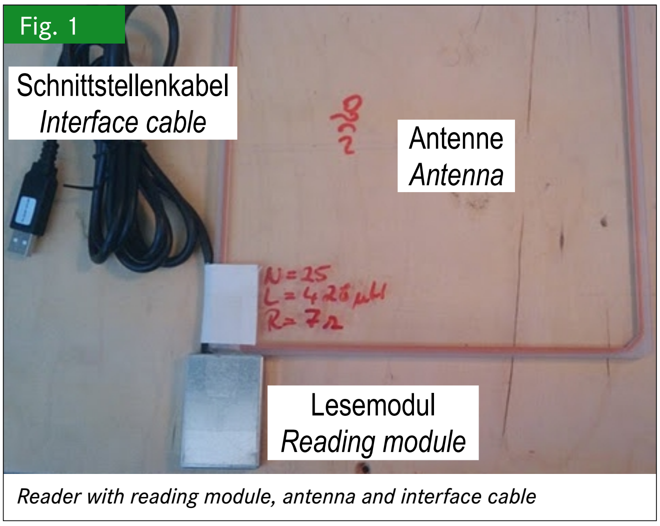
The aim of this work was to apply a self-developed and built RFID multi-reader device with space-division multiplex method so that several FDX-B transponders could be identified simultaneously. The operating frequency of the readers was 134.2 kHz. The RFID multi-reader trials were conducted on a test stand where the successful readings were documented according to speed, number of transponder ear tags and number of reader devices.

Materials and methods

For the investigation described here, nine FDX-B transponder ear tags (FlexoTronic R30, Caisley International, Bocholt) were used. The multi-reader device comprised up to eight individual readers controlled by a software programme. A reader device incorporated a reader module (5534 Reader Core MultiTag, HID Global, Erfurt), antenna and interface cable (**figure 1**). The USB interface cable fulfils two roles: it allows communication with the PC while also supplying the required operating current for the reader module. To avoid electromagnetic interference the reader module was fitted inside a housing of tinplate.

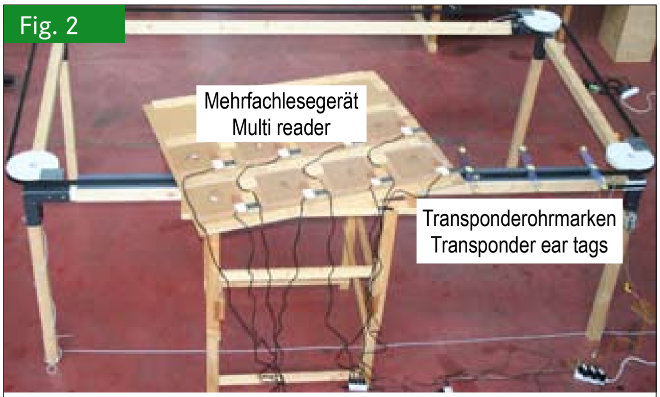
The test stand (**figure 2**) comprised a wooden frame with plastic pulley wheels at each corner guiding a drive belt with plastic carrier attached onto which were attached the trans-

Fig. 1



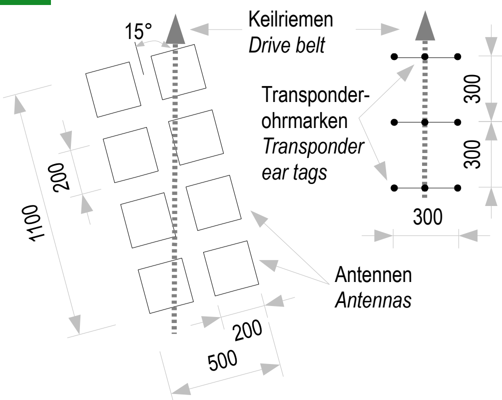
Reader with reading module, antenna and interface cable

Fig. 2



Test stand with multi reader device and transponder ear tags

Fig. 3



Arrangement of the antennas (left) and the transponder ear tags (right), dimensions in mm

ponder ear tags. Drive belt speed could be steplessly adjusted. A USB measuring system (DLP-IO20, DLP Design, Allen) recorded speed at one of the guide pulley wheels and number of belt circuits. The multi-reader device was placed on a height-adjustable wooden table.

Software was developed for recording the measurements and for operation of the individual readers (Java 1.6, Eclipse 3.5.2). Results were recorded as csv files and subsequently processed via table calculation software. A variance analysis was conducted using the statistics software R (Version 2.11.1, R Foundation).

The aim of the investigation was to determine the identification rate – the quotient from the number of transponders theoretically identifiable and those that were actually identified by the equipment under the following parameters:

- Speed [m/s]: 1.0; 1.5 and 2.0
- Number of activated readers [n]: 4; 6 and 8
- Number of transponder ear tags simultaneously moving past the reader [n]: 3; 6 and 9

The following parameters remained constant:

- Distance from transponder to antenna (60 mm)
- Parallel position of the transponder level to the antenna level

The different parameters allowed 27 variants that were replicated five times. One replication per variant represented 20 transponder passes under the multi-reader device.

The multi-reader device was positioned at an angle of 15° above the passing transponders so that every transponder passed through at least one reader field (**figure 3**). With a vertical positioning of 0°, the middle transponders would pass through the non-reading range.

Results

The results of the variance analysis with the target variables "identification rate" comprised 27 variants: in each case three manifestations of the parameters "speed", "number of readers" and "number of transponder ear tags" (**table 1**). All parameters were highly significant at $p < 0.0001$. The average of successful scans was 94.7 %, the standard deviation 0.8 %.

The results indicate that the number of successful readings is reduced, and their dispersion is increased, with increasing speed (**figure 4**). With increasing number of reader devices the idetification rate increased whereby dispersion decreased (**figure 5**). It was indicated that with six transponder ear tags a higher identification rate with less dispersion could be achieved compared with three or nine (**figure 6**).

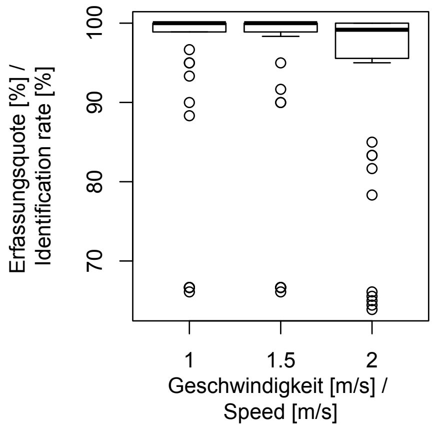
The result regarding number of transponder ear tags (**figure 6**) did not meet the expectations. The identification rate, as well as dispersion, was best with six transponder ear tags, and not with three as expected. The identification rate and the dis-

Table 1

Statistical evaluation with the target variable identification rate, the parameters speed, number of readers and the number of transponder ear tags

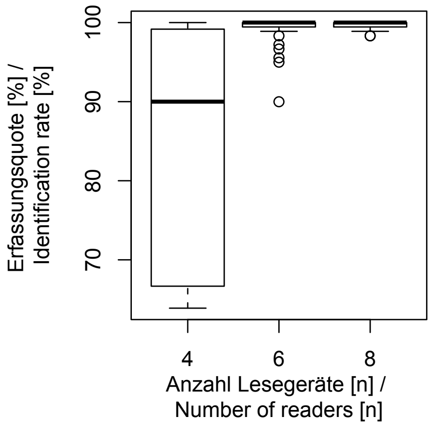
Einflussgröße *Independent variable*	**Freiheitsgrade [n]** *Degrees of freedom [n]*	**Quadratsumme** *Sum of squares*	**Mittelquadrat** *Mean squares*	**F-Wert** *F-value*	**p-Wert** *p-value*
Geschwindigkeit *Speed*	2	100,0	49,98	24,271	< 0,0001
Anzahl der Lesegeräte *Number of readers*	2	6176,6	3088,32	1499,676	< 0,0001
Anzahl der Transponderohrmarken *Number of transponder ear tags*	2	3314,3	1657,15	804,702	< 0,0001

Fig. 4



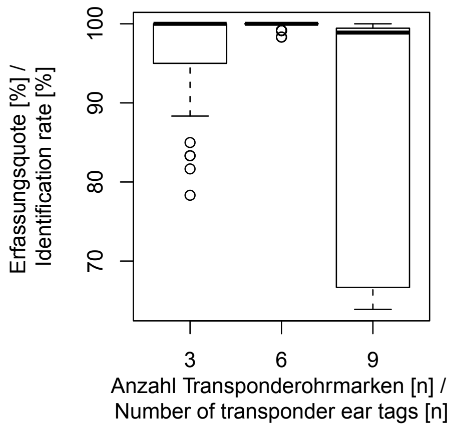
Identification rates in dependence of the parameter "speed"

Fig. 5



Identification rates in dependence of the parameter "number of readers"

Fig. 6



Identification rates in dependence of the parameter "number of transponder"

persion with nine transponders were, as expected, the worst. Altogether, one can assume that the position of the transponder ear tags on the belt had an effect. With any further trials this aspect should be considered and improved upon.

Conclusions

It is possible to successfully apply a multi-reader device with FDX-B compatible reader modules with a space-division multiplex system. At the same time there remains potential for optimisation and improvements. In future investigations the antenna configuration should be optimised through staggering their positions and the symmetrical configuration of the transponder ear tags randomised. The software for the test stand should also be further improved to allow more flexible and efficient experimental conditions.

It was clear from the low identification rate that operating the multi-reader device with only four readers is unsatisfactory. Where only the results from devices with six and eight readers are considered a successful identification rate of 99.5 % is possible, with a standard deviation of 0.6 %.

In further trials the positioning and distance between transponder and reader device should be investigated and single readers of higher performance applied. Only so is it possible to exploit the full potential of this technology and to apply it successfully under practical conditions.

Literature

[1] ISO 11785 (1996): Radio frequency identification of animals – Technical concept. International Organization of Standardization, Geneva

[2] Finkenzeller, K. (2002): RFID-Handbuch: Grundlagen und praktische Anwendungen induktiver Funkanlagen, Transponder und kontaktloser Chipkarten. Hanser, München

[3] Burose, F. (2010): Elektronische Ohrmarken für eine lückenlose automatische Identifikation von Schweinen von der Geburt bis zur Schlachtung. Dissertation, Universität Hohenheim, VDI MEG 487

[4] Kern, C. (2006): Anwendung von RFID-Systemen. Springer, Heidelberg

Authors

B. Sc. Benjamin Rößler is studying for his master degree,
M. Sc. Tobias Stekeler for his doctorate, and **Dr. agr. Daniel Herd** is member of the scientific staff in the department for Livestock Systems Engineering, Institute of Agricultural Engineering, Hohenheim University, e-mail: benjamin.roessler@uni-hohenheim.de

Prof. Dr. Thomas Jungbluth is director of Livestock Systems Engineering.