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Identification and evaluation of odour emissions from farming

Application of chemical sensor arrays

Odours from farms increasingly annoy the surrounding population. However, lack of measuring technology means these smells are often not evaluated. The target of the work here is the objective and reproducible recording of odours. Olfactometry is the state-of-the-art technology in odour measurement. With this, the problem lies with the standardisation of measurements.

In this report, the qualitative results of odour measurements are documented via multi-sensor array which impressively supports the suitability of the system used.

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Keywords

Emission, odour, multisensor-array

In the margin between the growing expectations on air quality and increasingly intensive livestock production, the recording of unwished-for odours has become a problem which can no longer be ignored. A system which enables an objective measurement of odours is necessary.

Present knowledge

Up until now, different methods including olfactometry, gaschromatography, mass-spectrometry and multi-sensor array have been used for odour measurement. The role of the individual components and their deficits have already been discussed in detail in the previous publication [1, 2]. Newer developments on the theme of sensors and evaluation algorithms were shown at the ISOEN99 conference, September 1999 in Tübingen [3].

Material and methods

Olfactometry

Olfactometry is at the moment the state-of-the-art technique for the measurement of air pollution in odour units and therefore units which can be associated with the effect of the odour. More detailed information on this is regulated by VDI Directive 3881 [4, 5, 6, 7].

Multisensor array

The construction and operating mode of multisensor array was described in detail in the previous part I of this publication series [1, 2]. The information contained in the measurement by the 18 sensors of the array is reduced to a single value per sensor (i.e. the maximum deviation during a measurement).This 18-dimensional vector is translated into a two-dimensional projection by prime component analysis (PCA) in a so-called component analysis plot.

Qualitative results: differences with the multisensor array

Investigation of odour emissions from livestock buildings inhabited by different types of livestock

Samples were taken from a pighouse, a cattlehouse and a henhouse and tested by multisensor array. The measurements were presented as a component analysis plot (*fig. 1*).

The aim was to achieve a definite distinction between the three groups of samples. The multisensor array is in the position to separate the odour emissions out of a pighouse from cattle and henhouse odour emissions. These differences can also be made by the human nose. The multisensor array therefore achieves the same accuracy here as does the human nose.

Differentiation of different cattle houses/ Comparison of various evaluation methods

Samples were taken from a building housing feeding bulls and one for dairy cattle and tested by multisensor array. The two odour samples, which are very similar as far as the human nose is concerned, could be differentiated by multisensor array. Produced from these measurements, was the component analysis plot (*fig. 2*).

Through these samples from different cattle houses it was possible to test the multisensor array's odour recognition abilities and also the example offered a way of comparing the different evaluation methods.

With this example it must be remembered that the measurement values marked with X originate from samples that were taken four weeks later. Through their construction, these samples were different from those in the component analysis plot. These differences, for example, could be influenced by meteorological changes, altered feed and the increasing weight of the animals.

The component analysis plot thus produced (fig. 2) shows the result of the primary component analysis (PCA), an unobserved model-based evaluation method. Here, 70%

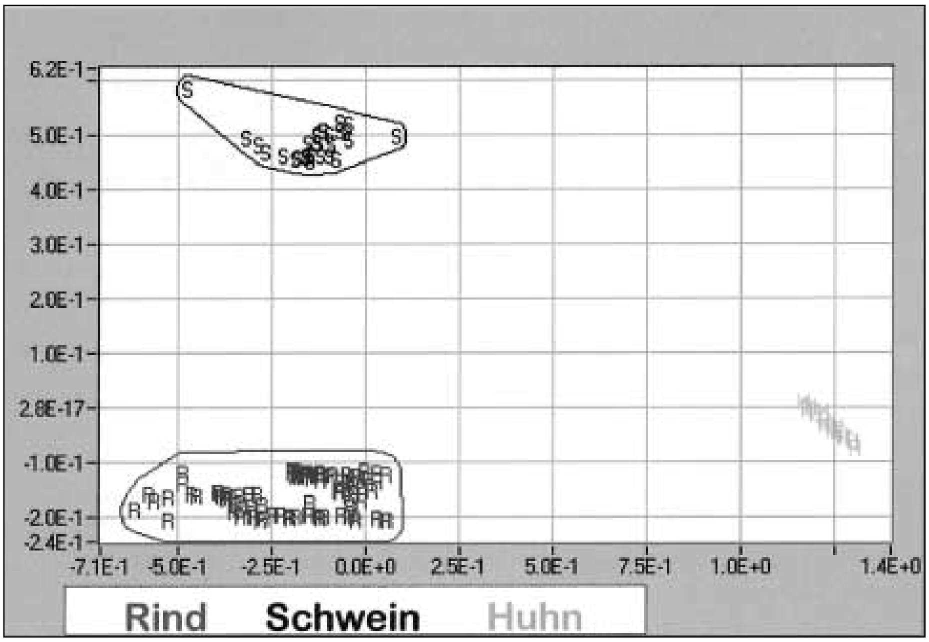

Fig. 1: PCA plot from pig house (S), cattle house (R.) and hen house (H) samples; Figure presentation according to FOX 4000 software packet

of the measurements were classified within the correct groups.

An evaluation using discriminatory analysis (DFA), which is an observed model-based procedure, could classify 90% of the later measurements to the respective four-week-old ones.

The highest recognition quota of 95% was produced by an programmed neuronal network with back-propagation architecture. This concerned an observed, model-free network. The comparison results of the evaluation procedure are once again brought together in *table 1*.

Conclusions

The results documented here show that it is possible to recognise different agricultural odours through multisensor array. Based on the air from livestock buildings, the odours from different types of livestock can be qualitatively differentiated . Additionally, the difference between dairy and beef cattle housing odours are also able to be determined. And in this case it was also possible to classify a sample taken at a later date.

Table 1: Comparing evaluation methods for the example of different cattle houses

Evaluation methods	Identification rate [%]
Prime component analysis (PCA) (unobserved, model-based)	70
Discriminative analysis (DFA) (observed, model-based)	90
Neuronal network with back-propagation architecture (BPN) (observed, model-free)	95

Literature

Books are signified with •

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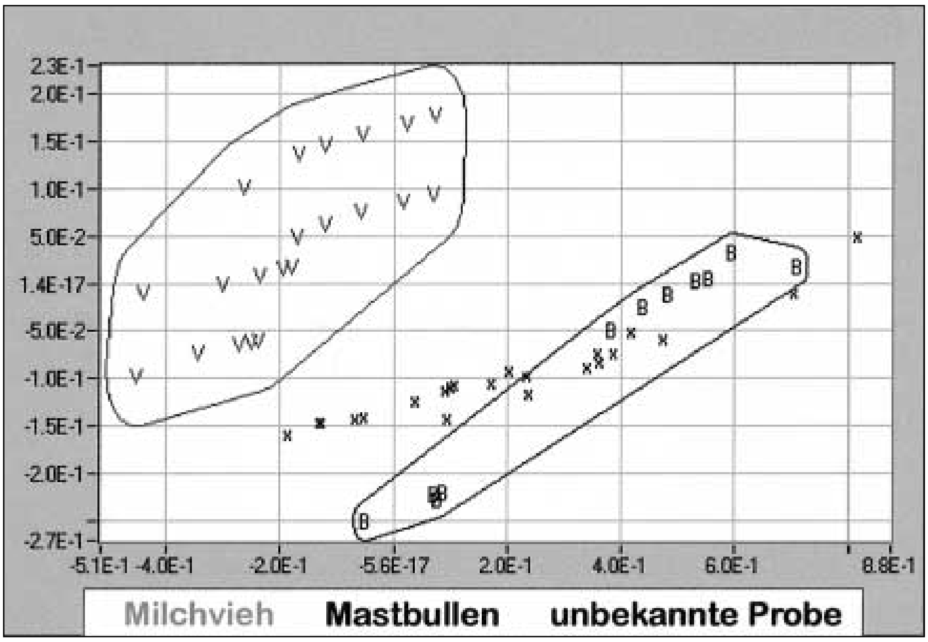

Fig. 2: MSA measurement results of samples from dairy cattle (V) and beef cattle house (B) air. The measurement points marked with X projected onto this plot originate from the same beef cattle house although these samples were taken four weeks later compared with those marked with (B). Figure presentation according to FOX 4000 software.