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Free-range Behaviour of Laying Hens

Automatic Image Recordation and Analysing System

Due to legal changes, as well as the increasing importance of organic agriculture, free-range housing systems for laying hens are on the rise. There are only a few reliable investigations about free-range behaviour and to what extent the laying hens take advantage of the free-range. At the Bavarian State Institute of Agriculture the free-range behaviour is being researched with the help of automatic image recording and analysis. On selected days during the study, the average number of hens on the free-range was 109 out of about 500. The identification accuracy on these days was about 84 %.

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Keywords

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At the Bavarian State Research Center for Agriculture two herds of 500 laying hens were observed in a mobile hen house. Both herds have access to a winter garden and a free-range (30 • 60 m) additionally to the hen house.

Ascertainment of the behaviour by graphic data was made by four digital reflex cameras with high resolution (6 millions pixels). The cameras are placed on an aluminium mast at a height of ten meters and were protected by an enclosure housing. Each one is connected by USB with a PC at the basement to store the collected pictures. The interval between individual images is set to one minute. *Figure 1* gives an overview of the camera locations and the free-range. *Figure 2* shows the camera view to hen house and free-range.

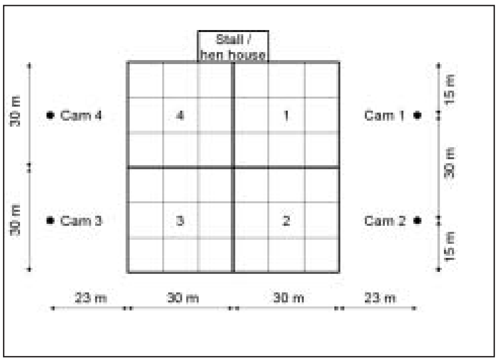

Fig. 1: Camera arrangement and recorded areas

Graphic data evaluation with Common Vision Blox

The software package „Common vision Blox“ of Stemmer® Imaging, used in the special case of hen identification in the free-range, offers user tools to analyse images. The image manager is the basis of the image analysing program and makes the appropriate information about the image representation and processing available to the used tools. The tool MANTO consists of two parts: A non linear multi-resolution filter (MRF) and a support vector machine (MCF).

Non linear multi-resolution filter (MRF)

With the help of the MRF the image is scanned for relevant display windows. The results of the search are scaled and the image information is handed over to the support vector machine in the form of vectors. The choice of the optimal preparation of the images with the MRF depends on the topic. „Trial and error“ is the only way to find out the right pre-processing code, however for this, support is provided in MANTO Teach.

The MRF is a sequence out of two different single filters, which are successively executed. Each filter reduces the resolution of an image per run by the factor 2. By this the picture resolution is reduced with n filter runs by 2^n. At our application three filter runs were used. The search speed rises by the decrease of the pixel quantity. However, the object localization is worse, because in x and y direction only each 2^n’nd pixel is considered and only each 2^n pixel is regarded as coordinate.

Support vector machine (MCF)

The second part of the tool MANTO is an adaptive sample classification algorithm. The information contained in the handed over

Fig. 2: Camera view to hen house and range areas

vectors is assigned to the given/trained classes by this algorithm. The necessary information about finding the relevant image sections as the case may be for correct classifying are stored in form of a MANTO classifier. To generate it, example images are stored in a „sample image list“ (SIL) during the learning or training procedure. These example images are all of the same size and already assigned to the appropriate classes. This SIL is the basis for the later generated Classifier (MCF). At this point it is very important to make no mistakes, because they directly influence the Classifier and the identification procedure.

Images belonging to the SIL are the only picture information MANTO receives. So it becomes clear that with the created Classifier only images can be evaluated, which are similar to those in the appropriate SIL. It becomes clear too that a SIL should contain as much as possible examples, in order to minimise the identification error.

It applies the following correlation: The average error rate is according to (number of examples in the SIL)$^{-1/2}$. This correlation applies up to a saturation point, provided that there are no inconsistencies in the SIL.

Recordation of laying hens in the free-range

The current evaluation of the acquired images shows that the identification accuracy is substantially affected by some factors.

- The colour of the image background (grassroots) and the contrast between image background and searched object (hens) are very important.
- A further criterion is the recording area. If a large area should be illustrated in an image it leads to sharpness losses within the contour ranges and due to the different distances between camera and hens to large variations in the shown object size.
- Furthermore the surface trimming is determining. With increasing number of animals per unit of area the identification accuracy decreases.

Because of the mentioned factors difficult analysis conditions result for the range in front of the hen house, whereby an own Classifier is necessary for this area.

Proceeding during the analysis

For controlling the tool MANTO a program was realized in „Visual Basic“. Therein the user has the possibility to change different parameters. Particularly the possibility of the definition of an „AOI“ (area of interest) is to emphasize, whereby the scanned image area and so the search time are reduced.

The free-range of a herd was divided into 18 squares with a side length of 10 m. During the analysis each chicken found is assigned to a field on the basis of the determined coordinates. The field name is transmit to a database including the file name, the x and y coordinate, a program internal degree of result security and the object class. The class informs about the kind of identification of the object. In the dataset it is to distinguish whether a hen was found automatically correct wrong or was not found automatic. The program routine contains the possibility to verify images by hand in definable intervals (e.g. each 20 picture). The user can check the existing animals in these images, remove automatically wrong found chicken and/or mark missing chicken by hand. This program section is the basis for a later verification of the identification accuracy.

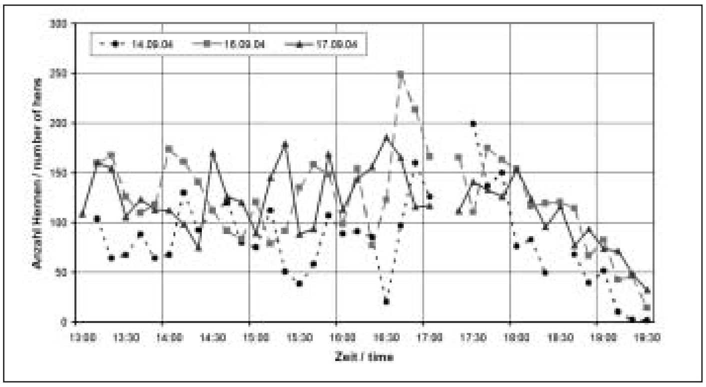

Fig. 3: Number of hens in the course of the day on the range

Behaviour in the course of the day

The temporal distribution of hens in the free-range can be determined by the information in the database. Thus the effective free-range use can be determined in a high temporal resolution. However it is not possible to identify single animals because the image data contain only the position of the single objects and not their identity.

On the basis of the results of three days (14., 16. and 17. 9. 2004) in the course of the day the free-range use is represented exemplary for a flock of 500 hens in 10-minute intervals (*Fig. 3*). The results of the automatic identification were corrected by errors in the identification.

In each case between 13:00 and 19:30 o’clock the hens had entrance to the free-range. Within this time no daily rhythm is to be observable. The values vary with different amplitudes around an average value, which is between 80 and 120 animals during these three days. Reasons for these fluctuations might be fortuitous events (e.g. birds of prey, airplanes of the nearby Munich airport). In the evening an even decrease of the animal numbers is observed.

Distance of the laying hens to the hen house

The question about the distance of the hens to the hen house can also be answered using the introduced method. This calculation is to be done by counting the animals per field and determine the middle distance of the field to the slip.

Average distance values for these three selected days vary between 13 and 22 m. A positive coefficient of correlation (r = 0.84) can be found between animal number at the free-range and the hen house distance.

Identification accuracy

For the three analysed days the automatic identification accuracy is 84 %. With increasing hen house distance the identification accuracy rises from almost 60 to 100 %, because the animal number and the grassroots positively affect themselves. This result is only valid for the evaluated days and the used Classifier and it is an order of magnitude for the attainable accuracy.

Literature

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