Dieter Ordolff, Kiel

Detecting Bloodstained Surfaces on Udders with an Image Processing System

An industrial image processing system is used to evaluate the efficiency of determining bloodstained udder surfaces. To verify accuracy, the results were compared to previously obtained ranges of optical parameters. The evaluation of actual data, obtained under more realistic conditions by the image processing system, produced useful results only for the „yellow-blue" parameter. The „luminance" and „red-cyan" ranges were very close to data obtained on the „white" surfaces of clean udders, where no hair was present, which would cover the „red" component of skin colour to a certain degree. The parameters for other conditions, like black or unclean surfaces, differed more clearly from results obtained on bloodstained surfaces.

Prof. Dr. agr. habil. Dieter Ordolff is member of the scientific staff at the Institut für Chemie und Technologie der Milch, BAFM, Hermann-Weigmann-Str. 1, 24103 Kiel, and at the Institut für Betriebstechnik und Bauforschung of the FAL, 38116 Braunschweig; e-mail: *ordolff@bafm.de*

Keywords

Udder, cleanliness, image processing

Automatic milking systems actually are not able to evaluate the status of cleanliness of udders, to detect lesions of teats and to manage cleaning of udder and teats according to the demands of actual regulations.

Results of basic research on application of optical parameters to fulfil these demands have been presented by [1]. Problems were mainly found with respect to pigmented surfaces. In a further step [2] used a CCD-colour-camera to evaluate the cleanliness of teat surfaces. Correct recognition of dirty teats was possible by connecting type and intensity of colours of all pixels.

Initial analyses of spectroscopic parameters, according to an industrial standard, to evaluate the efficiency of cleaning udders and teats indicated that manual cleaning mainly caused modifications of luminance of surfaces [3, 4]. The parameters red/green and yellow/blue were not useful to indicate cleaning efficiency on white surfaces, but a significant reduction of the level of „yellow" due to cleaning was observed on black surfaces. The parameter red/green was most efficient to detect bloodstained surfaces. It was concluded that for practical application a remote sensing system, based on video cameras, would be more useful than the device used in this investigation, requiring direct contact with the surface to be evaluated.

In another investigation [5] in two recording sessions an industrial image processing system was used to collect information about optical parameters to indicate the cleanliness of udder surfaces of ten cows, housed in an experimental stanchion barn at the Federal Agricultural Research Centre (FAL) at Braunschweig. A significant difference between unclean and clean surfaces was found for the parameter „white", while for „black" an „shadow" no difference between unclean and clean surfaces were to be seen. Similar to results, presented by [3, 4], also in this investigation luminance was the most variable parameter. However, the figures, representing the structure of colours at evaluated surfaces, indicate that only the application of all parameters enabled a reliable decision, to what extend cleaning the udder is necessary and whether it was efficiently done.

Material and Methods

In a further investigation the image processing system, described by [5], was used to evaluate the efficiency of identifying bloodstained udder surfaces. To detect lacks of specificity the results were compared with the previously obtained ranges of optical parameters (*Tab. 1*).

The data recording system produced three parameters, Y, U, V, to describe the optical condition of the evaluated surface, using the numeric range from 1 to 255, corresponding to an 8 bit data transmission system [6]. The parameter Y indicates the luminance. The chrominance signals U and V indicate the balances of red-cyan (parameter U) and yellow-blue (parameter V). A white object is represented by the values of 255 (Y), 127 (U) and 127 (V). The Y-U-V colour model used here is written down in the standard CCIR-601, dealing with conditions for transmission of colour video signals.

Images of the rear part of udders were recorded by a CCD-camera, which was placed on a trolley, also equipped with two 55 W halogen-lights to obtain stable illumination of the respective udder surface. Due to their triangular arrangement the light beams indicated the central area of the image to be recorded, simplifying a correct placement of the camera with a distance of about 1.5 m behind the cow.

The evaluation of images was based on conditions of surfaces, to be found as follows: dirt, white, black, shadow/contour, blood. The situation „shadow/contour" was included in the analysis, because initial tests

Table 1: Ranges for optical parameters

	Averages					
Surface	**Ymin**	**Ymax**	**Umin**	**Umax**	**Vmin**	**Vmax**
Dirt	46.4	78.3	111.7	123.3	133.7	139.1
White	92.6	150.8	112.2	123.4	136.3	151.2
Black	25.1	51.5	126	131	128.7	133.1
Shadow	55.7	74.8	122.8	131.5	132.6	143.3
Blood	83.2	135.7	113.7	121.3	158.1	172.1

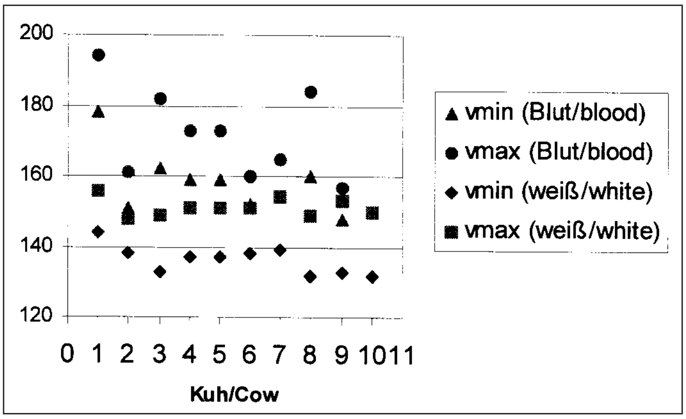

Fig. 1: Range „White/Blood" (yellow-blue)

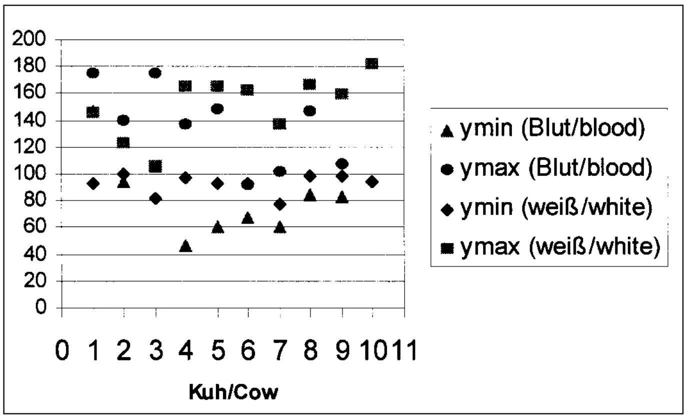

Fig. 2: Range „White/Blood" (luminance)

had shown that the signals, corresponding to unclean surfaces, to a certain amount may also be found at clean areas, due to poor illumination, caused by the movement of the cow or at some parts of outlines of udder or legs. Similar observations made [2].

Ten images of udders, recorded in the first session, were used to define the range of the optical parameters for evaluation of the status of surfaces (*Tab. 1*), corresponding to the averages of lowest and highest values resulting from the teaching procedure.

Results and Discussion

As already mentioned, in earlier investigations, using a similar spectroscopic method to describe the optical condition of surfaces [3, 4], it was found, that the parameter „red-green", corresponding to „red-cyan" in the actual system, as to be expected, was the most obvious indicator of blood. However, the evaluation of actual data, obtained under more realistic conditions by the image processing system, with respect to „blood" produced useful results only for the parameter „yellow-blue" (*Fig. 1*). The ranges for „luminance" (*Fig. 2*) and „red-cyan" (*Fig. 3*) were rather close to data, obtained especially at „white" surfaces of clean udders, where no hair was present, which would cover to a certain degree the „red" component of skin colour. The parameters for other conditions, like unclean surfaces (*Fig. 4*), differed more clearly from results obtained on bloodstained surfaces.

Similar to earlier investigations visual inspection of images indicated, that not all cows were in identical position, when clean and unclean udders were to be recorded. This situation, already mentioned by [2], may explain some irregular results. For practical application of the system, the relative position of the camera and udder therefore is to be stabilised, e.g. by using the signals, produced by sensors for monitoring the cow position, included in most automatic milking systems.

While shading, found to be a problem by [2], in the investigation described here did not affect the efficiency of classification of surfaces, it should be avoided by optimised illumination of udders. Since evaluation of the total udder surface requires at least two cameras, this problem may be solved by adapting illumination individually to the surface inspected by the respective camera. This also could be the way to avoid irregular classification of contours.

Summary

The analysis of images of unclean and clean surfaces of udders, recorded with an industrial image processing system, indicated, that the combination of luminance and chrominance allowed setting limits to recognise unclean and clean surfaces with some certainty. Based on the parameter „yellow-blue" the detection of blood also was possible with such a system. It is to be investigated, to what extend it would be useful to create for each animal an individual setting of parameters, corresponding to undamaged skin, especially with respect to surfaces covered more or less by hair.

Furthermore, for practical application more investigation is required to analyse additional aspects, like positions of cows, adding cameras for evaluation of full udder surfaces and optimisation of illumination of surfaces to be checked.

Literature

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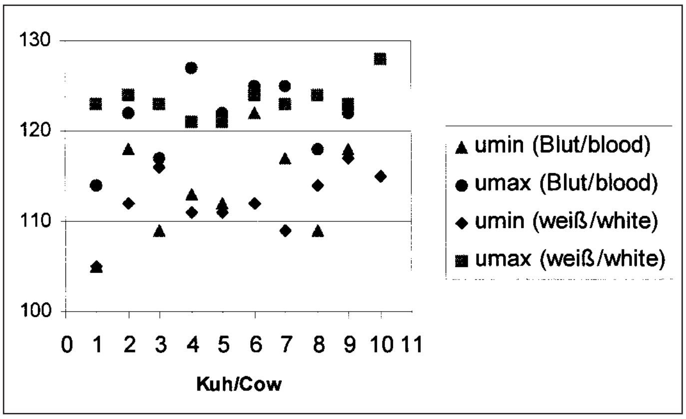

Fig. 3: Range „White/Blood" (red-cyan)

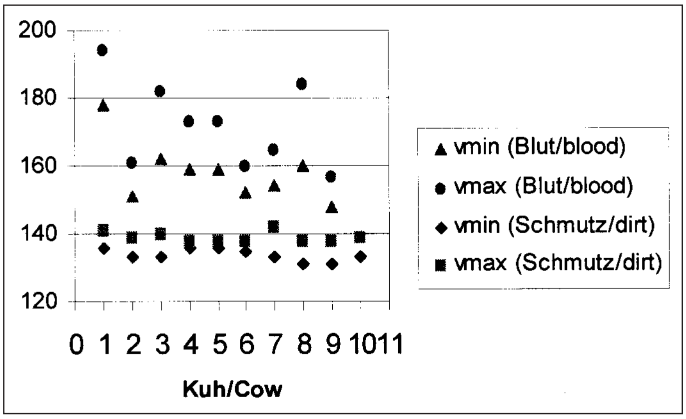

Fig. 4: Range „Dirt/Blood" (yellow-blue)