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THE IDENTIFICATION OF DAIRY COWS USING IMAGE PROCESSING TECHNIQUES

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Abstract. *Systems to recognize and identify individual cows have become more and more important for modern dairy farms to make precise and successful dairy management. Due to this, various types of identification systems have been coming to front line literature. Most of cow identification systems utilize electrical identification methods based on the RFID (radio frequency identification). However, RFID implementations can cause several problems. Therefore, in this paper we propose an effective and easy-to-use cow identification system by using image processing techniques. Specifically, the proposed system involves recognition of individual cow by identifying the landmark patterns on the cow body along with background modeling, and foreground marks extraction tuned on morphological operations. In order to confirm the system developed in this paper, we present some experimental results based on self-collected video sequences taken at Sumiyoshi Field Science Center, the University of Miyazaki.*
Keywords: Cow identification, Mark extraction, Similarity matching, Color histogram

1. **Introduction.** Today dairy farms are focusing on more intelligent systems to increase their products together with high quality standard. Farm management systems are also changing to precision dairy farming which leads to production environments with inclusion of cow welfare and health. We also well recognized that human-cow interactions are significant features to support farming systems wellbeing. Some research findings indicate that the negative interactions between farm personnels and their cows can lead to production loss and deteriorate animal health [1].

Thus it is necessary to make individual management of the cow as a first step for precise management systems. In other words the individual cow identification system is an essential component of modern dairy farms. When we are talking about individual animal identification system, mostly electronic identification system usually referred to as RFID (radio frequency identification), comes to our mind. There are many good features of using RFID, but more problems still remain unsolved. For example, for every application we use RFID, and the reading speed and distance are to be optimized [2].

On the other hand image processing techniques become more effective than RFID especially for making intelligent monitoring and animal behavior analysis including recognition and identification of individual cows. In this concern, many researchers have employed image processing techniques to investigate the identifications of dairy cows individually or in groups [3,4]. However, still we have many challenging problems to be tackled under various conditions such as weather and illumination changes. To overcome some of those

challenging problems we introduce a new way of image processing techniques for dairy cow identification system. The technique of using marks feature patterns for moving cows which we introduce in this paper is different from many other approaches and giving more accurate results. Specifically, we propose an individual cow identification system by investigating query marks movement patterns on the body of cows.

In order to do so, we organize the rest of paper as follows. Some related works are described in Section 2. In Section 3 the overview of the proposed method is presented. Section 4 shows some experimental results by using self-collected video sequences taken at the agricultural farms in University of Miyazaki, Japan. Finally, we conclude the paper in Section 5.

2. **Some Related Works.** Image processing techniques developed from video surveillance systems have been applied in various ways for modern dairy farms. For example, the applications include cow identification and recognition, standing heat detection, calving monitoring and cow lying system [6-8]. Moreover, many researchers have these techniques for analyzing cow behaviors such as estrus detection, body condition scoring, and lameness detection [9-11]. As far as the application of image processing to cow behavior analysis is concerned, the segmenting of the object from video frames and detection of the individual cow are the fundamental steps of the system. The complicacy of illumination and environment conditions requires new target detection algorithms. Background subtraction, frames difference and motion estimation are the most common cow detection methods [12]. In the background subtraction method, the background is obtained by background modeling, which is subtracted from the images to detect the target.

Accordingly, the background subtraction method is sensitive to the difference between the target and the background. In this paper we employ background modeling technique for cow body extraction from video images. However, it is important and necessary to develop a new method adapting to the farming environment for accurately detecting cows. In this paper, a series of algorithms were proposed to detect the moving target accurately for cows based on background subtraction. These algorithms we employed in this paper are robust and different from the traditional ones.

3. **Overview of Proposed Image Based Cow Identification System.** An overview of the proposed system is described in Figure 1. This system is composed of four modules: preprocessing module, background modeling and foreground subtraction module, mark patterns and features extraction module and similarity matching and identification process module.

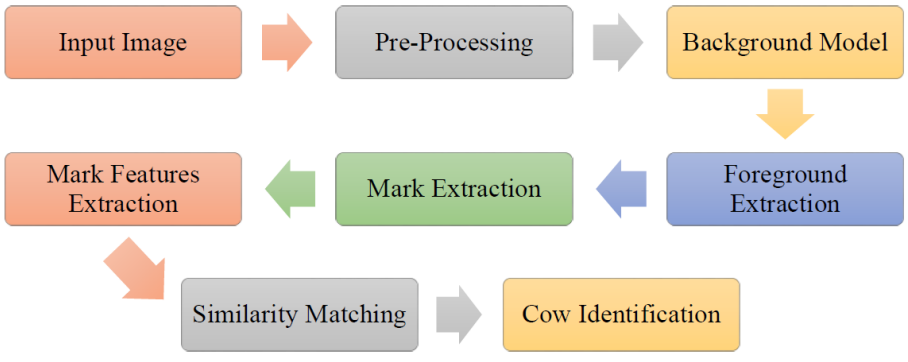

FIGURE 1. Overview of proposed cow identification system

3.1. **Preprocessing module.** The preprocessing module is the first and important part of any system for image processing techniques. It contains, both histogram equalization to increase image contrast and mathematical morphology operations and image filtering to remove noise form image.

3.2. **Background modeling and foreground extraction module.** In the second module, we perform the background modeling and foreground extraction process. In particular we make a process on the creation of the estimated background image. In which we focus on slow cattle movement in order not to be processed "rather than a moving object, as background". We then proceed to background subtraction between the estimate background and the input image to obtain the foreground. In this process we follow the background update scheme by employing a recursive median filter to avoid computation complexity. Then noise removal and labeling process are carried out with aids of morphological operations.

3.3. **Mark patterns and features extraction module.** After extracting foreground region of moving cow, we further extract the region in which a mark is drawn on the cattle, and moreover the color feature such as hue value in the HSV color space. Some examples are shown in Figure 2. In particular we take a histogram of the vertical direction and the horizontal direction. For this purpose the threshold value is set in the area having a large number of white pixels. Then we extract the area of cattle side. This is to eliminate the color of the tag attached to the ear of the cow so that in the next process only it will be recognized as a marker.

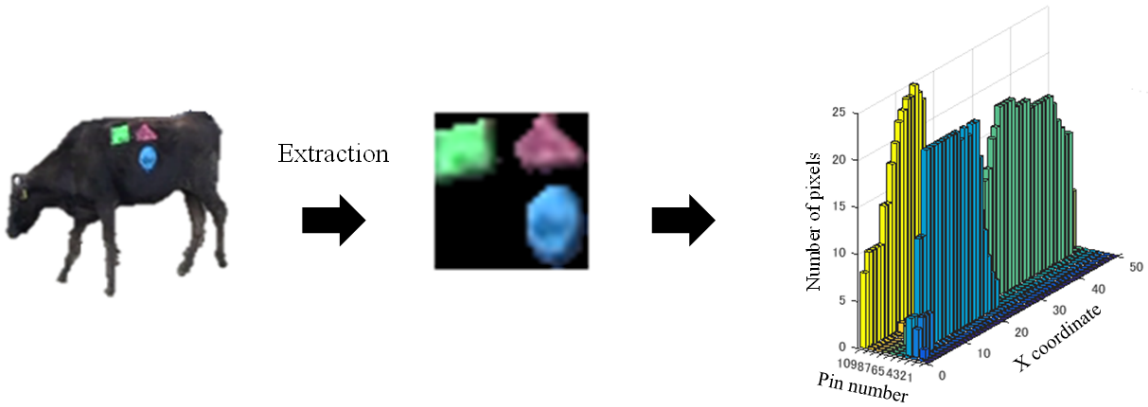

FIGURE 2. Marks and color features

(a) Pattern 1 (b) Pattern 2 (c) Pattern 3 (d) Pattern 4 (e) Pattern 5

FIGURE 3. Example of mark patterns

3.4. **Similarity matching and identification process module.** The final module is the similarity matching and identification process module which aims to detect the similarity between the images in the database and to carry out the identification process. We first consider the possible patterns of marks as shown in Figure 3. Here we only use the value of the HSV color space to extract the mark area, and to remove the area of the cattle of skin color (brown). This is to calculate the similarity by using the feature amount

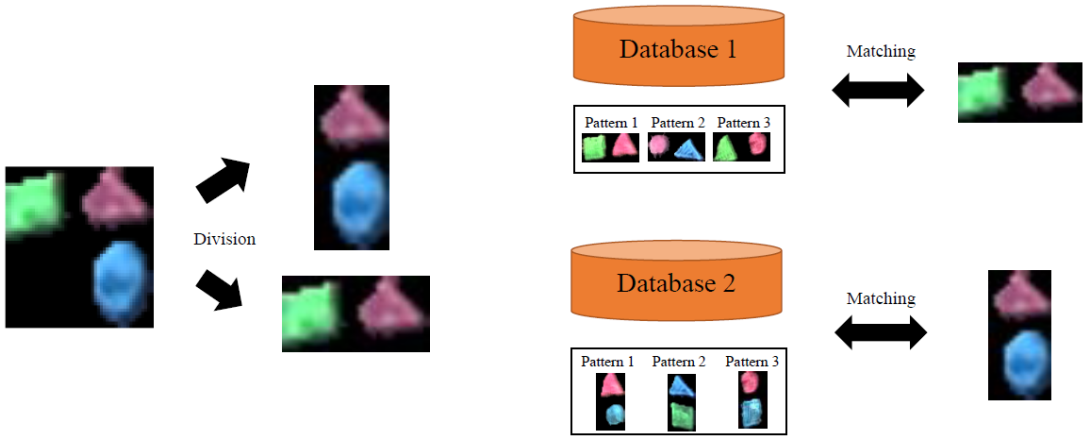

FIGURE 4. Cow identification process

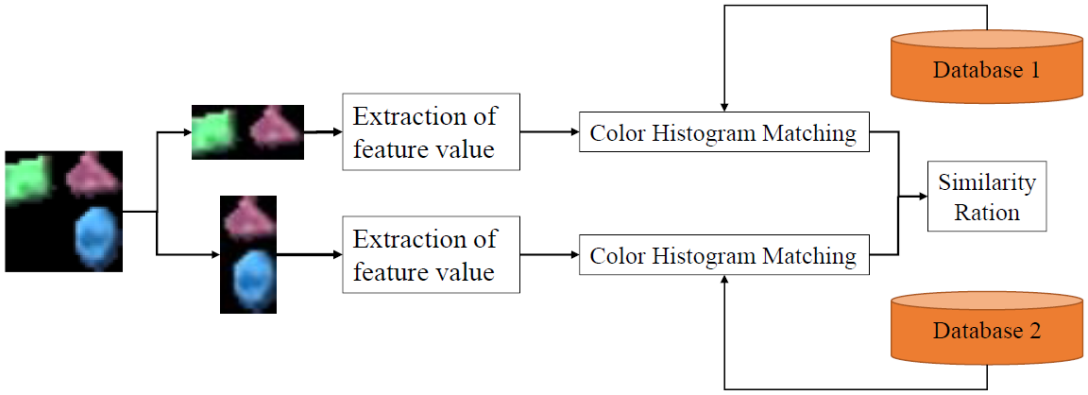

FIGURE 5. Summary of similarity matching process

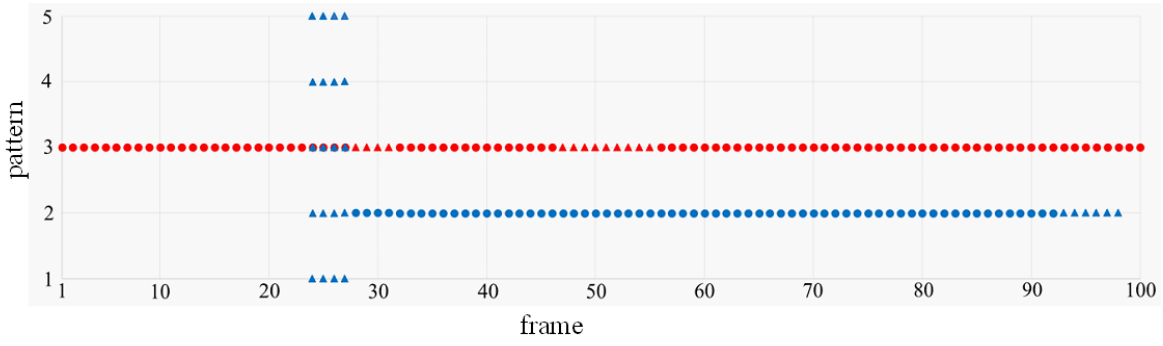

FIGURE 6. The identified results of Pattern 2 cattle and Pattern 3 cattle using the proposed method

of landmarks only. The identification process is shown in Figure 4. We also summarize the whole process as shown in Figure 5.

4. **Experimental Results.** In order to confirm the validity of our proposed method, we conduct a series of experiments by taking video sequences at Sumiyoshi Field Science Center, the University of Miyazaki. The experiment was performed 5 times under various weather conditions. In our experimental setup, the camera attached with a lamp is located at a height of about 4m from the ground. To prevent that cows would overlap on the screen, it was taken from as high position as possible. For each video sequence we perform background modeling and the background update scheme by employing a recursive median filter to avoid computation complexity. Then the morphological operations are employed

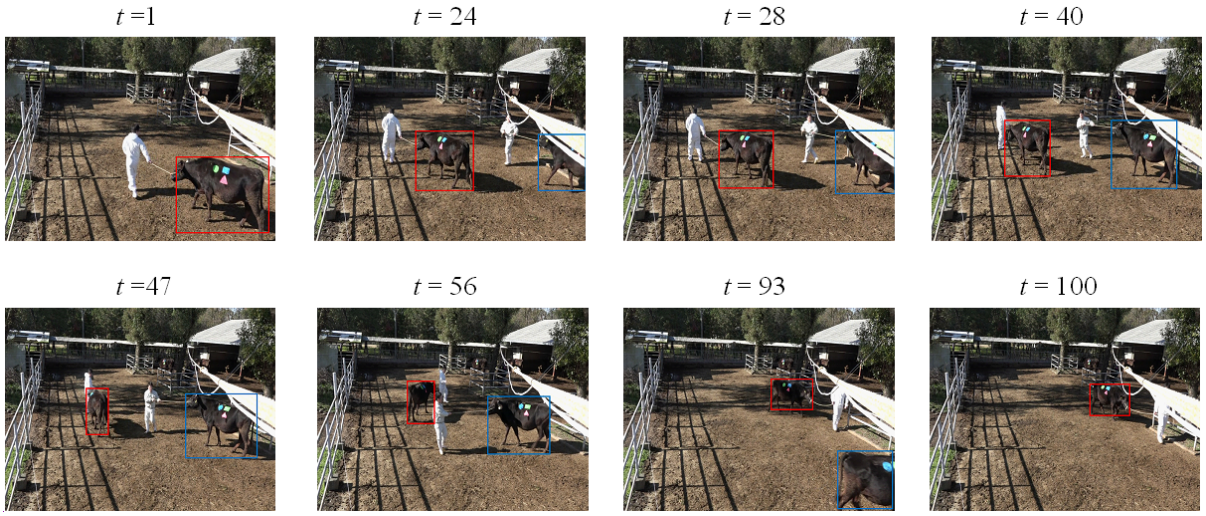

FIGURE 7. Tracking results of Pattern 2 cattle and Pattern 3 cattle from one video sequence

for noise removal and labeling process. After that the marks are extracted and similarity matching process is carried out to identify the individual cows. Some sample results for experiments are shown in Figure 6 and Figure 7.

5. **Conclusion.** In this paper, we have proposed an individual cow identification system by using image processing techniques. Different from many other approaches, we have employed mark and feature patterns for moving cows. Experimental results by using real life scenarios show that the proposed method is promising. In future, we would do more to improve the system by using different features.

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REFERENCES

[1] T. van Hertem, M. Steensels, S. Viazzi and E. C. B. Romanini, Improving a computer vision lameness detection system by adding behaviour and performance measures, *International Conference of Agricultural Engineering*, Zurich, 2014.

[2] T. Huybrechts, K. Mertens, J. De Baerdemaeker, B. De Ketelaere and W. Saeys, Early warnings from automatic milk yield monitoring with online synergistic control, *Journal of Dairy Science*, vol.97, no.1, pp.1-11, 2014.

[3] Y. Morio and Y. Ikeda, Development of holstein cow identification system using black and white patter, *Proc. of the XIV Congress CIGR P2204*, 2000.

[4] Y. Morio, Y. Ikeda and K. Horibe, Holstein identification with robustness against lighting condition, *J. Jpn. Soc. Agricultural Machinery*, vol.65, no.2, pp.94-100, 2003.

[5] T.-K. Dao, T.-L. Le, D. Harle, P. Murray, C. Michie and I. Andonovic, Automatic cattle location tracking using image processing, *Proc. of the 23rd European Signal Processing Conf.*, pp.2636-2640, 2015.

[6] C. Wen, S. Wang, X. Zhao, M. Wang, L. Ma and Y. Liu, Visual dictionary for cows sow-activity recognition, *Transactions of the CSAM*, vol.45, no.1, pp.266-274, 2014 (in Chinese).

[7] S. Porto, C. Arcidiacono, U. Anguzza and G. Cascone, A computer vision-based system for the automatic detection of lying behaviour of dairy cows in free-stall barns, *Biosystems Engineering*, vol.115, no.2, pp.184-194, 2013.

[8] T. M. Brown-Brand and R. A. Eigenberg, Development of a livestock feeding behavior monitoring system, *Transactions of the ASABE*, vol.54, no.5, pp.1913-1920, 2011.

[9] S. Viazzi, C. Bahr, A. Schlageter-Tello, T. Van Hertem, C. E. B. Romanini, A. Pluk et al., Analysis of individual classification of lameness using automatic measurement of back posture in dairy cattle, *Journal of Dairy Science*, vol.96, no.1, pp.257-266, 2013.

[10] T. T. Zin, H. Kai, K. Sumi, I. Kobayashi and H. Hama, Estrus detection for dairy cow using a Laser range sensor, *Proc. of the 3rd Intl. Conf. on Computing Measurement Control and Sensor Network*, pp.162-165, 2016.

[11] K. Sumi, I. Kobayashi and T. T. Zin, Cow identification by using shape information of pointed pattern, *Proc. of the 9th Intl. Conf. on Genetic and Evolutionary Computing, Genetic and Evolutionary Computing: Advances in Intelligent Systems and Computing*, vol.388, pp.273-280, 2015.