Cow Identification System using Ear Tag Recognition

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***Abstract*—In precision dairy farming, the valid record of individual cow identification is an important factor in large herds management. In this paper, we propose a cow's ear tag recognition system that can be used in dairy cow management. Firstly, cow's head detection is performed by using You Only Look Once (YOLO) object detector followed by ear tag recognition. The ear tag extraction and recognition processes are carried out by image processing techniques and Convolutional Neural Network (CNN) classifier on detected cow's head images. The experiments are conducted by using videos from dairy farm at Hokkaido prefecture, Japan. The proposed system achieved the reliable results which will support to give the informative status in smart farming.**

Keywords—cow management, precision dairy farming, ear tag recognition, object detector, Convolutional Neural Network

I. INTRODUCTION

The individual cow management is essential for many factors such as monitoring cow's Body Condition Score (BCS), milk production, heat detection and so on. The dairy cow management combined with Internet of Things (IOT) are becoming widely used in agriculture and livestock sectors according to agriculture 4.0 era. The lack of monitoring and proper healthcare on cow may cause health problems, low ability and even animal loss. Therefore, the aim of using technologies in precision dairy farming is increasing productivity and profit while also reducing costs.

In livestock dairy farming, individual cow identification is needed to consider for keeping track of cow's health and condition. Monitoring of individual cow take times and labor cost and it will also be difficult to handle in large-scale dairy farming. The individual cow identification system using image processing techniques and deep learning to classify different pattern of cow's body was proposed in [1]. Mostly, all cows in livestock farm have individual ear tag and the author used color threshold approach for extracting ear tag region, flood fill method, Hough transform and projection method for segmentation and performing template matching, k-nearest neighbor and support vector machines for character recognition process [2].

In this paper, we proposed identification of cow using cow's ear tag. The paper is organized into four sections. In section II, we describe our proposed method. Some experimental results are shown in section III and conclusion and future work are described in section IV.

II. PROPOSED MEHTOD

The proposed system is mainly composed with two part: cow's ear tag detection and recognition of ear tag. The overview of the system is shown in figure 1. The input to the system is video data and step by step operations are performed. Firstly, the positions of cow's head are searched in the videos for locating the cow position. After having cow's head, the ear tag extraction process is performed. Finally, the extracted ear tags are further processed into ear tag recognition process for identifying numbers on the tag.

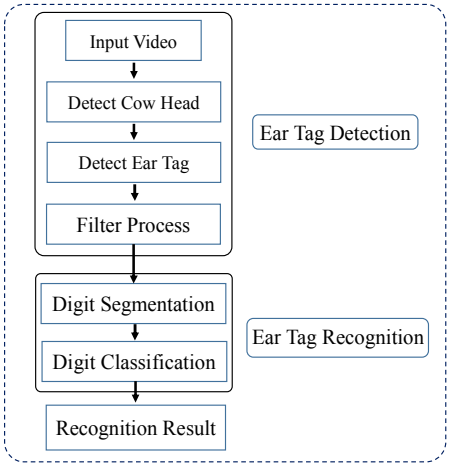

Fig. 1. Overall system architecture

A. Cow Head Detection

Basically, all cows in dairy farm have ear tag and unique ID number printed on it. In order to extract ear tag number, we firstly needed to perform cow's head detection. This cow's head detection also benefit in checking the number of existing cows in each camera views. For the detection process, we used YOLO detector as proposed in [3]. We prepared label cow's head approximately 20,000 images for training. One of the advantages of using YOLO detector is that cow's head detection process can perform in real time. The detection of cows' head from the input image frame is shown in figure 2.

After detecting cows' head from input video, ear tag extraction process is performed. The frame rate for processing is one frame per second. The input image is converted from RGB to HSV color space. We set threshold parameters on each HSV channel to extract yellow color of ear tag region.

B. Ear Tag Recognition

There are three main steps in ear tag recognition: preprocessing, segmentation and recognition.

1) Preprocessing

The filtered ear tag images are transformed into grayscale images and complemented. Then the transformed images are performed histogram equalization and binarized. This process is illustrated in figure 3.

Fig. 2. An illustration of cows' head detection process

Fig. 3. Illustration of preprocessing steps

2) Segmentation

Segmentation process is carried out by using histogram projection approach. Since only digit area is needed to be recognized, the other unnecessary borders are firstly removed. Unnecessary borders removal steps are as follow:

1. Sum white pixel values of binary images horizontally.
2. Eliminate horizontal borders that have sum result less than half image width.
3. Crop the original RGB image and eliminate vertical borders.

Then barcode area is detected using horizontal valley points. The valley points with horizontal summed values greater than half image width are discarded. The first two points of remaining valley points are taken as barcode start and end points. The barcode end point is taken as digit horizontal start point. This process is shown in figure 4.

After that four digits are segmented using vertical valley points. In each ear tag plate, there are five parts in the digit area which included 4 digits and one mini digit. So, four minimum valley points are taken as segment points. Then, the first four digits are cropped using segment points. This process is illustrated in figure 5.

3) Recognition

In recognition step, the Convolutional Neural Network (CNN) is applied to the system. For the training process, we prepared individual digits that are manually cropped from the video data. About '6000' digit images from 0 to 9 ('600' for each digit) are used as training data. Each digit image is performed histogram equalization, binarization and then resized into 64 × 32 image dimension. These scaled images are inputted to the CNN classifier. In recognition process, the extracted digit images are resized into same dimension and performed the digit classification.

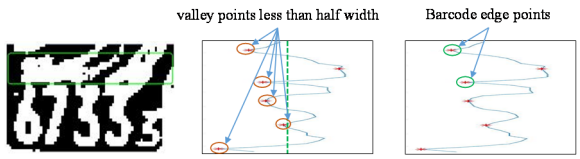

Fig. 4. Barcode area detection

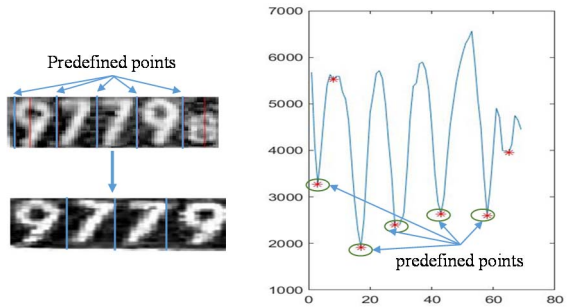

Fig. 5. An illustration on segmentation of individual digit

III. Experimental Results

The experiments are performed on dairy farm at Obihiro city, Hokkaido prefecture, Japan. The video data are collected from network camera (AXIS P1448-LE) equipped at front view. Each network camera can cover 5 cows per one cell. The data acquisition is performed on each camera view and stored in Network Attached Storage (NAS) every 5 minutes. The experiment is performed on the recorded 5 videos at November 25th, 2019 and all are run in parallel. The cow's head detection rate and ear tags recognition accuracy are shown in Table 1.

TABLE I. DETECTION AND RECOGNITION ACCURACY

No.	Video	Cow's Head Detection Rate	Ear Tag Recognition Rate
1.	Video 1	100%	80%
2.	Video 2	100%	100%
3.	Video 3	80%	100%
4.	Video 4	100%	60%
5.	Video 5	100%	80%

According to the experimental result, the system has overall accuracy of 96% for cow's head detection. For the ear tag recognition, the system has recognition accuracy of 84%. The recognition rate is decreased in some videos because the system cannot completely detect the ear tag region and sometimes because of recognition error. The system worked well in challenging environments such as sunny, cloudy and even in snowing days. In addition, the system can provide the number of existing cows presented in each camera view and its related cow ID number. Therefore, the system can give the useful information for dairy farmers.

IV. Conclusion and Future Work

In this paper, we proposed individual cow identification system by using cow's ear tag information. The YOLO detector is used for detecting cow heads in the input image sequences. And then, CNN classifier is used for recognizing numbers printed on the ear tag. The proposed system can give reliable information with the number of cows and related ID numbers for further processing. For future work, the modification will be made on ear tag recognition to have better recognition rate and this proposed work will be combined on intelligent monitoring system.

Acknowledgement

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