Vision-based Cattle Detection and Localization System in an RGB Color Space

Detection and localization system for cattle shed management

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Abstract— **In this paper, we present an approach to automatic cattle detection and localization system from natural scenes. Cattle shed scene has complex background and various illumination. In this reason, the proposed approach includes object detection method in complex background using active tags and RGB color filtering. In addition, we proposed localization method using image data and RFID data. First, we narrow down the localization range using RFID data. Then, we estimate more accurately the object location using vision-based methods.**

Keywords-animal localization; cattle shed surveillance system

I. INTRODUCTION

Robust object localization and object detection method have applications including gaming, security, defense and even medical service.

Recently, domestic stock farmers suffered from highly contagious livestock diseases, such as the Foot-and -mouth disease (FMD). These kind of contagious livestock diseases have often initial symptom of high temperature. For this reason, it is necessary to sense a temperature change of cattle in stock farms. Additionally, we are able to early detect and isolate a cow which has high temperature change through each object localization. This is important because isolation of an ill cattle prevents spread of the disease. Furthermore, we should isolate not only the sick cattle but also a group containing the sick cattle. Previous researches [1] of finding a group containing target object are less accurate in cattle shed. For this reason, we propose a vision-based cattle localization and detection system in stock farm. Our system performs vision-based ill cattle detection and localization, as shown in Fig. 1. Target stock farm is divided into multiple room. We called each room "cattle shed cell" and each cell has unique number as Fig. 1. Each cattle shed cell has one or two cows. Our system has one camera per each axis. Each camera can move horizontally on axis. We utilize the active tag [3] and Radio Frequency Identification (RFID) [4] information and camera images for assistance of object detection. Each active tag works along with temperature sensor. We put active tag and RFID on each cow's body. In other words, each cow has an active tag and a RFID chip. When it senses an increase in temperature that is above a given threshold, the tag light associated with the sensor lights up. We detect the active tag and estimate the object's localization. Then, mobile cameras collect cattle's image data using object position information.

Object localization and detection systems have two problems. Generally, vision-based object detection system has less accuracy on brightness change. As mentioned earlier, we propose active tag as technical assistance. It has merits and demerits. It helps the systems to achieve high accuracy by detection in dark environment, but it requires checking the batteries periodically. Second, it is difficult to estimate the object's location in a natural scene by using vision-based methods.

Our localization method has two steps. We localize object cattle using RFID primarily. We narrow down the localization range using RFID location information. Then, we estimate the object's location using vision-based method.

A common approach is a region-based method, which uses multiple feature or high complexity feature and Adaboost or neural network. [5],[6],[7]. This method needs a diverse training dataset and multi-features require large processing time. Also, the recently proposed camera-based real time mapping for Simultaneous Localization And Mapping (SLAM) [8],[9],[10] is not suitable for stock farm environment.

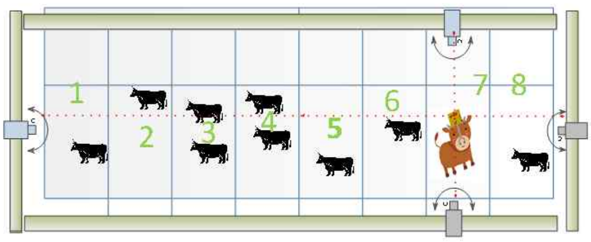

Figure 1. Vision-based ill cattle localization system

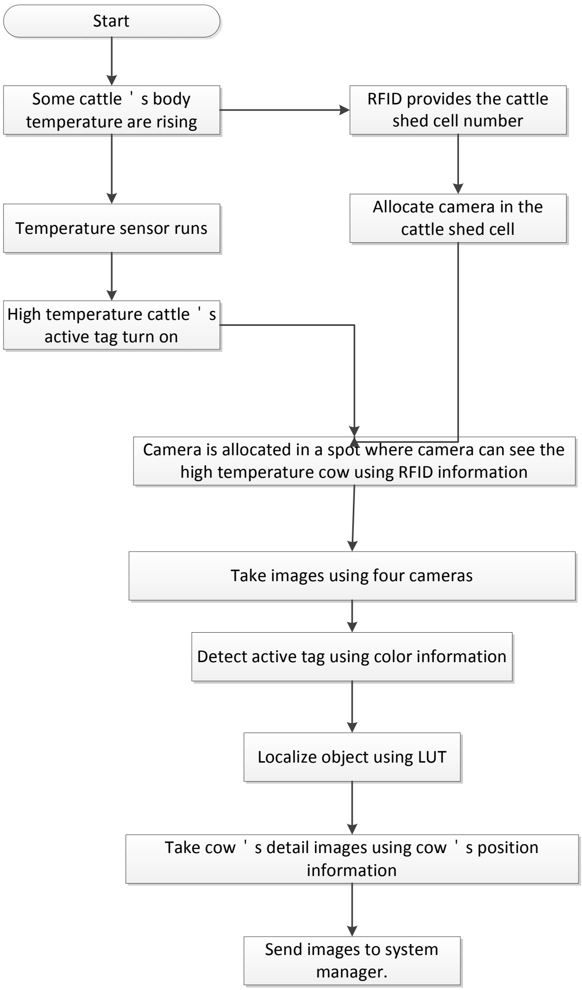

Figure 2. System Flow Chart

II. CATTLE DETECTION AND LOCALIZATION SYSTEM

In this section, we describe our system. We proposed ill cows detection and localization system in stock farms. Fig. 2 shows a system overview. This vision-based system works when the cattle's body temperature rises. If some cattle's temperature rises, the cattle's RFID provides the corresponding shed number. At the same time, the cattle's active tag turns on and four cameras convey the location of the targeted cow using the light Images are captured by these four cameras. An active tag has brighter and clearer color than general object. Accordingly, we detect active tags using color filtering. We make a localization map using color markers as Figs. 4(c), (d) and (e). Also, we estimate the active tag's position using matching LUT (Look-up table). LUTs are trained beforehand. We record the image of the affected cow using the estimated position. Finally, we send images to system administrator. These images are used for cattle shed management service.

Figure 3. Active tag sample

A. Cattle detection in RGB color space

Real datasets in cattle shed have more problems than indoor images. These images are more sensitive to lighting variation. In order to solve the problem, we propose active tags that provide illumination invariant color information. Our active tag is made of LEDs, as shown in Fig. 3. Each cow has one active tag, and each active tag turns on when the cow has high temperature.

Our active tag gives out a red light. Using this simple fact, we perform normalized color filtering to detect active tag. R-band pass filter has high weight.

B. Processing region define method and object localization using color marker and RFID information

A common approach is vision-based probabilistic model [11]. Natural scene includes various color and illumination. For this reason, it is difficult to perform object localization in wide natural scene. In order to solve the problem, we defined processing region using RFID information and color marker as shown in Figs.4 (b). Fig. 4.(d) and (e) show color marker examples. The marker is placed at one meter interval. We make color marker-based localization map as shown in Fig.4 (c). We have absolute position of four cameras. Thus, we estimate active tag position using LUT.

LUTs are trained beforehand using k-means clustering and Euclidean distance. We perform the training using 640 images. In order to overcome various illumination in cattle shed images, these images have two types brightness, such as 0.15klux, 0.3klux.

III. EXPERIMENT RESULT

We have tested our system on real datasets and test datasets. Real datasets are captured at the target cattle shed as shown in Fig. 4 (a), and test datasets take our indoor test-bed as shown in Fig. 5. These images are captured in jpeg RGB colored form in the size of 1600*1200 pixels. The indoor test-bed size is 4 meters * 6meters. We used Intel Xeon 3.2GHz, 16G RAM, Win7, Visual Studio C++ 2008 in all of our computations. Fig. 6 shows the system's GUI.

The test-bed has 1 meter x 1 meter grid, as shown in Fig. 5. Each grid component has unique number. We evaluate the localization system using the grid.

In our research, the performance of object detection is 79.16%. Localization performance is 71.52%. The main reasons of errors are comprised of two categories, as follows.

- Images have various illuminations. Because part of test images is a natural scene, the images have shadows spots and sunny spots. A sunny spot is so much brighter than an active tag. It is difficult to detect an active tag in sunny spots.

- Camera's position and PTZ (Pen, Tilt, Zoom) have errors because four cameras are mobile cameras. To solve this matter, we need to perform camera calibration. Camera calibration reduces error rate, but camera calibration method requires a considerable processing time.

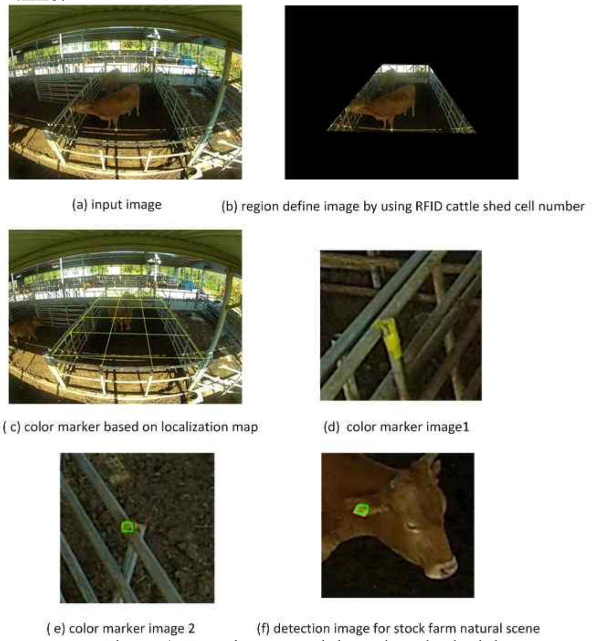

Figure 4. Experiment result in real cattle shed dataset

Figure 5. Indoor Testbed

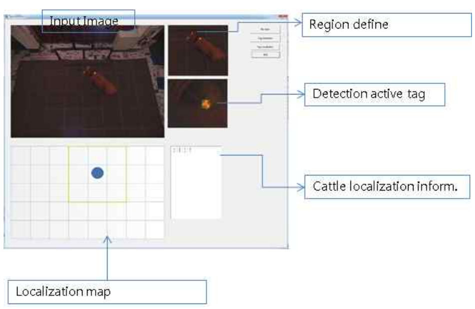

Figure 6. System GUI

IV. DISCUSSION AND FUTURE WORK

In this paper, we proposed object detection and localization in cattle shed. Cattle shed images has complex background and a variety of illumination changes. In illumination changes, the color active tag-based method is used for detection. In addition, our localization method is attractive. The proposed localization method has two steps. First, we estimate rough location using RFID. Then, we localize object using vision-based method. We have tested our approach on a number of real datasets, demonstrated its good capabilities of cattle shed area.

Object detection is difficult in cattle shed because cattle shed images have a lot of image noise. Our future work involves color filtering method and image segmentation method to solve illumination and complex background problem. Also, we need to solve the camera calibration problem. We will continue developing our detection and localization algorithm.

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