Abstract—Automatic detection of cow’s oestrus is important in cattle management. This paper proposes a method of oestrus detection by checking cattle mounting activity automatically. We use a video sensor and apply computer vision techniques to detect the mounting activity. Especially, we derive a color model for cattle’s fur, and distinguish a motion of cattle mounting and a motion of people walking. Based on the experiments with the video monitoring data obtained from a cattle shed, our method can detect the mounting activity automatically.

Keywords—IT-Agriculture, Oestrus Detection, Mounting Activity, Video Monitoring

I. INTRODUCTION

AUTOMATED activity monitoring in a cattle shed is an important issue because it can save a significant part of the breeder’s working time. In particular, failures to detect oestrus in a timely and accurate way become a limiting factor in achieving efficient reproductive performance. A traditional method of oestrus detection with manual observation [1] requires too much cost for a large-scale farm. Although some research studies on applying Information Technology (IT) to oestrus detection have been reported in the last decades [2], a more accurate and practical method is still required.

Standing to be mounted by a bull or another cow/heifer is the only conclusive sign that an animal is standing oestrus and ready to be inseminated [3]. Especially, we detect the mounting activity from the video data of Korean native cattle by applying computer vision techniques. Unlike the previous mounting detection methods with invasive sensors, such as pedometer [4] and activity meter [5] attached to her neck or leg, our method with video sensor is non-invasive and avoids stressful handling of individual sensors.

We first detect any motion from a video frame by using Gaussian Mixture Model (GMM) [7], which is one of background modeling techniques. Then, any upward motion is detected by using Lucas-Kanade Optical Flow [8], which is one of motion estimation techniques. Finally, RGB-based histogramming [9] is applied in order to eliminate upward motions caused by people (i.e. a breeder or a thief) walking activity in a cattle shed.

Our experimental results show that the proposed method can be used to detect oestrus, either as a standalone solution or to complement known methods [3-6].

II. MOUNTING ACTIVITY DETECTION

A cattle shed scene has complex background and various illuminations, in addition to occlusion. In order to overcome these difficulties in a cattle shed scene, we place a camera at a height of 1.5m and try to detect a cattle head in the mounting activity (See Fig. 1). That is, we determine whether a given scene has any upward motion caused by cattle mounting activity at a height of over 1.5m. If the monitoring system detects the mounting activity, it sends an alarm with a captured image to an administrator immediately.

![Fig. 1 Captured scenes from a cattle shed](image1)

A. Setting RoI

In this paper, we assume a large-scale cattle farm. From a practical point of view, applying computer vision techniques such as GMM/Optical Flow/histogramming straightforwardly to the 24-hour/365-day visual stream data generated from a large-scale cattle farm may require too much implementation cost. To detect cattle’s oestrus efficiently, we set Region of Interest (RoI) as a possible location for a cattle head in the mounting activity (See Fig. 2).

![Fig. 2 RoI for detecting a cattle head in the mounting](image2)

B. Detecting Motion

As explained, a cattle shed scene has complex background and various illuminations. If we apply Optical Flow directly to
RoI in order to detect upward motion vectors, it may include some upward vectors caused by non-moving objects such as fence. In order to reduce the computational workload and improve the accuracy, we need to apply any background modeling technique first to RoI. In this paper, if a current frame has any changed pixel, GMM [7] determines the pixels caused by moving objects such as cattle.

C. Detecting Upward Motion

Once any motion is detected from a current frame, we can determine whether any upward motion caused by the mounting activity is in the frame or not. In this paper, Lucas-Kanade Optical Flow technique [8] that is one of the motion estimation techniques is applied, in order to extract possible motion vectors.

We assume that the surveillance video data are consistently entered, and Lucas-Kanade Optical Flow technique uses feature points such as corners. These feature points are used for extracting possible motion vectors with the spatial coherence between a previous frame and a current frame. From the motion vectors extracted, we need to select “upward” vectors related with the mounting activity (i.e. motion vectors caused by a mounting cattle). In order to select “upward” motion vectors from extracted motion vectors, we use a tangent graph shown in Fig. 3. If a motion vector has Top/Top-Left/Top-Right direction (i.e. a vector direction between 1/4\(\pi\) and 3/4\(\pi\)) and length of more than 5, then the motion vector is considered as a possible vector for the mounting activity.

![Tangent graph and 8-direction graph](image)

(a) Tangent graph  (b) 8-direction graph

Fig. 3 Tangent and 8-direction graph

D. Detecting Upward Motion Caused by Cattle

Although Optical Flow technique can detect upward vectors caused by the mounting activity, it may also include upward vectors caused by people walking. In this paper, we propose a method for eliminating upward vectors caused by people walking activity by using color histogramming technique [9].

In a RGB color model, there are some differences between cattle’s fur color and the color of human skin or cloth. If the upward motion pixels detected by GMM have the RGB color values satisfying equation (1), the pixels are regarded as cattle’s fur. In equation (1), all the conditions are connected by ‘and’ operator.

\[
R \geq 84 \land G \leq 151 \land B \geq 52 \land B \leq 84 \\
\text{Max} \{R, G, B\} = R
\]  

E. Mounting Detection System

The flow chart of the proposed mounting detection system is shown in Fig. 4. The system first sets RoI in a given frame. Secondly, the system detects any motion by using GMM, and then extracts upward motion vectors by using Optical Flow. Then, the system eliminates “false” upward motion vectors possibly caused by people (i.e. a breeder or a thief) walking activity, in order to get “true” upward motion vectors caused by cattle mounting activity.

Finally, the system counts the number of consecutive frames having the “true” upward motion vectors. If the frame count is more than 2 seconds, the system sends an alarm with a captured image. Note that, the “false” upward motion vectors caused by people walking activity can also be used for the purpose of security.

![Detection of mounting activity](image)

Fig. 4 Detection of mounting activity

III. EXPERIMENT RESULTS AND DISCUSSION

A. Experimental Environment

We installed two HD cameras at cattle farms which are located at Jinju and Sejong in Korea, and set the resolution size to 640 × 480 pixels and the frame rate to 24 frames/second. The experiments were conducted on an Intel Core i5-750 at 2.67 GHz 4-core processor with 4GB of RAM. We have used the
OpenCV 2.3 library of GMM, Optical Flow, and histogramming techniques. From a total of 54 video data obtained, 48 video data were for cattle mounting activity at Jinju and 6 video data were for people walking activity at Sejong.

B. Experimental Results

From the 48 mounting data, 47 mounting activities were detected successfully. Fig. 5 shows the GMM and Optical Flow outputs for the mounting activity shown in Fig. 2. From the extracted “true” upward motion vectors, we can detect the mounting activity successfully.

In order to verify the histogramming technique, we conducted experiments with 6 people walking data and eliminated all the people walking activity successfully. Fig. 6 shows a scene with people walking and the “false” upward motion vectors caused by people walking are eliminated.

C. Discussion

From the result of experiment, one mounting activity was not detected by our system because of an occlusion caused by the fence (See Fig. 7 (a)). If another camera is installed at the other side of a cattle shed, the occlusion problem can be mitigated (See Fig. 7 (b)).

IV. Conclusion

We proposed an automated detection method for the cattle mounting activity from a video data by using GMM, Optical Flow, and histogramming techniques. To the best of our knowledge, automatic detection of the mounting activity with both motion and color information has not been reported, and we believe our system can be used for automatic detection of cattle mounting.

As a future work, we will conduct experiments with night scene and top-view camera position.

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