Generation Method of the Trigger Signal for the Automatic Capture System to the Harmful Animals with Intelligent Image Processing

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Abstract. Up to now, some damage by the harmful animals such as deer and wild boars are increased abruptly. Their damage such as crash between cars and harmful animals, eating all domestic vegetables are occurred at not only local area but also urban area. Under these backgrounds, an efficient and reliable capturing system for the harmful animals is requested, extremely. We aim at to develop an efficient automatic capturing system for harmful animals using image as a final product. Especially, we focus its generation method of the trigger signal for the capture devices. For the all days use without human's monitor and operation, we propose a new generation method for the trigger signal using an intelligent image processing and a new camera device Kinect. We consider activation of the trap according to the animal's shape and size furthermore motion by the optical flow analysis, automatically. The Kinect is equipped infrared radiation projector and its receiver camera, which can get the depth image. We construct an experimental device, which is simple and miniature of the real size and investigate detection ability. We discuss its effectiveness of the generation method for the realization of the capture system.

Keywords: Image Processing, Harmful Animals, Kinect, Depth image, Optical flow.

1 Introduction

Until today, some damage by the harmful animals such as deer and wild boars are increased, day by day. Their damage such as crash between cars and harmful animals, eating all domestic vegetables, and so on are occurred at not only domestic area but also urban area. Its total damage costs are more than $600 millions for one prefecture per one year in Japan. Conventionally, various trap systems [1]-[6] were developed and released to the field as shown in Fig.1. However, they were almost all operated by the manual. Furthermore, its capturing ability is not so enough because of human's obscure operation [1]-[3]. Under these backgrounds, an efficient and reliable automatic capturing system for the harmful animals is requested, extremely.

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Therefore, we aim at to develop an efficient automatic capturing system to the harmful animals using image as a final product in the field as shown in Fig 2 without human's operation. This shows ideal system that can capture the harmful animals according to their spices and number using plural visible and infrared cameras, automatically. It can communicate another surveillance network commuter by itself after the capturing them. Especially, for all day's use of this system, we adopt new image acquisition devices such as a Kinect for the construction of the automatic capturing system. This camera device is developed and came onto the market as game equipment. We use this device for generation of the trigger signal of the trap activation according to the analysis result of the animal's shape and size, furthermore, motion detection by the optical flow method. In this paper, we focus its generation method of the trigger signal for the trap device. About the confirmation of the effectiveness for our generation method of the trigger signal, we also construct an experimental device which is simple and miniature of the real size. We layout that infrared camera device Kinect and the trap which is constructed by 1/10 scale model compared with real one as the experimental device in the laboratory.

First, in the experiment for the reappearance and objectivity, we use a toy, which is moved by itself with the spring as the target object. Second, we adopt the two hamsters, which move each other randomly, in addition. Finally, we discuss its feasibility and possibility of our generation method of the trigger signal for the real trap system, which can be used for all day use based on these experimental results.

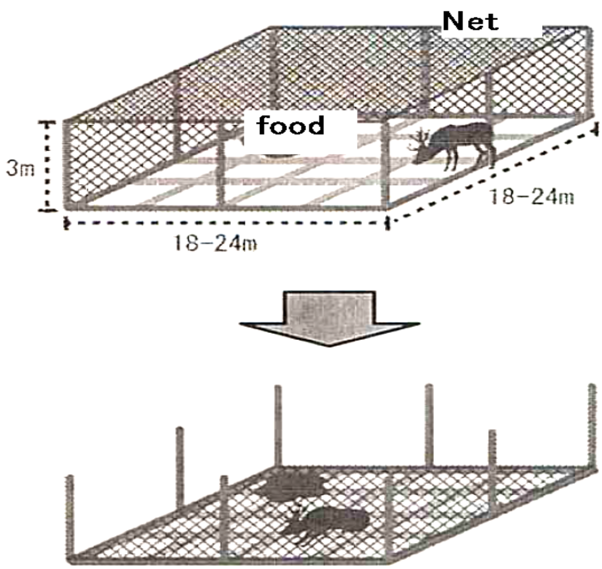


Fig. 1. The conventional trap system

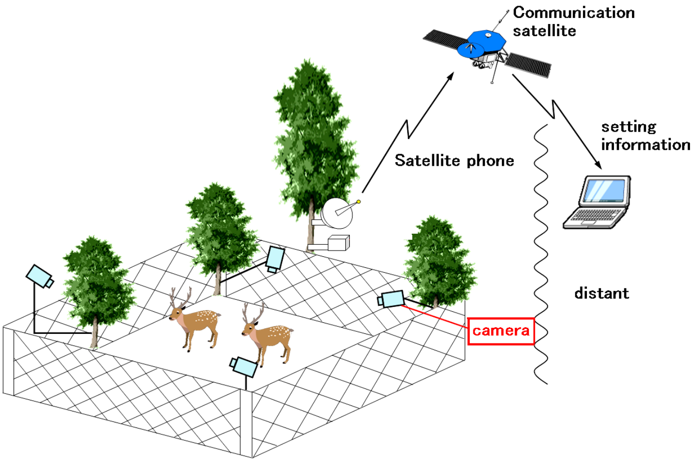


Fig. 2. Final proposed capturing system overview

2 System Construction

We denote here an experimental system constructed by the infrared device Kinect and the trap device, which is constructed by 1/10 scale model compared with real one in the laboratory as shown in Fig.3. We confirm and discuss detection ability using our generation method of the trigger signal for the trap.

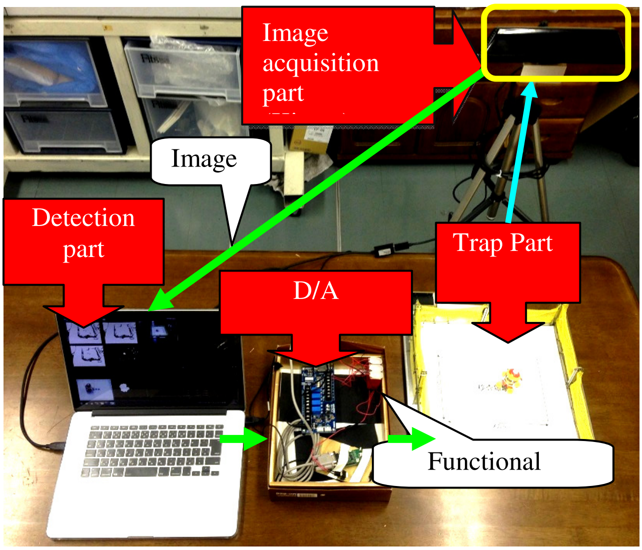


Fig. 3. Experimental trap system overview

2.1 Image Acquisition Part

We adopt a new image acquisition device such as a Kinect as shown in Fig.4 and Table 1 for the construction of the new capturing system. This camera device is developed and came onto the market as game equipment. Especially, the Kinect is equipped infrared projector and its receiver camera, which can get the length between the camera and a target object. After this, we use this length information as the depth image of the target object. Figure 5 shows an example image by this one.

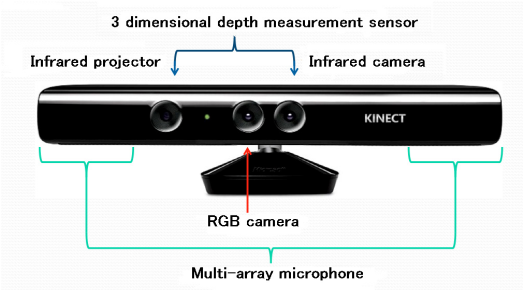


Fig. 4. Construction of the Kinect

Table 1. Specification of the Kinect

RGB camera	resolution VGA(640×480)
camera	resolution VGA(640×480)
frame rate	30fps
recognition length	0.4〜6m
vertical view	43.5degree
horizontal	57.5degree
tilt range	±30degree
audio format	16-kHz, 16-bit monaural PCM

Fig. 5. Example of the depth image using infrared radiation

2.2 Detection Part

We use this depth image from the Kinect for operation of recognition of the target object. First of all, we should recognize harmful animals by their shape and size with blob analysis [7], which is the domain constructed by several neighboring pixels. Still more, we should recognize them either true animals or not. Because there is sometimes miss recognition owing to the similar shape of the rocks or threes with using only shape and size of the animals [3]. Therefore, we need motion detection from the extracted blob in the depth image. The optical flow method can make possible to find motion of the animals easily. It is given by equation (1).

$$AE(x, y, dx, dy)=\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}\left| P_n(x+i, y+j) - P_{n-1}(x+i+dx, y+j+dy)\right| \quad (1)$$

Here AE is block matching value on block (N×M), P is frame, dx, dy denotes motion vectors.

Each procedure is described bellows.

1. First of all, we execute blob analysis for the depth image.
2. We account number of the pixel in the outline of the labeled blob as the size of the animal.
3. We compare the number of the pixel with some threshold value for the size judge.
4. We set the rectangle to the labeled blob and measure its long and short sides.
5. We get an aspect ratio of long and short sides as the shape of the animal.
6. We compare its aspect ratio with some threshold value for the shape judge.
7. We analyze depth image by the optical flow method for x and y direction.
8. We compare the analysis results of the optical flow method with some threshold value for the motion judge.

Figure 6 shows these procedures.

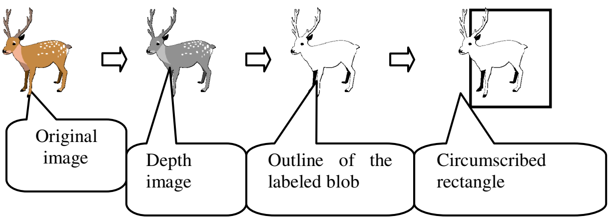


Fig. 6. Setting procedure of the circumscribed rectangle

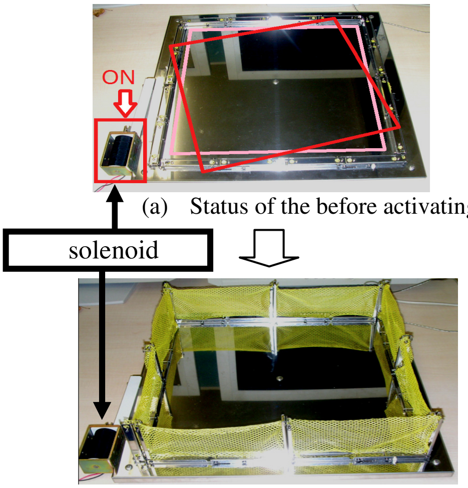
2.3 Trap Part

We describe the capturing part which we construct 1/10 scale model compared with real one [1]-[3], [5], [6] as the experimental device in the laboratory for the confirmation of the effectiveness of generation method of the trigger signal. The trap is constructed by several net units. The trap is activated by the spring and solenoid switch. Figure 7 shows the status of the before activation (a) and the one of the after activation (b) on the trap.

3 Experiments

To confirm the effectiveness of the proposed method, first of all we should consider reappearance and objectivity of the experiments. So we use here a toy which is moved by itself with the spring as the target object as shown in Fig. 8. Furthermore, we use real small animals such as two hamsters in addition as a trial. Toy's specification and its judged value is denoted bellows.

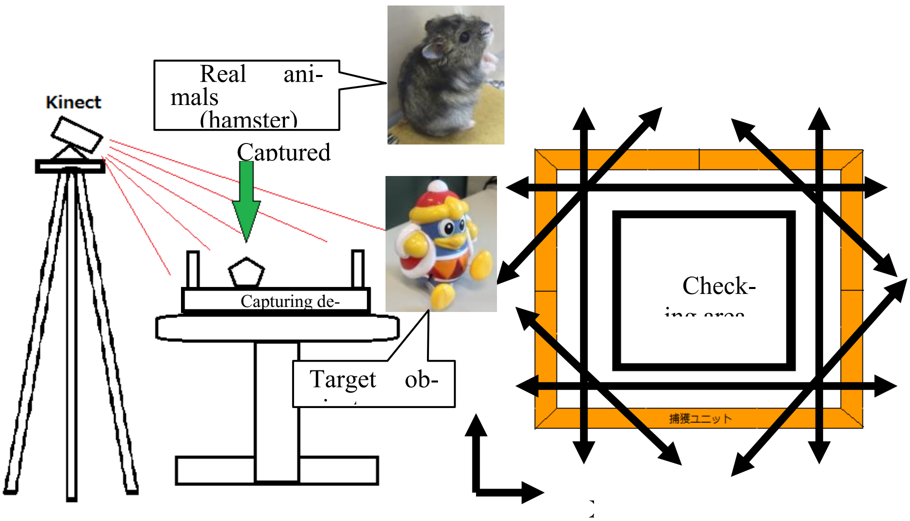
Size is 780 pixels (judged value is more than 780), aspect ratio is 1.0 (judged value is 0.7 ~ 1.3), moving speed is 10cm/s (judged value is more than 20 for x or y direction). Furthermore, the judge values of the hamster are also same. Here, we confirm the recognition of the target object and detection with the display of the PC and the trap. Finally we discuss basic feasibility and possibility for the real trap system based on the experimental results with our proposed generation method for the trigger signal.



(a) Status of the before activating on the trap

(b) Status of the before activating on the trap

Fig. 7. Construction of the trap system



(a) Layout of the experimental de-

(b) Checking area for the top

Fig. 8. Setting feature of the experimental device

Table 2. Experimental result under the day light (305 lux)

	The check of outside			The check of inner		
	Total number	Number of success	Success ratio	Total number	number of miss detection	Success ratio
Xdrection	10	10	100%	10	0	100%
Ydrection	10	10	100%	10	0	100%
Slanting direction	10	10	100%	10	0	100%

Table 3. Experimental result under the night (52 lux)

	The check of outside			The check of inner		
	Total number	Number of success	Success ratio	Total number	number of miss detection	Success ratio
Xdrection	20	20	100%	20	0	100%
Ydrection	20	20	100%	20	0	100%
Slanting direction	20	20	100%	20	0	100%

3.1 Experimental Conditions

Figure 8(a) shows setting feature of the experimental device. First, we use a toy which moves one way. We make experiments under the day light (305 lux: Room size: 10m×8m×3m) and night (52 lux: Room size: 10m×8m×3m). Moving direction, which is denoted by several arrows, of the toy in the experimental device is x and y, and slanting as shown in Fig. 8(b). We make experiments check in the checking area and outside of it.

3.2 Experimental Results

We got good detective ability with the proposed generation method as shown in Table 2 and 3. We could confirm the detection with the display of the PC and the trap behavior. Furthermore, we made additional experiments by using real small animals such as hamster as shown in Fig. 8, as a tentative trial. They are two and behave each other randomly. Its detective ability was 100% with ten times trials. From both experimental results, we confirmed our proposed generation method of the trigger signal is effective in the laboratory environment, basically.

4 Conclusion

We proposed a concept of the automatic capture system for harmful animals with intelligent image processing and the depth image. Especially, we focused on the generation method of the trigger signal for the trap. We constructed 1/10 scale model compared with real one as the experimental device in the laboratory. We got good detective ability in the regulated conditions in the laboratory using a toy and real small animals such as hamsters. We basically confirmed the feasibility and possibility of our proposed generation method for the trigger signal to the conventional capture devices. It is supposed that our proposed method makes possible to autonomous capture devices without human direct operation. Still more, this can be extended to application of another kind of animals such as wild boars, wolves and ownerless dogs according to its shape and size. However, it is still needed that we should implement our method of the generation for the trigger signal to the conventional capture devices [1]-[3], [6] and make experiments in the real fields.

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