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Detecting for high speed flying object using image processing on target place

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Abstract In this paper, we research the target system using an Image processing methods for measuring the moving object at a high speed. Measuring a fast-moving object is very difficult. Currently, Car, CCTV, plant factory has already utilized the advantage of infrared, ultrasound and radar. In particular, military and sport shooting hasn't applied the technology yet, they really need the technology for measuring high speed object. We detect the frame of the object using the infrared camera, and check the actual coordinates of object by using Canny Edge, Contour, Calibration, Transform process, and Threshold. In the experimental results of this research, we demonstrate the superiority of the target system; it is useful for military and sport shooting fields in the future.

Keywords Object detection · Target system · Canny edge · Contour · Calibration

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1 Introduction

To detect objects moving at high speed is a very important area of research and other areas, as well as the military. Using any kind of equipment, what size, to detect how fast objects are moving is very important [1]. For military shooting, it should detect the bullet flying at an average of 5.56 mm × 22 mm 940 m/s. So infrared, ultrasonic, radar, cameras, and a variety of target system to target the detection equipment can be considered. Equipped with multiple sensors to measure the amount of infrared or ultrasonic reflections coming from the actual target, infrared sensors, Ultrasonic sensors it is difficult to select unreasonable point of view. Although the current radar is getting a lot of attention, is still in the research phase, the preferred way to detect a small size moving object is difficult to comply. In addition, compared to other such equipment is too expensive.

The actual shooting is usually done indoors, but there is progress from normal outdoor shooting. In other word, because it can cause harm to humans taking into account safety hazard is a consideration from the outside. When shooting outdoors, there are many things to consider than the indoor environment. In particular, sunlight, rain, snow, etc. largely influenced by the natural environment; the target system developed for detecting the movement of objects that the user want is very difficult.

In this paper, we study the target system for detecting the actual position coordinates of the moving object to the available speed indoors as well as the outdoor environment. Infrared wavelengths are used at day and night, and no coding for the target of study, it is possible to use an infrared camera to determine the actual coordinates of the moving object at a high speed. The frame is provided with an infrared camera image processing using OpenCV image. In addition, we propose a method to place the necessary sculpture, the actual position coordinates can be measured precisely through the image processing in the target system.

2 Related research

Beyan Cigdem [2] mean Shift framework is used with the object tracking algorithm and Occlusion Handing. This algorithm expresses a description of the target object; the image moment helps to determine the size of the object. By using the Kalman filter algorithm can track the object, Bhattacharyya coefficient is used to determine the noise tracking [3]. Using the random Hough transform (ARHT) and algorithm for calculating the parameters of the lane recognized by the lane to detect the vision and recognize the image line-searching. In this paper, it proposed to realize the reliable lane, based on a particle filter algorithm [4]. In using the segmentation method, detection point and extracts the entire outline of the picture, or one based. Using the extracted result creates the outline of the person through the search and tracking algorithm. Real time detection using video ways [5], the existing histograms of oriented gradients (HOG) is a real time processing problems, but proposed approach, the Relational Similarity Features Depth (RDSF) based on the information obtained from the depth of the TOF cameras in real time to detect a person's area [6]. The detection and analysis of the paper, the image as a way to track the vehicle at night passing enough to the pattern proposed an algorithm that identifies the headlights of the vehicle headlight. First, a fast histogram and a threshold on the basis of the multi-step process using a light object segmentation to extract the effective light objects [7]. Is to prevent the access to the inlet or outlet by the vision. Limited system Advanced Driver Assistance Systems (ADAS) used by the tunnel to pass when the camera is in white or black with changes that can prevent and, ADAS applications that support the background processes used to fast because of this adaptability [8]. Signature forgery, counterfeit detection, selects system for Artificial Neural Network Logic, logic Puzzy by using counterfeiting [9]. Is to use the video to extract the crack in the floor of the bridge, bridges with tops and cracks in the system that uses computer vision analysis. This identifies the cracks using a statistical inference algorithm, and a high-quality image and Capture Using the training set and the charge image feature extraction [10]. Using the machine vision to detect the intelligent transportation system bus. This paper efficiently detects a moving object using a Probabilistic Modeling [11]. A system for recognizing the gesture of a hand using a vision. Detecting, tracking, and focusing the three are recognized as a gesture. This system will help in the field of HCI-based gestures [12]. The paper is a system for detecting a pedestrian of a vehicle using an infrared camera for night use. Proposed AdaBoost Learning Algorithm for IR imageries using RoI (Region of Interest) selection strategy based on novel key points; it detects the pedestrian effectively in real time. Figure 1 shows the solar radiation intensity generated from the sun. There is a wide range of wavelengths, such as visible sunlight, infrared, ultraviolet. Figure 1 present the visible range through to 380–780 nm, near-infrared 780–2000 nm. And also it represents the least solar radiation intensity in the infrared region of 940 nm wavelength, using the infrared wavelength of 940 nm may minimize the effects of the sun [13].

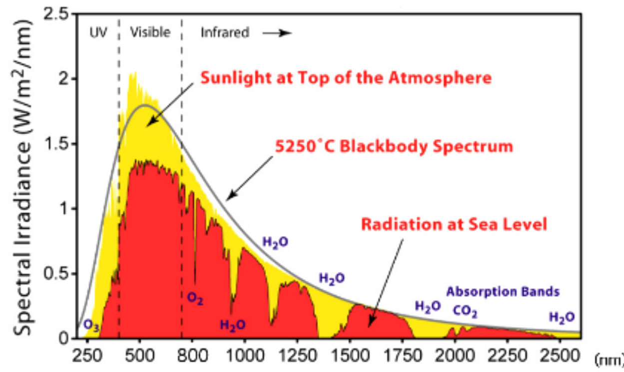

Fig. 1 Solar radiation robber

Bae [14] proposed a technique to detect small objects using a bilateral filter in the sky between the amounts of clouds. Weng [15] proposes a technique for detecting a target flying. The technique is applicable to the purge system of classifying the weather conditions and the target state, and uses Kalman filter to predict the position of the target. It shows the proposed technology has high accuracy of 90 %. Kim [16] introduces a way to track the highest weight is assigned to the path between the target and the binary proximity switches. The binary distribution and the proximity sensor evenly Shrivastava [17] based on the information obtained from the binary sensor OCCAMTRACK algorithm and particle filter algorithm, geometric post-processing piece rated calculates an estimate of the rate associated with the linear trajectory to track the target.

3 Target system design for detecting a moving object

In Sect. 3, we have proposed a designed to measure accurately the moving object.

Figure 2 illustrates the overall system architecture.

Through the two cams when the right image of the target object with the transport is in the temporary buffer, Arduino will transfer a signal from a vibration sensor through the main system. In the process, the main Candidate Frame Detection System is a temporary place in the frame buffer to the Arduino to store incoming time back and forth through the frame.

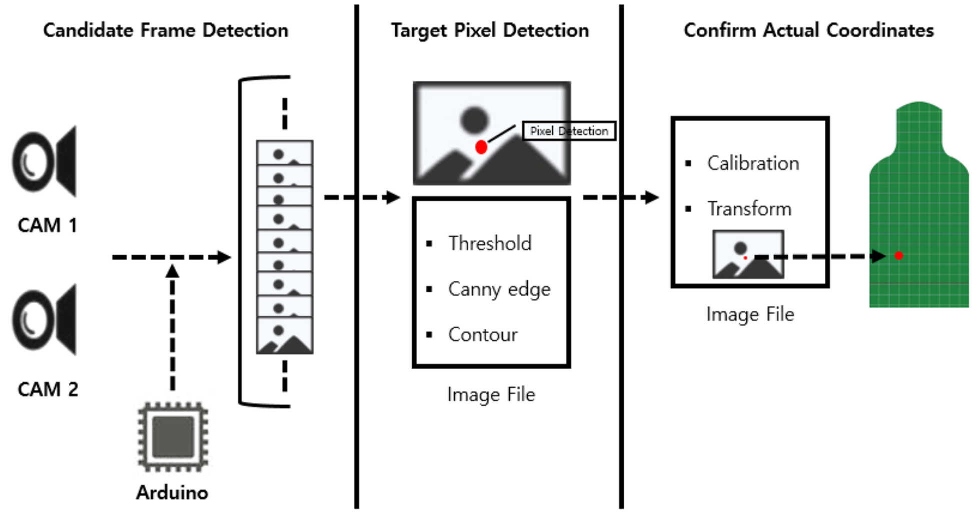

Fig. 2 Overall system architecture

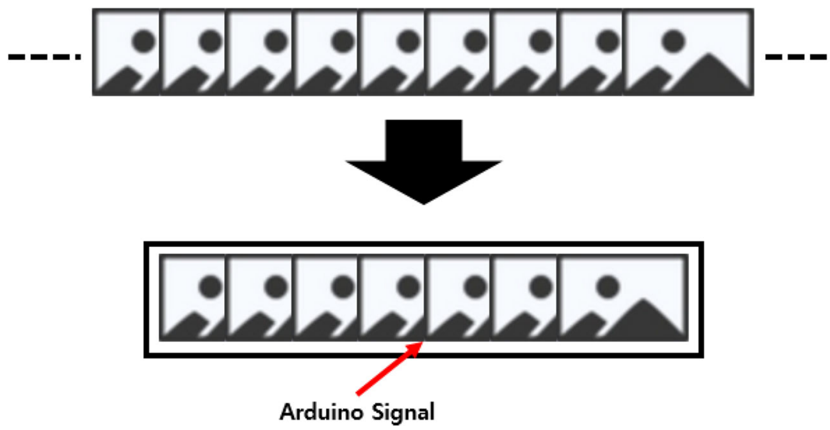

Fig. 3 Candidate frame detection

Then the Target Pixel Detection process, the frame of the detected object is detected by a difference image. And finding the pixel of the object is detected through the Threshold Image Processing, Canny edge is obtained at the center point of the rectangle drawn on the detected pixel as a square, and then Contour.

After completing the Target Pixel Detection process, we will first proceed to Calibration of the environment through the camera settings before determine the actual coordinates. Calibration is the process of applying the pixel values obtained through the image processing in real world coordinates. Finally, the pixel values are converted by a Transform with real coordinates.

3.1 Candidate frame detection

Figure 3 shows a picture frame to find the objects detected in the number of frames. The object is still stored in the temporary buffer by the time over in the two cams in order to prevent system overload. If the object is moved to the right in Target board, Arduino sends a signal to the main system.

3.2 Target pixel detection

Section 3.1 is Target Pixel Detection process, once the Candidate Frame Detection undergoes the process. Figure 4 finds the detected pixel of a real object from the object detected frame. First, frame detection calculates the average value of pixel values of the extracted seven frames to find the actual object. Then the differences between the pixel values chosen for the severe physical objects are detected frame by frame. The images usually generate a lot of noise. We identify the object to be distinguished from the other external noise coming from the pixel value in which the value giving the Threshold to find the pixel value of the object from the detected frame size.

Canny edge is an edge contrast of the image by changing the boundary to find a way between the two regions with different intensity. Equations (1) and (2) can determine the position of the light areas and dark areas representing the second derivative at edge. The formula (1) is a differential equation of two-dimensional function f (x, y), discrete data f (x, y) approximately differential expression of expression

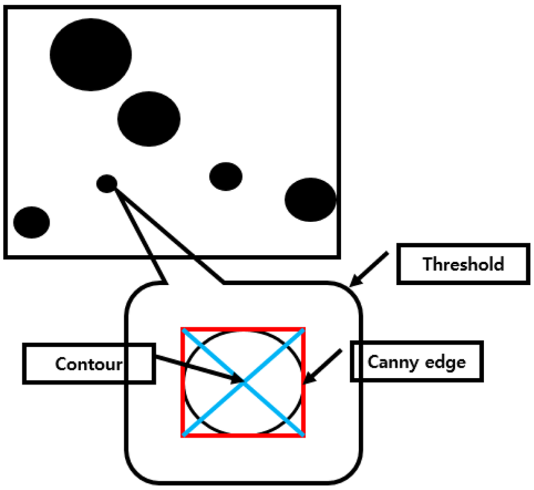

Fig. 4 Target pixel detection

(2).

$$\frac{\alpha f(x,y)}{\alpha x} = \lim_{\varepsilon \to 0} \frac{f(x+\varepsilon, y) - f(x,y)}{\varepsilon} \tag{1}$$

$$\frac{\alpha f(x,y)}{\alpha x} \approx \lim_{\varepsilon \to 0} \frac{f(x+1, y) - f(x,y)}{1} \tag{2}$$

Thus, Canny edge course is in the saved minimum and maximum values of X, Y of the pixels surrounded by the rectangle. Finally, Contour obtained the position of the pixel corresponding to the center point of the object to find the center point of the rectangle.

3.3 Confirm actual coordinates

The Confirm Actual Coordinates performs a process for calculating the actual coordinates determined by the position of the pixel corresponding to the object. Calibration must first go through a process before obtaining the actual coordinates.

$$s\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} f_x & C f_x & C_x \\ 0 & f_y & C_y \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} r_{11} & r_{12} & r_{13} & t_1 \\ r_{21} & r_{22} & r_{33} & t_2 \\ r_{31} & r_{32} & r_{33} & t_3 \end{pmatrix} \begin{pmatrix} X \\ Y \\ Z \\ 1 \end{pmatrix}$$
$$= A\,[R|t] \begin{pmatrix} X \\ Y \\ Z \\ 1 \end{pmatrix} \tag{3}$$

Calibration is a necessary procedure in the image processing. We look with the eyes of the space in three-dimensional view. When taking this as an image of the two-dimensional camera is changed this time, the point of the three-dimensional position on the image is determined by the position and orientation of the camera at the time of shooting. Therefore, when a three-dimensional point are projected onto the image to obtain the position and restores the three-dimensional space coordinates from the image coordinates to a station to be removed, it is possible to calculate the exact internal factors. The process to obtain the FIRA-meter value of these internal factors is called Calibration. In formula (3) (X, Y, X) is the coordinate of the 3D point, [R | t] is a rotation / movement conversion matrix for converting the coordinate system of the real world coordinate system to the camera, A is a Camera Matrix. Pixel values of the object position after performing the Calibration process is calculated as the actual coordinates through Transform.

4 System implementation

4.1 System Architecture

Figure 5 shows a state that places the Hardware for this study. The deployment of 1152 and more IR 850nm wavelength light emitting portion is to emit large amounts of infrared IR

Fig. 5 System arrangement

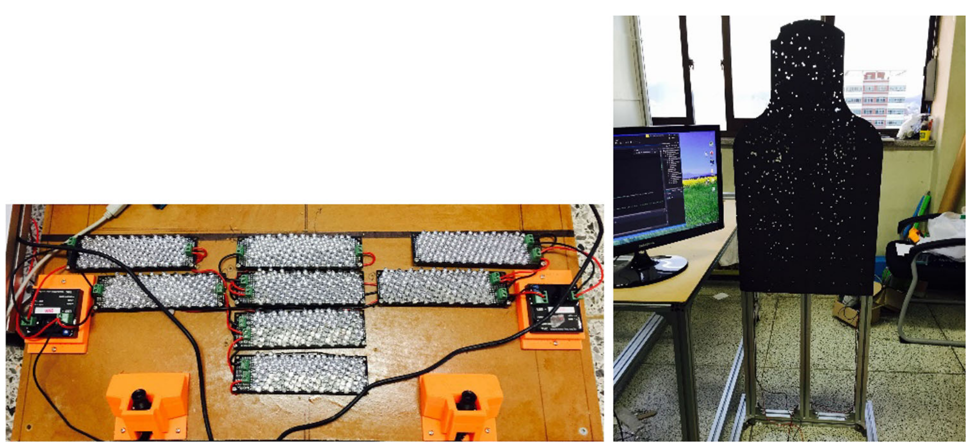

Table 1 Hardware kind and quantities

Kind	Quantities
IR CAM (Sony eyes camera)	2 EA
IR transmitter 850 nm (KID05BW85)	144 × 8=1152 EA
LED controller	2 EA
Arduino uno	1 EA
Piezo sensor	2 EA

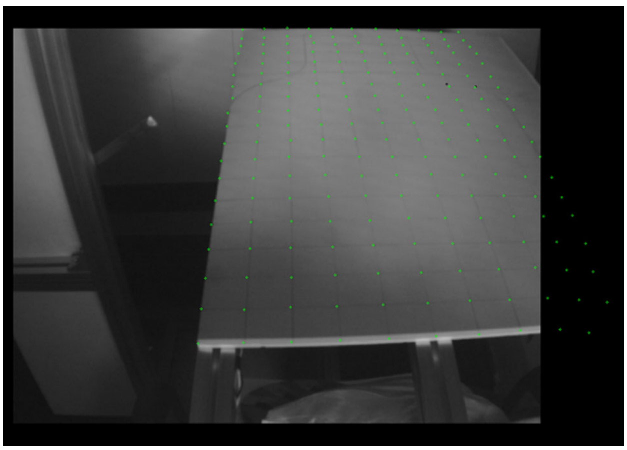

Fig. 6 Calibration image

CAM 2 band and looking at the target plate. 2 LED Controller were also use as an infrared light-emitting portion to match a constant current. If you want to hit the target board object on the back, connect the two Piezo Sensor to detect an impact with Arduino. Table 1 shows the type and quantity of each Hardware.

4.2 Callibration for confirm actual coordinates

Figure 6 is Warping the image coordinates and Calibration. Warping the image has a respective Pixel coordinates, it calculates the actual coordinates to be used by default.

4.3 Image processing flow

Section 4.3 and Fig. 7 shows the Image Processing Flow. CAM stores a frame from the first frame to detect the physical object are detected. Next, Threshold identifies the object in the frame image obtained by the difference. The identification part is made of square pixels with the Canny Edge that calculates the center of the object Contours and the Selected Contours through the process. It shows the central pixel value is calculated as the position coordinates through Transform.

5 Expriment analysis

In Sect. 5 we are placing a target plate for the proposed method and the experiment with inhabitant total.

Figure 8a shows the firing was with a BB bullet with a total performance of a real gun. We launched from several places to ensure that the entire shooting was accurately sensing the plate. (b) confirms whether or not the actual sensed is from the left camera and the right camera. But sensing the error of the on-screen mm make sure that there are exact. (c) Shows the resulting image implemented through image processing launched from a number of BB bullet.

Table 2 shows the Error Range in accordance with the number of times of each perform. As the execution count is increased Error Range increases, but approximately about 20mm is formed within can be confirmed.

Fig. 7 Image processing flow

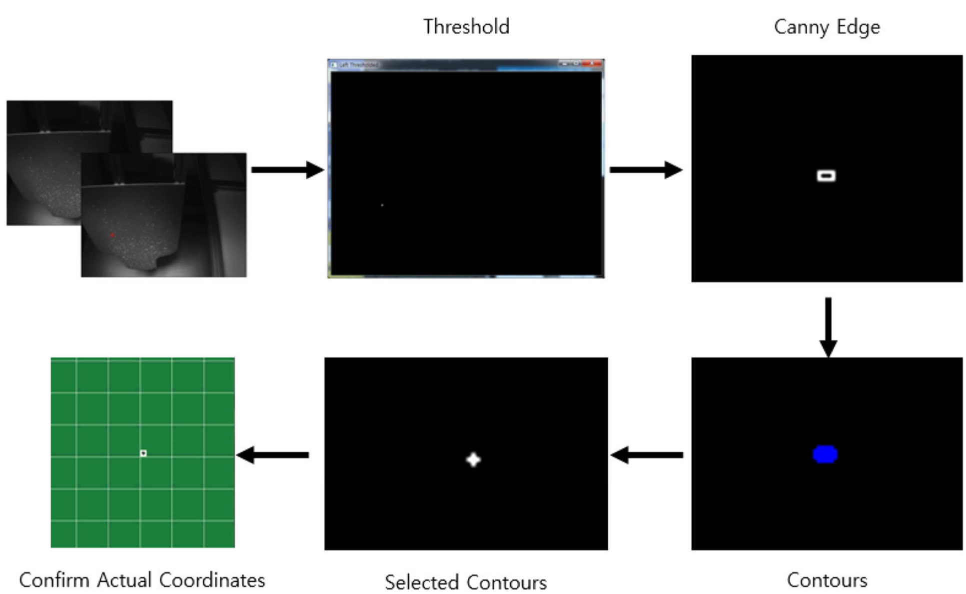

Fig. 8 Experiment using target system

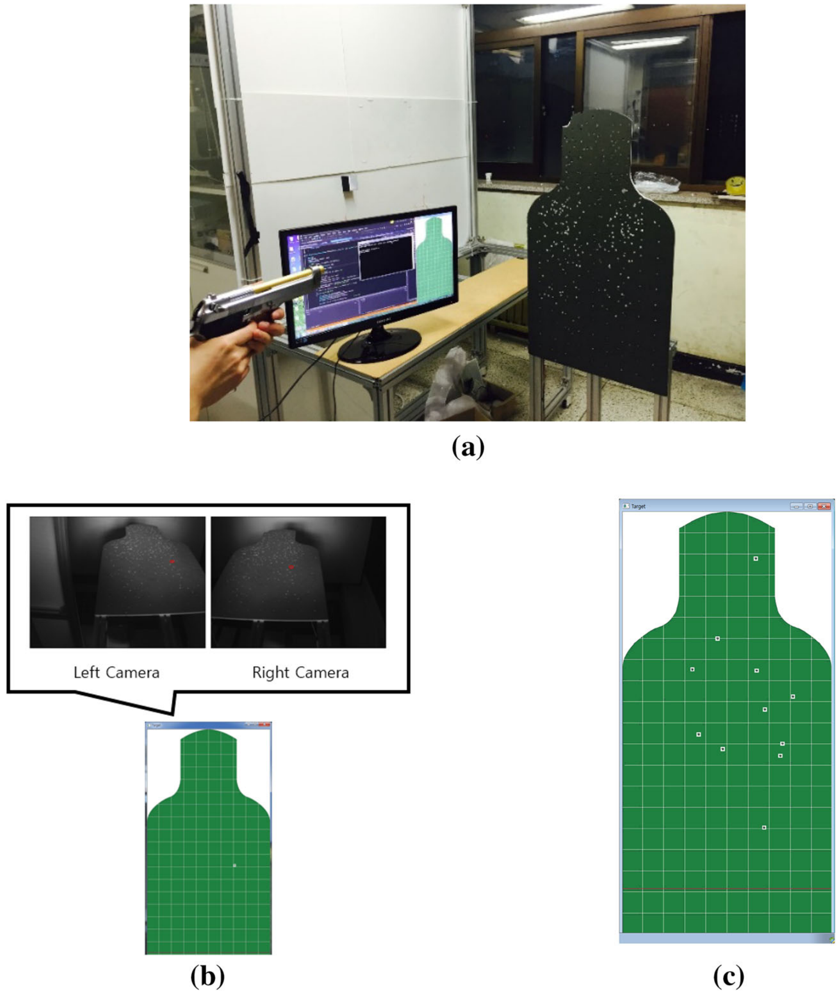

Table 2 Error range in experiment

Number of performed	Error range (mm)
10 times	About 18.4
50 times	About 22.3
100 times	About 21.5

6 Conclusions

We have proposed a target system Method for detecting the actual position coordinates of the moving object at a high speed through image processing. Through day and night by using a camera without the available IR-sensitive, image processing was applied to OpenCV. Also, considering the environment of an actual shooting range, and placing the structure of the prototype were tested. Experimental results of this study, shows the precise measurement of the error rate occurs in the required firing range of about 20 mm, but, if the accuracy is guaranteed that the target system is complete, the next may be used in various fields.

We increase the Calibration accuracy through automation Calibration of the way before the people to directly improve performance in the future, considering the infrared wavelengths of sunlight is strong zone will study how to solve the noise. It is also expected to proceed to additional ways to increase the accuracy of the position estimate of the target Pixel.

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