COIL GUN TURRET CONTROL USING A CAMERA

Emillia Iflachah, Didik Setyo Purnomo, Member, IEEE, Indra Adji Sulistijono, *Member*, *IEEE*

Emillia Iflachah is with the Department of Mechatronics Engineering, Electronics Engineering Polytechnic Institute of Surabaya (EEPIS), Indonesia. (Email: eminkngia@gmail.com).
Didik Setyo Purnomo Sulistijono is with the Department of Mechatronics Engi-neering, Electronics Engineering Polytechnic Institute of Surabaya (EEPIS), EEPIS Campus Sukolilo, Surabaya 60111, Indonesia. (Tel: +62-31-594-7280 ext. 4186; Fax: +62-31-594-6114; Email: didiksp@eepis-its.edu).
Indra Adji Sulistijono is with the Department of Mechatronics Engi-neering, Electronics Engineering Polytechnic Institute of Surabaya (EEPIS), EEPIS Campus Sukolilo, Surabaya 60111, Indonesia. (Tel: +62-31-594-7280 ext. 4186; Fax: +62-31-594-6114; Email: indra@eepis-its.edu).

ABSTRACT --- A conventional weapon usually by pointing to the target aimed by using hands. It is considered less effective and efficient in terms of military service because of spending lots of time to chase the target. So needed a tool to move the weapon automatically. This final project present about object tracking in a weapon and it's turret, that will be controlled by camera. The camera is used to detect moving targets based on a particular color. In a image sequence consisting of many different objects, accompanied by a different background, this system will be able to distinguish between the target or not. Camera detection is done by taking moving images with color composition that has been determined. Then, The image resolution is resized of the smallest of camera's resolutions, that is 320x240. Smaller image size are intended for the system's working to be faster. Capturing image process is use segmentation object process in digital image processing which aims to separate the object region with background. The weapon that will be used, have two degrees of freedom. Maximum 360 degrees rotation in x axis, and maximum 90 degrees in y axis. Both of them using brushed DC motor. At the direction of the y-axis motion required a gear for transmitting power between motor shaft and the shaft, so the shaft is not directly connected to the motor and no distortion. Turret have been designed had four buffers as a solid foundation to bear the entire load. Communication between the camera and weapons carried out by using the cable. Turret will be controlled using the PD control which is expected to reach a position with a quick reference.

Key Words: Object tracking, Digital Image Processing, Image sequence, PD (Proposional Deravative) Control

1. INTRODUCTION

Weaponry as a supporter of national defense and security equipment seems increasingly growing rapidly in developed countries. While, Indonesia still imports the artillery of the country. So this does not always done, then we need to conduct research and development independently. Artillery control technology is divided into two types, there are the control of conventional artillery and artillery with automatic control. A conventional control is controlled by the operator artillery directly, either by moving the handle on the turret and aimed it to the target or by using the remote control to move the turret. Gun turret is a rotating platform in pitch and yow. While the definition of automatic control is artillery controlled automatically using artificial intelligence. Artillery is equipped with various sensors like a camera and radar. Inefficient when using conventional control, because the operator must move the turret at the same time keep an eye on the target simultaneously. It has taken more time and possible loss of targets. While, using of automatic control that uses artificial intelligence movement will be relatively limited. In this project has been made a weapon system that utilizes the science of robotics, mechanics, and computer vision using image processing methods. By combining some of the science, has built a turret that its movement is controlled by the camera. Turret moves in accordance with the cameras that follow the direction of target movement. Cameras will be installed tip of the weapon to facilitate performance. While the camera and the turret will be linked by cable to communicate it works, so it's possible to miss the target position is relatively small.

2. DESIGN AND APPLICATION SYSTEM

The system has been created consisting of mechanical, hardware, and control systems. Mechanics has been done is in the form of coil gun turret and the camera / web-cam. Coil gun on the turret moving in the direction of the target position has been captured by a webcam. Picture of the integreted system can be seen in the block diagram as in Figure 2.1.

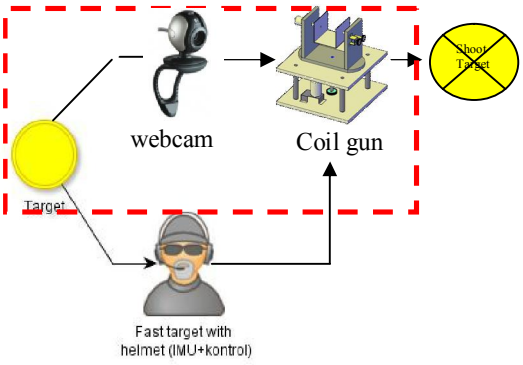


Figure 2.1. Block diagram of the integrated system

The dotted lines in the block diagram shows that the section is part of the work on this title.

2.1. Design and Application of Mechanic

Turret was designed to have platforms that have the dimension 40 x 40 cm with four buffer in between. Also put a dc motor as the driving system in x direction. For the top, there are two types of pads, the first pad to place a dc motor and the second pad. The second pad is a place to prop up the gun / cannon. Mechanical design can be seen in figure 2.2.

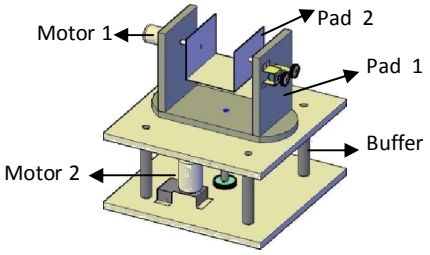


Figure 2.2. Mechanical design

Mechanical system consists of two pieces, there are the static foundation part and the turret (upper) that can move in rotation in x and y axis (pitch and yow). Figure 2.3 is a photo of the mechanics that have been made.

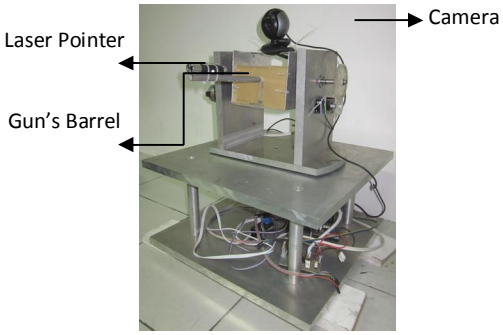
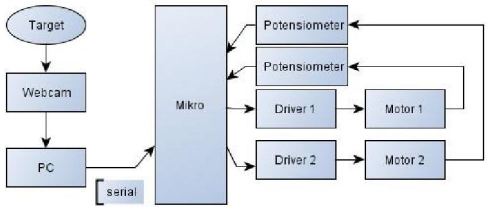


Figure 2.3. Mechanic

The camera is placed on the upper pad, precisely on the barrel of a gun that ends given the laser, as a marker that the end of the gun right on target or not.

2.2. Design dan Implementation of Hardware



The hardware will be used on the system consists of a minimum system, dc motor driver, a camera, and potentiometers. While the block diagram of the workings can be seen in Figure 2.4.

Figure 2.4. Block diagram of the hardware system's working

The target will be detected by a webcam that will be processed by a PC with computer vision. The results will be reprocessed by the micro in order to the motor can be driven toward a position corresponding to the target, the position of the motor will be read by the potentiometer motor by a potentiometer to determine how accurately the motor reaches that position.

2.3. Design and Implementation of Software

The detection of moving targets that have yellow color by the camera will produce x and y position of the target in a camera frame that has a resolution of 320x240 pixels. The frame be divided into four regions to facilitate the placement of the target to the center of the frame (red box in Figure 2.5). This meant that the detection target by a weapon that aided by the camera will be right at the midpoint of the object.

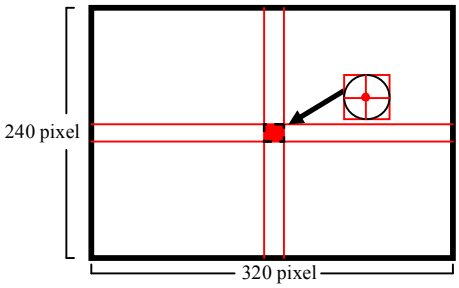


Figure 2.5. Illustration of the camera frame

If the object is not in a position at the midpoint of the frame, it will be initialized with a character. Characters will be sent via serial to the microcontroller and will be processed further so that the motor will move the camera position to the midpoint of the target. Can be briefly seen on a global program flowchart can be seen in figure 2.6.

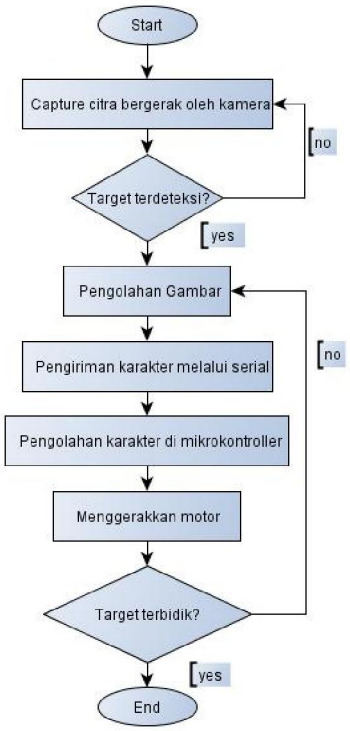


Figure 2.6. Flowchart of a global system

some for the system is needed to run properly, that is, OpenCV and codevisionAVR.

2.3.1. OpenCV

OpenCV is a library computer vision made by Intel ® which is Open Source, the library is a collection of functions C and some C + + classes that implement many algorithms image processing and computer vision at the final project will be used as a tool for image processing results the camera catches. Input obtained from the capture image that produces a particular color RGB composition of the object. Then converted to RGB and HSV color after it is converted back into trhreshold (floating). This was done so that the light intensity does not significantly affect the detection of moving image with a certain color. A brief explanation can be seen through the figure 2.7. in the form of block diagrams.

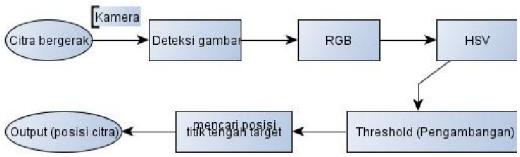


Figure 2.7. Block diagram of moving image detection with specific color (yellow)

OpenCV libraries will be included in visual c + + 2008. On this occasion, has been used the Windows Forms Application as the design of its GUI as well as a compiler. The output of the program is as shown in Figure 2.8.

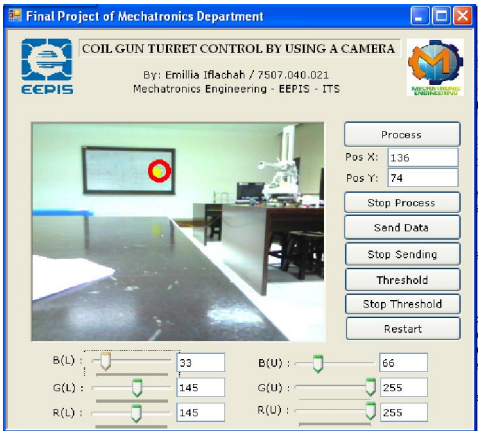


Figure 2.8. Results Output program using Windows Forms Application

Description:
- Picture Box = As video view webcam
- Process Button = Button is used to process the catch images from the webcam.
- Text Box 1 = Text box is used to display the target position x
- Text Box 2 = Text box is used to display the position of the target y
- Stop Process Button = is used to temporarily stop processing the image captured by a webcam.
- Send Data Button = is used to send data to the controller.
- Stop Sending Button = is used to temporarily stop sending data to the controller.
- Threshold Button = Button is used to display the new window that displays the threshold of the

image catches the webcam.
- Threshold Stop Button= is used to pause the display threshold.
- Restart Button = Button is used to restart the program
- Trackbar = three trackbar to set the lower limit of RGB, three others to set the upper limit of RGB.

2.3.2. CodevisionAVR

In addition to programming on the PC side, this system also requires programming in the controller are processed in CodevisionAVR. One of the tasks of the program that runs on the side of the controller is to coordinate with the PC. While the data sent from the PC to determine what should be done by the controller. Data transmitted in the form of initialization is a character, as follows:

i) If the object is at position x:
- X> = 170 pixels then it is symbolized with the letter 'd'
- X> = 220 pixels then it is symbolized with the letter 'h'
- X <= 150 pixels then it is symbolized with the letter 'a'
- X <= 100 pixels then it is symbolized with the letter 'f'

ii) If the object is at position y:
- Y> = 130 pixels then it is symbolized with the letter 's'
- Y> = 170 pixels then it is symbolized with the letter 'g'
- Y <= 110 pixels then it is symbolized with the letter 'w'
- Y> = 70 pixels is symbolized with the letter 't'

In order turret to achieve the desired position in a proper state without having a large oscillation, it is necessary to PID control. Flow diagram of PID control is like the figure below 2.9.

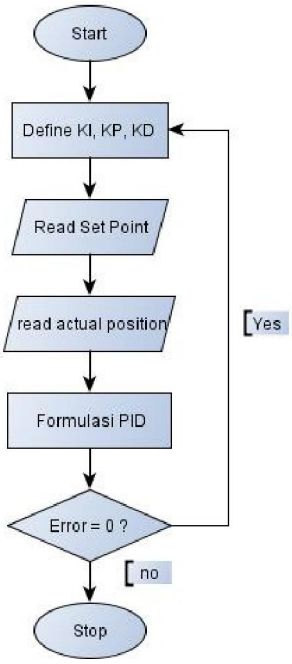


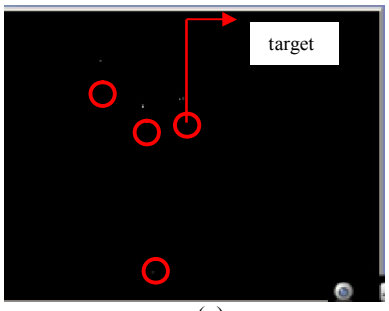
Figure 2.9. PID control flow diagram

The first thing to do is set the value of kP, ki and kD, after that set the set point and a reading position of x and y turret. After getting the value from the set point and actual position of the turret, then it can be calculated error value happens to make substraction. Error value is obtained, then used to calculate the value of P, I, and D, as shown in the program listing follows.

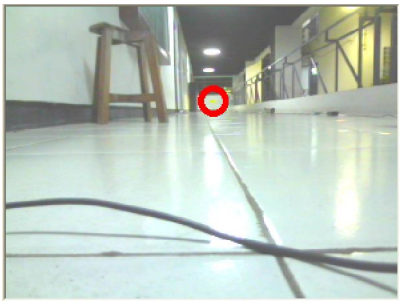
3. RESULT

The writer has done trials and data retrieval of the camera and the system that have some results, there are:

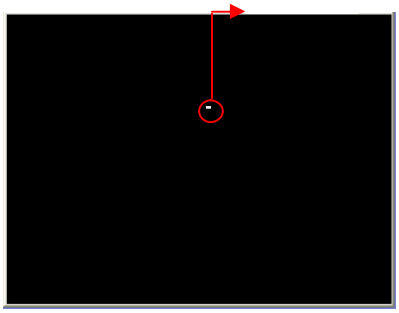
a. camera successfully detect targets from a distance of 30.5 cm diameter 0-25 meters from the turret at night, but not in the afternoon, that is can be seen in figure 2.10.



(a)



target



(b)

Figure 3.1. comparison of detection during the night and day

b. Laser can shoot accurately at any distance, as shown in Table 1.

Table 1. distance that can be read by a laser

No.	Distance between target and kamera	The laser on target ?
1.	30 cm	Right
2.	50 cm	Right
3.	75 cm	Right
4.	1 meter	Right
5.	1,5 meter	Right
6.	2 meter	Right
7.	2,5 meter	Right
8.	3 meter	Right
9.	3,5 meter	Right
10.	4 meter	Right
11.	4.5 meter	Right
12.	5 meter	Right
13	5.5 meter	Right
14	6 meter	Failed
15	7 meter	Failed

There are images that showing a relation between distance and synchronization direction between laser and camera .

Figure 3.2. distance and synchronization direction between laser and camera

On the third picture, show the direction between camera and laser is not synchrony. The direction of laser is not on target

c. There is a different time delay between using saving memory last position of the object and not.

Table 2. Delay with saving memory an without saving memory

Direction	Distance	Delay with *saving memory*	Delay without *saving memory*
Right	0,5 cm	1,12''	0.74''
Left	0,5 cm	0.90''	0.73''
Upper	0,5 cm	0.86''	0.71''
Down	0,5 cm	0.47''	0.38''
Right	1 meter	0.72''	0.93''
Left	1 meter	1.01''	1.77''
Upper	1 meter	1.26''	0.68''
Down	1 meter	1.64''	0.68''
Right	2 meter	0.93''	1.02''
Left	2 meter	0.60''	1.09''
Upper	2 meter	0.74''	1.11''
Down	2 meter	0.72''	1.51''
Right	3 meter	1.46''	1.26''
Left	3 meter	0.77''	1.30''
Upper	3 meter	2.01''	0.85''
Down	3 meter	1.69''	2.25''
Right	4 meter	0.78''	1.64''
Left	4 meter	0.94''	1.04''
Upper	4 meter	1.36''	1.94''
Down	4 meter	1.80''	1.36''

4. CONCLUSION

Of this project can be concluded that:

a. To track a moving target is needed detection picture program (using OpenCv) and controller program (using CodevisionAVR).
b. In order the tip of weapon have a similar direction with a view of camera, the thing to do is adjust the position of camera and weapon. In this project camera and laser can shoot targets on the right point if they have a maximum distance 5.5 meters if detect target that have diameter 30.5 cm
c. To have a fast responds, it is needed a good design of mechanic, hardware, and software.

5. REFERENCE

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