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ROBOTOR AN AUTONOMOUS VEHICLE FOR TARGET DETECTION AND SHOOTING

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ABSTRACT

Humans have evolved to better survive and have evolved their invention. In today's age, a large number of robots are placed in many areas replacing manpower in severe or dangerous workplaces. Moreover, the most important thing is to take care of this technology for developing robots progresses. This paper proposes an autonomous moving system which automatically finds its target from a scene, lock it and approach towards its target and hits through a shooting mechanism. The main objective is to provide reliable, cost effective and accurate technique to destroy an unusual threat in the environment using image processing.

Keywords: Capacitor Bank, Coil Gun, Image Processing, Microcontroller, Trigger Mechanism.

1. INTRODUCTION

The robotic industry is one of such invention that will evolve parallel to us because somewhere we view them as our descendants. Every day we see new products in the market with new innovation, better efficiency and accuracy. The trend of robotics has affected every phase of our life. The information that the robot process or generate can be sent in a wired fashion or though wireless communication. To process the data a processing unit is required, generally a microprocessor perform this task. The data can be an image or video as well. Then image processing comes into the picture. A robot must have a vision system to capture the images or videos in the vicinity. Then they can be sent to the microprocessor for processing and some information can be extracted out of them.

The eye for a Robot is its sensors to understand the circumstances. There are several types of sensors like IR proximity sensor or sharp IR which can be used depends on their requirements, instead of those, Cameras are now being widely used due to the remarkable improvement in

computer world especially in image processing. Apart from cameras ,gestures are also used to control a robot.[1]

A computer can process its brain 1000 times faster than a human brain but one human life is more important than 1000 computers. Indian military needs most advance technology to better protect the nation. So the problem was to minimize the loss of our defense personnel by constructing a robot as efficient as humanly Soldiers that can go to a remote area and shoot the target down.

The main objective of this project is to make an autonomous robot which is capable of going to a remote area, recognizing a target there, follow it, and shoot target once it is within an acceptable distance. The successful execution of the prototype will reinforce the positive contribution of the technologies used.

2. RELATED WORK

A number of robots have been built which can follow a defined path or take pictures in surroundings or can detect an object but there is no one which can find a target, follow it and shoot it down from a certain distance. Most of the robots make use of sensors like infrared sensor, proximity sensor or white line sensor to trace their path. Some make use of motion planning with complete information in which they collect information about the premises or the environment before staring the motion and act accordingly [2]. Some may also use a Kinect camera as a vision system [3]. At the present time robots are not able to work in all odd circumstances they can perform only in special circumstances that are customized for them.

3. PROPOSED METHOD

We have developed a system in which a robot autonomously goes to any remote area and detects its target and shoot from an acceptable distance. The robot is pre-programmed and comprises of a micro-controller with good quality webcam and has a self-made linear projectile mechanism. The webcamcaptures the real time frame or image of the surrounding more specifically called an arena [4]. Then the frame of an image goes as an input in the computer software called MATLAB® and the image is being processed using Image processing techniques. Then signal has been produced for the robot whether to move or take left, right and forward. There is also a trigger mechanism installed in a robot which activates the linear projectile shooting mechanism. This trigger mechanism gets activated when the robot fully detects its target and achieved its acceptable distance and linear projectile mechanism is activated based on the Fleming thumb rule and the bullet is fired in the direction of the target. The figure 1 shows the Work Flow of the proposed method.

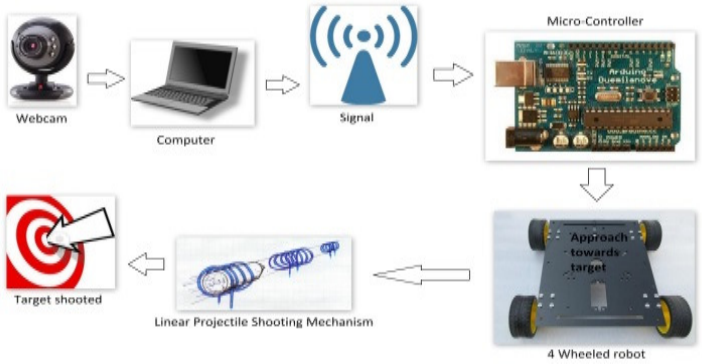

Fig.1: Work flow of proposed method

The functional block diagram of the system is as below:

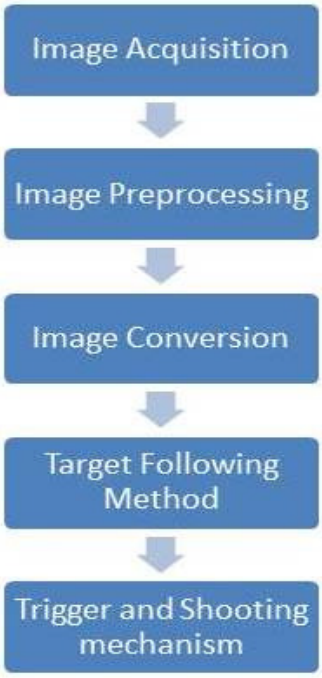

Fig.2: Functional Block diagram of system

3.1 Image acquisition The first step is to capture a scene through a camera. The camera should be more reliable and it should have good specification like Pixel value and Resolution. Most frequently used cameras are CMOS based because they are less in cost and easily available in the market.

3.2 Image preprocessing Image preprocessing commonly comprises of a series of sequential operations including image enhancement or normalization, geometric correction, Contrast adjustment, Histogram Equalization, removal of noise etc. It is done before applying the feature extraction techniques. Using the above mentioned techniques, we alter the image pixel values permanently and use this improved data for later analyses.

3.3 Image conversion Image captured by camera goes into the computer in which image processing is done using Matlab® software. The original RBG image is converted into NTSC format through command "rbg2ntsc". In the NTSC format, image data consist of three components: **luminance (Y), hue (I), and saturation (Q).**The first component, luminance, represents grayscale information, while the last two components make up chrominance [1]. We take the chrominance of object which differentiate the target from any other component which image consists.

3.4 Target detection Now we extract the boundary of detecting object so that computer understands that target particularly. We evaluate the center of the target and center of the frame. Now let Euclidean distance, D is the distance of the center of the frame from the center of the object.

$$D = \sqrt{[(x-a)^2 + (y-b)^2]} \qquad (1)$$

Where x and y are the spatial coordinate of the center of the target and a and b are the spatial coordinate of the center of the frame.

Our goal is to minimize the distance D. Microcontroller gives the instruction based on how much the spatial coordinates differ from center of the target to the center of the frame. Table no. explains the detail of instruction given by the microcontroller.

Table 1 Instructions given by microcontroller

P	D	Relative x coordinate	Move
<300	>35	<0	LEFT
<300	>35	>0	RIGHT
<300	<35	-	FORWARD
>300	<35	-	STOP+ trigger on

Where, P=Number of pixels used to outline the target.

D = Distance between the center of frame and the center of object.

Relative x-coordinate = x-a

4. HARDWARE DESCRIPTION

Fig.3: Hardware model of Robotor

The robot is self-assembled consist of metallic chassis having 4 geared DC (Direct Current) motors of 50 RPM, 1 servo motor has operated speed 1.18 Sec per 60 degrees at 4.8 volts at no load, 4 plastic wheels are attached to the motor, one CMOS based camera is mounted in the front of the robot. The Camera is connected to the computer. A microcontroller ATmega328 is connected to the computer.it operates at 5 V DC supply having 32 KB flash memory and 16 MHZ clock frequency.

Computer is connected to the micro-controller by the USB cable connector. The computer sends the signal command to micro-controller in which direction it has to be moved.

The shooting mechanism comprises of Coil gun, Capacitor bank and Trigger mechanism. Figure 5 shows the block of shooting mechanism.

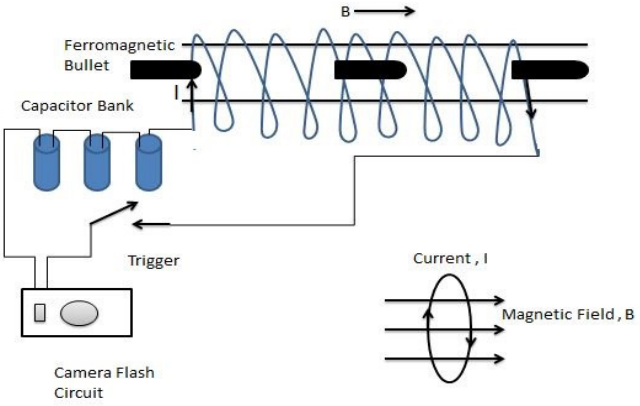

Fig.4: Working principle of shooting mechanism

4.1 Trigger and shooting mechanism The trigger mechanism is activated once the robot takes its position after image detection is complete. The mechanism is designed using a servo motor with an alligator clip attached to its axle and another fixed alligator clip. The two alligator clips are placed at an angle of 90 degrees not touching each other. When the servo rotates along with first clip it touches the second clip and the circuit is complete and hence the coil gun gets activated the target is shot down.

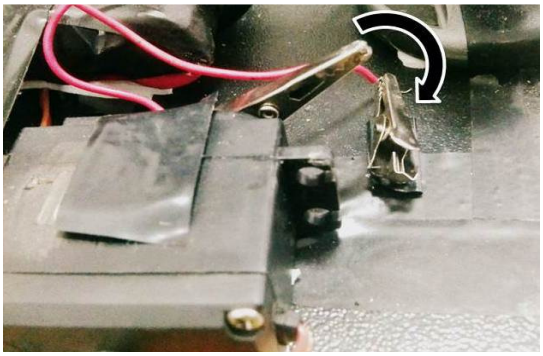

Fig.5: Triggered mechanism

4.2 Coil gun The gun is charged projectile accelerator which makes use of magnetic effect of electric current to accelerate a ferromagnetic substance used as bullet. The coil gun has been made by winding copper wires around a non-ferromagnetic barrel. After the image detection is complete, the trigger mechanism is activated using servos and the coil gun turns on. If the gun is loaded, the bullet is fired in the direction of the object and the target is shot down.

Fig.6: Coil tube

4.3Capacitor bank: A capacitor bank consisting of 330V capacitors, 220mF charge were interconnected in parallel. The capacitor bank stores charge for the coil gun. The charge when discharged across the copper coil make it magnetized and then its acts as coil gun. It also enhances the ripple current capacity.

Fig. 7: Capacitor are connected in parallel

5. EXPERIMENT AND RESULTS

In this section the detailed experiments which are done by Robotorare explained. Conversion of image from RGB to NTSC format is shown in figure 8.

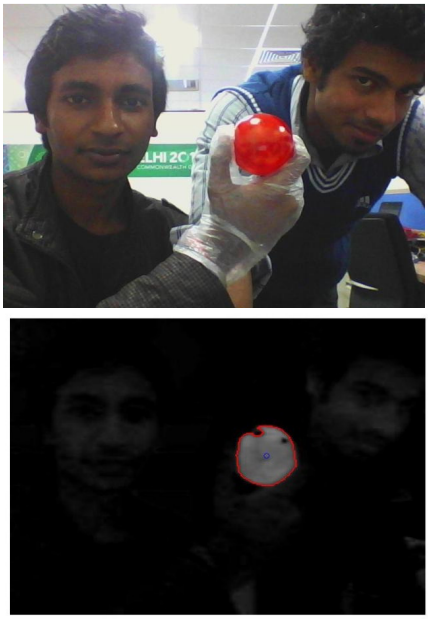

Fig.8: Image conversion from RGB to NTSC

The experimental procedure is as follows:

1. Set the Robotor at a distance of 30 cm from the target facing any direction.
2. Start autonomous action.
3. If the robot goes near the target and shoot it. Repeat the same procedure from the beginning.
4. After five trials, set the robot at a distance of 60 cm from the steps and restart.
5. Repeat above procedure with 90 cm and 120 cm also.

Table 2: Observation table

Distance from Robotor	**30cm**	**60cm**	**90 cm**	**120cm**
Number of Trials	5	5	5	5
Successful Performance	5	5	5	4
Unsuccessful Performance	0	0	0	1
Success Rate (%)	100	100	100	80
Distance from Robotor	**30cm**	**60cm**	**90 cm**	**120cm**
Number of Trials	5	5	5	5
Successful Performance	5	5	5	4
Unsuccessful Performance	0	0	0	1
Success Rate (%)	100	100	100	80

The varying the distance of the Robotor from the target we can know the range for which it can detect and shoot the object successfully. The use of our vision system and the technique of object detection using NTSC format of the image to control the Robotor obtained satisfactory results. The robot could detect and shot the target many times. In case of changing the distance from using above steps, we got good results except when the distance was 120cm. In that case it failed once to hit the target.

6. CONCLUSION

This paper has presented an autonomous moving robot has been implemented which is capable to detect a certain object, approaches towards its target and shoot it down. The result shows that the accuracy to find the target is **95 %** which demonstrate its accuracy and efficiency. The main constraint of this approach is that it can shoot only static object but no one is always static in nature. So our future work is to make an autonomous system which could predict the direction of moving targets using object tracking.

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