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Implementation of Turret and Firing Control System by Eye Tracking Method Using Armoured Combat Vehicle Based On LABVIEW

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***Abstract*-Eye tracking has been an important interesting area of research for quite some time now. In day-to-day applications, eye-tracking can be used as a computer Interface for both industrial and non-industrial applications. Here it mainly focuses the controlling of firing systems with the help of eye movement and blink. A military tank is an invaluable armoured fighting unit for front-line combat which incorporates both defensive and offensive capabilities. Most of the modern tanks require 4 members to operate, i.e. commander, driver, gunner and loader (Optional). Thus, when a tank gets destroyed, four precious lives are lost. In order to avoid such loss, number of persons to operate the armoured combat vehicle is reduced. The number of members required for operating a tank by one as well as increases the easiness of targeting an enemy by implementing a new method of controlling the tank's turret by eye tracking. Image of eye is captured using a camera, which is placed in front of the eye. The turret position is controlled using the eyeball movement and the gun can be fired with the help of blink. This will help in attacking the enemy quickly. Also, the number of persons required to control the tank is reduced.**

***Key words* -- Turret control, Firing control, LABVIEW, Eyeball traction, Eye blink detection.**

I. INTRODUCTION

One of the promising fields in artificial intelligence is HCI. Human-Computer Interface (HCI) can be described as the point of communication between the human and a computer. HCI aims to use human features to interact with the computer. The system tracks the computer user's movements with a video camera and translates them into the movements of the mouse pointer on the screen. The growing use of the computer, both in work and leisure, has led to the development of PC-associated handling applications, mainly using graphic interfaces. This way, the traditional methods of control or communication between humans and machines (joystick, mouse, or keyboard), that require a certain control motor on the part of the users.

Eyeball tracking is one the widely researched area and it is widely used in assisting paralyzed people. Here the Eye Tracking is used to control the military tank. A military tank is an invaluable armored fighting unit for front-line combat which incorporates both defensive and offensive capabilities.

Most of the modern tanks require 4 members to operate, i.e. commander, driver, gunner and loader (optional). Thus, when a tank gets destroyed, four precious lives are lost. In order to reduce the number of members required for operating a tank by one as well as increase the easiness of targeting an enemy by implementing a new method of controlling the tank's turret. There are various methods of tracking eyeball ball i.e. by using IR rays, electrooculography and using image processing techniques. Eyeball tracking using IR rays requires the use of IR emitting diodes; the rays are directed into the eye for tracking its movement. But prolonged exposure of IR rays to eyes is harmful.

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Therefore, it can't be used for application which requires tracking of eyeball for long period. In case of Electrooculography, it requires complex circuitry to tap the EEG signal for tracking the eyeball, which hinders normal operation of a person. Using a camera for tracking eyeball is a safe and 'hinder-free' method. In previous research, it is possible to track the eyeball successfully by using a camera. But one more proposed method is using a better algorithm for detecting and tracking eyeball movement.

To integrate eyeball tracking system, the turret rotation and weapon firing system. Thus, this allows the driver to control both the tank's movement and the weapon system. Because the firing of the weapon is controlled using the eye blink, the delay in firing the weapon is expected to decrease.

II.PREVIOUS METHOD

Most of the military tank requires 4 members to operate. When a tank gets destroyed, four precious lives are lost. There are various methods of tracking eyeball ball i.e. by using IR rays, electrooculography and using image processing techniques. Eyeball tracking using IR rays requires the use of IR emitting diodes; the rays are directed into the eye for tracking its movement. But prolonged exposure of IR rays to eyes is harmful. Therefore, it can't be used for application which requires tracking of eyeball for long period. In case of electrooculography, we require complex circuitry to tap the EEG signal for tracking the eyeball, which hinders normal operation of a person.

III.PROPOSED METHOD

A camera is used for tracking eyeball is a safe and 'hinder-free' method. Also a better algorithm is used for detecting and tracking eyeball movement. The number of persons to operate the tank is reduced by one and increases the ease of targeting enemies. The computer positions the turret precisely by implementing a PID algorithm or better control Algorithm. Thus, this allows the gun to be aimed at the target. The turret's position is used to move the cursor on the display. The cursor shows the direction in which the calibre is positioned. This cursor moves in par with the eyeball movement, allowing the user to aim and fire the weapon with ease. This helps the user to target the enemies with ease.

III. EYEBALL TRACKING

Image of the eye is captured using a camera and centroid of the iris is found to track the eye, which is used controlling the weapon systems of the military tank and eye blink is detected to issue firing command.

A.Camera Position

Camera is placed in front of the eye, so as to get the image of the eye as shown in Fig 1. Any small camera with auto- focus capability is sufficient for this purpose. For the purpose of illumination, infrared emitting diodes are used, which are positioned in such a way that the rays don't fall on the eye directly.

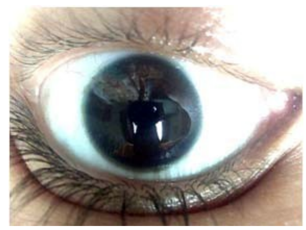

Fig 1: Image captured by the camera

The obtained image of the eye is in inverted position because it was easier to mount the camera in an upside down position, but it won't affect the eyeball traction. If a micro cam is used, then the obtained image will not be in an inverted position, and small changes in the code will be sufficient for proper functioning.

B. Region of Interest

The image from the camera is sent to the processor running LabVIEW code for extracting the iris region. The image from the camera is in RGB colour space. This image is changed to HSV colour space and the saturation colour plane is extracted and the obtained image is shown in Fig 2a. Since the obtained image is sharp, it is blurred using 5x5 Gaussian filters and the obtained image is shown in Fig 2b. Using a proper threshold value, we convert the image into binary image which is shown in Fig 3a. We again smoothen the image using a 10x10

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median filter and then using particle analysis, we find the area of each region. It was found that, the iris region occupies the maximum area and thus the centroid of the largest area is found, as shown in Fig 3d. With the help of centroid, we track the iris region.

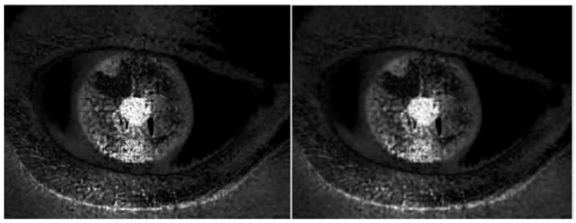

Fig 2: (a) Saturation Plane, (b) After applying Gaussian filter.

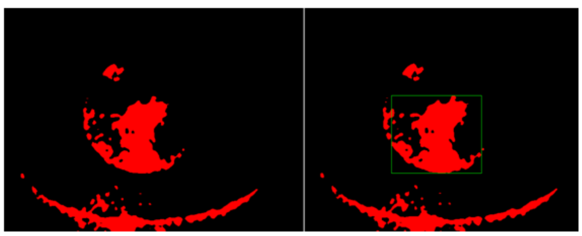

Fig 3: (a) Threshold, (b) ROI

C. Blink Detection

Blink is used as a firing command for the guns. Blink is detected in a very similar way as the ROI. When a person blinks, the image obtained is shown in Fig 4a.When the above procedure is applied, i.e. extracting the saturation plane of the image and converting into a binary image using proper threshold value, the image obtained is shown in fig 4b.

Fig 4: (a) Eye Blink, (b) Thresholded image of the blink

It is clear from the image that the area of the regions obtained is very small compared to the areas which are obtained when the eyes are open. Using this distinction, blink is detected.

Distinguishing between voluntary and involuntary blink is crucial in order to eliminate wrong commands for weapon firing. Normal human being blinks about 10 to 15 times per minute with each blink lasting no more than one-tenth of a second. To eliminate involuntary blinks, we follow the following procedure. Once the blink is detected, we wait for 0.4 seconds and capture the image again. If the eyes are still closed, then the voluntary blink is confirmed. That is, eyes are required to be closed for at least 0.4 seconds to confirm it as a blink and also to eliminate wrong signal which may arise from involuntary blink.

IV. TURRENT CONTROL

The computer, present in the tank, processes the image of the eye obtained from the camera using the methodology explained above. Based on the eyeball movement, the turret is manoeuvred. The block diagram of turret control is shown in Fig. 5. Normally, the turret's elevation or depression is controlled using hydraulic cylinder while the turret's traverse motion is accomplished using hydraulic motors and gearbox.

The camera 1 shown in Fig.5 captures the image of the eye. The image of the eye is sent to the computer where the centroid of the iris region is detected. The change in the position of eye along x-axis and y-axis is calculated. The change in eyeball position along x-axis is given to the Turret Horizontal Position actuator, which moves the turret along x- axis by the required amount. The change in eyeball position along y-axis is given to the Turret vertical Position Actuator, which moves the turret along y-axis by the required amount.

Before the soldier uses the tank, the computer must calibrate for that particular user. It is essential to find the distance between the x-coordinate when the iris is at centre position and the x-coordinate when the iris is at corner position. This is achieved by making the user to move his eyeball to the centre and to the corner. The x-coordinate in both the position is

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found out. Subtracting the coordinates will give the distance between them. Using this, when the user moves from centre to corner position, the turret is made to rotate 90 degrees.

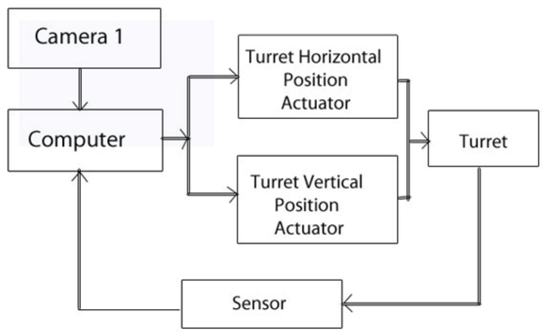

Fig 5: Turret Control using Eyeball Movement

V. FIRING CONTROL

Eye blink is used as a command to fire the weapon. The eye blink is detected as explained in section II. The Fig.6 is a functional block diagram of the firing system as well as the user interaction system.

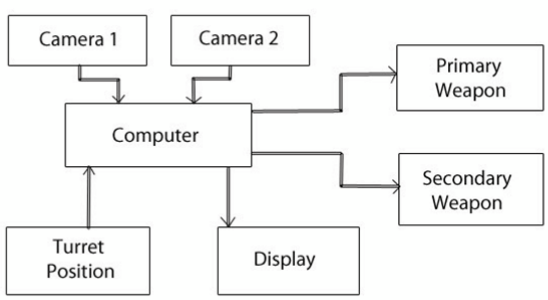

Fig 6: Gun Control using Eye Blink

The camera 1 sends the captured image of the eye to the computer. It checks for blinks. If a blink is detected, the Primary weapon is made to fire. It is also possible to fire the secondary weapon with the help of the eye blink. A switch is provided, which is located in such a way that it is comfortable for the user to access. Using this switch we can toggle between, the primary weapon and secondary weapon.

The camera 2 is positioned outside the tank, which captures images of the environment at 30fps. The image is filtered and it is displayed in the monitor (display) which is located inside the tank. This allows the user to see the environment and it also help to position the gun. The turret's position is used to move the cursor on the display. The cursor shows the direction in which the calibre is positioned. This cursor moves in par with the eyeball movement, allowing the user to aim and fire the weapon with ease. This helps the user to target the enemies with ease.

VI.EXPERIMENTAL RESULTS

We built a prototype to test the proposed system's feasibility and accuracy. The NI LabVIEW was used to process the images from the camera as well as to control the turret and gun controls. The Intex webcam (2MP) is used to capture the image of the eye. The resolution of the captured images was 640x480. But for the real time operation, it would be better if micro-cams are used, since they occupy less space and are easier to mount on spectacles. The captured images were transferred to LabVIEW using a USB cable. The PC's configuration is: core i7 2.0 GHz-2.9 GHz, 4GB RAM. The centroid of the image was found out to track the eye. The eye was captured under various illumination and position.

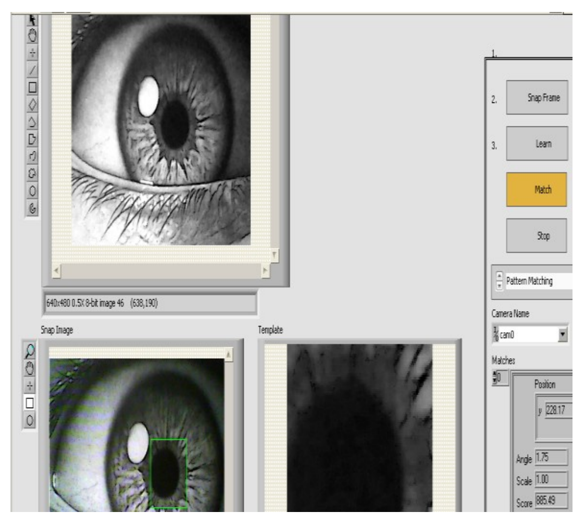

Fig 6: Experimental Result of Turret and Firing Control System Using Eye Blink

The turret system was designed using two servo motors, which were driven by 6V DC supply. One servo motor provides horizontal movement of the turret whereas the other servo

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motor provides vertical motion. These servo motors were controlled using Arduino UNO development board. The Arduino board was connected to the PC running LabVIEW using an USB cable.

The distance moved by the iris region in x-axis was determined by the LabVIEW code. Using the in-built blocks present in the 'Arduino toolkit for LabVIEW', the horizontal servo was actuated to turn by the required angle. Similarly the distance moved by the iris region in Y-axis is determined and thus, the servo which is responsible for vertical movement of the turret is actuated. By this, the turret was positioned to the desired direction.

To test the effectiveness with which the code differentiated between voluntary and involuntary blink, we carried out an experiment. Two LEDs were used. The red LED was made to glow in case of involuntary blinks and the green LED was made to glow in case of voluntary blink. The camera was made to capture the image of a person's eye at 30fps for about an hour during which we asked him to give firing commands by closing his eye for about 400ms. The code was able to differentiate between the voluntary and involuntary blinks accurately.

VII.CONCLUSION

Thus, our proposed system modifies the conventional method of targeting an enemy and firing the weapons in a military tank by controlling the weapon system using eyeball movement and blink. In a battle, our eye sees the enemies first, and then we turn our weapon in that direction to fire. There is a considerable lag. Using our proposed system, the calibre is made to follow the eye's gaze and it is made to fire using eye blink. This is help in attacking the enemy quickly. Also, the number of persons required to control the tank is reduced as the driver can control both the tank as well as the firing system simultaneously.

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