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Iris Movement Detection by Morphological Operations for Robotic Control

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Abstract-* The main aim of this paper is to develop an efficient interface to track the iris movement and to use this information to control the direction of robotic vehicle. Interacting with real or virtual objects with help of a human eye is gaining popularity. This paper gives information about morphological operations to detect eyeball movement and how we can use it to move a robot in direction of the line of sight of the user. Through a web camera, we continuously capture the photographs of either the left or the right eye. Since the target eye is stationary with respect to the camera, so accurate and fast movement is detected in the eye region of the photograph. Then performing the morphological operations on the captured eye images, we are generated digital codes. Then send this information to the robotic vehicle by wireless link. The robotic vehicle receives the digital data and performs some operation on it. According to the digital data the robotic vehicle controls its direction. The eye blinking feature is also used by the algorithm to control the starting and stopping of robotic vehicle. A high speed and accuracy tracking scheme using Evolutionary Video Processing for eye detection and tracking is proposed. One of the future challenges in the development of iris recognition systems is their incorporation into devices such as personal computers, digital camera and embedded devices. In such applications, the computational complexity and noise tolerance of the recognition algorithm play an important role. This paper addresses the computational complexity of the necessary first step in iris recognition, namely iris detection. High resolution images not only provide high recognition rate but also useful in safeguarding the iris recognition system from fake iris attack .

Index Terms **-Iris detection, Morphological Operations, MATLAB, Hardware Implementation.**

I. INTRODUCTION

Image processing is a rapidly growing area of today's world. Its growth has been fuelled by technological advances in digital imaging, computer processors and mass storage devices. Fields which traditionally used analog imaging are now switching to digital systems, for their flexibility and affordability. Important examples are medicine, image and video production, photography, remote sensing, and security monitoring. These and other sources produce huge volumes of digital image data every day, more than could ever be examined manually. Digital image processing is concerned primarily with extracting useful information from images. Ideally, this is done by computers, with little or no human intervention. Image processing algorithms may be placed at three levels. At the lowest level are those techniques which deal directly with the raw, possibly noisy pixel values, with de-noising and edge detection being good examples. In the middle are algorithms which utilize low level results for further means, such as segmentation and edge linking. At the highest level are those methods which attempt to extract semantic meaning from the information provided by the lower levels, for example, handwriting recognition.

Eye tracking is a technique whereby an individual's eye movements are measured so that the researcher knows both where a person is looking at any given time and the sequence in which their eyes are shifting from one location to another. Eye movements can also be captured and used as control signals to enable people to interact with interfaces directly without the need for mouse or keyboard input, which can be a major advantage for certain populations of users such as disabled individuals. The field of mathematical morphology contributes a wide range of operators to image processing, all based around a few simple mathematical concepts from set theory. The operators are particularly useful for the analysis of binary images and common usages include edge detection, noise removal, image enhancement and image segmentation. The two most basic operations in mathematical morphology are erosion and dilation. Both of these operators take two pieces of data as input: an image to be eroded or dilated, and a structuring element (also known as a *kernel*). The two pieces of input data are each treated as representing sets of coordinates in a way that is slightly different for binary and gray scale images.

Many different methods have been used to track eye movements since the use of eye-tracking technology was first pioneered by Rayner & Pollatsek, 1989. Electro-oculo graphic techniques, for example, relied on electrodes

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mounted on the skin around the eye that could measure differences in electric potential so as to detect eye movements. These methods proved quite invasive, and most modern eye-tracking systems now use video images of the eye to determine where a person is looking. According to the annual report of the Ministry of Public Health and Welfare, 0.73 million people have a motor disability on the legs and the arms. Since these people find it difficult to move their arms or legs to drive a wheelchair, so driving it through their eyes becomes an effective method.
This paper develop an effective method to detect iris movement by estimating the size of the left and the right portion of the sclera with respect to the iris and to use the information in controlling the direction of a robotic vehicle. By wearing a cap with a fixed camera mounted on it such that the camera continuously focuses on eye, the user can control the movement of the robotic vehicle in either direction through eyes. Moreover, by simply closing eye for predefined number of seconds, we can stop the robotic vehicle at any time. The embedded unit can be based on any microcontroller, here we use 89V51 microcontroller. We receive continuously, serial data (integer value of iris movement) from the computer every 1 millisecond and process it using the "Iris data" flow shown in Fig 1. As shown in block diagram, webcam captures HD images of position of the eye. The webcam sends the images to the computer i.e. MATLAB environment.

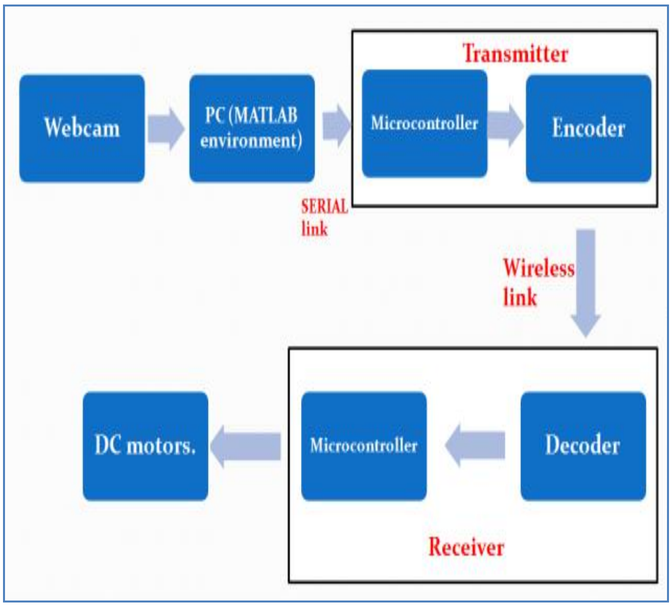

Fig .1 Block diagram of complete system

In the MATLAB software, by image enhancement & other morphological operations done on this eye position image. The MATLAB software generates different codes of different eye position. This code is send to transmitter on serial link. The transmitter consists of two section uC89V51 & encoder HT12E. Microcontroller sends this data to encoder (HT12E). Encoder & RF module transmit data on wireless link to the receiver. At the receiver, receiver receives the digital data. Again receiver section consists of two sections decoder (HT12D) & uC89V51. The received digital data decoded by decoder & output of decoder is given to the microcontroller. The microcontroller drives DC motors depending upon the decoded data & robot vehicle moves. This paper is organized as follows ,section II describes interfacing & programming of digital camera ,In section III development of robotic vehicle is given ,In section IV results are provided & section V conclude the paper.

II. INTERFACING & PROGRAMMING OF DIGITAL CAMERA.

Objective of this phase would to efficiently interface the digital camera with laptop/PC by using an RS-232 cable or USB port[1]. Also to program the digital camera using MATLAB software so that it captures at 20frames/sec. The camera is to be mounted on the operators cap & is focused on the iris. The flowchart for image processing is shown in fig.2.

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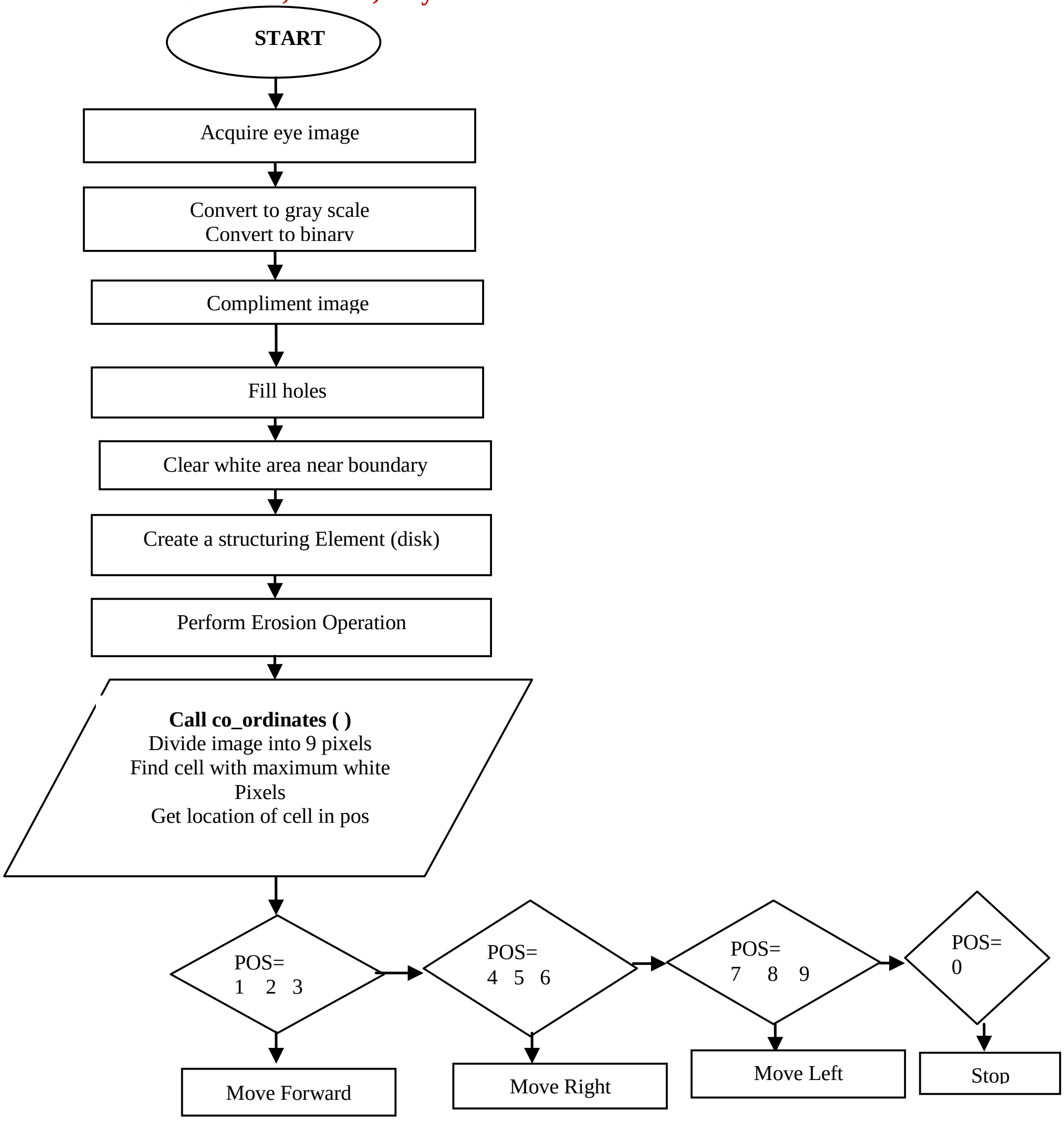

Fig. 2 Flowchart for processing of image

III. DEVELOPMENT OF ROBOTIC VEHICLE

In order to make things simple & remove the complications caused due to wires for data transmission purpose we are using a wireless transmitter-receiver module [5]. Due to this reason the range of robotic vehicle is also increased & results in better performance as compared to wired one. For this wireless transmission purpose, IC's used are HT12E & HT12D along with A 434 RF transmitter & receiver module.

A. Transmitter Section

After MATLAB processing on image, PC will give out appropriate control signals to the serial port this serial data via DB-9 is given to microcontroller through an FRC cable. This FRC cable will give serial data to microcontroller(80C51) through pin no. 10 & this microcontroller converts the serial data stream into a parallel data of 4 bits which is given to lower bits of port 2 (if RI = 1). This data of 4 bits is then given to transmitter IC i.e. HT12E which again encodes the parallel data into serial data & gives it to A434 transmitter module which transmits the data at frequency of 433.92 MHz with the help of antenna connected to pin no. 4 of transmitter. Fig.3 shows circuit diagram for transmitter & flowchart for transmitter is given in Fig.4.

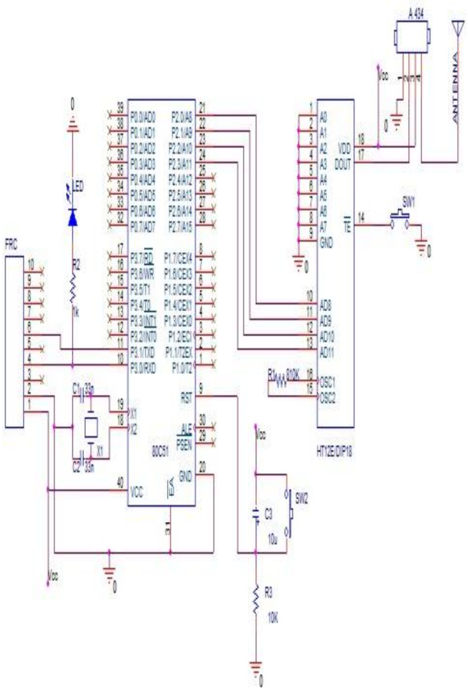

Fig. 3 Circuit diagram for transmitter

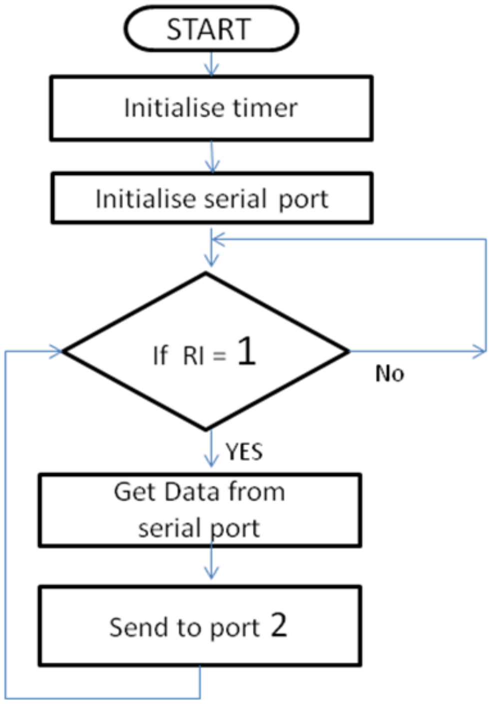

Fig. 4 Flowchart for Microcontroller 80C51

B. *Receiver Section*

With the help of wireless link, antenna connected at the reciver of A434 module will receive the data from pin no. 8. them.Fig.5 shows circuit diagram for receiver & flowchart for receiver is given in Fig.6. This data is further given to decoder IC HT12D which decodes the received data into parallel data stream & will give out the decoded data to microcontroller at the reciever end which is placed on the robot. This data is given at port 2 of microcontroller. Only the lower 4 bits of the data are given to microcontroller & the higher 4 bits of data are default high .

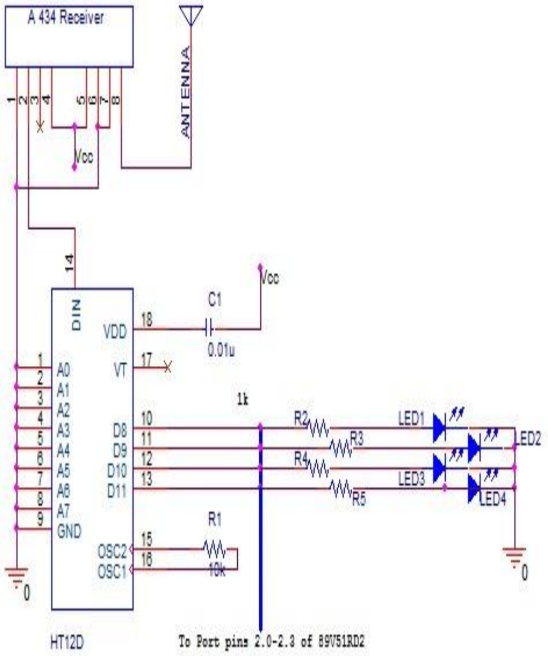

Fig. 5 Circuit diagram for Receiver

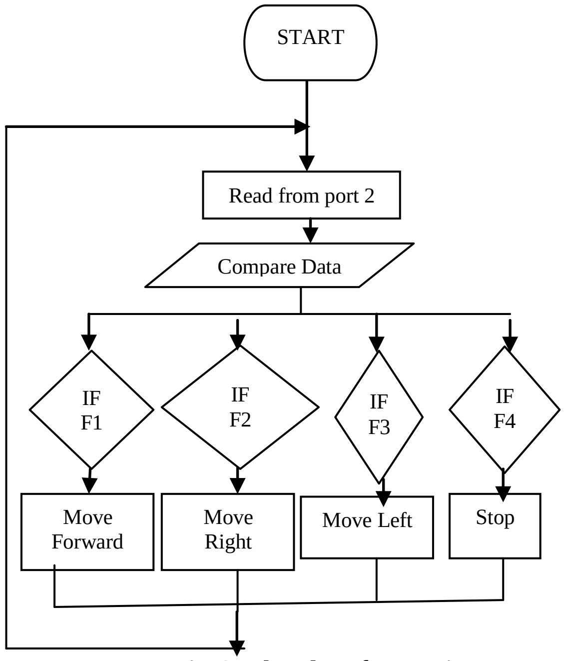

Fig. 6 Flowchart for Receiver

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IV. SIMULATION RESULT

Iris position for Forward control of robot:-In the below fig 7, we can observe that the iris position is at exactly center position. Top right window shows the binary image of the rgb image. Then this binary image complemented that means white pixels converted into black pixels. When the white portion of the iris is detected at center column then robotic vehicle moves in forward direction.

Iris position for leftward movement of robot:-In the below fig 8, we can observe that the iris position is at exactly leftward position. Top right window shows the binary image of the RGB image. Then this binary image complemented that means white pixels converted into black pixels. When white portion of the iris is detected at right column, then robotic vehicle moves in leftward direction.

Iris position for rightward movement of robot:-In the below fig 9, we can observe that the iris position is at exactly rightward position. Top right window shows the binary image of the RGB image. Then this binary image complemented that means white pixels converted into black pixels. When the white portion of the iris is detected at left column then robotic vehicle moves in rightward direction.

When Iris Is Not Detected (To Stop Movement of Robot):-In the above fig 10, we can observe that eye is completely closed; hence no iris is detected. Top right window shows the binary image of the RGB image. Then this binary image complemented that means white pixels converted into black pixels. When white portion of the iris is not detected in image, then robotic vehicle movement is stop. The signal transmitter from the system has an antenna for better range. The commands are transmitted from the image processing software to the USB port. The USB port connector receives the command in the form a binary number. Based on the binary number received on the pins, voltage is generated on the pins.

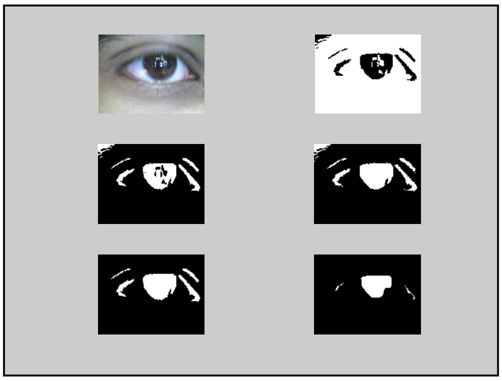

Fig .7 Iris position for Forward control of robot

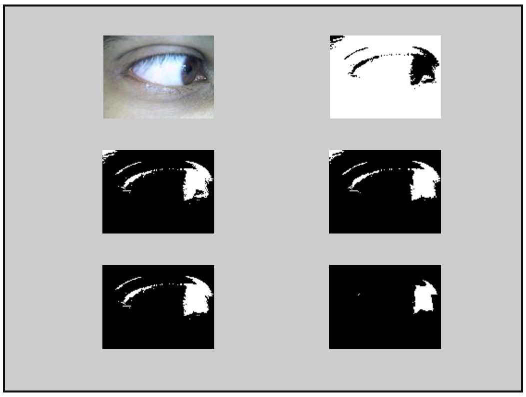

Fig .8 Iris position for leftward movement of robot

There are four transistors, one for each direction i.e. left, right, forward and backward. Then, the corresponding signal is transmitted from the transmitter in the circuit to the receiver circuit.

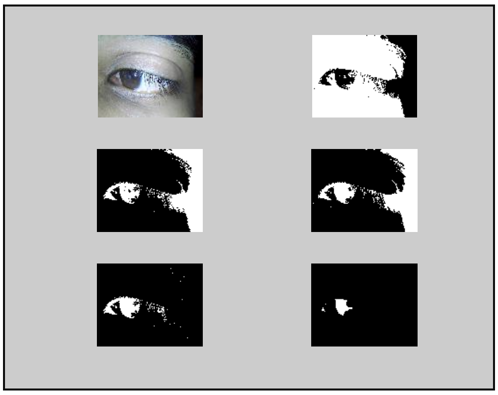

Fig .9 Iris position for rightward movement of robot

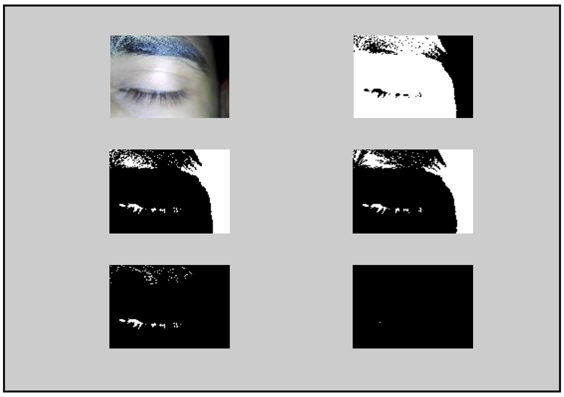

Fig .10 When Iris Is Not Detected

At the time of eye blink, signal is transmitted back to the image processing software in the system so as to stop the Robot vehicle. Fig .11 shows result for movement of robotic vehicle.

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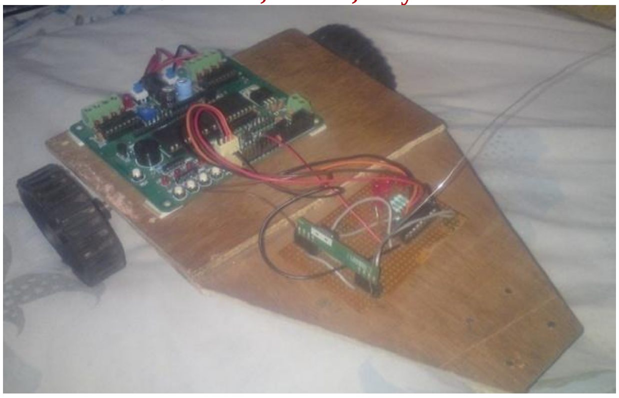

Fig .11 Result for movement of robotic vehicle

V. CONCLUSION

This paper presents a simple yet accurate approach to detect the eyeball movement. The algorithm is fast and efficient enough to detect any kind of movement in the eyeball and can be adjusted to detect movements of specific intensity. The setup is simple and requires only a web camera mounted on a cap worn by the user. I have also presented a simple method to make use of the eyeball movement to control a robot. The approach can also be used to control a computer mouse, in virtual environments to interact with virtual objects, etc. Eye movement detection is an important form of human computer interaction and can be utilized to develop many innovative applications and to interact with the computers in a more natural way. The user has to only look left or right to move the robotic vehicle towards the desired direction. The diagonal motion is achieved when user looks left or right for only small duration of time.The system is tested on equal terrain and indoor environment. The USB INTEX night vision camera is attached to the cap which is worn by the user. The camera starts capturing as soon as it is plugged in. Then start executing the MATLAB program so that the user interface is displayed on the screen. The proposed robot vehicle system is easy to operate by the user. The cap worn by the user is light weighted carrying only a small camera with LEDs. The user has to only look left or right to move the robot vehicle towards the desired direction. The diagonal motion is achieved when user looks left or right for only small duration of time. The experimental results are good.

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