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Eyeball Operated Wheelchair for Locked-In Syndrome Patient

Gagandeep Singh
Department of Electronics and Communication Engineering, New Delhi, India

Abstract:- The aim of the paper is to develop an efficient eyeball movement tracking interface and to control the movement of wheelchair using tracking information. Locked-in syndrome is a condition in which a patient is aware of the surroundings but cannot move or communicate verbally due to complete paralysis of almost all voluntary muscles in the body except for eye movements and blinking. The individual is conscious with no loss of cognitive function and thus is able to communicate with eye movements. This condition is also known as pseudo coma. This paper gives information about how eyeball movement of LIS patients can be detected and how we can use this information to move a wheelchair in direction of the eyeball. We continuously capture the images of either the left or the right eye using a head mounted web camera. Highly accurate and fast movement in the eye region of image is detected as the eye is stationary with respect to the webcam. To control starting and stopping of wheelchair eye blinking feature is used by the algorithm as LIS patients can only move and blink their eyes. In this paper, accurate and high speed eye detection and tracking algorithm using video processing in MATLAB is proposed.

Keywords:- *Eyeball movement; wheelchair; PIC16F877A; MATLAB; locked-in syndrome.*

I. INTRODUCTION

Eye tracking is a technique in which eye movements of an individual are measured to know where the eyes are focused. This technique is used to know the time interval for which a person eye is focused to any location at any given time and the sequence in which person eye is changing its focus from one location to another.

As an advantage to certain population of disable individual, control signals generated by capturing eye ball movement can be used by this individual to interact with interfaces directly without use of any external peripheral like mouse or keyboard.

Mathematical morphology is a theory that provides a wide range of operators for analysis and image processing, all based on simple mathematical concepts from set theory, topology and random functions. The operators are particularly useful for the analysis and transformation of the binary or grayscale images and for some common usages like edge detection, noise removal, image segmentation and image enhancement.

Millions of people are suffering from Locked in syndrome (LIS). Locked-in syndrome (LIS), also known as pseudo coma, is a condition in which a patient is aware of what all is happening in its surrounding environment but cannot move or communicate verbally due to complete paralysis of almost all voluntary muscles in the body except for eye movements and blinking.

Locked-in syndrome is most often caused by damage to a specific part of the brainstem known as the pons. The pons contains important neuronal pathways between the cerebrum, spinal cord and cerebellum. In locked-in syndrome there is an interruption of all the motor fibers running from grey matter in the brain via the spinal cord to the body's muscles and also damage to the centers in the brainstem important for facial control and speaking.

Locked-in syndrome (LIS) patients generally communicate with others through coded messages by moving or blinking their eyes, which are not affected by the paralysis. The symptoms of locked-in syndrome and that of sleep paralysis are quite similar. Consciousness is preserved in locked-in syndrome. Sometimes they can retain the ability to sense stimuli and sensation throughout their bodies. Some patients may have the ability to move some or all of the extraocular muscles and some facial muscles. Though the vocal cords of patient with locked-in syndrome are not paralyzed they lack coordination between breathing and voice which prevents them from producing voluntary sound.

Since no cure or standard treatment for LIS is available, therefore, eye tracking technique can be used to help people with LIS communicate with their environment using interactive interface.

Since these people find it difficult to drive a wheelchair using their arms or legs or voice command, so driving it using their eyes become an effective method.

II. PROPOSED MODEL

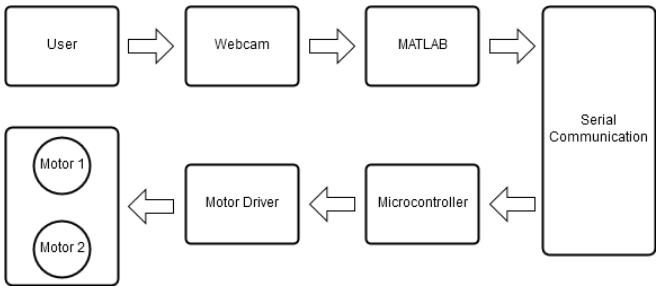


Fig 1:- General block diagram of wheelchair

The system operates on basis of eye movement which is fed as an input signal to control the motion of wheelchair in

any direction. The camera is mounted on head cap such that it focuses on eye, analyses the eye ball movement of the person and microcontroller accelerates the vehicle.

Moreover, stopping of wheelchair is controlled by the blinking of eye. To stop a wheelchair individual need to close the eye for a predefine number of seconds, the wheelchair will stop with a predefine delay to avoid jerk. Delay function has been implemented for smooth starting and stopping of the wheelchair.

Webcam captures HD images of position of the eye. The webcam sends the images to the MATLAB environment for image processing. Serial data received from the MATLAB every 1 millisecond after image processing is fed to the embedded microcontroller PIC16F877A which is used to control the motors.

For different eye positions, different control signals are generated by MATLAB code. This generated signal is send to the serial port. Microcontroller read the data from serial port and drives the motor using motor driver circuit according to the serial data.

III. MATLAB INTERFACING

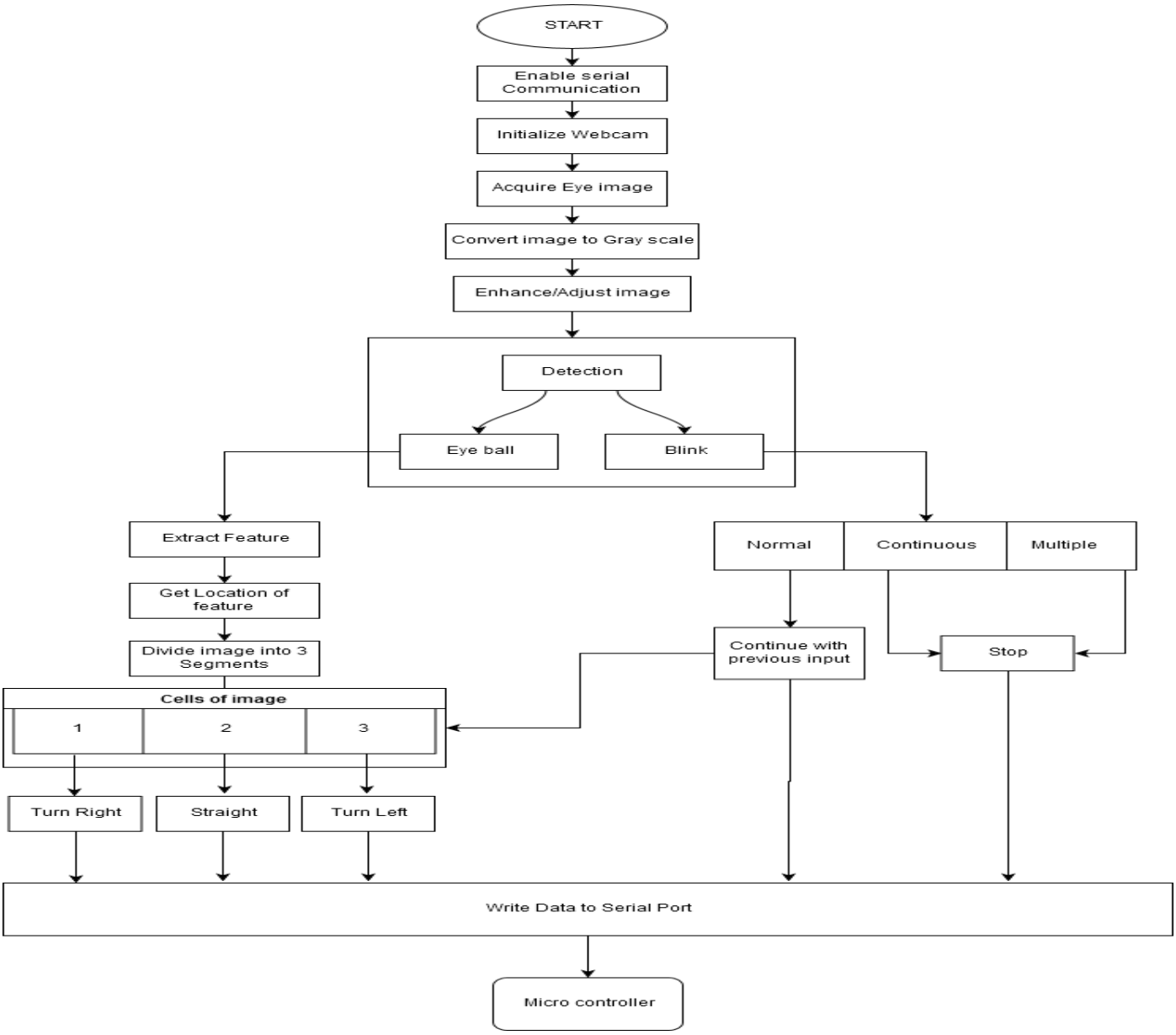


Fig 2:- Flowchart of image processing

Initialize serial port communication at 9600 Baud rate; using USB interface the digital camera with laptop/PC. Program MATLAB to capture image from the camera interfaced at 20frames/sec. Focus the camera on the eye by mounting it on the head cap.

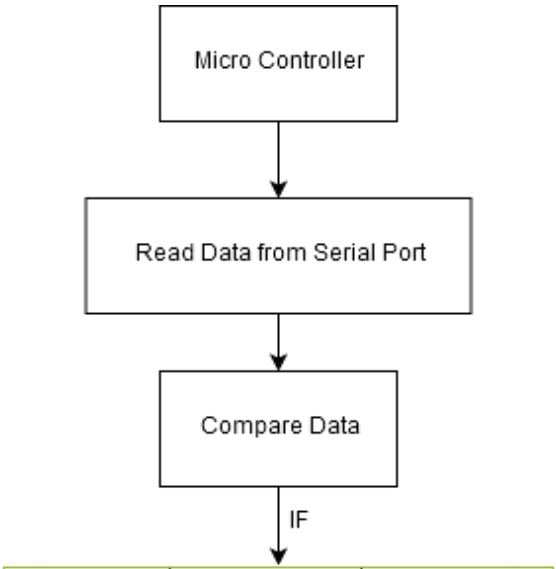
Once the colored image of eye is captured, it is then transformed to a gray scale image. Gray scale image represents an image as a matrix where every element has a value corresponding to how bright or dark the pixel at the corresponding position should be color.

Then adjust the intensity value of gray scale image by saturating pixel values. This operation increases the contrast of the output image. Extract feature of the eye and to get the location of the eye ball.

Divide image into three segments of pixel and find the location of feature pixel and send the data to serial port, to be read by microcontroller to control the direction of movement.

IV. MICROCONTROLLER INTERFACING

With the help of DB9 cable, microcontroller connected to MAX232 will receive the data from MATLAB. Microcontroller will compare the data and give required command to motor driver circuit for the movement of motors.



DATA	MOTOR 1	MOTOR 2
POS = 1	ON	OFF
POS = 2	ON	ON
POS = 3	OFF	ON
STOP	OFF	OFF

Fig 3:- Flowchart for microcontroller

V. HARDWARE

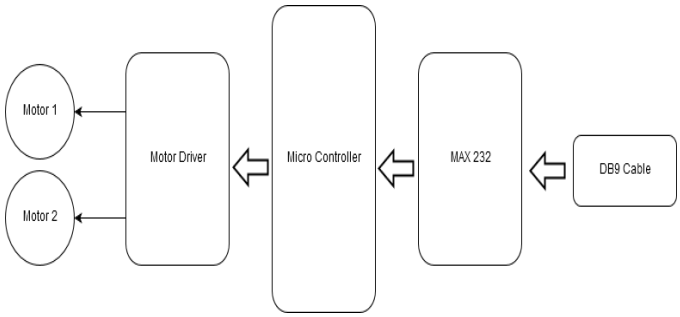


Fig 4:- Block diagram of hardware of circuit

A. Microcontroller

PIC16F877A is a powerful easy-to-program microcontroller with 200 nanosecond instruction execution cycle. PIC16877A is CMOS FLASH-based 8-bit microcontroller. The PIC16F877A features 8 channels of 10-bit Analog-to-Digital (A/D) converter, an ICD, 256 bytes of EEPROM data memory, 2 comparators, Universal Asynchronous Receiver Transmitter (USART), 2 capture/compare/PWM functions, and synchronous serial port which can be configured as either 3-wire Serial Peripheral Interface (SPI) or the 2-wire Inter-Integrated Circuit (I^2C) bus. All of these features make it ideal for more advance applications in industrial, automotive and consumer applications.

B. Motor driver

L293D is a Motor Driver IC usually used to control DC motor on either forward or reverse direction. This 16 pin IC is designed to control two motor simultaneously using two H-Bridge in any direction. It acts as an interface between microcontroller and motors. It consists of Dual H-bridge circuit. Low current rated motors are controlled using H-bridge.

Rotation of motor connected across left side will be regulated by left input pins and right motor will be regulated by right input pins. Rotation of motor is based on input provided in form of Logic 1 or Logic 0.

C. Motor

Our wheelchair circuit uses two DC geared motors to drive the wheelchair in forward, backward, left and right directions using input from motor driver IC. Motors are powered using rechargeable and easily replaceable 12v 15Ah battery.

D. MAX232

TX, RX, CTS, and RTS signals are converted using dual transmitter/dual receiver IC named MAX232. The signals from RS-232 are converted to TTL circuit signals. In MAX232, RS-232 to TTL voltage level conversion is done using two receivers and TTL to RS-232 voltage level conversion is carried out by two drivers.

TX and RX uses first driver-receiver pair of MAX232 and CTS and RTS uses the second driver-receiver pair.

E. DB9 cable

DB9 is common connector of D-Sub types of connector. It has 9 pins for male connector and 9 holes for female connector.

DB9 type connectors are designed to work with the EIA/TIA 232 serial interface standard. DB9 connectors were commonly used for serial communication. Many peripheral devices like keyboards, mice, joysticks, etc. are interfaced using DB9 cable.

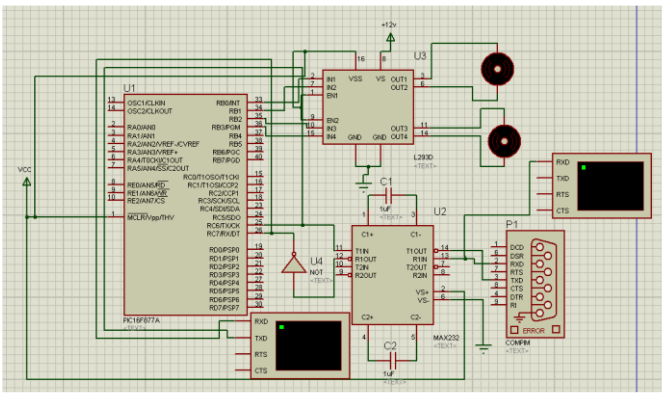


Fig 5:- Circuit diagram for microcontroller

VI. SIMULATION RESULT

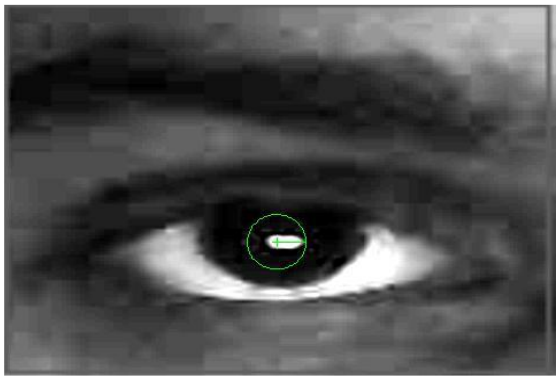


Fig 6:- Eyeball position for forward movement

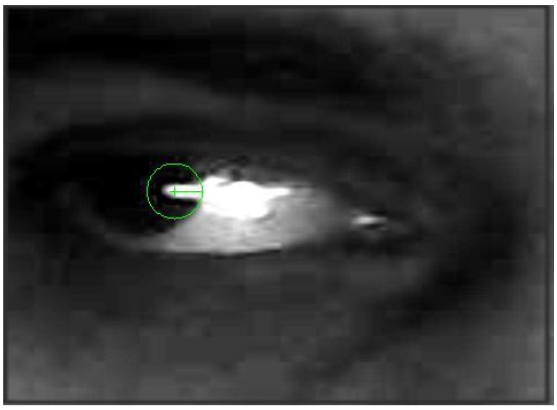


Fig 7:- Eyeball position for right movement

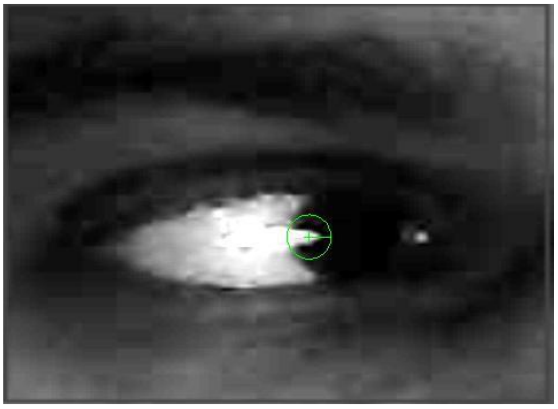


Fig 8:- Eyeball position for left movement

VII. ACKNOWLEDGMENT

A patient suffering from complete locked-in syndrome has an ability to move or blink eyes only. The idea is to design a human-machine interface that can provide a power to the patient, of controlling the wheelchair movement with respect to the movement of eyeball.

Since the wheelchair make the LIS patient feel more independent and gives the control of the movement of wheelchair to the patient according to their will or desire the name given to this wheelchair is “Willchair”.

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