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Real Time Iris Based Robot

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***Abstract*—Disability of movement has huge impact on the life of physically disabled people. Therefore there is need to develop a robot which can be controlled using iris movement. Presently iris controlled robotic systems exist in which iris movement detection is done using MATLAB. This paper proposes a system which aims to design a robot controlled by iris movement. The system is designed using Raspberry Pi and Pi Camera Module which make the system cost effective and stand alone. An Open Source Computer Vision is integrated on Raspberry Pi for real time image processing. A general purpose higher-level language, Python is used for programming the Raspberry Pi. The main aim of the system is to recognize iris from an image of eye and find the centroid of the iris. The centroid position is further used to operate the robot in various directions.**

Keywords—OpenCV, Raspberry Pi, Arduino, Canny Edge Detection, Hough Circle Transform, Segmentation.

I. INTRODUCTION

Today's era of automation demands for development of systems for physically challenged people. The proposed system aims to help people with physical disability. Iris is the only external organ of human which can move even if complete body is paralyzed. Hence iris is gaining importance in the field of automation.

Each iris has unique and random pattern [1]. The idea of iris control is of great use not only in the field of robotics but also for people who are unable to walk and use wheelchairs. Hence one of the major applications of proposed approach can be wheelchair controlled by iris movement. Iris recognition is done regardless of size, position and orientation using statistical method [2] and using gradient transform [3]. Recently, the systems are developed in which iris centroid detection is done using image processing toolbox in MATLAB [4], [5], [6]. Traditionally, electronic wheelchair control systems were developed based on eye gaze [7].

Moreover, in some systems image processing is done using Python [8] which is a higher- level programming language and easy to implement. Iris movement detection for robotic control can be done using Morphological Operations [9], [10]. An effective and fast eye location algorithm is used to calculate the centroid of an iris. This algorithm is based on the geometric characteristics around eye area [13]. Active contours [12] in an eye are detected using circular curve gradient measurement. The active contour considers the boundary of pupil. The eyeball controlling mechanism is used in some applications like cursor control system of a computer [14] and firing system for military tank [11].

The design of proposed system is divided into two parts. First part consists of capturing video of iris movement and processing it frame by frame to locate the centroid of the iris. The second part consists of robot control according to the movement of iris in real time.

The rest of paper is organized as follows: Section II describes the proposed system of Iris Controlled Robot and working of each hardware unit. Section III shows image processing algorithm implemented to get required location of iris centroid. Section IV presents results obtained from image processing and Section V finally discusses the conclusion.

II. THE PROPOSED SYSTEM

The prototype of proposed system can be implemented using Raspberry Pi [16] and an Arduino. Raspberry Pi is a mini computer that plug into any monitor or TV. It has 900 MHz quad-core ARM processor. The proposed system flow is shown in the Fig. 1.

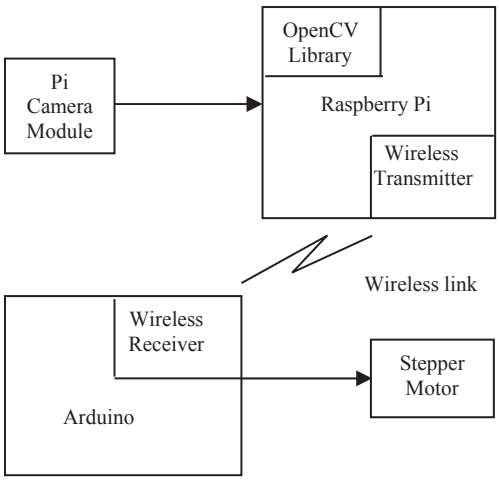

Fig. 1. Proposed System Design.

The Pi camera module is connected to the Raspberry Pi via camera serial interface. Pi camera captures video of an eye continuously and Raspberry Pi processes the video frame by

frame. An OpenCV (Open Source Computer Vision) library is integrated on Raspberry Pi used for real time image processing. The programming language used to program the Raspberry Pi is Python, which connects the Raspberry Pi with real world. The processed data are then transferred to Arduino through wireless communication. Arduino drives the stepper motors according to the data coming from Raspberry Pi.

A. *Raspberry Pi*

Raspberry Pi is a credit card size computer which has 1 GB RAM, quad core ARM cortex A7 CPU, 4 USB ports, Ethernet, HDMI and Audio-Video port. The camera module is interfaced to Raspberry Pi via Camera Serial Interface (CSI). The official Operating System for Raspberry Pi is Raspbian. Python is higher level programming language used to write programs in Pi. An Open Source Computer Vision (OpenCV) is integrated on Raspberry Pi for image processing.

B. *Pi Camera Module*

Pi camera module takes a High-Definition Video as well as still images. Module has 5 megapixel fixed focus camera and can be controlled programmatically. The camera has 15 pin flex cable which can be easily inserted into the CSI port.

C. *Arduino*

Arduino is an open source hardware prototyping platform used to build electronics projects. The Arduino has both physical hardware i.e. Microcontroller and piece of software. The Arduino's Integrated Development Environment (IDE) a simplified version of C++. The Arduino can be programmed via USB.

D. *OpenCV*

OpenCV is an open source library used for computer vision applications. It is used for computational efficiency. It has C, C++, Python and Java interface. It mainly focuses on real time applications. It provides not only open but also optimized code for computer vision. OpenCV can also be integrated with Python. Hence OpenCV-Python is a library designed to solve computational problems.

E. *Stepper Motor*

Stepper motors are interfaced to General Purpose Input Output (GPIO) pins of Arduino. Arduino gets data coming from Raspberry Pi and drives motors accordingly.

III. IMPLEMENTATION

The software flow in the proposed system is shown in the Fig. 2.

A. *Image Pre-processing[15]*

The image acquired by camera is raw and cannot be processed directly as it is inefficient and impractical. Hence image pre-processing steps are applied as follows:

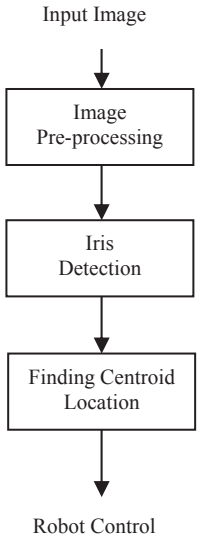

Fig. 2. Software Flow.

1) Image Segmentation: This step is applied to divide the image into sub-parts and the region of interest is extracted. The region of interest is isolated from its background.

2) RGB to Gray Conversion: The colour image is then converted into monochrome image i.e. gray scale image. Gray scale is range of shades between black and white. Eight bit gray scaling is done so that that the image has 0-255 different gray levels.

3) Canny Edge Detection: Canny edge detection is done to reduce the amount of data while preserving structural edges that are used for further processing. Hysteresis thresholding [15] is applied to detect valid edges. It sets two thresholds minimum and maximum. Edges between these two thresholds and those form connectivity are considered as valid edges. All other edges are discarded.

4) Median filtering: Median filtering is the image filtering technique used to remove noise. In this technique, median of all the pixels in the kernel window is calculated. The central pixel is replaced with this median value.

B. *Iris Detection*

Next step is detecting iris from eye. This is done using Hough Circle Transform. The Hough transform takes images generated by edge detection and connects the disjoint edge points together. Hence it is used to detect circles in an image.

C. *Finding Centroid Location*

The perimeter of iris detected by Hough Circle Transform also shows centroid of circle. The co-ordinates of centroid are calculated to find the location of centroid in an image. According to the location, control is given to robot.

IV. Results

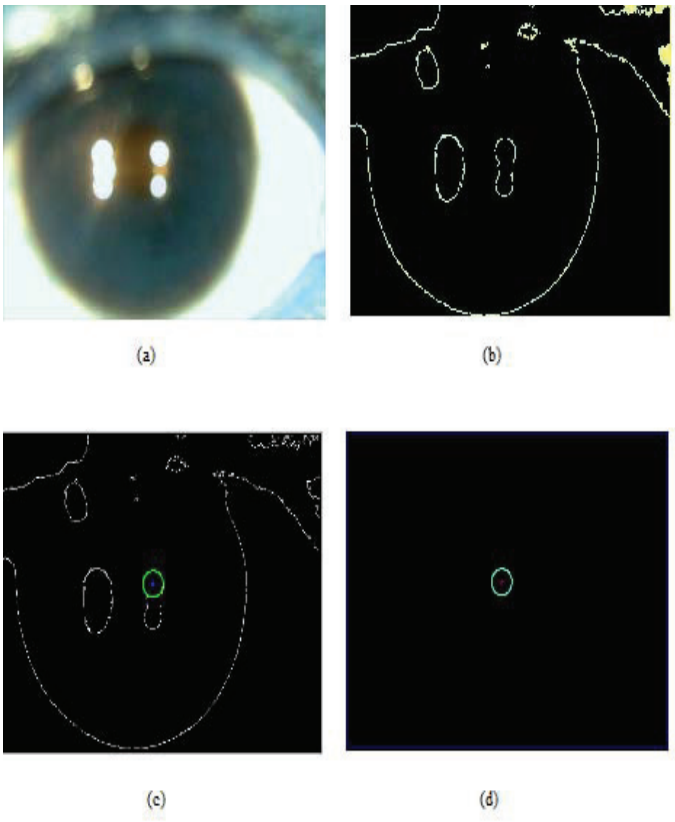

Fig. 3. Iris centroid location of eye looking forward.

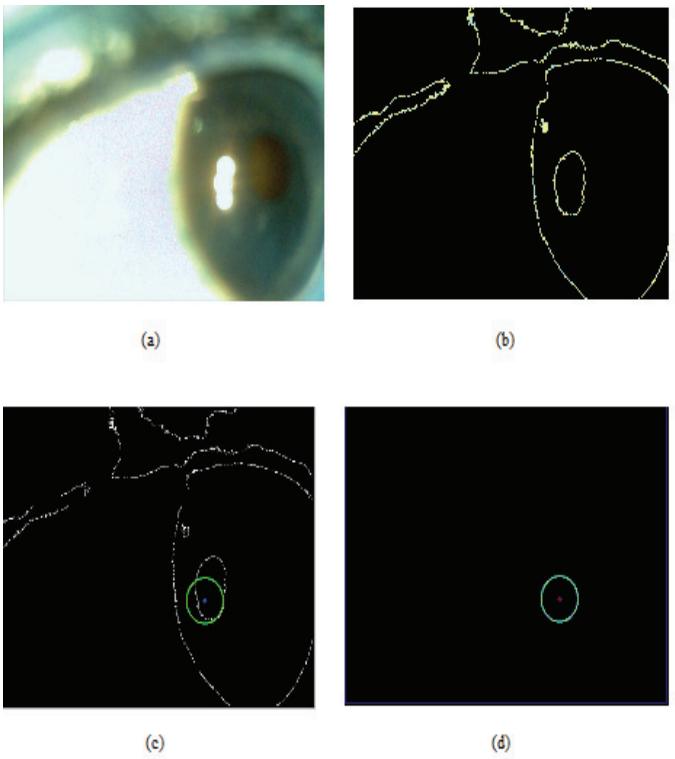

Fig. 4. Iris centroid location of eye looking left.

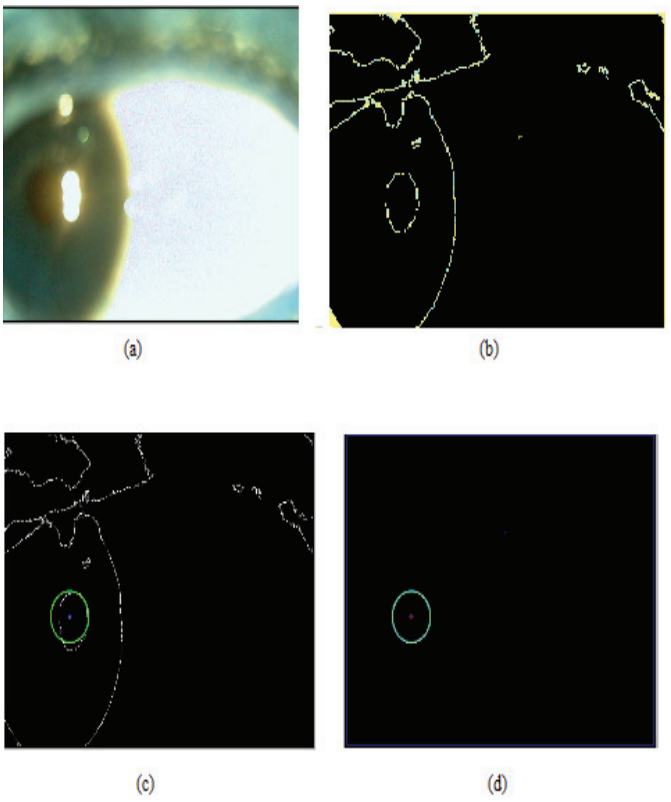

Fig. 5. Iris centroid location of eye looking right.

Images of eye are taken and image processing algorithm is applied to get location of centroid. Fig. 3, 4 and 5 show captured image of eye looking forward, left and right and processed images in OpenCV to get centroid location.

In each of the figures below the sub-figure (a) shows input image of eye captured by camera. The sub-figure (b) shows the output of Canny Edge Detection. The sub-figure (c) shows iris boundary detection using Hough Circle Transform. The sub-figure (d) shows centroid location of iris.

V. Conclusion

In this paper, a robotic system is proposed for physically challenged people, which is based on iris movement. An iris detection algorithm is applied to get centroid location of iris. The choice of Canny Edge Detection and Hough Circle Transform gives correct detection of iris circle and centroid. According to the centroid location obtained from image processing, the control movement can be given to robot. A credit card size computer Raspberry Pi makes this system compact and stands alone.

REFERENCES

[1] John Daugman, "Probing The Uniqueness And Randomness of Iris Codes: Results from 200 Billion Iris Pair Comparison", Proceedings of The Ieee, Vol. 94, No. 11, November 2006.

[2] John Daugman, "How Iris Recognition Works", Ieee Transaction on Circular Systems for Video Technology, Vol. 14, January 2014.

[3] Vishwanath G. Garagad, Nalini C. Iyer, "A Novel Technique of Iris Identification for Biometric Systems", International Conference on Advances in Computing, Communication and Informatics, 2014.

[4] George Constantin Rascanu, Razvan Solea, "Elecric Wheelchair Control for People with Locomotor Disabilities using Eye Movement", Unpublished.

[5] Razvan Solea, Adrian Filipescu, Ardiana Filipescu Jr., Eugenia Minca, Silviu Filipescu, "Wheelchair Control And Navigation Based on Kinematics Model and Iris Movement", Ieee 7th International Conference on Cis & Ram, 2015.

[6] Gunda Gautam, Gunda Sumanth, Karthikeyan K C, Shyam Sundar, D. Venkataraman, "Eye Movement Based Electric Wheelchair For Physically Challanged Persons", International Journal of Scientific & Technology Research, Vol. 3, Issue 2, February 2014.

[7] Kohei Arai, Ronny Mardiyanto, "Eye based Electric Wheel Chair Control System", International Journal of Advanced Computer Science and Applications, Vol. 2, No.12, 2011.

[8] Neena Mani, Aby Sebastian, Alen Mathews Paul, Alex Chacko, Anupa Raghunath, "Eye Controlled Electric Wheelchair", International Journal of Advanced Research In Electrical, Electronics and Instrumentation Engineering, Vol. 4, Issue 4, April 2015.

[9] Osama Mazhar, Muhammad Ahmed Khan, Taimoor Ali Shah, Sameed Tehami, "A Real Time Webcam Based Eye Ball Tracking System using Matlab", Ieee 21st International Symposium for Design and Technology in Electronic Packaging (Siitme), October 2015.

[10] M. S. Ghute, A. A. Parkhi, K. P. Kamble, Mohsina Anjum, "Iris Movement Detection by Morphological Operations for Robotic Control", International Journal of Engineering Science and Innovative Technology, Vol. 2, Issue 4, July 2013.

[11] Sabarish Kuduwa Sivanath, Suman Adhepalli Muralikrishnan, Parthasarathy Thothadri, Vijaykumar Raja, "Eyeball and Blink Controlled Firing System for Military Tank using Lavview", Ieee Proceedings of 4th International Conference on Intelligent Human Computer Interaction, Kharagpur, India, December 27-29, 2012.

[12] E. M. Arvacheh, H. R. Tizhoosh, "Iris Segmentation: Detecting Pupil, Limbus and Eyelids", International Conference on Image Processing (ICIP), 2006.

[13] Li Weijun, Xu Jian, Wang Shoujue, "A Fast Eye Location Algorithm based on Geometric Complexity", Proceedings On 5th World Congress on Intelligent Control and Automation, June 15-19, 2004.

[14] Pinos Eduardo, Mendez Xavier, "Cursor Control System of a Computer by Electro-Oculographs Signs for Motor Disability", Ieee Canada International Humanitarian Technology Conference (Ihtc), 2014.

[15] S. Sridhar, Digital Image Processing, Oxford University Press, New Delhi, 2011.

[16] Roshani D. Ninama, Rutu P. Nayak, "Eye Movement Controlled Wheel Chair", International Journal for Technological Research in Engineering, Vol. 1, Issue 9, May 2014.

[17] Sushama Shelke, Shaila Apte, "A Fuzzy based Classification Scheme for Unconstrained Handwritten Character Recognition", IEEE Internation Conference on Communication and Computing Technology (ICCICT 2015), Jan. 15-16, Mumbai, 2015.