

# Controlling Digital Device Using Smart Eye-Tracking System

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## ABSTRACT

Smart eye tracking system is designed for controlling any devices which has digital screen, with the eye ball movements and gestures without the help of required hardware. This paper proposes the design and implementation of cursor control system based on the movement of the eye ball. Then the movement of the eye ball is tracked and the cursor movement is regulated accordingly and gestures like blinking enables enter and blinking twice enables right click and left click. These gestures and tracking system enables the users to use the entire device. The image processing module consists of webcam and python customized image processing, the eye movement image is captured and transmitted to Raspberry pi 3 model B version 2 microcontroller for processing with open CV to derive the coordinate of eyeball. The coordinate of eyeball is utilized for cursor control on the Raspberry pi screen to control the system.

**Keywords** - Eye Tracking ,Control Gestures, Raspberry Pi, Image Processing.

## I. INTRODUCTION

The number of paralyzed people keeps increasing year by year perhaps because of two common factors. Some are born this way while others have untoward accidents. According to the statistics from the Department of Social Welfare, the total number of disabled people in India is 504640. Among them, 37,363 are visual, 30,303 hearing, 170 speech, 106,252 physical, 117, 799 learning, 3,130 mental and 11,713 multiple disabled people. The disabled people have a limited ability to control the electrical and electronics devices (On and OFF) at their home because normally the switches are placed at a height of 15m while the comfortable height for a wheelchair user is up to 13m only. It is also mentioned that the number of disabled friendly facilities are still minimum in major countries. Therefore,

providing a very practical facility that can ease accessing home appliances and other systems is really required which can greatly improve the lives of the disabled.

### 1.1 Importance of Specially Designed Systems for Disabled

Nowadays personal computers are carrying a huge part in our live as they are used in areas such as work, education, entertainment etc. The common part in all these applications which are computer based are the input methods (keyboard and mouse). While this is not a problem for a lively personal, this may be an unbeatable bound for people with limited freedom of movement of their wing. In these cases it would be preferable to use input methods which are based on more abilities of the region such as eye movements. To empower such replacement input methods a

system was made which follows a low-price path to supervision a mouse cursor on a computer system.

The eye tracker is stationed on images which are documented by a mutated webcam to acquire the eye movements. These eye movements are then epitomized to a computer screen to position a mouse cursor subsequently. The position of the cursor in the screen will regulate according to the spot of the eye ball. Camera is used to grab the image of eye movement.

## II. LITERATURE SURVEY

### 2.1 SMART WHEELCHAIR BASED ON EYE TRACKING

AUTHORS: Aniwat Juhong, Nutthanan Wanluk, Pintavirooj and Sarinporn Visitsattapongse

This project is a smart wheelchair based on eye tracking which is drafted for people with locomotive detriment. The accompaniment controlled module can be used with any electrical wheelchair. The sharp wheel chair consists of four sector including imaging processing module, wheelchair- controlled module, SMS manager module and appliance-controlled module. The image deal with module compose of a webcam installed on the eyeglass and C++ customized image processing software. The captured image which is carried to raspberry Pi microcontroller will be handled using OpenCV to formulate the 2D direction of eye ball. The parallel of eyeball movement is then wirelessly carried to wheelchair-controlled module to control the progress of wheel chair. The wheelchair- controlled module is two dimensional revolve stages that are feed to the joystick of the electrical wheelchair to restore the hand operated control of the wheelchair. The

movement of eyeball is also utilised as the cursor control on the raspberry Pi screen to control the operation of some armed appliance and send message to smart phone.

### 2.2 EYE BALL MOVEMENT TO CONTROL COMPUTER SCREEN

AUTHORS: Arslan Qamar Malik, and Jehanzeb Ahmad

The paper introduces a peculiar idea to control computer mouse cursor movement with human eyes. In this paper, a working of the device has been express as to how it helps the limited people share their knowledge with the world. Number of universal manner such as Head and Eye Movement Tracking Systems etc. Prevail for cursor control by making need of image processing in which light is the primary source. Electro- oculography (EOG) is a recent technology to sense eye signals with which the mouse cursor can be manged. The signals recorded using sensors, are amplified, then noise is detached and then digitized, before being carried to PC for software interfacing.

### 2.3 CONTROLLING MOUSE CURSOR USING EYE MOVEMENT

AUTHORS: Chhabria, Dharaskar and Shrunkhala Satish Wankhede

In this paper, a lone human computer interface system employing eye motion is imported. Traditionally, human computer interface handles mouse, keyboard as an input device. This paper introduces hands free interface between computer and human. This automation is intended to restore the conventional computer screen pointing devices for the use of handicapped. The paper presents a unique idea to control computer mouse cursor

movement with human eyes. It controls mouse-moving by naturally affecting the position where eyesight targets on, and copies mouse-click by affecting blinking action. However, the planned vision-based virtual interface controls system work on numerous eye movements such as eye blinking.

#### 2.4 CURSOR CONTROL SYSTEM USING FACIAL EXPRESSIONS FOR HUMAN-COMPUTER INTERACTION

AUTHORS: A.Geetha and M.Mangaiyarkarasi

Vision based mostly human-computer interface is bestowed during this paper. The interface detects eye movements and interprets them as indicator management commands. The used image process ways of embody digital camera for detection the face, and guide matching methodology based mostly eye region detection. The Haar feature technique is employed for eye feature extraction. SVM classification method is used for classifying the eye movements. The classification of eye movements like eye open, eye close, eyeball left, and eyeball right movements are used for cursor top, bottom, left and right movement respectively. The interface is predicated on a notebook equipped with a typical net camera and needs no additional light-weight sources. In Hough transform, circular method is used to control the cursor movements. This methodology is employed for physically challenged persons to work with the computers effectively with their eye movements.

#### 2.5 COMMAND THE COMPUTER WITH YOUR EYE- AN ELECTRO-OCULOGRAPHY BASED APPROACH

AUTHORS:, Kristie Huda, Mohiuddin Ahmad and Shazzad Hossain

In this paper, a user freelance human laptop interface system victimization eye movement and blink feature detection is introduced. A hands free interface between laptop and human will doubtless replace the normal human laptop interface devices like mouse, keyboard etc. This technology is meant to relinquish practicality to peoples with severe motor disabilities to regulate a laptop by simply moving their eyes. This paper describes a technique of dominant mouse pointer on a monitor victimizes the electrical potentials developed by eye movements called Electrooculography (EOG) signals which are employed to detect eye movement and blink features. The EOG signal is recorded from electrodes placed at acceptable positions round the eyes. The captured EOG signal is then analyzed to discover and classify eye movement options of interest. The detected options were then to generate management signals to regulate a mouse pointer. The cursor control application is implemented offline.

### III. SYSTEM ANALYSIS

#### 3.1 EXISTING SYSTEM

In Existing system they use eye ball rotation for control the wheel chair which is used for disabled person. They use four modules including imaging processing module, wheelchair-controlled module, SMS manager module and appliance-controlled module. The coordinate of eyeball movement is then wirelessly transmitted to wheel chair-controlled module to control the movement of wheel chair. The drawback the existing system is other electronic device can be controlled by sending SMS alert to the registered smart phone. When the mobile is switched off or not reachable the controlling of device is difficult. And by using this system small electronic device like fan, lights alone be controlled.

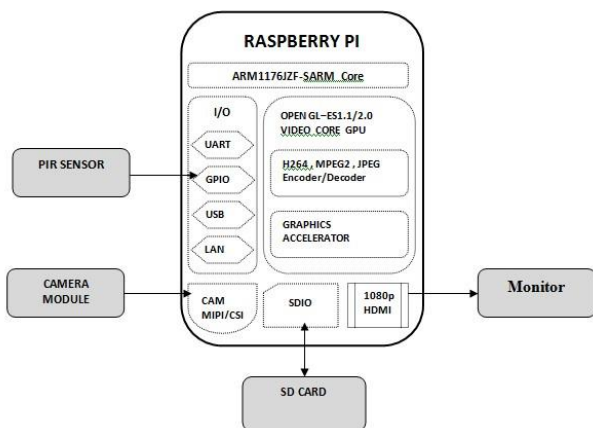
### 3.1.1 Disadvantages

- Difficult to implement
- High cost
- Complex system
- Accuracy depends on camera clarity

### 3.2 PROPOSED SYSTEM

This particular system will be a mile stone for the development of many systems for the disabled people. There are various deformities on comparing one person to other, the development of these kind of system needs a serious data collection and analysis. The eye ball movement control system consist of two parts namely person detection system and cursor control system. When personal computer is attached with the person detector system, thus when the person approaches the system is automatically switched on. The position the eye is tracked. The movement of the eye is tracked and used as the input. The image of the eye is acquired then it is converted into grey scale and the centroid of the eye is found and it is used as the reference to move the cursor on the screen.

#### 3.2.1 System Architecture



**Fig 3.1.** System Architecture of the Proposed System

### 3.2.2 Advantages

- High quality receiving data
- Low power consumption
- High data speed and low cost
- Faster input process
- Easy to implement and use

## IV. HARDWARE SPECIFICATION

### 4.1 INTRODUCTION

The various hardware components involved in the proposed system are raspberry pi 3 model B version 2, webcam, PIR sensor. The webcam and PIR sensor are attached to the raspberry pi 3 model B version 2. Let us discuss about all these components in detail.

### 4.2 RASPBERRY PI MODEL B VERSION

Raspberry pi is AN ARM based mostly mastercard sized SBC(Single Board Computer) created by Raspberry Pi Foundation. Raspberry Pi runs Debian based GNU/Linux operating system Raspbian and ports of many other OS exist for this SBC.It has Broadcom BCM2837 64bit Quad Core Processor powered Single Board Computer running at 1.2GHz with 1GB RAM. It is packed with BCM43143 wireless local area network on board, Bluetooth Low Energy (BLE), 40pin extended GPIO, 4 x USB 2 ports, 4 pole Stereo output and Composite video port. It also has CSI camera port for connecting raspberry pi camera easily. The Raspberry Pi doesn't have a constitutional real clock, and doesn't "know" the time of day. It have many models All models feature a Broadcom system on a chip (SoC), which includes a ARM compatible central processing unit (CPU) and an on chip graphics processingunit (GPU,a Video Core IV).Secure Digital (SD) cards area unit wont to store the software package and program memory in either the SDHC or small SDHC sizes. Most boards have between one and 4 USB slots, HDMI and

composite video output, and a 3.5 metric linear unit jack for audio.

#### 4.2.1 Layout of Raspberry Pi 3

The layout of the raspberry pi 3 model B version 2 is shown in the figure below. The below figure also represents the various parts

#### 4.2.2 Key Features

1. Same full size HDMI port
2. Same 10/100 Ethernet port
3. Same CSI camera port and DSI display ports
4. Same micro USB power supply connection
5. SoC – Broadcom BCM2836 quad core Cortex A7 processor @ 900MHz with VideoCore IV GPU

#### 4.2.3 Pin Configuration

1. BCM - Broadcom pin number, commonly called "GPIO", these are the ones you probably want to use with RPi.
2. GPIO and GPIO ZeroWiringPi - Wiring Pi pin number (shown as a tooltip), for Gordon Henderson's Wiring Pi library
3. Physical - Number corresponding to the pin's physical location on the header
4. Rev 1 Pi - Alternate BCM numbers for the original, 26-pin model "A" and "B" Pi

#### 4.2.4 Raspberry Pi Operating Systems

An operating system makes Raspberry Pi run. Since Raspberry Pi may be a credit sized pc that's supported UNIX operating system, optimum performance of RPI will be achieved if it's operated during this atmosphere. Raspbian provides over a pure OS: it comes with over thirty five packages, pre-compiled code bundled during a nice format for simple installation on RPI. Important to notice is that the

Raspberry Pi doesn't operate during a Windows atmosphere. To get access to Pi from windows we tend to need a Putty code. Putty is an SSH and TelNet client.

#### 4.2.5 Advantages

- Low cost
- Low power
- High speed operation
- High reliability

#### 4.3 WEB CAM

A digital camera may be a video camera that feeds or streams its image in real time to or through a raspberry pi. Webcam with mic comes with high speed USB interface. The webcam also offers great camera resolution and is available with AWB (Automatic Whiteness Balance) so that you get clear and natural images. With the CMOS sensing element incorporated during this digital camera, the pictures are rendered with supreme quality.

##### 4.3.1 Steps to Setup Webcam to Raspberry

Pi

- Turn on your Raspberry Pi, open a terminal window
- Connect the webcam into the USB port and enter the following command that will list all the USB devices that are being connected. Command - `lsusb`
- It will display camera listed as ausb device, for example "Bus 001 Device 006:ID0c45:602c MicrodiaClasOhlson TWC-30XOP Webcam"
- If your Webcam is compatible, you can try to take some pictures to verify its functionality by installing fswebcam software

#### 4.4 PASSIVE INFRA RED SENSOR

A passive infrared sensor (PIR sensor) is associate electronic device that measures infrared (IR) lightweight diverging from objects in its field of read. They are most frequently employed in PIR-based motion detectors. Infrared radiation enters through the front of the device, referred to as the 'sensor face'. At the core of a PIR device may be a solid state device or set of sensors, made up of pyro-electric materials— materials that generate energy once exposed to heat. Typically, the sensors ar just about 1/4 in. sq. (40 mm<sup>2</sup>), and take the shape of a skinny film.

##### 4.4.1 Working

PIRs are basically made of a pyro-electric sensor (which you can see above as the round metal can with a rectangular crystal in the center), which can detect levels of infrared radiation. Everything emits some low level radiation, and therefore the hotter one thing is, the a lot of radiation is emitted. The detector in an exceedingly motion detector is truly split in 2 halves. The two halves are wired up in order that they cancel one another out. If one sees a lot of or less IR radiation than the opposite, the output can swing high or low.

### V. SOFTWARE SPECIFICATION

#### 5.1 PYTHON

The Python programing language really started as a scripting language for UNIX. Python programs are like shell scripts in this the files contain a series of commands that the pc executes from high to bottom. Python may be a terribly helpful and versatile high level programing language, with straightforward to scan syntax that permits programmers to use

##### 5.1.1 Features

- Simple
- Easy to Learn
- Free and Open Source
- High-level Language
- Portable

##### 5.1.3 Advantages

- Presence of Third Party Modules
- Extensive Support Libraries
- Open Source and Community Development

Object Oriented fewer lines of code than would be potential in languages such as assembly, C, or Java. Python programs don' t need to be compiled before running them, as you are doing with C programs. However, you may need to install the Python interpreter on your pc to run them. The interpreter is that the program that reads the Python file and executes the code. There are programs that can package Python code into stand-alone executable programs so you can run Python programs on computers without the Python interpreter installed. Like shell scripts, Python will automatize tasks like batch renaming and moving massive amounts of files. Using IDLE, Python's REPL (read, eval, print, loop) operate may be used rather like a program line. However, there are additional helpful stuff you will produce with Python. Programmers use Python to create things like:

- Web applications
- Desktop applications and utilities
- Small databases

Python conjointly contains a massive assortment of libraries, that quickens the event method. There are libraries for everything you'll think about - game programming, rendering graphics, GUI interfaces, web frameworks, and scientific computing Python 2

and Python 3 come pre-installed on Raspbian, but to install it on another Linux OS or to update it, simply run `sudo apt-get install python3` or `sudo apt-get install python`. To access Python from the electronic communication, sort “python” or “python3” counting on that version you would like to use. This exposes the Python REPL (read-eval- print-loop), from that you'll enter Python commands rather like you employ the program line. Use Ctrl-D to exit the REPL.

## VI. IMPLEMENTATION METHOD

### 6.1 INTRODUCTION

Various steps involved in tracking and mapping the movement to screen are

- Capturing real time image using Web- Camera focusing pupil of eye.
- Processing the individual image frame.
- Flipping of each image frame.
- Conversion of each frame to a grey scale image.
- Color detection and extraction of the different colors (RGB) from flipped gray scale image.
- Mouse Movement
- Processing the individual image frame.
- Flipping of each image frame

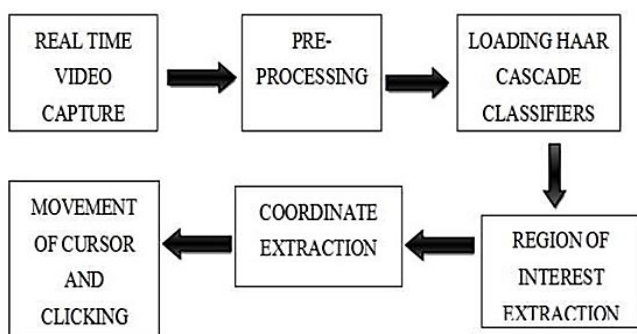


Fig 6.1 Functions Hidden Under Proposed System

### 6.2 PERSON DETECTION

The person detection is done using the PIR sensor. The PIR device itself has 2 slots in it, every slot is

formed of a special material that's sensitive to IR. The lens used is not really doing much and so that the two slots can 'see' out past some distance. When the device is idle, both slots detect the same amount of IR, the ambient amount radiated from the room or walls or outdoors. When a heat body sort of a human or animal passes by, it first intercepts one half of the PIR sensor, which causes a positive differential change between the two halves. When the nice and cozy body leaves the sensing space, the reverse happens, whereby the sensor generates a negative differential change. These change pulses are what is detected.

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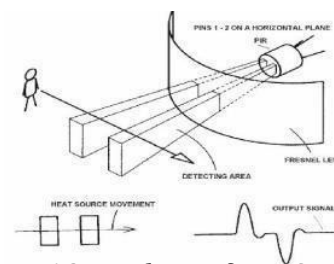


Fig 6.2 Working of PIR Sensor

### 6.3 CAMERA ACTIVATION

The image of the eye is tracked when the PIR sensor detects a person. The PIR sensor enables the camera.

The camera tracks the image of the eye and stores it in the memory location mentioned in the main program. As a primary section, Acquisition is very important. Obtaining a transparent image of the pupil within the eye is crucial to the eye-tracking method. A changed low price USB digital camera is employed for capturing a close-up image of 1 eye pupil. An integral a part of the planning method, therefore, is to determine the optimum camera settings and light source positions to produce a clear image. Matlab program is employed to decision the digital camera for deed the important time video input file. The tracked image of the eye is converted into grey scale and the centroid of the eye is calculated. Thus when the centroid is calculated the continuous eye ball tracking is done. Thus by this way the image tracking is displayed as the result.

#### 6.4 CURSOR MOVEMENT BASED ON EYE BALL POSITION

The gray region of the image obtained when subtraction must be regenerate to a binary image for locating the region of the detected pupil . A grayscale image consists of a matrix containing the values of every picture element. The picture element values lay between the ranges zero to 255 wherever zero represents pure black and 255 represents pure white color. We use a threshold value to convert the image to a binary image. This means that each one the picture element prices lying below threshold value is regenerate to pure black that's zero and therefore the rest is regenerate to white that's so the resultant image obtained may be a monochromatic image consisting of solely black and white colours. The conversion to binary is required because it is easy to find the properties of a monochromatic image. Final output image: (after boundary detection and centroid): For the user to control the mouse pointer it is necessary to determine a point whose coordinates

can be sent to the cursor. With these coordinates, the system will management the pointer movement. An inbuilt function is used to find the centroid of the detected region. The output of function is a matrix consisting of the X (horizontal) and Y (vertical) coordinates of the centroid. These coordinates amendment with time because the pupil moves. Centroid of the image is detected Coordinates area unit placed and hold on in a very variable currently the desired pupil trailing of eye is achieved. The pointer location is set by assignment X and Y position of bounding box. If the X and Y positions of Bounding box varies, accordingly the position of the cursor will also vary. Now the mouse movement in monitor is achieved by mistreatment pupil of eye movement detection that may be an alternate approach for the bit screen. Works may be done to perform the operations mistreatment the inherent.

This image shows the operation of the system when a person is detected. This is done when the PIR sensor triggers the system. The working of the PIR sensor is explained above This image shows the console window of the raspberry pi. This is where the execution status of the code is displayed and the execution is started by using certain commands. After the conversion of the RGB image into grey scale and after the morphological process , centroid calculation is done. The above figure shows the centroid calculation of the eye for tracking.

#### VII. CONCLUSION

The goal of this study is to propose a system that can help disabled people to operate their personal computer without the help of others. This technique can be implemented in their wheelchairs so that they can operate without an extra person. The developed technology is a base for the various applications which are to be developed for the disabled people.



The implementation of the AI unit can further enhance the sophistication of this system.

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