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HUMAN EYE-CONTROLLED MOUSE

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Abstract: *With advanced technologies in this digital era, there is always scope for development in the field of computing. Hands free computing is in demand as of today it addresses the needs of quadriplegics. This project presents a Human computer interaction (HCI) system that is of great importance to amputees and those who have issues with using their hands. The system built is an eye-based interface that acts as a computer mouse to translate eye movements such as blinking, gazing, and squinting towards the mouse cursor actions. The system in discussion makes use of a simple webcam and its software requirements are Python (3.6), OpenCv, numpy and a few other packages which are necessary for face recognition. The face detector can be built using the HOG (Histogram of oriented Gradients) feature along with a linear classifier, and the sliding window technique. It is hands free and no external hardware or sensors are required.*

Keywords: *Human-computer interaction, Eye-tracking mouse, OpenCV*

I. INTRODUCTION

The computer mouse or moving the finger has been a very common approach to move the cursor along the screen in the current technology. The system detects any movement in the mouse or the finger to map it to the movement of the cursor. Some people, who do not have their arms to be operational, called as 'amputees' will not be able to make use of the current technology to use the mouse. Hence, if the movement of their eyeball can be tracked and if the direction towards which the eye is looking at can be determined, the movement of the eye ball can be mapped to the cursor and the amputee will be able

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to move the cursor at will. An ‘eye tracking mouse’ will be of a lot of use to an amputee [1].

With the intending of pc technological know-how and technology, the use of computer systems has introduced about massive facilitation in every element of society. However, the commonplace computer input gadgets are normally designed for normal successful users, rather than aged and disabled ones. The use of computers calls for a mouse, a touchpad, a keyboard, or different outside gadgets. Users with upper limb disabilities are incapable of controlling the mouse or keyboard easily, which makes it extraordinarily tough for them to apply a computer. For commonplace laptop customers, the lengthy-time period usage of conventional input devices causes continual soreness in fingers, shoulders, or neck, and greatly will increase the chance of getting cervical or vertebral spondylosis. In order to facilitate the disabled use of computers, enormous work has been accomplished and two varieties of answers are offered [2]. The first answer is to use contact-kind auxiliary device, e.g., infrared sensors and infrared reflectors, to hit upon the user’s moves to control a laptop. Takami et al. Invented a special sort of eyeglasses with 3 mild- emitting diodes. By sitting in front of a pc with eyeglasses, the consumer’s image may be captured by means of the camera, and the head actions are judged, in order to perform the computer. Evans et al. Used infrared light-emitting diodes and photodetectors as auxiliary equipment to determine the user’s head position to operate a computer. Chen et al. produced a mouse and a keyboard that can detect infrared signals. The computer mouse or transferring the finger has been a completely not unusual approach to shifting the cursor along the screen inside the current technology. The device detects any motion in the mouse or the finger to map it to the motion of the cursor. Some people, who do not have their arms to be operational, called ‘amputees’ will no longer have the ability to utilize the contemporary generation to use the mouse. Hence, if the movement in their eyeball may be tracked and if the direction toward which the eye is looking can be determined, the motion of the eyeball may be mapped to the cursor and the amputee could be able to pass the cursor at will. An ‘eye tracking mouse’ could be of quite a few uses to an amputee to make use of the present era to use the mouse. Hence, if the movement of their eyeball is tracked and if the course closer to which the eye is determined can be determined, the movement of the eyeball is frequently mapped to the cursor and therefore the amputee is prepared to transport the cursor at will. An ‘eye tracking mouse’ is going to be of lots of use to an amputee Currently, the eye tracking mouse isn't available at an outsized scale, and only some companies have developed this technology and have made it available. We will prepare a watch tracking and facial landmarks-based mouse where most of the functions of the mouse are available, so the user can move the cursor using his face. We try and estimate the ‘gaze’ direction of the user and move the cursor along the direction along which his face is trying to move and click on operations are done by closing the proper or left eye [3].

MOTIVATION

The purpose of “HUMAN EYE CONTROLLED MOUSE” is to develop a system which will only use web-cam to use human eyes as pointing device for computer system and provide user friendly human-computer interaction

II. LITERATURE SURVEY

This chapter discusses the application of eye movements to person interfaces, each for reading interfaces (measuring usability) and as a real manipulate medium with in a human-pc dialogue. For usability evaluation, the person's eye movements are recorded all through gadget use and later analysed retrospectively; but the eye movements do no longer have an effect on the interface in actual-time. As an immediate control medium, the eye movements are acquired and used in real-time as enter to the consumer-pc dialogue. A survey on head-based totally Human-Computer Interaction which facilities highlights, for instance, head following, face and appearance acknowledgment, eye following, and motion acknowledgment HCI is added through Porta (2002) and Turk (2004).

In [4]The camera mouse was proposed by Margrit Betke for people who are quadriplegic and non - verbal. The movements of the user are tracked using a camera and these can be mapped to the movements of the mouse pointer which is visible on the screen. The "Camera Mouse" system had been developed to provide computer access for people with severe disabilities. 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. Body features such as the tip of the user's nose or finger can be tracked. The visual tracking algorithm is based on cropping an online template of the tracked

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feature from the current t image frame and testing where this template correlates in the subsequent frame. The location of the highest correlation is interpreted as the new location of the feature in the subsequent frame. Various body features are examined for tracking robustness and user convenience.

In [5] Yet another method was proposed by Robert Gabriel Lupu for human computer interaction that made use of head mounted device to track eye movement and to translate it on screen. The proposed ETM system consists of two hardware devices, webcam and video glasses and the software application running the eye tracking algorithm. The webcam, mounted on a video glasses frame with the help of an aluminium bar, has a modified system lens in order to be used at a short suitable distance (less than ten centimeters) from user's eyes. It captures images only in infrared light by using an infrared filter on top of the lens. Six infrared LEOs provide constant illumination of the eye so that the natural light has an insignificant influence on pupil detection. The software application detects the pupil and maps its webcam position on computer screen in concordance with user gaze direction. Therefore, the mouse cursor is moved in the point of screen coordinates. By gazing at the point for one to two seconds, the software generates left click event. In this way the user can point and click the mouse.

In [6] The Controlling Mouse Using Eye Movements was proposed by Satish Wankhede and V. Dharaskar. During this paper survey implementation of controlling mouse motion is done by tracking face and multiple eye blink, Face detection is an important aspect that are undertaken using featured-based and image-based method. Featured-Based method finds the facial features and performs geometrical analysis for their locations, areas and distances from each other. Image-based method is based on scanning the image of interest with a window that looks for faces at all scales and locations. The detected face from this method is used with template matching. It has used universal approaches for eye detection namely regression approach, Bayesian approach and discriminative approach. These approaches give output as minimizing distances between actual and predicate eye positions, learning of eye appearance and non-eye appearance and treat the problem as feature classifications.

In [7] The Gaze Pointer was proposed by Muhhamad Usman Ghani. This can be achieved by using image processing algorithms and computer vision. The system consists of a laptop built-in web-cam which takes live image frames and Gaze Pointer application processes the frames to extract user's Point of Gaze (PoG). Algorithm presented in this paper performs operations on grayscale images. As a first step BGR to grayscale color space conversion is performed. Histogram equalization is applied on grayscale images to normalize contrast in acquired image. For face detection, a machine learning based approach is used that is Object detection algorithm. Eye patch extraction can also be performed using same object detection algorithm. For pupil detection, extracted eye patch must be smoothed to avoid false detections. For image binarization, edge detection approach is used. Eye region being used to trace the Test Area is to be detected, for this purpose a simple calibration technique is designed. After features detection, a simple point of Gaze calculation algorithm is designed which systematically interrelates the detected feature points to result in a precise PoG calculation. To improve the projection results, image quality must be enchanced. Sophisticated Pre-Processing algorithms should be introduced to compensate lighting variations and web-cam resolutions.

In [8] Another technique by Prof. Prashant Salunke presents techniques of eye tracking using Hough transform. Firstly, the system captures images by using a low illumination and analogic CCD camera. The first task is to compensate for natural head movements to ensure that the user's eye is always in the field of view of the camera tracking the eye. LEDs (LED I) is mounted in front of the camera lens to acquire the bright pupil image. First, the pupil and the Purkinje image are detected from the captured image. Then, the gaze position is computed from these two images by using the eyeball model. Eye movement input is faster than other current input. Aim of this system is user can control the mouse movements and buttons only by the eyes movement and eyes blink(cursor) on the screen, the central coordinate of the screen is set as a start point. As the pupil move to some direction, the coordinate of the mouse pointer on screen change according to the movement of the pupil. The most unique aspect of this system is that it does not require any complicated wearable attachments.

In [9] Here we introduce a one-time calibration procedure by Surendra Ranganath where the calibration data of each user is stored for reuse every subsequent time the user operates the

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system. Neural networks are used in our system to map the complex and non-linear relationship between the pupil and glint parameters to the gaze point on the screen under varying head poses. An infrared sensitive CCD B/W camera JAI CV-M5OIR with a 16mm fixed focus lens is used to acquire images. Two sets of LEDS are mounted coaxially with the camera lens and located directly below the screen on the vertical axis defined by the screen 873 center. The inner ring of LEDs (LED I) is mounted in front of the camera lens to acquire the bright pupil image. The outer ring of LEDs (LED 2) is fixed coaxially with the lens but mounted further from the optical center to obtain the dark pupil image.

III. PROPOSED METHODOLOGY

Implementation is the system in which the theoretical concept will become a functioning device. a load of resistance and the impact on cutting-edge tactics is shifting to the purchaser branch at this factor. If the implementation procedure isn't always planned and controlled, it will result in confusion, consequently, the maximum crucial stage in the improvement of a new gadget and the user ought to believe that the brand-new gadget will work and be affective. The technique of the usage of the constructed gadget is known as implementation. This includes all operations for the usage of the brand-new software. the principal challenge inside the corporation is to make sure that the structures' tactics are strolling efficiently as soon as the making plans is entire. Such specifications should be met earlier than the implementation process

The system proposed in this paper works based on the following actions:

- Squinting your eyes
- Winking
- Moving of head around (pitch and yaw)
- Opening the mouth

The methodology is as follows:

1. Since the project is based on detecting the features of the face and mapping them to the cursor, the webcam needs to be accessed first, which means that the webcam will be opened. Once the webcam is opened, the program needs to extract every frame from the video. The frame-rate of the video is generally around 30 frames per second, so a frame at every 1/30th of a second will be used to be processed. This frame undergoes a set of processes before the features of the frame are detected and mapped to the cursor. And this process continuously takes place for every frame as a part of a loop.

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2. Once the frame is extracted, the regions of the face need to be detected. Hence, the frames will undergo a set of image-processing functions to process the frame in a suitable way, so that it is easy for the program to detect the features such as eyes, mouth, nose, etc.

Detection and Prediction of Facial Features

To detect the face and the features, a prebuilt model is used in the project, which has the available values that can be interpreted by python to make sure that the face is located in the image. There is a function called 'detector ()', made available by the models, which helps us to detect the face. After the face is detected, the features of the face can now be detected using the function 'predictor'.

The function helps us to locate 68 points on any 2D image. The values of the function that are obtained are in the form of 2D coordinates. Every one of the 68 points are essentially values of the x and y coordinates that, when connected, will roughly form an identifiable face.

They are then stored as an array of values. Four sets of arrays are taken as 4 different parts of these values which are stored in the array, to separately be stored as the coordinates to be connected to represent the required regions, those are the: Left eye, Right eye, nose and the mouth. Once the 4 arrays are prepared, boundaries, or 'contours' are drawn around the points using 3 of these arrays by connecting these points, using the 'draw contour' function and the shape formed is around the two eyes and the mouth.

Mouth and Eye Aspect Ratios

Once the contours are drawn, it is necessary to have a reference for the shapes, which, when compared with, gives the program any information about any action made by these regions such as blinking, yawing, etc. These references are understood as ratios, between the 2D coordinates, and a change in the coordinates, essentially tell us that, the parts of the region of the face have moved from the regular position and an action has been performed. The system is built on predicting facial landmarks of the face. The Dlib prebuilt model helps in fast and accurate face detection along with 68 2D facial landmarks. Here, Eye-Aspect Ratio (EAR) and mouth-aspect-ratio (MAR) are used to detect blinking/winking and yawing respectively. These actions are translated into mouse actions.

Similarly, the MAR goes up when the mouth opens. This is used as an action to

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start and switch off the mouse. For example, if the ratio has increased, it can mean that the distances between the points representing the region of the face have changed and an action has been performed by the person. This action is supposed to be understood as the person trying to perform an operation using the mouse. Hence, for these functionalities to be made operational, there need to be some defined 'aspect ratios', which when cross a defined limit, interprets an action being performed.

Detection of Actions Performed by Face

After the ratios are defined, the frame can now compare the ratios of the parts of the face with the ratios defined for different actions, of the current frame being processed. It is done using the 'if' statement. The actions which the program identifies are:

a) For activating the mouse: The user needs to 'yaw' which is opening his mouth, vertically, in turn increasing the distance between the corresponding 2D points of the mouth. The algorithm detects the change in the distance by computing the ratio, and when this ratio crosses a specified threshold, the system is activated and the cursor can be moved. The user needs to place his nose towards, either the top, bottom, left or right of a rectangle that appears, to move the cursor in the corresponding direction.

b) Left/Right Clicking: For clicking, he needs to close any one of his eye, and make sure to keep the other open. The program first checks whether the magnitude of the difference is greater than the prescribed threshold by using the difference between the ratios of the two eyes, to make sure that the user wants to perform either the left or right click, and does not want to scroll (For which both the eyes need to squint).

c) Scrolling: The user can scroll the mouse, either upwards or downwards. He needs to squint his eyes in such a way that the aspect ratio of both the eyes is less than the prescribed value. In this case, when the user places his nose outside the rectangle, the mouse performs scroll function, rather than moving the cursor. He can move his nose either above the rectangle to scroll upwards, or move it below the rectangle to scroll downwards.

SYSTEM ARCHITECTURE

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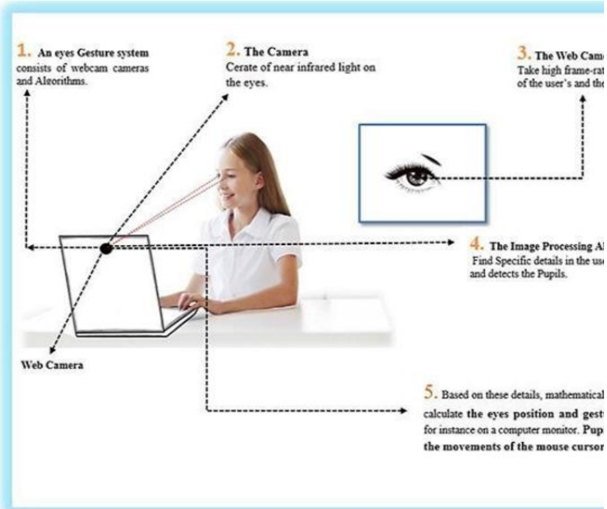

Fig.1 System architecture

IV. IMPLEMENTATION

Currently, for face detection, perhaps deep learning models perform the best. But face detection was there before the emergence of deep learning as well. Earlier, classical feature descriptors and linear classifiers were a really good solution for face detection. And the Dlib library provides one such classical solution for face detection. That is, HOG and Linear SVM.

HOG is a simple and powerful feature descriptor. It is not only used for face detection but also it is widely used for object detection like cars, pets, and fruits. HOG is robust for object detection because object shape is characterized using the local intensity gradient distribution and edge direction.

Step1: The basic idea of HOG is dividing the image into small connected cells

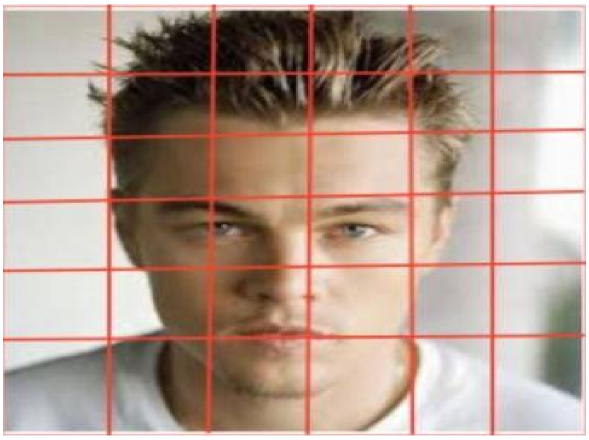

Fig.2 Image is divided into small cells

Step2: Computes histogram for each cell

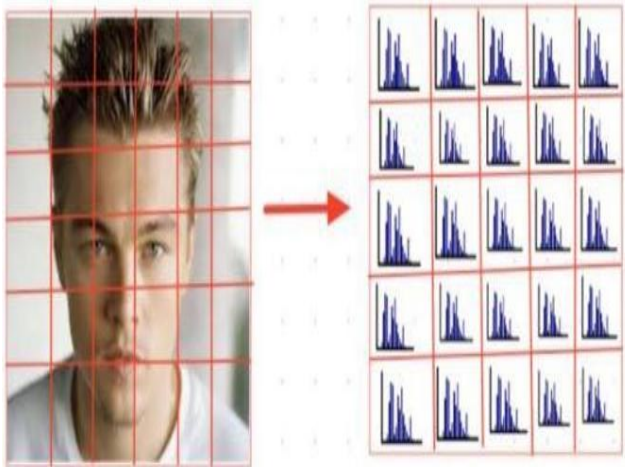

Fig.3 Calculate histogram for each cell

Step3: Bring all histograms together to form feature vector i.e., it forms one histogram from all small histograms which is unique for each face

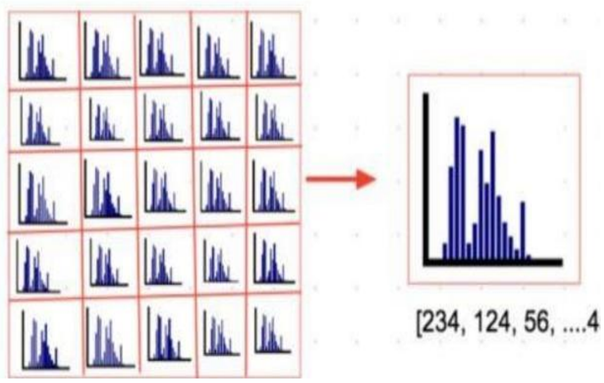

Fig.4 Small histogram forms into one histogram

V. RESULTS

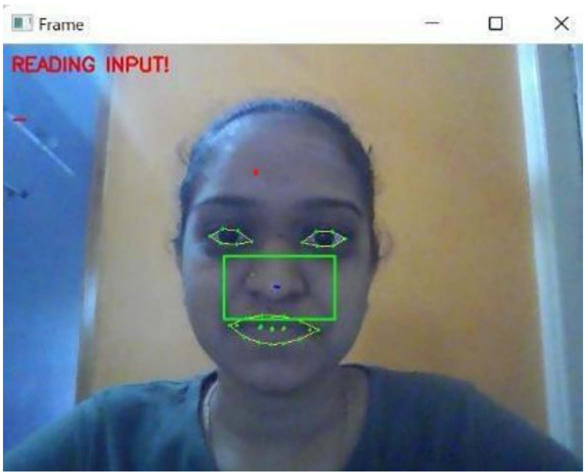

Fig.5 Open mouth to start reading input

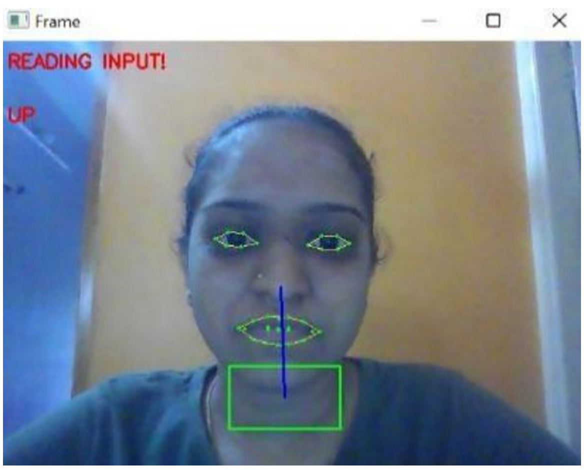

Fig.6 Move the nose up to move cursor up

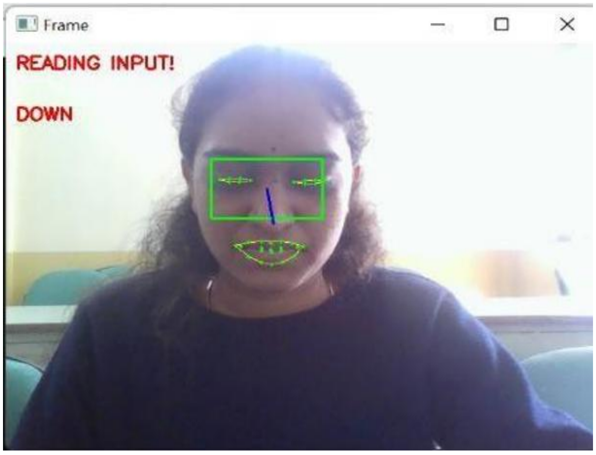

Fig.7 Move the nose down to move cursor down

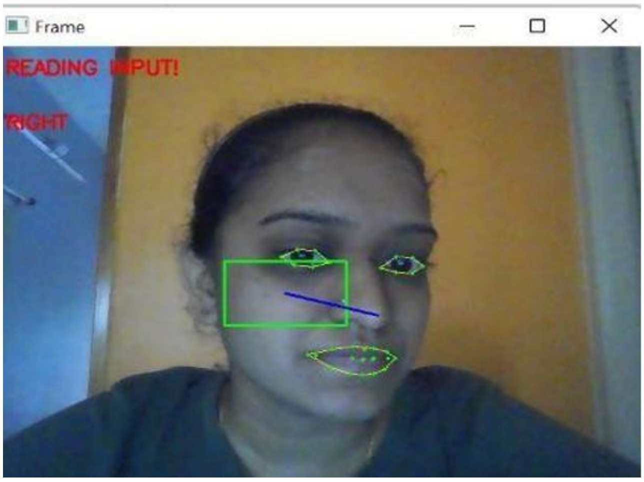

Fig.8 Move the nose right to move cursor right

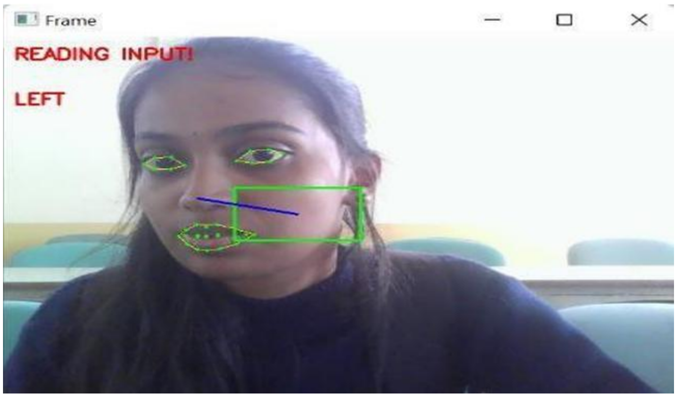

Fig.9 Move the nose left to move cursor left

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VI. CONCLUSION

This work can be extended to improve the speed of the system by using better trained models. Also, the system can be made more dynamic by making the change in the position of the cursor, proportional to the amount of rotation of the user's head, i.e., the user can decide, at what rate he wants the position of the cursor to change. Also, future research work can be done on making the ratio more accurate, since the range of the values are the result of the aspect ratios, which is usually small. Hence, to make the algorithm detect the actions more accurately, there can be some modification in the formulae for the aspect ratios used. Also, to make the process of detection of the face easier, some image processing techniques can be used before the model detects the face and features of the face.

In future, many people who are unable to operate a standard computer mouse or keyboard because of disabilities of their hands or arms, can get possible alternative in multimodal system, which allows controlling a computer without using standard mouse and keyboard. Using head movements to control the cursor across the computer screen and by using the speech for giving the control commands. Automatic speech recognition and head tracking in joint multimodal action are combined to operate the system.

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