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HUMAN EYE BASED COMPUTER MOUSE

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ABSTRACT

Many persons with neurological disorders or those who have been paralyzed by an accident are unable to use computers for everyday chores like sending and receiving messages, browsing the internet, or watching their favourite TV shows or movies. It was found through a recent research study that because eyeballs move naturally when interacting with computing equipment, they are a fantastic candidate for ubiquitous computing.

The ability to utilise computers again for these patients may be possible by utilising the underlying information from eye movements. In order to do this, we suggest an entirely eye-controlled mouse gesture control system. The goal of this effort is to create a free, open-source, general eye-gesture control system that can accurately track eye movements and let users conduct activities that are associated with particular eye motions or gestures using a computer webcam. It recognises the user's pupil on their face and then monitors its movement. For the user to feel comfortable using it like other everyday devices, it must be accurate in real-time.

Keywords: IMouse, Eyes_Gesture_Control_System, Eye_Tracking_Systems, Mouse_Cursor, Eye_Mouse, Webcam.

I. INTRODUCTION

Fundamentally paralyzing diseases like paraplegia, which renders a person unable to move from the neck down, are becoming more common in today's society. In the majority of OECD (Organization for Economic Co-operation and Development) nations, women are more likely than men to experience disability [1]. Their eyes are the only organ that can produce various actions. 518 million persons out of a population of 7 billion reported having a disability in the 2011 Census. Around 10% (or 650 million) of the world's population, as of February 7, 2018, has a disability.

Many people with Amyotrophic lateral sclerosis (ALS) [3] or those who are paralysed are unable to perform routine daily tasks on computers. Even when it comes to eating, they require assistance from someone else to feed them. For their daily tasks, these people require assistance. At the moment, people with impairments frequently type on keyboards by holding long sticks in their mouths. The method we offer will enable people with disabilities to lead independent lives. They will have the opportunity to amuse themselves, mingle with others, and live their lives.

The development of innovative and cutting-edge HCI techniques is accelerating. This study area is actively being worked on by many professionals. Human eyes contain a wealth of information that can be collected and applied in a variety of ways [2]. (i.e. interacting with Computers). Eye movement exhibits an a person's area of interest. The goal of tracking eye motions is to monitor human eye movements. By recording eye movements and using them as control signals, direct interaction with interfaces can be made possible without the need for a keyboard or mouse.

Digital instruments have been interacted with using existing computer input devices such a mouse, keyboard, and other types of input devices. These computer input devices cannot be used independently by people with impairments. In this study, a computer input device that can only be operated with the eyes is created for wearable computers and those with disabilities [4]. Additionally, such data might be utilised to generate the appropriate outputs for operating a computer, such as moving wheelchairs or commercially available robotic equipment like the robotic arm, to enable these patients to feed themselves. They will become physically capable as a result, and they will become valuable contributors to society.

The goal of this study is to investigate and enhance potential uses for the eye gesture tracking technology.

Especially those fields that can aid physically handicapped people in using computers and programmable controlled equipment. As a result, these people could still handle their obligations, enhance the quality of their lives, and carry on with their daily activities—often without the need for assistance. The majority of eye tracking technologies used today track the pupil in real time using video. We used the same methodology and technologies and enhanced them to create a system that is more reliable and precise. A high-definition, compact, and transportable Cam was used. This is easily accessible and inexpensive. Through a USB connector, this camera is simply connected to any laptop or PC.

II. LITERATURE SURVEY

The literature was examined in order to address the objectives, comprehend the study topic, concentrate on the research questions, organise the data collection strategy, define the words, and correctly identify the framework. Understanding the study field that involves eye detection and mouse cursor movement was the most crucial challenge.

As I read through the literature, I noticed that the emphasis was on how to create a system that can satisfy the demands of people who are physically unable and that system should be very simple to grasp.

The "sixth sense" technology, developed by a team at MIT [6], promises to improve human-computer interaction by utilising hand and eye gestures. The entire system can be mounted on the user's helmet so that it can be used anywhere in the world and projected onto flat surfaces (like walls). The issue is that it doesn't generate a system that can communicate with other compatible devices or offer improved aid and accessibility to the impaired.

An eye tracking algorithm based on the Hough transform was created in 2018 [10]. This method can identify a person's face and eyes. It recognises the user's face and eyes using a webcam. Matlab is the system's foundation. The real-time tracking and time-speed problems in this system are the problem. The system is relatively sluggish [11] and requires an expensive, high-quality computer system to function effectively.

The authors unveiled an improved system in 2017.

A pupil centre coordinate detection method utilising the circular Hough transform methodology was first introduced in 2015 [16]. The webcam in this system use Hough Transform Techniques to identify a person's pupil [17]. The problem with this approach is that it is not real-time and takes a long time. It takes a long time to capture the body first, then the face, the eyes, and ultimately the pupil. A face and eye-controlled system based on MATLAB was created in 2014 [18], [19]. The mouse is moved by moving the eyes and face on a webcam. The problem with this technology is that it only functions within a few centimetres of the source. A method based on pictogram selection was created in 2013 [20] and used an eye tracking technology. It makes the system dependable by utilising a variety of eye-tracking approaches. The problem with this technology is that it won't function if any liquid is found in the eyes. When women apply eyeliner or mascara to their eyes, for example, the system malfunctions. Human eyes [21] use a two-lens system housed in a liquid called vitreous humour to project light waves from various objects in the outside world onto the retina.

[23]. In order to accommodate very precise colour vision, the fovea is densely packed with cones, with around 161,900 per square millimetre. We can see from the structure of a retinal exterior that just a small region of our visual field can be resolved in high resolution [24].

III. METHODOLOGY

It relates to the field of Human-Computer Interaction (HCI) and demonstrates how a low-cost eye tracking solution can be created for patients with disabilities by enhancing current open source frameworks used for Computer Vision and HCI. The system model and overview are shown in Fig. 2.

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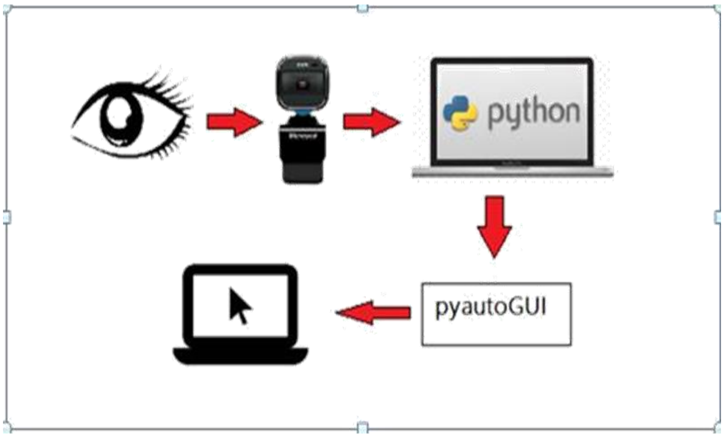

Figure: Block Diagram

The System prototype uses camera input to identify and track the user's pupil in real-time [25]. Computers or microcontrollers can use this "tracking" information to perform a variety of tasks. One of these tasks is to track the pupil-movement [26] and then store that tracked eye movement to control a computer's mouse pointer, allowing someone with a disability like, say, Amyotrophic Lateral Sclerosis, to use it to communicate with others.

It comes with a high resolution web camera that is strategically placed, as well as an open-platform software module that is simple to install and is compatible with all current laptops and desktop computers. This system can be viewed as a seamless movement between the concept, design, and proof of concept phases. It involves implementing portions of research papers and collaborating with the open-source community to design and create a prototype, all while making sure that only open-source, affordable, easily accessible, and commercially off the shelf (COTS) items are used.

IV. MODELING

Python was used to design the mouse system, and the following Python modules were imported to make the system operate.

- A Python extension module called NumPy It offers quick and effective actions on collections of related data.
- Scipy is a Python library that is open-source and used for technical and scientific computing.
- OpenCV is a collection of programming tools with a real-time computer vision major focus.
- PyautoGUI is a Python-based, cross-platform GUI automation module. This allows you to automate computer chores by controlling the mouse and keyboard as well as performing simple picture recognition.

A. Use Case Diagrams

Use case diagram for 0 indicates that the system completes the subsequent stages.

1) Software is active.

1) Turn on the laptop's webcam and display a picture of a person.

2) Face detection is carried out.

3) The system recognises a person by their eyes.

4) After performing the aforementioned action, perform the subsequent procedure.

5) The system then uses a laptop's webcam to recognize eyes and a face.

6) Students discovered that a person can now control the mouse cursor with eye movements. The computer's home screen displays the progress of the core.

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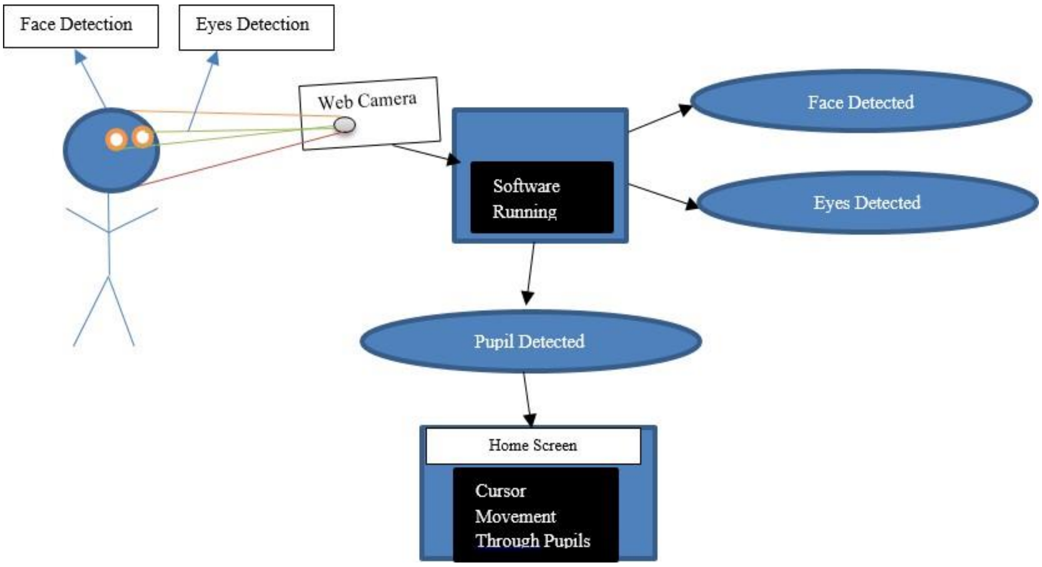

Figure: System Use Case Diagram

B. Activity Diagram

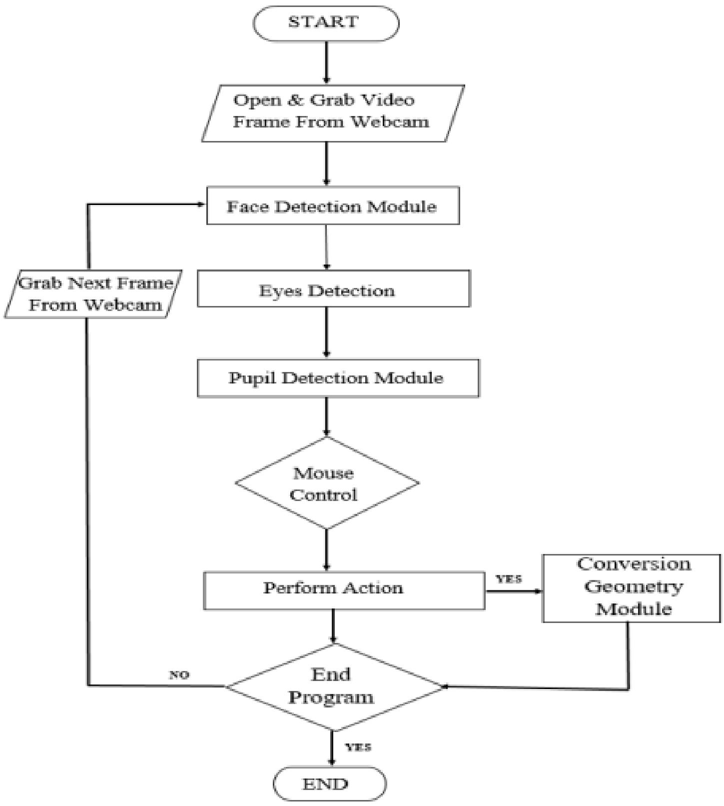

Figure: Activity Diagram

The order in which activities are held in the system is depicted in Fig.

Figure 4 depicts the system's operation. The I Mouse software has the following phases from beginning to end.

1) Switch on the webcam and record some footage.

2) The system takes a step and finds the face.

3) The system detects the presence of eyes.

4) The mechanism locates the pupil of the eye.

5) The system will find the eyes and carry out geometric translations using only the image of the user's face from the webcam.

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6) Take initiative The mouse control function recognize a gesture, moves the mouse cursor, and translates the coordinates to the user's screen. then carry out the subsequent action.

1) Vertical scroll

2) Scroll left to right

3) Move diagonally

4) Repetition of the system end or halt as well as the entire system cycle.

C. System Sequence Diagram

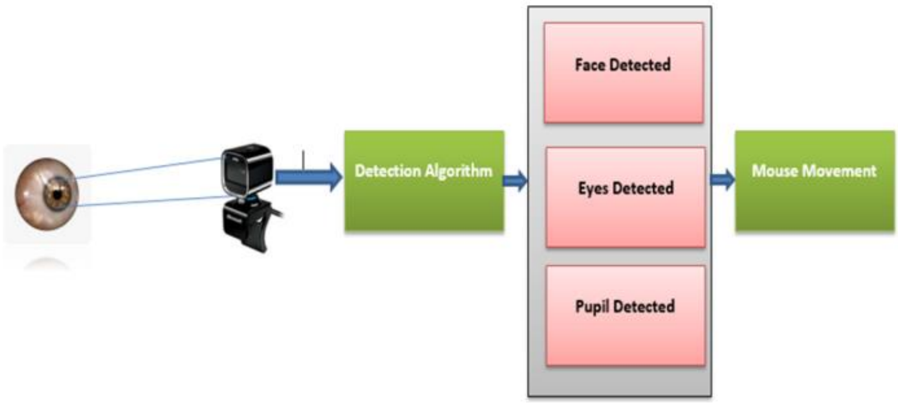

Figure: Sequence Diagram

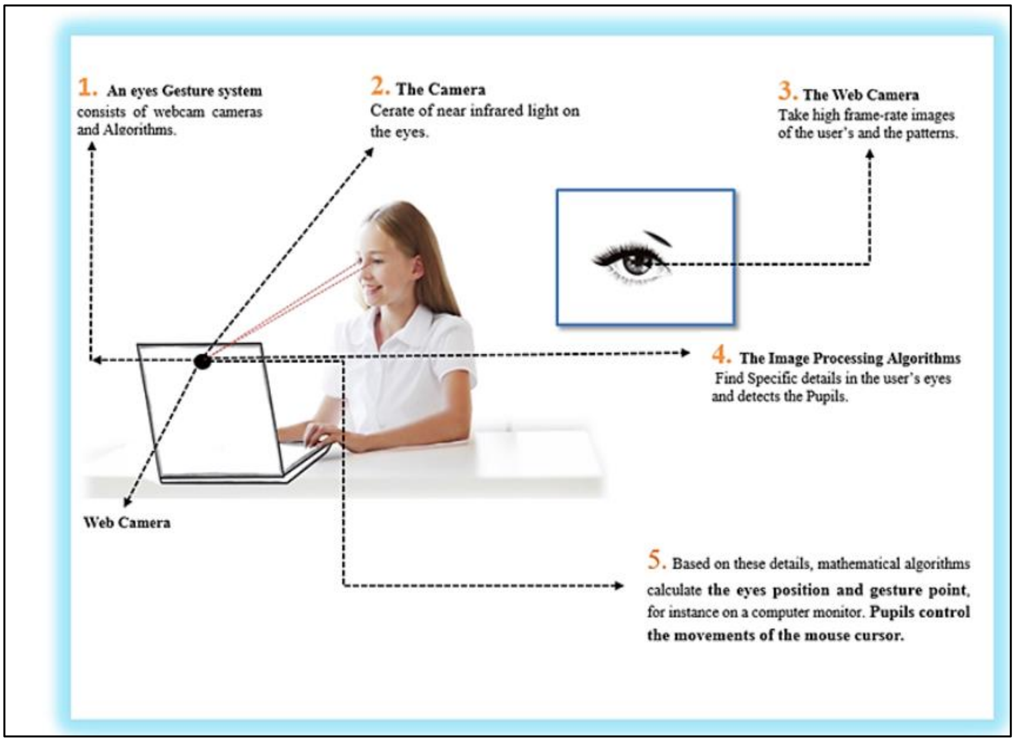

Figure: System Functionality Diagram

The user's interactions with the system are depicted in Fig. in order. The six fundamental modules of our system are elaborated in Fig.'s system sequence diagram. Using detection techniques, the system uses the webcam to identify a person's pupil in the first module. The machine then finds the face. The mechanism then finds and seizes the eyes. The machine then finds the pupils. The system begins moving the mouse cursor in the last module by monitoring pupil movement.

V. IMPLEMENTATION

Using Python, an image is created. First, it opens the camera and starts taking video. It then selects a frame and changes it to a grayscale image because it converts images to binary form, making it easy to find things. The face

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is detected using Haar-cascade. Haar-cascade detects items from other photos after training on many positive and negative images. It will crop the frame and pass it on for additional processing after detecting the face. The Haar-cascade algorithm will detect eyeballs and trim the frame. Eye-cascade The Haar cascade recognises eyes. A numpy-supported four-variable array gives us x, y, w, and h all at once. The camera detects eyeballs from x and y; w is the width, and h is the height. These variables construct a rectangle around the eye and crop the image, as seen in Fig. The rectangle begins at x and finishes at x+w horizontally and y and y+h vertically.

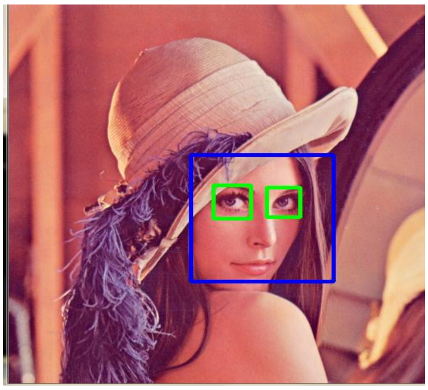

Figure: Output Of The System

Fig. shows output. For further processing, the application will blur the little image. It then finds Then use the Hough Transform to draw a circle around the pupil. Sometimes the camera sees black rings around the eyes as pupils.

The technology detects circular dark patches in the rectangle's centre to fix this. The camera will only track the eye's pupil this way. Define x and y using pyauto gui for cursor movement. Y moves the mouse vertically, x horizontally. Both of them start with a random value, so when the code runs, the mouse starts moving. Check the gap between two frames to detect eye movement. Human eyes move somewhat. To fix this, the eye is considered motionless if its position difference is less than 5 pixels. If the eye's horizontal location is larger than 5 pixels and its vertical position is less than 5 pixels, it's travelling horizontally. The eye moves diagonally if its horizontal and vertical positions differ by more than 5 pixels. The mouse cursor moves vertically, horizontally, and diagonally when we move our eyes.B. System Analysis & Evaluation The Haar-cascade and Hough Transform contour detecting algorithm's findings are presented first.

B. The System Analysis & Evaluation:

We begin by showcasing the outcomes of the operational contour detection technique, which makes use of the Haar-cascade functions and Hough Transform.

C. Harr-cascade Algorithm:

The system performs two tasks in this algorithm. determine the person's face and eyes The face-cascade function is shown in Fig.

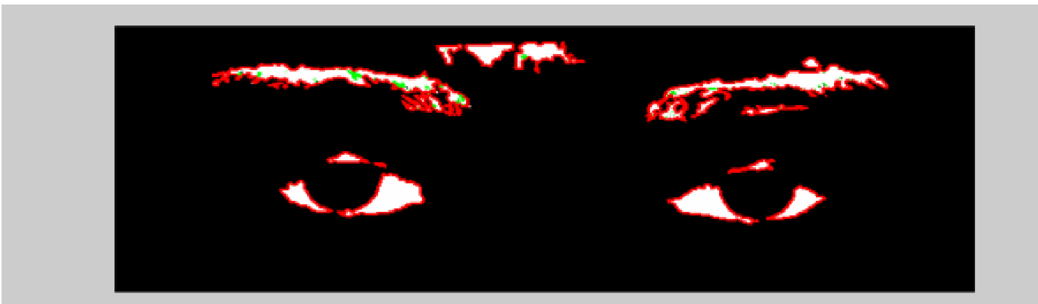

Figure: Face-Cascade

Face-cascade is used to initially identify the user's face in an image. It crops the image and run scan around the face for later processing. The user's eyes are picked up from the image once the face has been extracted. as depicted in Fig. below.

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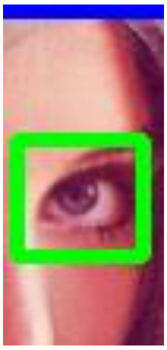

Figure: Eye-Cascade

Because both eyes move simultaneously, tracking can be done by looking at just one eye's motions. This programme selects the user's left eye (the right eye when the image is flipped in a camera) and tracks eye movement. It crops this picture by drawing a box around it.

D. Hough Transform Algorithm

From this cropped image, a circle is drawn around the Hough Transform pupil to track its movements. This system identifies the pupil, ignores other dark spots, and tracks only the pupil of the eye, as shown in Fig. 10 below.

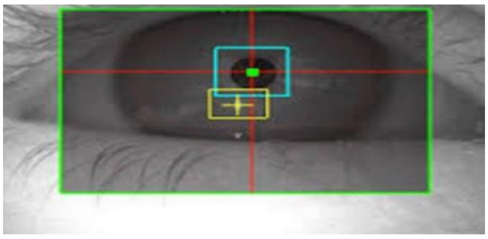

Figure 10: Hough-Transform

After that, each frame's eye coordinates are located. The eye is regarded as moving if its coordinates change, otherwise they are regarded as remaining static. This entire processing process takes less than one second to complete. This means that this project can be applied to real-world circumstances.

E. Mouse vs. Eye Histograms

Please note that the readings were collected under optimum lighting settings and may differ in other circumstances if pupil detection is inaccurate in the histograms for mouse vs. eye control, which are displayed below. The 0and 0 provides an illustration of this.

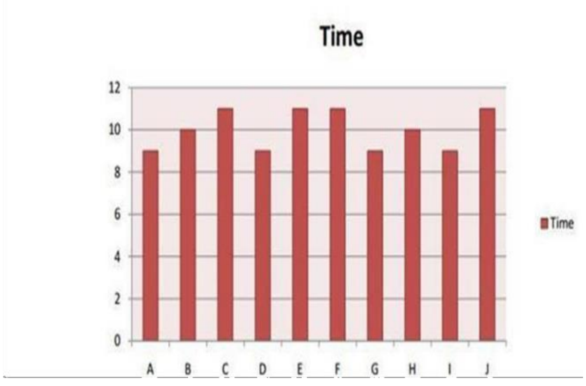

Figure 11: Timings Of Actions A Through J For Mouse Control

Please note that the results for 0 and 0 are rounded to the closest millisecond. We can see that after mastery is attained, the user can carry out the identical tasks in roughly the same amount of time as they can be carried out with a mouse. After tracking the pupil, the coordinates are saved in variables, and the mouse cursor is moved in accordance with changes in these values and the detection of blinks. At this point, the eye mouse begins functioning properly.

VI. RESULTS AND DISCUSSION

People with disabilities frequently find it difficult to use computers for fundamental tasks; in these circumstances, the system will automatically detect the person's condition. It begins to establish a connection between mouse and eye movements when it notices a person's pupil. As the pupil moves, the mouse pointer will begin to move. Based on the blinking of the eye, the mouse clicks.

We test our system by shifting the position of the eyes and introducing fluids to the eyes. We also run short- and long-distance tests on this system. In terms of distance, the results varied. The outcome is shown in TABLE 1.

TABLE 1: Distance Coverage Using I-Mouse System

Distance	Max	Min	Average
10cm	6.458523cm	4.50689cm	1.0965423cm
20cm	6.890525cm	4.90598cm	0.5898252cm
30cm	7.588226cm	5.25595cm	0.4281392cm
40cm	7.895558cm	5.59855cm	0.2272527cm
50cm	8.062259cm	5.95268cm	0.2802207cm

The findings from various distances are displayed in TABLE 1. We gauge the outcomes from various distances. Our system operates effectively and in real-time out to a distance of 50cm at the most. The system is operating at a very rapid pace; at this point, its maximum value is 6.458523 cm and its minimum value is 4.50689 cm. The average distance travelled by the mouse is 1.0965423 cm.

The average mouse movement at 20 cm is 0.5898252 cm. The mouse is now functioning properly at that time. The average value is 0.4281392 cm at a distance of 30 cm, and the mouse is operational. The mouse speed is slowing down as we draw closer to the system. The mouse moves a little more slowly at 50 cm, but it still operates slowly.

VII. CONCLUSION

This device seeks to provide a low-cost eye-tracker that will enable the user to control a computer system's mouse cursor. The system is simple to use and cost-effective, relying just on a laptop camera and C++ and Python programming language software modules. To adjust the interface or just extract spatial attention data for the objectives specified in the "future applications" section, the spatial field of view history can also be rendered on the world process as needed, indicating eye movements and where the user spent a lot of time gazing. Finally, we point out that the project can be used in a variety of environmental settings with just minor adjustments to the brightness and contrast needed to retain its durability. This is a remarkable accomplishment for such a cheap eye-tracking technology.

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