OCULAR HANDLED VIRTUAL MOUSE USING HAAR CASCADE ALGORITHM

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Abstract — This paper has an executable functionality to dominate the locomotion of the computer's cursor using the motion of iris of eye. The iris of eye is determined precisely and it enhances physically challenged people to operate the cursor in all the directions. It enables people to engage and sink in digital surroundings without using conventional input device like a mouse.

Keywords— Pycharm, visage recognition, ocular location, Haar cascade algorithm.

I. INTRODUCTION

Originally, the primary functions of personal computers were data processing and solving arithmetic and computational problems. However, within two decades, computers have grown indispensable in every aspect of our daily lives. These activities, which include education, entertainment, editing, business and music, that includes both the professional and personal spheres.

Computers are effortlessly operatable to the normal user due to their architecture. However, utilization of a computer can be highly rigorous for people who have physical challenges like Symbrachydactyly and Choreoathetosis. In the process to upgrade the communication between the human and machine, a great deal of research has been organized on human-computer interfaces. Most of these are only available to average folks. Two examples of these engagement strategies are Natural Language Processing (NLP) and face recognition. Even if all these technologies work efficiently, that does are suit the people with physical challenges. People with any speech impairments feels virtual assistants like Siri, as a difficult thing to work with since these assistants highly focuses on speech and voice input.

Number of researchers have endeavoured to create technologies that facilitate the signals and stimuli from the brain, such as magnetic resonance imaging (MRI), magnetoencephalogram (MEG) and computed tomography scan (CT), to enable humans with physical challenges to communicate with machines. Additional techniques include deep brain stimulation (DBS) in which the electrodes are attached to the skull. These techniques are not feasible since they involve risky methods. Some sophisticated techniques, such as infrared oculography (IO), were extravagant and overpriced for the people who are in need of them.

The approach employed in this study is unique from the previous ones since it allowed us to follow the eyes without the need of electrodes, rays, or other source. It is attainable and applicative because all we need is a personal computer or laptop or tablet and a web camera. The program is made to process user's iris movement quickly, going through each frame as it comes out of the camera one after the other. Next, the frames are compared with one another and with the previous frames. Once the iris is detected and processed, cursor is tend to move accordingly. Eye-controlled mice offer several benefits beyond aiding individuals with physical disabilities. These include heightened efficiency, simplicity of use, capacity for multitasking, potential for innovation, research prospects, enhanced gaming, and healthcare uses.

Automatic adaption to the eye motion of user without the necessity of manual adjustments can be done with the help of certain algorithms. This eye controlled virtual mouse has become user friendly since it does not need any extensively made calibration procedures.

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II. OBJECTIVE

To make an essential non-verbal indication that can discreetly convey information about a user's purpose and attention which makes it possible for intelligent interactive systems to function well. In addition to serving as a substitute for a traditional mouse and keyboard, it can also be used to make input that indicates a user's intention. The main theme is to allow users to interact with computers or devices by simply having a look at different elements on the computer. It tends to improve the human computer interaction in efficient manner.

III. LITERATURE REVIEW

By removing the need for physical mouse to control the computers, there raised a system termed as eye controlled virtual mouse, which had come true with the help of computer vision and deep learning. This will favour to stop the spread of communicable diseases to the manhood (Shriram et al., 2021). This technique enables freestanding computer interaction by acknowledging the hand gesture using web camera or any other built-in cameras. However, this unique research part of eye controlled virtual mouse was not straightly mentioned by the Shriram et al., (2021) study.

Tracking eye in virtual reality environment was gone through by Clay, Viviane, Konig, & Kong (2019), but their investigation did not give any sparks on eye controlled virtual mouse systems. Many new research in this field was done by Wroblewski et al., (2014), who made a study on visual field testing with virtual reality goggles. Then unique research was done by Pfeiffer et al., (2020) in the field of eye tracking based classification of information search behaviour. Along with this, Souchet et al.,(2021) studied the evaluation of cognitive load and visual fatigue using virtual reality eye tracking technique. Unfortunately, their result did not tell the drawbacks of this research. A multimodal gaze controlled virtual keyboard was introduced by Cecotti(2016), it left many footprints for building virtual mouse systems that are managed by hands and eyes.

Scientists have made many studies on computer vision, hand tracking, virtual reality and so on, but there is no detailed data in the histories which specifies the system to be managed by eye. Upcoming studies must focus on making systems which are controlled by eyes and making use of deep learning and techniques in computer vision. It helps to have a replacement for traditional mouse related computer interaction. It is highly useful in the places where physical mouse becomes impractical. If the accuracy, usability and other possible applications are monitored and improved, then this interaction becomes irreplaceable.

In 2014, people saw the creation of a face-and-eye driven mouse system that had been evolved using MATLAB and that tracked motions of the user's face and eyes on a web camera. Unknowingly, this technology's effective range totally differs from the source. Hence it had become a drawback. In order to ensure system's dependency, different types of eye tracking techniques through a variety of eye-tracking techniques is introduces. One among them was a method based on pictogram selection and eye-tracking technology (2013). This system encountered many challenges since it fails when the eye is applied with the eyeliner or mascara.

Web camera and MATLAB enabled eye tracking system was introduced based on Hough transform in the year of 2018. This system was good to know the person's face and eyes. Unknowingly the speed of this system is the major disadvantage and so it is termed as a failed one. Moreover, it is costly and needed a high tech computers to work well. Tracking was also not up to the point. To overcome these challenges, a better system came to the usage which is made to detect the centre of pupil and coordinating them using circular Hough transform approach. In this, the pupil is identified with the help of Hough transform technique. This system failed to take photos of the body, face and eyes one after another.

IV. METHODOLOGY

The first step is to switch on the ordinary web camera of the system. Next, with the help of the face recognition algorithm, face of the user is captured and monitored effectively. Since the face contains organs like nose, ear and lips, it is necessary to detect only the eye of the user. Eye, in the sense, particularly the iris is tracked and movements of iris are captured. The image of iris has very weak intensity due to its black hue when compared to other regions of eye. Hence it helps to track the eye easily. Considering the Canthus part of the eye, the focus of the iris is calculated. Then it is matched with the cursor and tends the cursor to move efficiently.

V. IMPLEMENTATION

A. *Pycharm*

Pycharm is the tool that helps to do the analyzations by running all ad-hoc python commands that are necessary for eye gaze. Pycharm helps to work in depth with the data frames that are needed for eye gaze. The main theme of Pycharm's design of this Integrated Development Environment was to facilitate Python programming on different operating systems, including Windows, Linux, and mac operating system. Pycharm has controlling options for changing versions, tools for testing things and debugger to eliminate bugs. Pycharm helps in developing Python plugins by giving different types of APIs. This Integrated Development Environment is capable of making Hyper Text Markup Language, Cascading Style Sheets and Javascript files although it is made specially for Python. It has perfect interface that one can work with plugins they need.

B. *OpenCV*

OpenCV is a library which is an open sourced computer vision. It is a machine learning software library. It helps to switch on the web camera of the system and it detects the face of the user without any flaw. This OpenCV becomes highly optimized library when it is combined with Numpy. When the computer vision is given with its requirements, the platform expedites its perceptions into products. Furthermore, OpenCV is has BSD license which gives almost zero restrictions while using library. It allows to modify the program in the way that fits into its characters. Nearly 2500 algorithms and procedures are given by OpenCV module to execute machine learning and deep learning functionalities like object detection, visage recognition etc.

C. *MediaPipe*

A machine learning pipeline which helps in processing the image or video captured through the web camera is MediaPipe. It converts the input image into graph and creates the calculators (node) and streams (edges). This calculator intakes the input through a port and transforms the output through other port. Each and every time when the MediaPipe graph runs the image is opened, processed and then finally closed. Once can quickly identify and detect faces in the photos or video streams using the MediaPipe Face Detector job. All facial traits are pointed out insida a single frame..

It uses AI and ML model which specifically uses single image or iterative streams of images. machine learning (ML) model that can handle either a steady stream of photos or a single image is used for this task. In addition to the visage locations, it specially outputs the left and right eye location, mouths, nose tips, and visagial important points. To promote the rapid improvements in machine learning and AI modules into the projects, MediaPipe offers a range of libraries and tools which allows the user to enhance the Artificial Intelligence and Machine Learning algorithms efficiently. These are readily pluggable into the projects and ease to adapt to the several types of modules. If it does not meet up with your needs then it can be easily modified. Finding and identifying object classes is possible with the help of MediaPipe Object Detector.

D. *Pyautogui*

A python library named Pyautogui helps in automating the communication with graphical user interface. Basic graphical user interfacing scripts can be made with the help of Pyautogui. This library is used to locate the images that are captured through web camera and performs actions according to the algorithm.

E. *Visage Recognition*

A machine learning algorithm name Haar Cascade algorithm is used to detect and identify the user's face. It uses edge or line detection technique to easily point out the faces. Pycharm is embedded with this algorithm and hence the face is recognized with in a fraction of second easily. The main purpose of this visage recognition is to grow the system and algorithms that are able to know or identify the individuals with help of facial features. Apart from this eye gaze technology, this visage recognition is used in other fields too. For example, researchers uses facial recognition to do a secure transaction and this will help them to prevent their identity details from being theft. And in addition to this, it enhances the authentication factor.

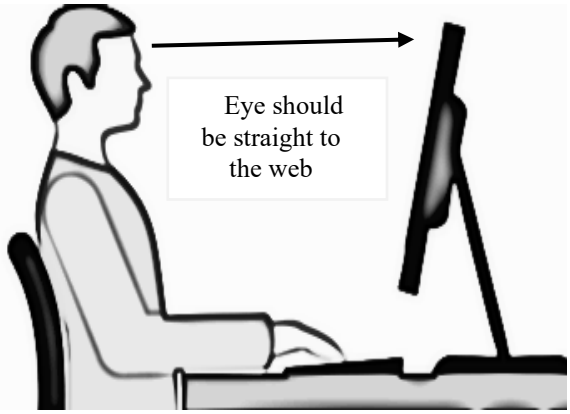


Fig 1: Stance of the user

F. Extracting ocular region

When user appears before the system, the eye should be extracted separately in order to detect its motion. For this, the algorithm considers the input as three regions. It checks whether the eye is in any of the three regions or not. Once if the eye is found by the algorithm, it eliminates other regions so that it would be easier to detect the motion of eye.

G. Extracting ocular location

Once the area of the eye is known, eye is normalized so that the background images and noises are eliminated. To effectively determine the movement, the contrast and brightness of the input is increased by transforming the input image into binary image. Two fixations are made by the algorithm. The movement of each eye is calculated by maintaining those fixations as centre point. These fixations are constant throughout the process.

Fig 2: Detecting ocular location

H. Monitoring motion of eye

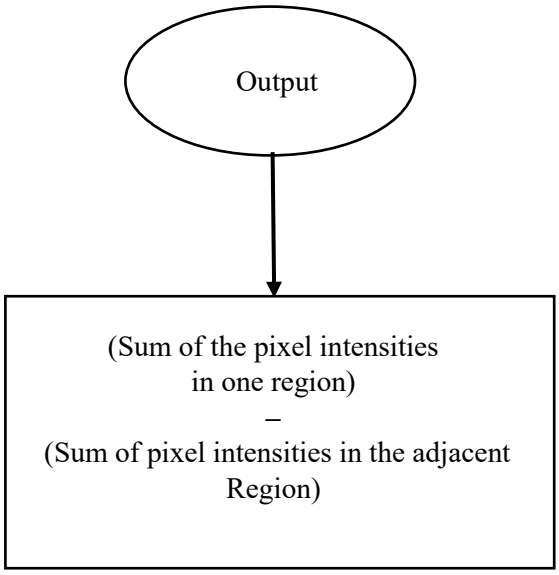
This algorithm detects the focal point of the eye that shifts from one object to another. Since our eye has fast saccade movements, it is tough for the algorithm to detect the correct position of eye. This eye motion is mapped with the direction so that if the saccade moves to left of the fixation then the cursor moves left.

Fig 3: Detecting motion of eye

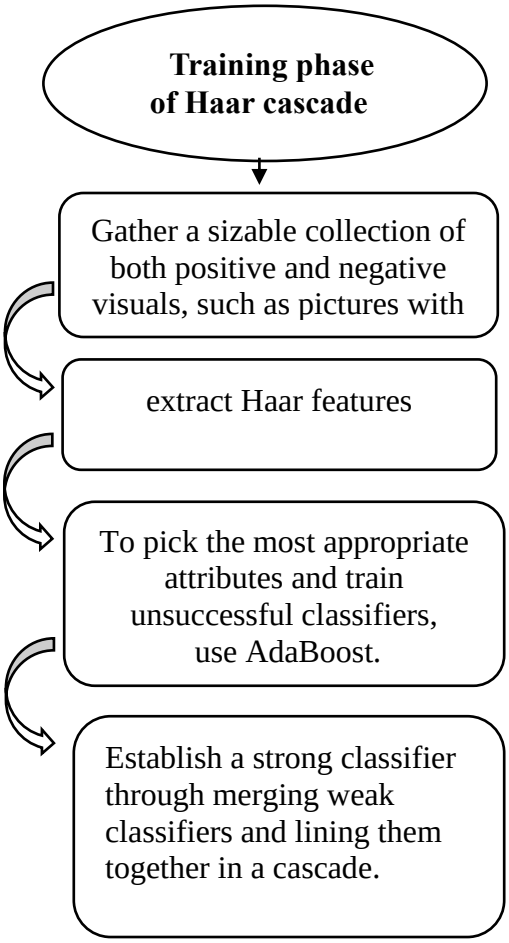
I. Algorithm

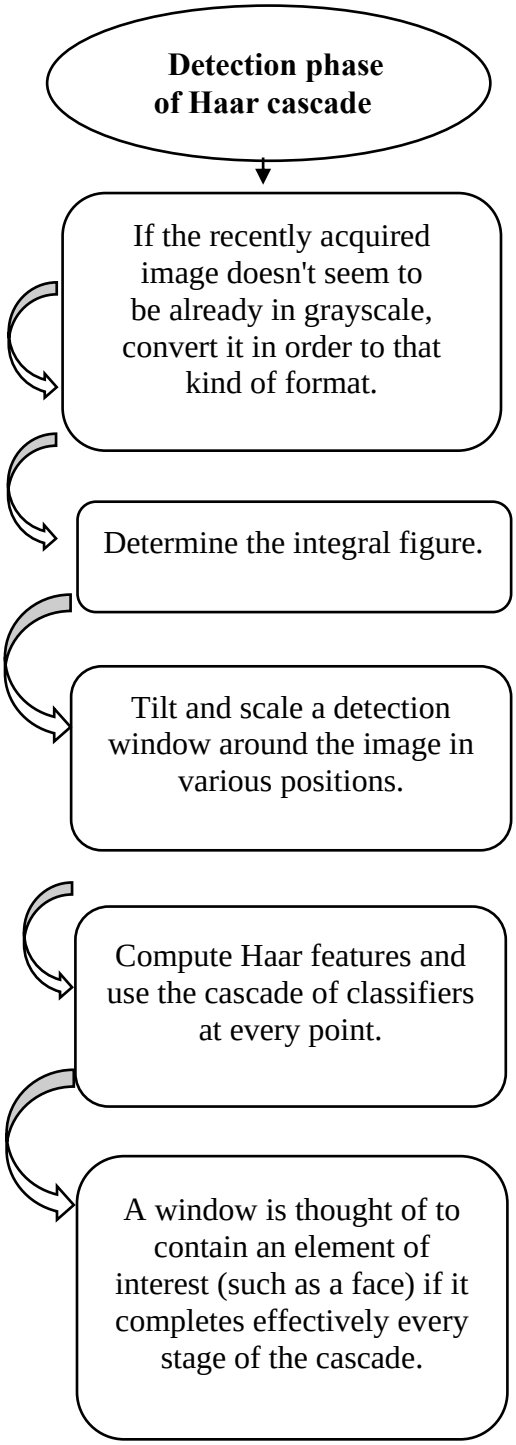
Eye gaze uses Haar cascade algorithm that paves way for identification and detection of objects in the screen. It considers the input in form of rectangular patterns and these patterns varies in their size and intensity. It is further transformed into cascade classifiers and every classifier has several phases and are subset of chosen features. The non object part which increases the computing load are easily rejected and not considered again. The main property of this algorithm is its adjusting parameters. It can minimize and maximize the size of the detected objects as per the requirements. Finally it scans all the images using different scales and positions.

This algorithm is mostly known for its usage in visage detection and it a machine learning related functionality for detecting the appearing objects. This algorithm was first implemented by Paul Viola and Michael Jones in their publication named as “Rapid Object Detection using a Boosted Cascade of Simple features”. It is feasible for one to contrast these traits of this algorithm to convolutional kernels. They tend to be made up of adjoining rectangular areas positioned at specific locations throughout a detection window.



Researchers built this Haar Cascade algorithm with the help of two phases. Each phase carries certain step to make the process complete





VI. RESULTS AND DISCUSSIONS

Thus the detection of iris and its movement was successfully developed and tested. The motion of eye is precisely noted and pointer is made to move in all the directions. Further enhancement has to be done in order to do other cursor actions effectively and correctly. With the help of this gadget, customers will be able to manage the mouse cursor on a computer at a reasonable price. The system is simple and ease to use. This system needs a laptop with web camera and few of the Python software modules.

Furthermore, users can alter the connecting interface and get the spatial attention data for other features by viewing the histories in the display of the software. The eye movements and regions where the user focused for a longer amount of time are shown openly. Notably, the project is adaptable and, changes in brightness and contrast adjustments can be done in every circumstances. For a low-cost eye tracking device, this accomplishment is quite interesting. Improving human-computer interface or interaction. This system is highly efficient and has more adaptability.

Future innovations have laid a strong way and response to this study and outcomes of the eye movement monitoring virtual mouse control system is enormous. Other optimization for activities requiring quick cursor movements, longer user training sessions, improved interaction with highly efficient software, and ongoing iterative improvement on basis of feedback and new trend advancements are some of the possibilities that deserve the enquiry.

The analyzation and discussion show a viable path and tells it as a more accessible, easier and good way to have interactions with the computer using eye controlled virtual mouse system. Its potential to completely change the field of human-computer interaction is shown by the feedbacks of the users. Continuous development should grow based on analysed improvements in project and advancements regarding the new trends.

The system will adapt with the customer expectations if it receives continuous upgrades that analyses new technologies, thus improving algorithms, and works as per the users' requirements. The research and outcomes of the eye controlled virtual mouse system indicates a major breakthrough in the field of communication between the user and the computers. Remarkable precision, comparable economy, and precision highlights the system's potentiality strongly and accurately.

The system's user-friendly design and high user integration and interaction rate make it a viable replacement for conventional kind of devices. While knowing certain drawbacks, such as task-specific difficulties and heterogeneity, the results offer a strong basis for further research and advancement. Realizing the full potential of the virtual mouse control system and that will depend on addressing these constraints through task specific interaction and improved integration. The creation of an eye-controlled virtual mouse is an important breakthrough in the field of human-computer interaction. It delivers better access for those who are handicapped and offers a fresh method for users to connect with their virtual spaces. Considerable studies and real-world uses of this type of technology have generated promising findings addressing user delight, accuracy, and usability.

Likewise there has been an apparent rise in the eye-controlled virtual mice's response time. Lag was a prevalent problem with the early versions of this technology, which could be aggravating to users as well as decrease the system's efficiency. But advancements in software and hardware have mitigated these lags by rendering the experience more responsive and enjoyable. The invention enables eye-controlled tools more practical for daily usage, including in job settings and for leisure.

The effect of light exposure on eye-tracking system performance is one crucial aspect. Adjustments in the surrounding brightness might affect gaze detection clarity, which leads to uneven cursor movement. To lessen these effects, researchers are looking into techniques like increased camera sensitivity and adaptive algorithms. User fatigue is a further concern. Eye strain via frequent use of eye-tracking gadgets can limit the duration that it can be used productively and make the user feel less at ease. To mitigate fatigue ergonomic studies need to be conducted to design ideas like adopting regular breaks and reducing the calibration process to demand a minimal amount of human effort.

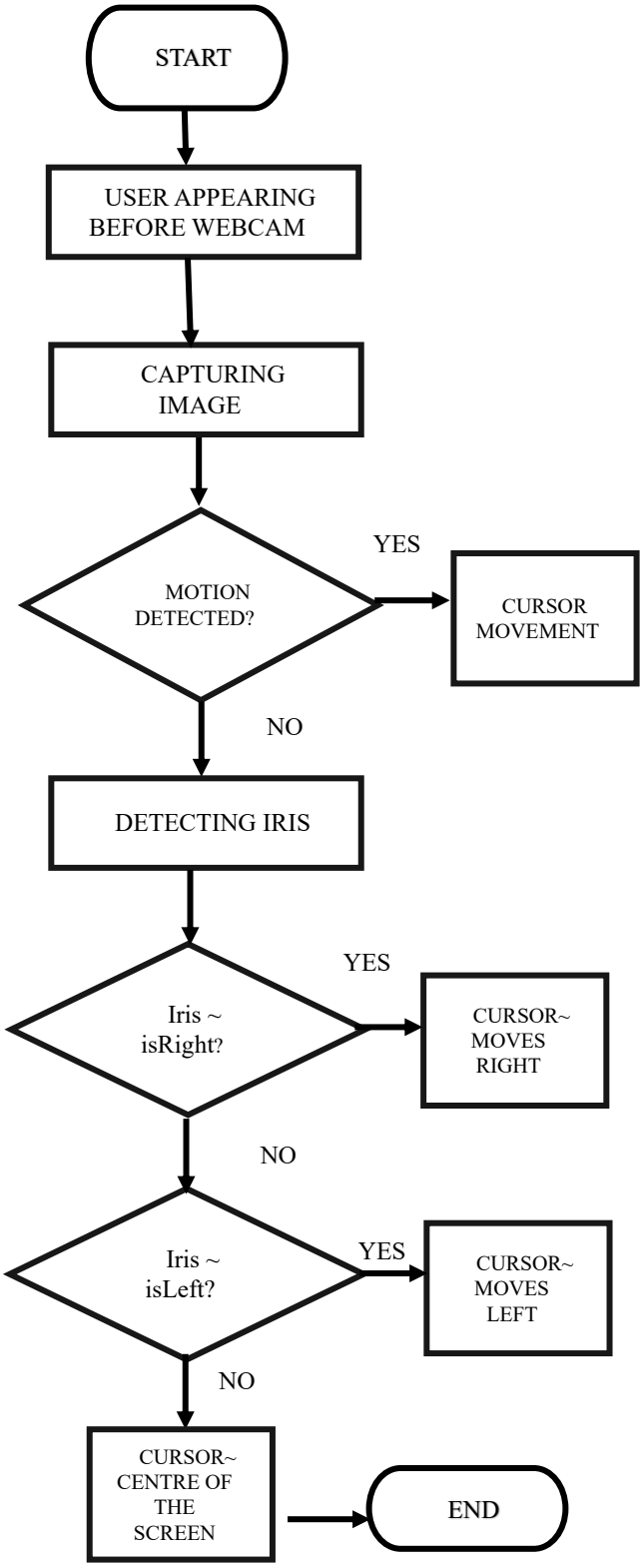


Fig 4: FLOW OF DETECTION

VII. CONCLUSIONS

In the future, eye-controlled mouse systems have the potential to influence the computer interaction, pointedly for individuals with physical challenges. It is a low cost solution that allows the people to access computers with their eye. It is highly convenient and has high accessibility. If the research work on this eye gaze continues, complete cursor handling mechanism using eye is possible and other functionalities like cut, copy, paste may also be implemented. Eye controlled mouse is not only a newfangled thing, it also paves a way to build the accessibility gap between the normal user and the physical challenged ones.

Future eye-controlled virtual mice possess the capacity to fundamentally change user experience, accessibility, and human-computer interaction. The development and mainstream popularity of this unique interface is predicted to be dependent on an abundance of developments and advances in technology. More developments in eye-tracking technology will be advantageous to eye-controlled virtual mice in the years to come.

More sophisticated technologies and higher-resolution sensors will provide superior accuracy and responsiveness, facilitating even more detailed cursor control. This could boost the technology's usefulness for an expanded variety of uses, including graphic design and gaming—two fields that demand precise input. Eye-controlled virtual mouse will be necessary in these immersive environments as the use of augmented reality (AR) and virtual reality (VR) technologies proliferate. All things considered, the probable future of the eye-controlled virtual mouse remains bright, with upgrades in ergonomics, technology, and integration planned to further improve the device's use and performance. The way we interact with machines and digital environments will be totally altered by these systems as they develop more thoroughly, making technology more understandable and inclusive toward individuals of all skill levels.

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