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HUMAN COMPUTER INTERACTION USING FACE, EYE AND IRIS MOVEMENT

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ABSTRACT

Human-computer interaction (HCI) is an interdisciplinary field focused on computer technology design, specifically the interplay between humans and computers. A motion capture system facilitates this interaction by using digital signal processing to convert analog input, gathered from individuals with disabilities using specialized hardware and software, into informative digital data. In prior work, a cognitive-based knowledge processing system was devised to elicit feedback and enhance neural schema tone. Cognitive technology-based software must be capable of discerning dynamic situations and executing tasks aligned with system decisions. The system tracks human facial and eye movements to manipulate mouse inputs by recognizing movement patterns, and it operates in four phases: observing iris movement, identifying input operations, predicting tasks based on input, executing tasks and generating output, and collecting user feedback for system cognitive improvement. The proposed system employs iris movement patterns to control input devices and enable actions like clicking and double-clicking through eye blink recognition, enhancing computer accessibility, particularly for individuals with disabilities, by utilizing their natural eye movements For interaction

Keywords: Human-computer interaction, Cognitive technology and neural schema.

I. INTRODUCTION

Professionals across various fields now harness the capabilities of remotely accessible and manipulable images in innovative ways. In the realm of imaging science, image processing refers to the manipulation of images through mathematical operations, employing various forms of signal processing. This encompasses working with single images, sequences of images, or videos, such as photographs or video frames. The outcomes of image processing can manifest as modified images or a collection of image-related characteristics and parameters. Most image-processing techniques treat images as two-dimensional signals, applying conventional signal-processing methods. Nevertheless, images can also be processed as three-dimensional signals, with time or the z-axis representing the third dimension, further expanding the scope of image analysis and manipulation possibilities.

Digital Image Processing

Image processing primarily pertains to digital image processing, although optical and analog image processing methods remain viable alternatives. This article focuses on overarching techniques that are applicable across these diverse approaches

Computer Graphics and HCI

HCI, often referred to as man-machine studies or man-machine interaction, encompasses the field concerned with the design, implementation, and evaluation of computer systems and associated phenomena intended for human utilization.

II. METHODOLOGY

Hardware

1. Processor type Intel Dual Core 2GHZ
2. Processor Ram 4GB
3. Hard Disk 160Gb

Software

1. Tool Visual StudiO 2010 or later

2. Operating system Windows 7

FRONT END AND BACK END

Front end: C#.net

Back end: MS SQL Server

Existing system

The utilization of computing technology empowers students and employees with disabilities to independently engage in a broader spectrum of tasks. This includes tasks like reading and creating documents, communicating with peers and colleagues, and conducting online information searches. Such technology not only enhances their overall productivity but also promotes greater inclusivity and accessibility in educational and workplace settings.

Drawbacks

The software architecture has been designed with the primary objective of translating various movements into switch events. This system also integrates a head-mounted camera to track and monitor eye movements. The architecture is composed of several key components, including low-pass and derivative filters for movement processing, an unsupervised classifier that continuously adapts to the user's movement strength, and a finite state machine that incorporates a timer mechanism to prevent unintended movements from triggering false positives. This technology has consistently played a crucial role in assisting individuals with disabilities, including those with visual impairment, speech impairment, and motion-related disabilities or disorders. Assistive Computer Technology encompasses a wide range of customized equipment aimed at enhancing the quality of life and accessibility for individuals facing these

Limitation

- The system exhibits a significant number of false positives, indicating that it often registers unintended movements as valid input actions. This can result in an inaccurate and frustrating user experience.
- To capture user input effectively, the architecture relies on specialized hardware, such as a head-mounted camera. This requirement may limit the accessibility and adoption of the system, as users must possess or acquire specific equipment for it to function properly.
- The processing demands of the architecture are notably high, which means that it may require extended periods to perform the necessary computations. This can lead to delays in user interaction and may not be suitable for real-time applications

Proposed System

Utilizing a user's eye movements as a natural and efficient input source, our proposed algorithm activates upon detecting a face from a USB camera feed under suitable lighting. Eye tracking, measuring gaze or eye motion, plays a central role. When the user remains relatively still, the system autonomously detects and analyzes blinks and mouse movements, often triggered by involuntary blinks. By analyzing the eye and iris positions, the system interprets these movements to execute mouse functions. Precisely measuring three-dimensional eye movements is essential for research, diagnostics, and surgery. Video-oculography, a non-invasive method, characterizes horizontal and vertical eye movements but faces challenges in measuring torsional movements without invasive markers. This approach offers versatility in various applications, making it suitable for clinical practice.

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Flow diagram

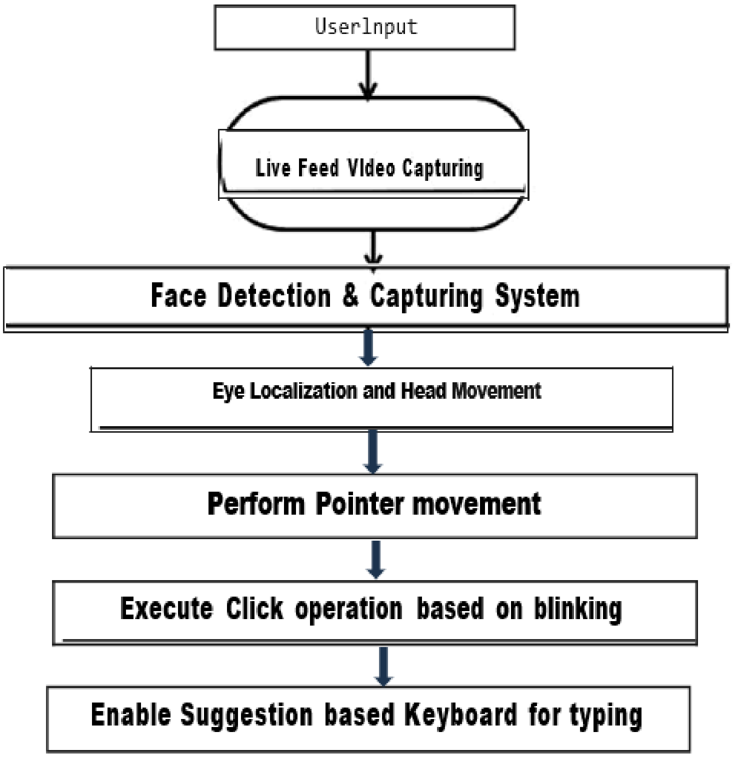

Figure 1: Flow diagram

III. MODELING AND ANALYSIS

CAPTURING LIVE FEED

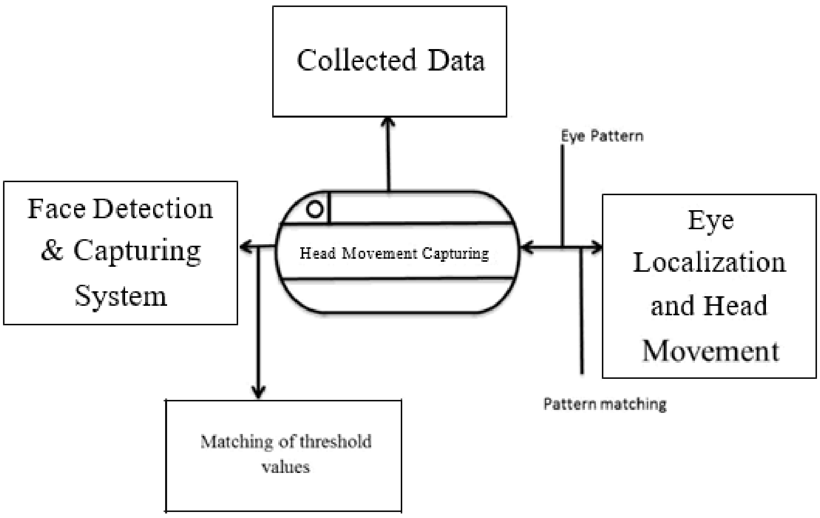

Figure 3.1: capturing live feed

The range covered in this technique spans from 1024x768 to 1344x780, which typically corresponds to the horizontal and vertical axes. The key angle used in this method is determined through the inverse tangent function.

Specifically, it's calculated as tan^(-1)(b/a) = + tan(y dist / x dist), with the angle measured in degrees.

To ensure consistency, all radian values are converted to degrees before they are applied in the predefined pattern recognition process. Notably, the angle calculated for pattern recognition varies among users due to their unique physical characteristics

An image sensor, also known as an imaging sensor, serves as a device that detects and captures the data comprising an image. It accomplishes this by transforming the variable attenuation of waves, which occurs as these waves interact with objects (either passing through them or reflecting off them), into signals. These signals manifest as brief bursts of current that encode the image information. These waves can encompass light or other forms of electromagnetic radiation. Image sensors find application in both analog and digital electronic imaging devices, including digital cameras, camera modules, medical imaging tools, night vision equipment like thermal imaging devices, as well as in radar, sonar, and various other systems. With the progression of technology, digital imaging tends to supersede analog imaging method

Step to capture

1. A CCD sensor or web camera is employed to capture a live feed from the user.
2. A face and eye detection algorithm is utilized to identify and recognize the user's input.
3. The camera is activated to capture the live feed provided by the user.
4. Using the captured input, a Region of Interest (ROI) is identified by checking for face patterns.
5. The captured input is stored as an image, and the pixel point values are normalized to facilitate the recognition of both the face and eye input.
6. Edge detection and shape detection techniques are applied to recognize the eye pattern and filter the input from the image.

IDENTIFICATION OF INPUT SIGNAL

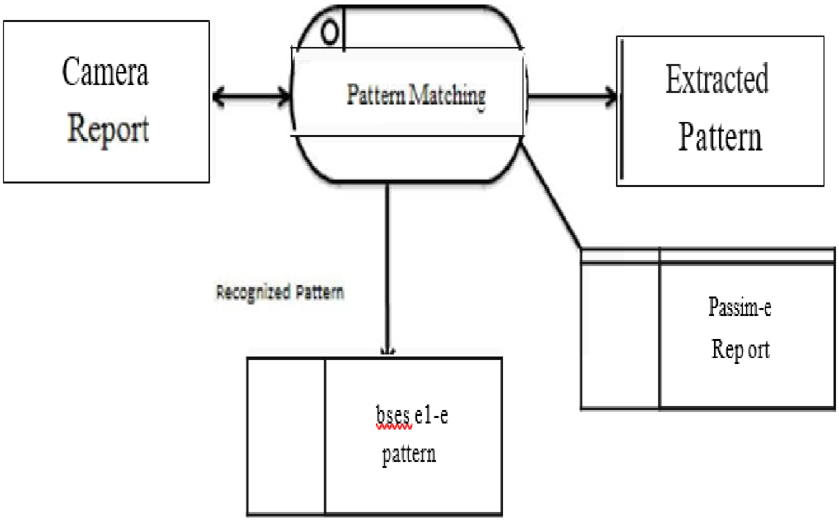

Figure 3.2: Pattern Extraction

Pixel coordinates are typically represented in (x, y) format. By analyzing both the prior and current y-coordinate positions, it's possible to determine whether the user is reading the current line, the next line, or the previous line. If the user is reading the same line, comparing the current and previous x-coordinate positions can reveal whether the user is reading from left to right or from right to left. In practice, human reading isn't perfectly straight, so the absolute difference between the y-coordinates is considered to account for this natural variability in reading patterns.

The user input is initially captured using a camera. The input image then undergoes image enhancement techniques, which include sharpening and segmentation. Sharpening is applied to eliminate background noise from the image, providing accurate pixel values for the iris. The second technique, segmentation, groups similar pixels together, facilitating the isolation of the iris from the input image. Subsequently, the enhanced image is processed by a motion sensor, specifically designed to detect iris movement. The motion sensor identifies pixel points and their coordinates, which are then used to calculate the precise movement of the iris. This process helps accurately track and analyze the iris's motion for various applications.

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Iris Movement Updation and Performing Mouse Movements

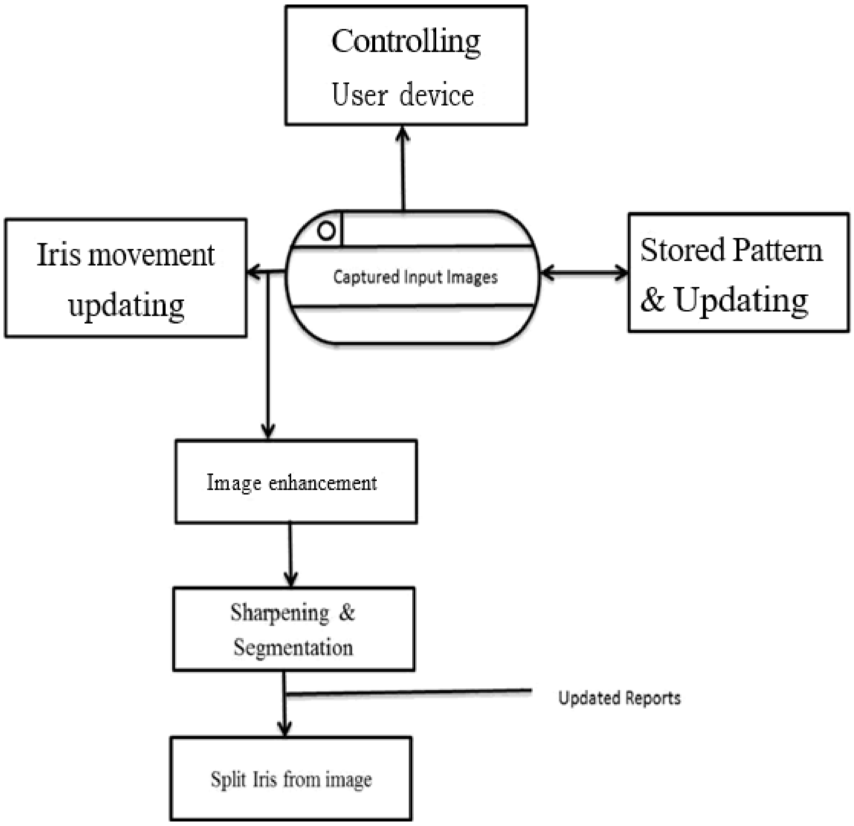

Figure 3.3: iris Movement Update

The input image is subjected to an image enhancement technique to extract iris movement information. By comparing successive video frames continuously, the system identifies eye movement patterns and translates them into corresponding mouse movements. These mouse movements can occur in various directions, and their accuracy is continuously validated using Artificial Neural Networks (ANN), ensuring precise and responsive control based on the user's eye movements.

In sensor-based lighting systems, the placement and accuracy of sensors may not be perfect, leading to the incorporation of a delay time before triggering any lighting changes. Users often have the option to customize this delay time, but a common default value is around 15 minutes. This means that the sensor must detect no motion for the entire delay period before the lights are either switched off or dimmed. In more advanced systems with dimming capabilities, the lights gradually decrease in intensity over several minutes, minimizing disruption in nearby areas. If the lights are off and someone enters the space, most current systems will automatically switch the lights back on when motion is detected. However, systems designed to turn lights off completely in unoccupied areas, requiring occupants to manually switch them back on when needed, are gaining popularity due to their potential for increased energy savings. This is because occupants may realize they don't need additional electric lighting if there's sufficient daylight available in the space.

Steps for Pattern Matching and Mouse Movement

1. Continuous images are processed to identify and extract the Region of Interest (ROI).
2. Pixel points within the ROI are compared across consecutive images.
3. Movement patterns are discerned by examining the behavior of the same pixels in the detected shapes.
4. Patterns of mouse movement are deduced from the pixel value changes.
5. Mouse control is activated, and corresponding movement commands are executed.
6. Supervised learning, specifically utilizing back propagation, is employed to recognize input types and trigger click operations during specific action events.

CLICK AND DOBLE CLICK OPERATION

The system assesses user reading behavior by calculating the absolute difference between coordinate points: if this difference is smaller, the user is considered to be reading the same line, but if it's larger, a scrolling operation is triggered. The identified pattern is then matched against predefined patterns to determine the required action, followed by task execution. This input sequence is also used to detect blink operations for mouse click events; continuous blinking can trigger single or double clicks. Additionally, the system can provide keyboard input based on eye movements, enhancing its versatility and usability.

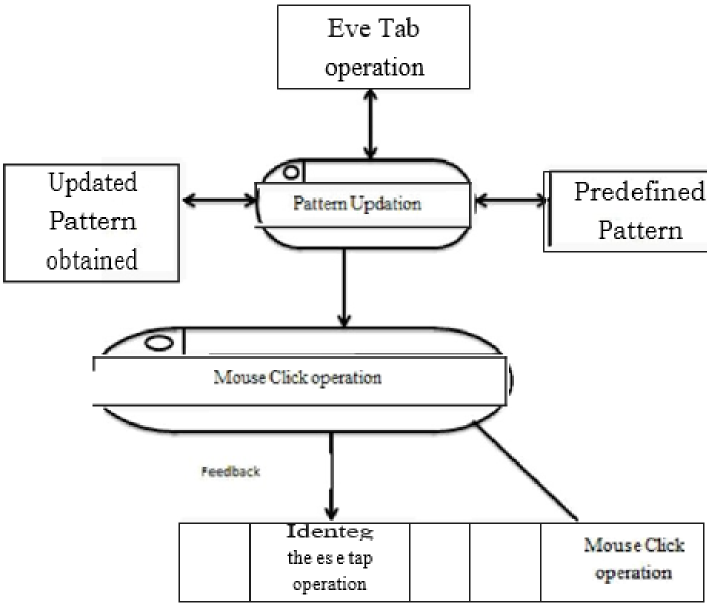

Figure 3.4: Mouse Operation

PERFOEMING KEYBOARD OPERATION

The system facilitates keyboard operations through the creation of a virtual keyboard environment, where letter selection and typing are accomplished using head movements and eye blinking actions. Recognizing that this combination of inputs can be time-consuming, the system introduces a suggestion-based typing feature. With this feature, as the user types a character, a list of suggested words is presented, allowing for quicker word selection and input, thus optimizing typing efficiency and reducing completion time.

IV. RESULTS AND DISCUSSION

Figure 4.1: live feed capturing

Figure 4.2: Roi Idetification

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Figure 4.3: Performing Mouse Movement

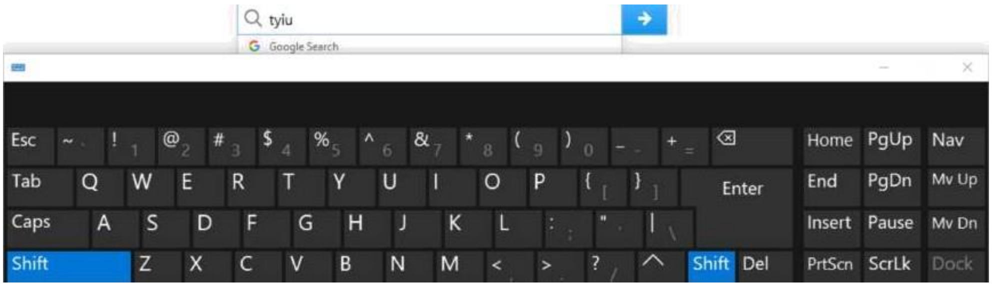

Figure 4.4: Typing using virtual Keyboard

V. CONCLUSION

Eye movement stands out as a crucial real-time input method for human-computer interaction, particularly benefiting individuals with physical disabilities. The proposed system prioritizes simplicity and convenience by exclusively relying on the user's eye movements. Leveraging facial and eye motion, the system can generate user input for both keyboard and mouse functions. The model's quality is assessed using metrics related to knowledge processing, including factors such as the enhancement ratio of the cognitive system, the capacity to handle dynamic situations, and the time needed to execute procedures. This approach enhances accessibility and usability for users, particularly those with physical challenges, by providing an efficient means of interaction with computers.

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