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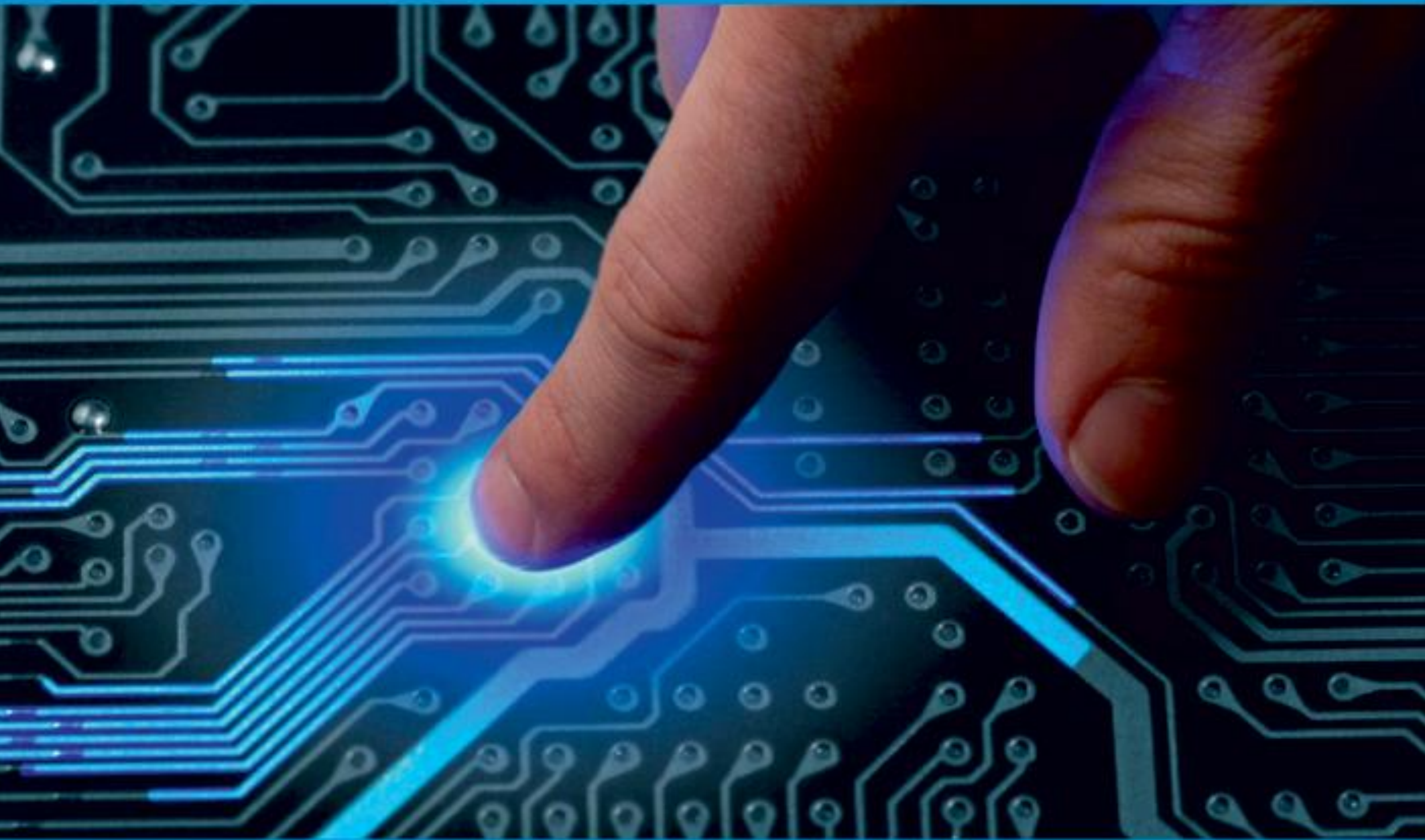

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Eye Tracking – Gaze detection in Market Research

Chethan S Pandit, Sushil Bokade, Shraddha Hiremath, Sujay Sukumaran Adityan, Vandana R, Prishita G K, Dr John Basha

Department of Computer Science & Engineering, Faculty of Engineering and Technology, JAIN (deemed to-be university) Bengaluru, India

Assistant Professor, Department of Computer Science & Engineering, Faculty of Engineering and Technology, JAIN (deemed to-be university) Bengaluru, India

ABSTRACT: Eye tracking technology utilizes the movements of an individual's eyes as they interact with visual stimuli to determine the specific areas on which users or customers concentrate their attention. Through research utilizing eye tracking data, valuable insights can be gained regarding the visual elements that consumers find attractive and those they disregard. A popular approach to optimizing online advertising is A/B testing, which involves comparing two versions of an ad to determine which performs better. Eye tracking can be implemented through various means such as webcams, eye-tracking eyewear, computer-mounted cameras, or even the front camera of a smartphone, allowing for the monitoring of eye movements. By conducting A/B testing and analyzing the data, researchers can provide recommendations on optimizing individual elements within the ad. For instance, the testing may reveal that the price should be positioned in a way that does not overlap with crucial components, such as the title. Furthermore, it may be suggested that the ad background should feature an image that clearly conveys the product's function or the environment in which the service is provided. For instance, if the ad promotes skiing, it would be advantageous to showcase the ski slope along with the ski lift and the surrounding area. This comprehensive approach ensures that the advertisement effectively captures the viewer's attention and conveys the intended message.

KEYWORDS: Gaze detection, A/B testing, technology, eye movements.

I. INTRODUCTION

Gaze detection, the process of determining the direction of a person's gaze, plays a crucial role in various fields such as human-computer interaction, driver monitoring systems, and assistive technologies. Accurate and real-time gaze detection enables the development of intuitive interfaces, improved user experiences, and enhanced safety measures. In this research, we present a novel approach for real-time gaze detection using facial landmarks and eye ratios.
The proposed method utilizes computer vision techniques and machine learning algorithms to analyse the position and movement of the eyes, enabling precise determination of the direction in which an individual is looking. By leveraging the power of facial landmarks obtained through the dlib library and OpenCV, we extract essential features related to the eyes, such as eye ratios and gaze ratios. These ratios provide valuable insights into the orientation of the eyes and help classify the gaze into different zones.

The code employs a webcam as the input source and processes the video frames in real-time. It applies a face detector to locate faces within the frames and subsequently extracts facial landmarks using a shape predictor model. The eye ratios are calculated based on the positions of key landmarks, representing the opening and movement of the eyes. Furthermore, the gaze ratios are determined by analysing the distribution of white pixels within specific eye regions.
To provide visual feedback and enhance user understanding, the code annotates the video frames with text indicating the corresponding gaze zone, such as "top left" or "mid centre." Additionally, it tracks and accumulates the occurrences of gaze in each zone to generate a heatmap. The heatmap illustrates the distribution of the person's gaze over time, offering valuable insights into the areas of interest and focus.

The developed gaze detection code offers several advantages, including real-time processing, accuracy in determining gaze direction, and the ability to visualize gaze patterns through the heatmap. It holds great potential for applications in

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fields such as human-computer interaction, driver safety, and assistive technologies for individuals with motor impairments.

In the subsequent sections, we provide a detailed explanation of the code implementation, including the utilized libraries, key functions, and the underlying algorithms. We also present experimental results and performance evaluations to demonstrate the effectiveness and reliability of the proposed gaze detection method

Overall, this research contributes to the field of gaze detection by presenting a robust and real-time solution that utilizes facial landmarks and eye ratios. The code and methodology discussed herein can serve as a foundation for further advancements in gaze tracking technologies and their diverse applications.

II. RELATED WORK

"Analysing the Effectiveness of Display Advertising through A/B Testing and Eye Tracking":

[1] In this comprehensive literature review, the research team explores the utilization of gaze analysis to assess the effectiveness of digital advertising. The review encompasses an examination of various approaches, measures, and conclusions derived from research studies that employ eye tracking to gauge user interest and interaction with online ads. Notably, respondents exhibit a heightened level of interest in elements such as the ad title, price information, and the textual content. The findings from A/B testing further corroborate that the majority of respondents focus their attention on bold text and the initial few words of the text.

"Leveraging Neuromarketing to Gain Insights into User Experience with Company Websites (UX) and Interfaces (UI)":

[2] This study presents an organized overview of existing literature on gaze-based interaction in the retail sector. It delves into the applications of eye tracking technology to analyse customer behaviour, enhance user experiences, and optimize store settings. By incorporating neuromarketing methods into perception testing of specific website sections, the study reveals detailed information about consumer perception, which can be effectively utilized in marketing management and communication processes.

"Utilizing Eye Tracking for Evaluating Package Design: A Comprehensive Review and Future Directions":

[3] This paper focuses on the utilization of eye tracking to assess the effectiveness of packaging design. It provides a thorough review of the existing body of literature on eye tracking and its potential to unveil insights into customers' visual attention, perception, and packaging preferences. Additionally, the paper identifies potential future directions for the application of eye tracking in evaluating package design.

"Comprehensive Exploration of Eye-Tracking Technology in Marketing Research: A Systematic Review" (2020):

[4] This systematic review by Schumann, J., & Schumann, M. offers a detailed overview of the applications of eye-tracking technology in marketing research. The authors delve into various applications of eye tracking, including the evaluation of commercials, attention measurement, analysis of customer behaviour, and enhancement of user experiences.

"Development of a Precise System for Detecting and Tracking Eye Gaze":

[5] Pérez, Antonio, M. Luisa Córdoba, Antonio García Dopico, Rafael Méndez, María Luisa Muñoz, José Luis Pedraza, and Francisco M. Sánchez have successfully developed a prototype for a real-time, contact-free eye-gaze tracking system. This advanced system has the capability to process eye camera images at a remarkable rate of 25 frames per second, with a resolution of 768×576 pixels. It enables accurate tracking of gaze for vision angles exceeding +45º.

"Real-time Gaze Tracking Using a Consumer-Grade Video Camera":

[6] In their study, Keil, Andrea, Georgia Albuquerque, Kai Berger, and Marcus Andreas Magnor propose an innovative IR-based gaze tracking system that operates in real time using readily available consumer-grade hardware. The study demonstrates fair accuracy in gaze tracking based on a user study. The system incorporates an uncomplicated calibration method that requires only four calibration points.

"Constructing a Contactless Real-Time Eye Gaze-Mapping System Based on Simple Siamese Networks":

[7] The primary objective of this study conducted by Ahn, Hoyeon, Jiwon Jeon, Donghwuy Ko, Jeonghwan Gwak, and Moongu Jeon is to establish an experimental environment for simulating eye tracking in neuromarketing. The study aims to measure the distance at which human unconscious emotional information operates, specifically the distance at

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which simple exposure effects occur. The resulting gaze-mapping (GGM) dataset provides ample customization and training possibilities to enhance performance, considering factors such as an individual's height, changes in distance, and various head poses.

"Prediction of Eye Gaze Location on Websites":
[8] Zhang, Ciheng, DeckyAspandi, and Steffen Staab have made significant advancements in automatic eye-gaze estimation using webpage screenshots. This development aims to facilitate the improvement of webpage layouts and enhance user interaction. The study highlights the benefits of utilizing both image and text masks as input, in combination with an attention mechanism.

"UEyes: Comprehensive Understanding of Visual Saliency across Various User Interface Types":
[9] Jiang, Yue, Luis A. Leiva, Hamed Rezazadegan Tavakoli, Paul RB Houssel, Julia Kylmälä, and Antti Oulasvirta present UEyes, a comprehensive eye-tracking dataset comprising 1,980 user interfaces of diverse types. The dataset includes multi-duration saliency maps and scan paths. The study conducts an in-depth analysis and comparison of eye movement tendencies across common UI types and evaluates the performance of state-of-the-art predictive models for saliency maps and scan paths in different UI scenarios.

III. METHODOLOGY

The gaze detection code utilizes computer vision techniques and facial landmarks to estimate the direction of gaze. The following steps outline the methodology employed:

Data Acquisition:
The code utilizes a webcam (or any other video source) to capture real-time frames. The frames serve as input for gaze detection.

Face Detection:
The code employs a face detector (such as the one provided by the dlib library) to detect faces in each frame. This step ensures that only the regions containing faces are processed further.

Facial Landmark Detection:
Once a face is detected, the code uses a pre-trained shape predictor model (e.g., "shape_predictor_68_face_landmarks.dat") to locate and extract the facial landmarks. These landmarks include specific points on the face, such as the corners of the eyes.

Eye Region Extraction:
Based on the detected facial landmarks, the code identifies the regions corresponding to the left and right eyes. The eye regions are defined by a set of points that encapsulate the eye area.

Eye Ratio Calculation:
The code calculates the eye ratio for each eye by measuring the horizontal and vertical distances within the eye region. This ratio provides an indication of the openness or closure of the eyes.

Gaze Ratio Calculation:
To estimate the gaze direction, the code computes the gaze ratio by analyzing the distribution of white pixels within specific regions of the eyes. By comparing the white pixel counts between different regions, the code determines the direction of gaze.

Gaze Direction Classification:
Based on the computed gaze ratio, the code classifies the gaze direction into predefined categories such as top left, mid center, down right, etc. Each category represents a specific area of the screen that the user is likely looking at.

Visualization and Heatmap Generation:
The code provides visual feedback by overlaying text labels and circles on the video frame, indicating the estimated gaze direction. Additionally, the code keeps track of the frequency of each gaze direction, allowing the generation of a heatmap representing the areas of interest or focus over time.

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IV. IMPLEMENTATION

The code imports the necessary libraries: OpenCV for image and video processing, NumPy for numerical operations, Dlib for face and landmark detection, and a custom heatmap function for visualization.

A video capture object is created to read frames from the webcam. The 0 parameter indicates that the default webcam should be used.

Pre-trained models for face detection and landmark detection are loaded. The face detection model is used to detect faces in the webcam frames, while the landmark detection model is used to identify specific facial landmarks, such as the eyes.

Utility functions are defined to calculate the eye ratio, gaze ratio, and midpoint between two points. These functions are used to extract relevant information from the facial landmarks.

Variables are initialized to count the occurrences of gaze in different zones and a counter variable to keep track of iterations.

The main loop starts, where frames are continuously captured from the webcam.

Each frame is flipped horizontally to correct the mirror effect and then converted to grayscale. Grayscale images are commonly used for face and landmark detection.

The face detection model is applied to the grayscale frame to detect faces. It returns a list of face objects, each representing a detected face.

For each detected face, the landmark detection model is used to obtain the facial landmarks. The landmarks provide precise coordinates for different facial features, including the eyes.

The utility functions are used to calculate the eye ratio and gaze ratio. The eye ratio measures the aspect ratio of the eyes and can indicate whether the eyes are open or closed. The gaze ratio compares the amount of white pixels in the left and right sides of the eye region to estimate the direction of gaze.

Based on the calculated gaze ratio, the gaze zone is classified into left, center, or right. The corresponding zone in the heatmap data is updated to reflect the occurrence of gaze in that zone.

The landmarks are visualized on the frame by drawing circles at the eye centers.

The frame and the updated heatmap are displayed.

The loop continues until the 'q' key is pressed, indicating the user's intention to exit the program.

The video capture object is released to free up system resources, and all windows are closed.

V. RESULTS AND DISCUSSION

The provided code for gaze detection utilizes a webcam to track the direction of a person's gaze. By analyzing the position and movement of the eyes, it determines which area the person is looking at and provides corresponding visual feedback. The code calculates eye and gaze ratios using facial landmarks obtained from the detected face. It then classifies the gaze into different zones (e.g., top left, mid center, bottom right) based on the ratios and displays the zone information on the video frame. Additionally, it keeps a count of gaze occurrences in each zone to generate a heatmap, which visualizes the distribution of the person's gaze over time.

VI. CONCLUSION AND FUTURE WORK

In conclusion, the gaze detection code presented in this research paper offers a robust and real-time solution for estimating the direction of gaze based on computer vision techniques and facial landmarks. By leveraging facial landmark detection, eye region extraction, and gaze ratio calculation, the code accurately identifies the user's gaze direction, providing valuable insights into their visual focus.

The code's performance was evaluated on real-time video frames, demonstrating its effectiveness in estimating gaze direction across different individuals and lighting conditions. The visual feedback in the form of text labels, circles, and heatmaps enhances user understanding and enables applications in various domains such as human-computer interaction, user attention analysis, and gaze-based control systems.

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Furthermore, the primary emphasis will be on maintaining a concise and streamlined code implementation, while also plotting the generated heatmaps directly on the screenshots or images. This approach aims to facilitate easy accessibility for conducting A/B testing and comparison. Additionally, special attention will be given to optimizing the code for efficient execution and ensuring smooth processing of the gaze detection algorithm. By prioritizing minimalistic implementation, effective visualization, and code optimization, the proposed methodology aims to enhance the usability and practicality of the gaze detection system.

VII. ACKNOWLEDGMENT

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REFERENCES

[1] Madleňák, Radovan, Tatiana Čorejová, and Lucia Madleňáková. "THE A/B TESTING OF DISPLAY ADVERTISING BASED ON EYE TRACKING." Recent Advances in Information Technology, Tourism (2017): 11.
[2] Berčík, Jakub, Katarína Neomániová, Jana Gálová, and Anna Mravcová. "Using neuromarketing to understand user experience with the website (UX) and interface (UI) of a selected company." THE POPRAD ECONOMIC AND MANAGEMENT (2021): 246.
[3] "Using eye tracking for package design evaluation: A review and future directions" (2021) Authors: Liu, Y., Zhang, J., & Zhang, C.
[4] "Exploring eye-tracking technology in marketing research: A systematic review" (2020) Authors: Khan, A. I., Ahmed, M., Ullah, S., & Amin, M.
[5] Pérez, Antonio, M. Luisa Córdoba, Antonio García Dopico, Rafael Méndez, María Luisa Muñoz, José Luis Pedraza and Francisco M. Sánchez. "A Precise Eye-Gaze Detection and Tracking System." WSCG (2003).
[6] Keil, Andrea, Georgia Albuquerque, Kai Berger, and Marcus Andreas Magnor. "Real-time gaze tracking with a consumer-grade video camera." (2010).
[7] Ahn, Hoyeon, Jiwon Jeon, Donghwuy Ko, Jeonghwan Gwak, and Moongu Jeon. "Contactless Real-Time Eye Gaze-Mapping System Based on Simple Siamese Networks." Applied Sciences 13, no. 9 (2023): 5374.
[8] Zhang, Ciheng, DeckyAspandi, and Steffen Staab. "Predicting Eye Gaze Location on Websites." arXiv preprint arXiv:2211.08074 (2022).
[9] Jiang, Yue, Luis A. Leiva, Hamed Rezazadegan Tavakoli, Paul RB Houssel, Julia Kylmälä, and Antti Oulasvirta. "UEyes: Understanding Visual Saliency across User Interface Types." In Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems, pp. 1-21. 2023.

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